CHAPTER 2

AFFECTED ENVIRONMENT

GENERAL DESCRIPTION

Part of the land administered by the Bureau of Land Management (BLM) in the 13 EIS States would be affected by the proposed vegetation treatment program (Figure 2-1). The more extensive areas include large, contiguous sections of the grasslands and savannas of the Great Plains, and the desert grasslands and shrublands of the Great Basin and Southwestern United States. BLM-administered lands constitute approximately 20 percent of the total area of the 13 States covered by this EIS, or about 158 million acres (Table 2-1). Of each State's total land area, the greatest proportion of BLM-administered lands are in Nevada, Utah, and Wyoming, with 69, 42, and 30 percent, respectively. North Dakota and Oklahoma have the lowest proportion, with 0.2 and 0.007 percent of their total land area under BLM jurisdiction (BLM 1988).

The natural environments and cultural characteristics of BLM-administered land and adjacent lands vary widely across the 13 States. Physical characteristics, such as climate and ground-water supplies, and biological parameters, such as plant productivity and the presence of special status species, differ markedly. Because of these differences, the impacts of each alternative BLM vegetation treatment program are likely to differ from one area to another. The BLM lands have been divided into eight regions for analysis (Figure 2-2), based primarily on the dominant plant species according to the classification system of Garrison et al. 1977. The dominant plant species were considered the most appropriate basis for partitioning the BLM lands because they are characteristic of broad areas of the West; reflect the soils, climate, and past land-use practices; and would most immediately reflect the results of vegetation treatment. The analysis regions include (1) sagebrush, (2) desert shrub, (3) southwestern shrub-steppe, (4) chaparral-mountain shrub, (5) pinyon-juniper, (6) plains grassland, (7) mountain/plateau grassland, and (8) coniferous/deciduous forest. Riparian areas are located within these regions and will be addressed where appropriate.

The sagebrush analysis region occupies the largest contiguous area of public lands and constitutes 31 percent of the EIS program area. The desert shrub and plains grassland areas also are relatively contiguous regions and compose 19 and 10 percent of the

Table 2-1

Acreage of BLM-Administered Lands and Percentage of State, 1987

State	Total Acreage of BLM Land	Total Acreage of State	Percentage of Land Managed by BLM
Arizona	12,285,326	72,688,000	16.9
Colorado	8,288,840	66,485,760	12.5
Idaho	11,953,795	52,933,120	22.6
Montana	8,920,710	93,271,040	9.6
Nevada	48,714,404	70,264,320	69.3
New Mexico	12,855,255	77,766,400	16.5
North Dakota	67,331	44,452,480	0.2
Oklahoma	3,026	44,087,680	0.01
Oregon[1]	13,539,906	61,598,720	22.0
South Dakota	279,473	48,881,920	0.6
Utah	22,129,277	52,696,960	42.0
Washington	311,292	42,693,760	0.7
Wyoming	18,412,451	62,343,040	29.5
Total	**157,761,086**	**790,163,200**	**20.0**

[1] Excludes 2,148,877 acres of BLM-administered land in western Oregon outside the study area.

Source: U.S. Department of the Interior, Bureau of Land Management 1988.

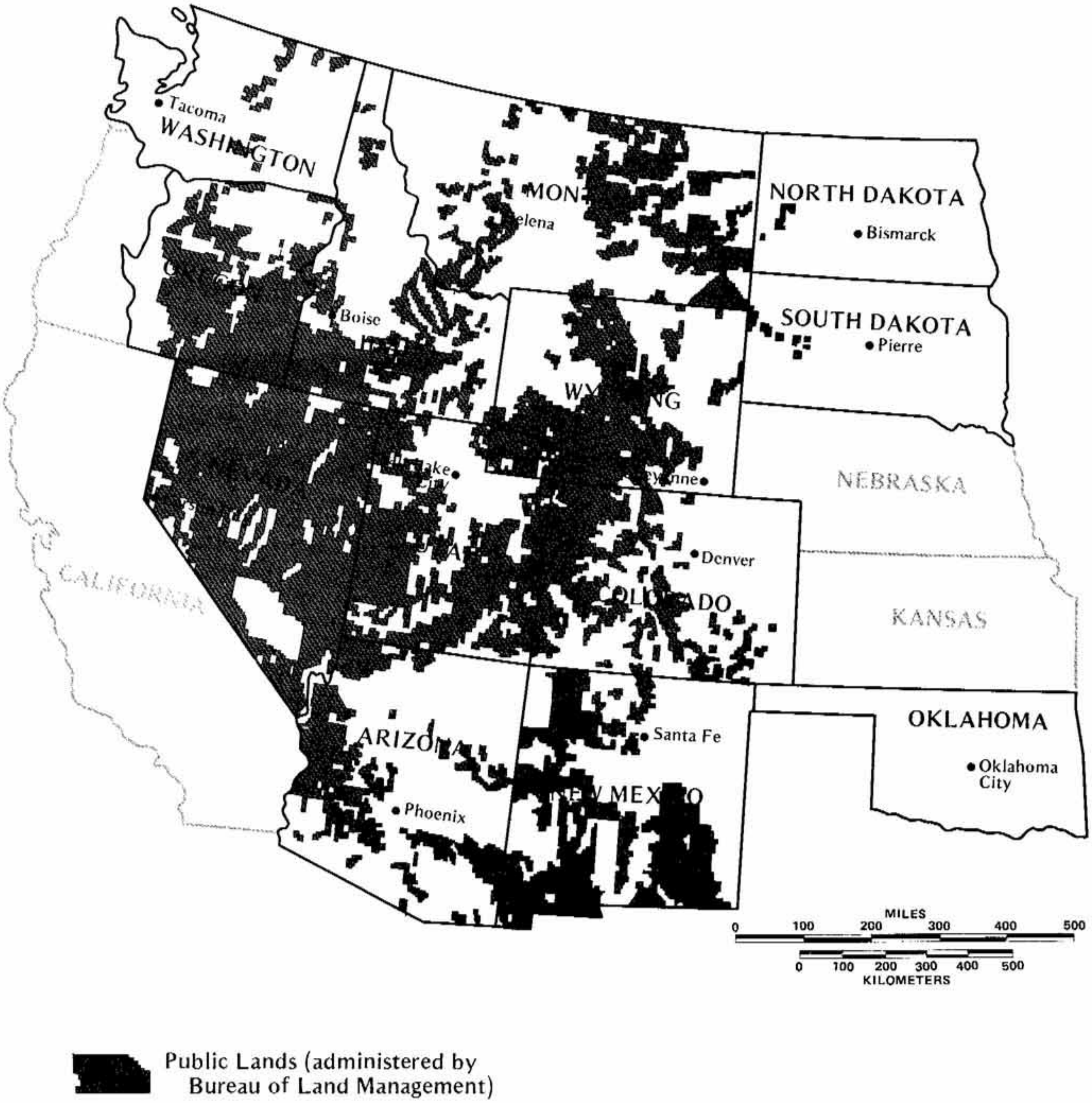


Figure 2-1
Bureau of Land Management Lands in the Study Area

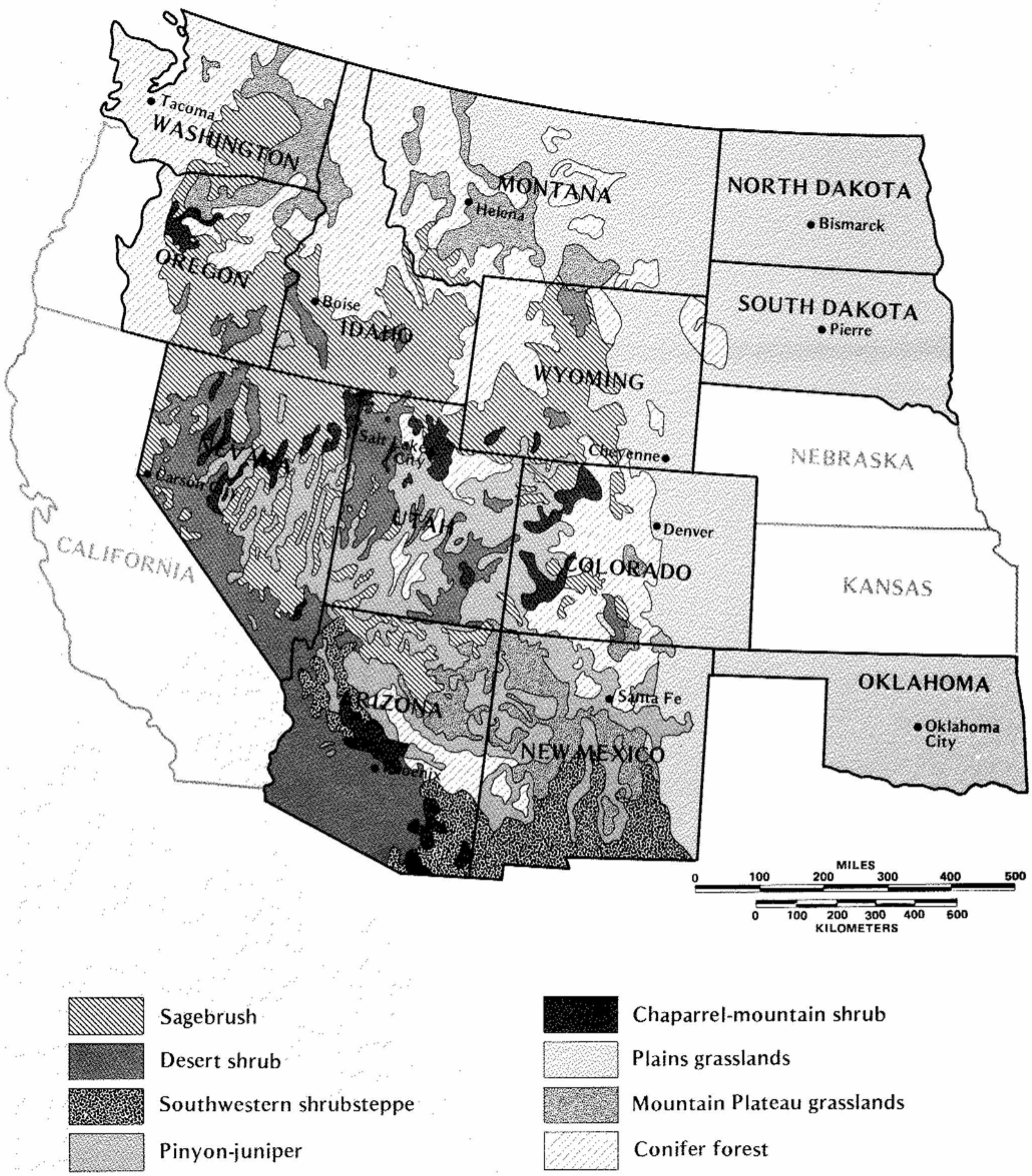


Figure 2-2

Vegetation Analysis Regions of the States in the Study Area

BLM program area, respectively. The southwestern shrubsteppe and mountain/plateau grassland areas are discontinuous regions and account for only 8 and 6 percent of the BLM program area, respectively. Pinyon-juniper, coniferous/deciduous, and chaparral-mountain shrub forests are confined to areas of higher elevation and constitute 17, 5, and 4 percent of the program lands.

This chapter describes the potentially affected environment of the 13 Western States in the EIS program area for the following resource elements: (1) vegetation, (2) climate and air quality, (3) geology and topography, (4) soils, (5) aquatic resources, (6) fish and wildlife, (7) cultural resources, (8) recreation and visual resources, (9) livestock, (10) wild horses and burros, (11) special status species (12) wilderness and special areas, (13) human health and safety, and (14) social and economic resources.

Where applicable, resources will be addressed by the eight analysis regions; some resources are more effectively discussed on a regional basis. The description of potentially affected environmental elements will emphasize rangeland resources because 85 percent of the area projected for vegetation treatment under the proposed action is characterized by rangeland vegetation.

ANALYSIS REGION DESCRIPTIONS

Vegetation

Plant communities are characterized by continual change (Zwolinski 1990). Vegetation communities are dynamic, and change through time and space occurs universally (Miles 1979; Patterson 1986). Change can be readily observable, as when one plant community replaces another through the process of plant succession. Such change occurs because of differences in establishment, growth and survival rates of plants, competitive ability of different species, and species longevity (Miles 1979). Changes can also be subtle, such as changes in the proportion and production of individual species on a site, and the establishment or death of individual plants. Evidence for change in vegetation can be found by direct observation over time, historical evidence, preserved biological evidence such as pollen and macrofossils in ancient packrat middens, and study of vegetation development on similar sites (Miles 1979; Smeins 1983).

Vegetation has undergone periodic, gross disturbance throughout most of evolutionary time (Miles 1979). For example, forest fires may have been common in the Tertiary period, beginning 70 million years ago, during the time of the evolution of most of the plant species currently present on earth (Harris 1958). The pattern of vegetative communities has fluctuated widely in the last 10 to 12,000 years, since the melting of the continental glaciers. During the post-glacial period, climate has been both notably warmer and cooler than it is at present. The boundary of forest and shrub/grassland has fluctuated accordingly (Mehringer and Wigand 1987), as well as those of other drier site plant communities. Only a weak stability was achieved in some semiarid pristine systems in the west (West 1985), and some may have been remnants of previously more favorable climatic conditions (Smeins 1983). A trend toward greater aridity, with the associated increase of many xerophytic woody plants, may have already been in existence. When European man arrived on the rangelands of western North America he observed ecosystems that were in a state of flux, although he often interpreted them as static phenomena (Smeins 1983).

Prior to European settlement, fire was the most common influence on the landscape in the intermountain west (Gruell 1983), and in much of the southwest (Wright 1990). In drier parts of the west, however, the significance of fire effects on vegetation can be difficult to separate from the effects of drought (Wright 1990). The break-up and reduction of fuels caused by grazing and cultivation that came with European settlement, and then the introduction of organized fire suppression, have caused a drastic decrease in fire occurrence and size (Gruell 1983; Swetnam 1990). With the omission of fire as a dominant ecological factor on many sites has come significant changes in vegetation. Successional changes that have occurred on some sites would unlikely have occurred in the pre-European environment, where frequent fires suppressed woody vegetation (Gruell 1983). Significant increase in density of woody species have occurred on some sites, as well as invasion of woody species onto sites where frequent fire used to preclude their dominance. Fire exclusion has had the most marked effect on ecotones, tension zones between two different community types. Naturally occurring fire was used to remove woody species that were sensitive to fire from communities that were more fire adapted.

In the western United States, factors which have affected vegetation development include climate (particularly drought), insects, diseases, wind, domestic livestock grazing, browsing by wild ungulates, and fire (Gruell 1983). It is important to understand the effects these factors have on the path of successional change in order to manage vegetation and habitat (West and Van Pelt 1987). Knowing the frequency and results of natural disturbances, such as fire, is necessary in order to understand the environmental pressures to which vegetation has adapted and the kinds or amounts of vegetation a site can support, and thus the post treatment changes that are likely to occur. A land manager makes choices to encourage or retard plant succession to achieve the vegetation community that best meets multiple resource management objectives. In many of the arid and semiarid areas of the west, removal of livestock grazing pressure alone does not result in dramatic or rapid change of existing vegetation (Potter and Krenetsky 1967; Rice and Westoby 1978; Robertson 1947; Lommason 1948; Harniss and West 1973). Present day vegetation communities are a product of past human use and alteration of former disturbance regimes, but are subject to a multitude of present day demands and expectations. Manual, mechanical, or chemical treatments which mimic natural processes are selectively used to restore degraded plant communities or induce vegetation change to achieve a new situation which satisfies these demands and expectations.

Vegetation communities on BLM-administered lands in the EIS area reflect the climatic, geological, and topographic diversity of the Western United States. The descriptions of the vegetation analysis regions must be general, as each type encompasses site specific variations in species composition which may have been significantly modified by weather, fire, biotic factors, and human activities. Distribution and boundaries of these communities are further affected by local characteristics of elevation, latitude, slope, exposure, temperature inversions, and cold air drainages.

The most diverse vegetation communities, and the most complex to summarize, are the riparian communities. Riparian communities are not controlled by the surrounding vegetation community in the analysis region, but by available water, soil, stream channel substrate and morphology, elevation and latitude, climate, and land-use history (Brinson et al. 1981). Riparian communities are the most severely altered ecosystems in the United States (Brinson et al. 1981), resulting in diverse situations and intergrades between riparian and upland communities. Consequently, riparian communities are less likely to fit standard community descriptions than their adjacent uplands. Although riparian is not an analysis region, it is discussed separately here because it is not controlled by the same environmental factors as the analysis regions within which it occurs, nor is it directly related to the vegetation of the uplands of the analysis region.

Sagebrush

The sagebrush analysis region occupies extensive areas in the Upper and Lower Basin and Range Provinces, the Colorado Plateau, the Columbia Plateau, and the Wyoming Basin. It is also scattered throughout the northern, central, and southern Rocky Mountains (Figure 2-2 and Figure 2-3). It is one of the most extensive vegetation types on BLM lands in the EIS area.

Natural habitat differences within the region are great, ranging from near desert to subalpine climates and including a wide variety of physiographic and soil types (Tisdale and Hironaka 1981). Most of the sagebrush zone is found at elevations from 2,000 to 7,000 feet (Wright et al. 1979). Sagebrush communities may also occur up to 10,000 feet in the mountain ranges of the EIS area (Cronquist et al. 1972). Where sagebrush dominates below 7,000 feet, annual precipitation varies between 8 and 20 inches (Wright et al. 1979).

Environmental diversity has resulted in a comparable variety of species, subspecies, and varieties of sagebrush adapted to specific habitats (Tisdale and Hironaka 1981), although overall floristic diversity of the analysis region is moderate to low (West 1983). Basin big sagebrush and Wyoming big sagebrush usually dominate between 2,000 and 7,000 feet. Basin big sagebrush occupies deep, well-drained alluvial soils where annual precipitation averages 10 to 16 inches, and Wyoming big sagebrush occupies an 8- to 12-inch precipitation zone on shallow soils (Wright et al. 1979). Mountain big sagebrush can be found at elevations from 5,000 to 10,000 feet where annual precipitation varies from 14 to 20 inches (Wright et al. 1979).

The aspect of the typical sagebrush community is fairly dense to open vegetation with nonspiny shrubs 2 to 6 feet high and an understory of perennial and annual grasses and forbs (Cronquist et al. 1972). Increasingly to the south, however, sagebrush may grow to the virtual exclusion of grasses and does not represent a grazing disclimax (Brown et al. 1982). Important shrubs in the sagebrush analysis region include big sagebrush, black sagebrush, low sagebrush, rabbitbrushes, Mormon tea, bitterbrush, snowberry, and horsebrush (Cronquist et al. 1972). Important perennial grasses include bluebunch wheatgrass, Sandberg bluegrass, Idaho fescue, western wheatgrass, Great Basin wildrye, junegrass, Indian ricegrass, squirreltail, muttongrass, needle-and-thread grass, and Thurber needlegrass. Red brome and cheatgrass are introduced annual grasses that have become abundant. Common forbs include wild onion, sego lily, balsam root, Indian paintbrush, larkspur, rubberweed, lupine, phlox, locoweed, mulesear, and various annual mustards (Cronquist et al. 1972).

The most dependable combination of both moisture and temperature conditions favorable for growth occurs for a short period after snowmelt. Growing season precipitation is less dependable for soil moisture recharge, and higher temperatures cause greater evapotranspirative losses. The

1 Northern Pacific Border
2 Cascade Mountains
3 Columbia Plateau
4 Northern Rocky Mountains
5 Upper Basin and Range
6 Lower Basin and Range
7 Colorado Plateau
8 Middle Rocky Mountains
9 Upper Missouri Basin and Range
10 Black Hills Uplift
11 Wyoming Basin
12 Southern Rocky Mountains
13 Rocky Mountain Piedmont
14 Great Plains
15 Central Lowlands
16 Ozark Plateau

Source: A.W. Kuchler, Potential Natural Vegetation of the Conterminous United States, Second Edition (American Geographical Society, 1975) with BLM Physiographic Regions by Kenneth Brown and Richard Kerr, 1979.

Figure 2-3
Physiography of the States in the Study Area

grasses and forbs depend on resources in the surface soil in the interspaces between shrubs and therefore have a constrained growing period. Sagebrush can draw its moisture and nutrients from deep in the profile or through fibrous roots near the surface, giving it extreme resistance to environmental extremes (West 1983). Sagebrush is also long-lived (in excess of 40 years), has great reproductive capacity through abundant and consistent seed set, and produces secondary chemical compounds in its foliage that probably discourage herbivory (West 1983). Altogether, these characteristics make sagebrush extremely competitive in this environment (West 1983). Sagebrush is killed by fire, however, and insects and fire appear to be its primary environmental vulnerabilities (West 1983).

Disturbances from cultivation, fire, herbicides, excessive grazing, and insects, combined with natural variability, have changed the botanical composition and productivity of native sagebrush communities. Since the beginning of European settlement, the abundance of many native species has been reduced, sagebrush has become more abundant, and many exotic species, mostly annuals, have invaded the region (Tisdale and Hironaka 1981). Cheatgrass competition provides a major barrier to the seedling establishment of other species and has replaced the native bluebunch wheatgrass over wide areas (Cronquist et al. 1972). However, the sagebrush region itself is ecologically stable and its boundaries closely resemble those at the time of European settlement (Tisdale and Hironaka 1981).

Before 1900, domestic stock had greatly reduced the more palatable herbaceous component of the sagebrush region, as most varieties of sagebrush are not highly palatable to domestic stock, especially during the growing season (Tisdale and Hironaka 1981). Affected areas were susceptible to invasion by aggressive, less palatable species, particularly introduced annuals, such as cheatgrass and medusahead (Brown 1982, Tisdale and Hironaka 1981, West 1983). Improved management systems or complete elimination of livestock will not change this situation through natural ecological succession within any reasonable timeframe (Bowns 1990). Cheatgrass and medusa-head produce enormous numbers of seedlings after the first fall rain, and their root systems can grow throughout most of the winter. Native perennial grasses have higher soil temperature thresholds for growth. By the time spring comes, these annuals have built extensive root systems that can use soil moisture both earlier and at higher rates than the native grasses (West 1983). The annual grasses generally dry out by mid-June, and the dry stands are very susceptible to wildfire.

The fire history of the sagebrush region has not been firmly established, but fire was probably uncommon on drier sites because of sparse fuels, and more frequent, averaging 32 to 70 years, on more mesic sites with greater herbaceous production (Wright et al. 1979). Incidence of wildfire has contributed significantly to the dominance of cheatgrass on millions of acres in the Upper Basin and Range and the Columbia Plateau. Burning every few years or burning in early summer depletes perennial grasses and encourages annuals, which create very flammable fuel and further increases fire frequency (Wright and Bailey 1982; West 1983). Once established on a site, cheatgrass may virtually exclude perennial native species, thereby perpetuating the cheatgrass fire cycle, leading to a spiral of deterioration through depletion of volatile nutrients and accelerated soil erosion (West 1983). The increasing acreage of these fire-perpetuated cheatgrass communities and resulting loss of sagebrush habitat is a cause of great concern to land managers in the Upper Basin and Range and Columbia Plateau. Protection and restoration of native sagebrush communities must be a management consideration in some areas of this analysis region. Reclamation of these sites to perennial vegetation requires intensive techniques such as chemical fallow (Eckert and Evans 1967) or plowing and seeding (Wright and Bailey 1982).

Desert Shrub

The desert shrub analysis region is a composite of generally the most arid portions of the Upper and Lower Basin and Range Provinces, the Colorado Plateau, the Wyoming Basin, and the Columbia Plateau (Figure 2-2 and Figure 2-3). This analysis region includes the hot and cold deserts of the Western United States, which are dominated by shrubs in open stands, with a large amount of bare soil or desert pavement exposed. Understory vegetation is generally sparse, except when flushes of annuals are produced by seasonal precipitation in the hot deserts.

The vegetation of both the hot and cold desert has adapted to a low rainfall regime of 2 to 15 inches annually (Benson and Darrow 1981). Desert plants have evolved different ways to survive the harsh growing conditions prevalent in this region. Annuals germinate while temperature and moisture conditions permit them to grow to maturity and produce seed, often within a single season; the seed remains in the soil until favorable growing conditions occur once again. Certain perennials, called phreatophytes, develop extensive root systems that reach the water table. Perennial shrubs often have deep root systems that access deep soil moisture, as well as shallow roots that compete with herbaceous vegetation for surface moisture. Some plants, such as cacti and other succulents, have special tissue that allows them to store moisture in their stems or leaves. Other adaptations of desert plants include various combinations of small leaf size; thick waxes, resins, or pubescence on leaf surfaces; and the ability to drop leaves and go into dormancy in response to drought. High soil salinity or alkalinity constitute yet another difficulty by presenting a physiologically dry environment. For example, areas in the Columbia Plateau and Wyoming basin support salt-desert shrub communities because of salty and fine textured soils in a climatic regime that would otherwise support grassland (Blaisdell and Holmgren 1984). Plants in these areas have developed physiological processes to remove excess salts from their tissues and regulate salt uptake by the roots.

The Mojave and Sonoran Deserts constitute the hot desert portion of the analysis region. Located mostly in California, the Mojave extends into southern Nevada, northwestern Arizona, and the tip of southwestern Utah. It is a transitional area between the cold desert and the Sonoran Desert and shares many species with both (Brown 1982). Precipitation occurs mostly in the winter. The Joshua tree is the most widely recognized, but not the most widespread, species of the Mojave. Common shrubs include creosotebush, bursage, thornbush, shadscale, all scale, spiny hopsage, and greasewood. Pickleweed, seep weed, alkali weeds, glassworts, and saltgrass are common species associated with saline basins. The Mojave Desert is especially rich in annual plants, which are abundant during the rainy season in winter and spring (Brown 1982).

The Sonoran Desert receives summer and winter precipitation, separated by spring and fall drought (Brown 1982). It is characterized by a high percentage of trees and large shrubs, and is particularly rich in succulents (Benson and Darrow 1981). Saguaro is characteristic of the mostly frost-free portions of the Sonoran Desert. Other common shrubs and succulents include creosotebush, blue palo verde, bursage, mesquite, desert ironwood, allthorn, ocotillo, jojoba, acacia, and many species of Opuntia, yucca, and agave. Annual herbs are abundant after summer and winter rains (Benson and Darrow 1981).

The cold desert portion of the analysis region occurs in the rainshadow east of the Sierra and Cascade ranges throughout Nevada, western Utah, southeastern Oregon and southwestern Idaho, and to the east in the Wyoming Basin and Colorado Plateau. These areas are dominated by low-growing, much branched, mostly nonsprouting, spineless shrubs; and species diversity is characteristically low (Brown 1982). Most precipitation comes in the winter in the western portion of the region, with a gradual shift toward a stronger summer influence to the east, where wet and dry seasons are less distinct than in other deserts (Brown 1982). Shadscale is characteristic of these areas. Other important shrubs include winterfat, Mormon tea, gardner saltbush, mat saltbush, black sagebrush, fourwing saltbush, rabbitbrush, greasewood, horsebrush, bud sagebrush, and snakeweed. Common annual species include exotics such as halogeton, Russian thistle, and cheatgrass. Scattered perennial grasses include galleta, Indian ricegrass, squirreltail, alkali sacaton, and Sandberg bluegrass (Blaisdell and Holmgren 1984). Blackbrush dominates some cold desert areas in southeastern Utah, where it forms communities with scattered individuals of Mormon tea, buckwheats, shadscale, sandsage, indigobush, snakeweed, galleta, and cheatgrass (Cronquist et al. 1972).

The effects of historic use on hot and cold desert communities vary. Changes in some communities are well documented, while in others little change has occurred. The causes of observed change are complex and not always entirely understood. Quantitative data on the extent of change in this region is rare (Branson 1985).

Low amounts of above-ground biomass and widely spaced individuals make wildfire a rare occurrence, and fire has not been documented as an ecologically important factor in the development or maintenance of these communities either before or after settlement. However, grazing by domestic stock has caused vegetation changes in these communities, particularly the cold desert. The nature of the changes is related to the kind of livestock, season and intensity of use, and site potential (Branson 1985). Since these areas have always been dominated by shrubs, the observed changes include reduction of total cover or reduction of palatable shrub or grass species, such as black sagebrush, bud sagebrush, winterfat, and Indian ricegrass, which are replaced by shrub species not grazed by livestock or by exotic annuals, such as halogeton and Russian thistle (Branson 1985). In addition to livestock grazing, disturbances such as construction of energy and transportation corridors, military operations, surface mining, and recreation have created depleted vegetation conditions in this part of the analysis region (Blaisdell and Holmgren 1984).

Hastings and Turner (1965) concluded that warmer temperatures and less rainfall in the past 100 years must be considered the principal cause of vegetation change in much of the Sonoran Desert (Branson 1985). However, depletion of saguaro populations in parts of the Sonoran Desert has been attributed to suppression of reproduction by livestock grazing (Branson 1985).

Southwestern Shrubsteppe

The southwestern shrubsteppe analysis region occupies most of the Lower Basin and Range Province in southeastern Arizona eastward through southern New Mexico (Figure 2-2 and Figure 2-3). It includes the semidesert grasslands of southeastern Arizona and southern New Mexico, and the Chihuahuan Desert.

Elevations of the semidesert grasslands range from 3,300 to 5,000 feet (Brown 1985). More than half of the 10 to 20 inches of annual precipitation falls during the summer growing season (Benson and Darrow 1981). These grasslands are best developed on deep, well-drained soils on level sites on the higher plains. Their aspect is a grassy landscape broken up by large, well-spaced shrubs. In the southwest they often form an alternating landscape mosaic with Chihuahuan desertscrub (Brown 1985). Large acreages of this grassland are now dominated by mesquite, tarbush, acacia, and creosotebush (Brown 1985). Black grama and tobosa are the most characteristic grasses of the semidesert grasslands. Other important grasses on the better sites include sideoats grama, hairy grama, other gramas, bush muhly, vine mesquite, Arizona cottontop, slim tridens, pappus grass, tanglehead, threeawns, and curly mesquite (Brown 1985). The introduced perennial Lehmann lovegrass now occupies extensive areas in some western portions and is spreading at the expense of more palatable native grasses (Brown 1985). Other shrubs and succulents characteristic of this grassland include yuccas, bear grass, sotol, agaves, allthorn, sumac, hackberry, Javelina-bush, ocotillo, acacias, and mimosas. Many species of cacti occur throughout the drier sites, especially on rocky outcrops.

The northernmost extensions of the Chihuahuan Desert are also included in this analysis region, where it occupies rain shadow basins, outwash plains, low hills, and bajadas across southern New Mexico. Elevations range from about 1,200 to 5,000 feet. Precipitation is highly variable from year to year, but averages approximately 8 to 12 inches, and falls mostly in the summer when evapotranspiration rates are high (Brown 1982). Perennial vegetation of this desert consists largely of shrubs. Creosotebush, acacias, and tarbush dominate the intermountain plains and lower bajadas. Mesquite dominates sandy, wind-eroded hummocks. Dense stands of succulents, such as lechuguilla, sotol, yuccas, beargrass, and candelilla, occur on rocky mountain slopes in association with scattered ocotillo and many species of cacti, including Opuntia, Ferocactus, Echinocereus, Echinocactus, and Mammillaria. Annuals are important components only during the summer rainy period. Principal understory species include mariola, goldeneye, desert zinnias, and dogweeds.

The expansion of Chihuahuan Desert into former grassland is well documented and continues to be observed today (Brown 1982), but the mechanisms by which the encroachment has occurred are not well understood (Wright 1980). The desert grasslands are thought to have been burned frequently by Indians (Benson and Darrow 1981). This practice kept encroachment of woody species to a minimum. Frequent burning ceased with the coming of European settlement. The combination of reduced fire frequency and overgrazing by settlers' livestock resulted in an expansion of woody communities from lower and higher elevations. Cattle helped spread mesquite by depositing undigested mesquite seeds throughout the grassland (Benson and Darrow 1981).

Loss of ground cover resulted in loss of topsoil in some areas, to the point that the site could no longer support a grassland community (Branson 1985). Thus, the change to shrubland in some parts of the region may be permanent. Fire exclusion continues to be considered an important factor in the continued occupation of former grassland areas by woody species. Increase of woody species has continued in areas protected from grazing (Humphrey and Mehrhoff 1958). Others, however, discount the importance of fire, particularly in the maintenance of brush-free range in southern New Mexico (Buffington and Herbel 1965), where there is less supportive evidence of fire occurrence.

Hastings and Turner (1965) made a case for climatic trends toward warmer and drier conditions, combined with historic overgrazing, as a cause of vegetation changes in this region, but this theory is not universally accepted (Wright 1980). Other studies have documented that certain woody species, such as burroweed, are highly responsive to short-term climatic trends, and that such natural causes by themselves can be responsible for dramatic shifts from grasses to shrubs (Martin and Turner 1977). Wright (1980) concluded that occasional fires, in combination with drought, competition, rodents, and lagomorphs played a significant role in controlling shrubs in this region, with the exception of black grama uplands.

Chaparral-Mountain Shrub

The chaparral-mountain shrub analysis region occurs in mountain areas throughout the Upper and Lower Basin and Range Provinces and is scattered through the northern, central, and southern Rocky Mountains (Figure 2-2 and Figure 2-3). It is a composite of interior chaparral and mountain shrub communities.

The interior chaparral discontinuously occupies mid-elevational foothill, mountain slope, and canyon habitats in Arizona below the Mogollon Rim, and occurs as isolated communities through the drier mountains of southern New Mexico (Brown 1982). Precipitation averages 15 to 25 inches annually in a summer-winter pattern separated by spring and fall drought (Brown 1982, Davis and Pase 1977). Vegetation communities consist of dense to moderately open stands of evergreen, and sclerophyllus shrubs of relatively uniform height. Most chaparral shrubs are deep-rooted, sprout readily from the root crown, and regenerate quickly after burning (Brown 1982). Shrub live oak is a common dominant of the interior chaparral. Associated shrubs include mountain mahogany, yellowleaf silktassel, sumac, hollyleaf buckthorn, pointleaf and Pringle manzanita, desert ceonothus, other oak species, and sophoras. Important grasses are now largely confined to rocky, protected sites in the gentler terrain, and include sideoats and hairy grama, cane bluestem, plains lovegrass, threeawns, and wolftail. Forbs are not particularly abundant except for a brief period after burns (Brown 1982).

The mountain shrub type is found in higher foothill and mountain regions of Colorado, Utah, Nevada, New Mexico, and southern Idaho from approximately 5,000 feet to higher than 8,000 feet, depending on latitude. Aspect is that of a thicket up to 18 feet in height, or a relatively open stand. This type is typically positioned on the altitudinal gradient above pinyon-juniper woodland and below coniferous forest (Brown 1982). Precipitation varies from 15 to 21 inches annually and is spread throughout most of the year (Brown 1982). The combination of low precipitation and poor soil development on steep slopes precludes the establishment of more mesic communities (Brown 1982). The dominant species of the mountain shrub areas is Gambel oak. Other important shrub species include mountain mahoganies, snowberries, serviceberries, chokecherry, buckbrushes, New Mexican locust, and cliffrose. In the northern areas, bigtooth maple, bitterbrush, sagebrushes, rabbitbrushes, wild rose, elderberry, and currants are locally common. Scattered individuals of ponderosa pine and Douglas-fir occur throughout. Grasses are often scarce, and consist primarily of bluegrass, brome, needlegrass, and wheatgrass. Common forbs include yarrow, lupines, fleabane, groundsels, penstemons, dandelion, and mulesear.

Shrub densities in some areas of interior chaparral have increased since the turn of the century (Brown 1982, Herbel 1985). Reduction of fire frequency is usually considered to be the primary factor causing this trend (Brown 1982, Herbel 1985). Significant changes in vegetation are not well documented for the mountain shrub type. There has been a general depletion of palatable herbaceous components from past livestock grazing (Brown 1982) and a reduction in fire frequency as well. Exclusion of fire has contributed to decadent stands of shrubs that have lost much of their value for wildlife browse.

Pinyon-Juniper

The pinyon-juniper analysis region occurs at mid elevations in the Upper and Lower Basin and Range Provinces, the Colorado Plateau, the central and southern Rocky Mountains, and the Columbia Plateau (Figure 2-2 and Figure 2-3). It is a cold adapted evergreen woodland characterized by the unequal dominance of two conifers, juniper and pinyon pine. It is one of the most extensive vegetative types on BLM lands in the EIS area.

The pinyon-juniper woodland reaches its greatest development on mesas, plateaus, piedmonts, slopes, and ridges from 3,200 to 8,400 feet (Blackburn and Tueller 1970, Evans 1988). Precipitation ranges from 10 to 25 inches annually (Blackburn and Tueller 1970).

The eastern woodlands receive more summer precipitation than western areas, where most of the precipitation comes during the winter as snow (Brown 1982). The aspect of these woodland communities is highly variable. Trees rarely exceed 36 feet in height, and may present a closed canopy of single or many tree species with little or no understory vegetation, or the community may appear as an open stand of scattered trees with a diverse and well-developed understory (Evans 1988). Pinyon-juniper communities occur on a wide variety of soils, ranging from shallow to moderately deep and from coarse and rocky to fine compacted clays (Evans 1988). Current climate is more important than are soils in delimiting the elevational distribution of pinyon-juniper woodlands (Evans 1988). The principal contact is with sagebrush-grassland at the lower elevational limits where moisture is a limiting factor, and with chaparral-mountain shrub or montane conifer forest at the upper elevational limits where temperature is a limiting factor (Brown 1982, Wright et al. 1979).

Typically, juniper is found in pure stands at the lower elevational limits of the zone and may extend into the sagebrush zone. At higher elevations, pinyon enters the community, forming a mixed woodland throughout the middle of the elevational range, and eventually replaces juniper at the upper limits of the zone (Cronquist et al. 1972). The woodland exhibits wide geographic variation, with different tree species, different shrub species, and different herbaceous understory. Pinyon is absent from most woodland stands in eastern Oregon, Idaho, and western Wyoming. Throughout most of Nevada and western Utah, singleleaf pinyon dominates, along with Utah and western junipers. Singleleaf pinyon is replaced by doubleleaf pinyon throughout the Colorado Plateau and east into the central and southern Rocky Mountains. Rocky Mountain juniper, Utah juniper, and oneseed juniper are common associates (Cronquist et al. 1972). In the dry mountains of southern New Mexico and sub-Mogollon Arizona, Rocky Mountain and Utah juniper and doubleleaf pinyon disappear, and alligator juniper (a sprouting species of juniper), Emory oak, gray oak, and Mexican pinyon appear (Brown 1982). The associated understory layer of shrubs, grasses, and forbs in these communities is commonly composed of representatives from adjacent sites above and below the woodland zone, and varies widely.

The correlation of pinyon-juniper presence to soil properties, climate, or topography is highly variable, and these species can become dominant wherever their moisture and temperature requirements are met (Brackley 1987). The range of the pinyon-juniper community types overlaps that of many other vegetation types, including sagebrush, semi-desert and plains grassland, mountain shrub, and ponderosa pine (West and Van Pelt 1987).

Fires are believed to have been widespread in most of the pinyon juniper type before settlement, and limited the extent of the community (Burkhardt and Tisdale 1976; Brackley 1987; Branson 1985; Leonard et al 1987; West and VanPelt 1987; Tausch et al 1981; Wright 1990), particularly in areas where it overlapped the range of communities with more fire tolerant species. Wright (1990) states: "Historically, fire has been the dominant force controlling the distribution of pinyon-juniper, particularly juniper, but fire cannot be separated from the effects of drought and grazing."

Droughts and competition from grass probably slowed down the invasion of juniper into adjacent shrublands, particularly at lower elevations. Because young pinyon and juniper trees are easily killed by fire, occasional fires would kill most trees establishing in an area. West and Van Pelt (1987) believe that many pinyon-juniper sites used to cycle between grass/shrub domination, and pinyon-juniper communities, with fire as the chief driving factor. There are stands of pinyon and juniper, however, such as in the upper Rio Grande River drainage where fire probably had little importance (Branson 1985). These may be areas of rough topography or poor soils that did not produce enough fuel to carry a fire (Wright et al 1979).

At the time of settlement, grazing by domestic livestock significantly reduced the amount of fuel. Without fuel, fires could not carry. Fire frequency decreased considerably, and the range and density of pinyon and juniper increased (Burkhardt and Tisdale 1976; Branson 1985; Tausch et al 1981; Wright 1990). Viewpoints in opposition to this explain that pinyon and juniper are merely reestablishing themselves on areas where they were removed for mining and other uses in the 1800's (Lanner 1977). Extensive removal of pinyon and juniper did occur in the central Great Basin, particularly central Nevada, where demand for charcoal, fuelwood, and fenceposts continued into the 1920's (Young and Budy 1987). However, it is unclear how much demand and removal of these species occurred in other areas where pinyon and juniper appear to be expanding their range.

Mehringer and Wigand (1987) argue that in central Oregon, the present rate and degree of expansion in juniper communities is no different than that which has occurred at other time periods in the last 10,000 years, and that climate, not grazing or fire exclusion is the cause of the expansion. Davis (1987) thinks that the migration of pinyon and juniper to lower elevations is in response to climatic cooling but that it has been accelerated by historic vegetation disturbance, particularly grazing.

Tausch et al (1981) studied pinyon and juniper age and dominance on 18 mountain ranges throughout the Great Basin, and found many stands of trees that predate the historic period. However, tree dominance is increasing, particularly at lower elevations, with about 30 percent of their plots containing trees that established between 1845 to 1895. They acknowledge the role of grazing and reduced fire frequency, as well as revegetation of formerly denuded areas as important factors to consider when explaining present pinyon and juniper expansion. No juniper trees were found that predated 1880 in a study area in north-central Oregon.

Many of the oldest trees established under sagebrush plants that have since died, while younger trees establish under the canopy of other junipers (Eddleman 1987). Significant loss of understory vegetation (Tausch et al 1981; Brackley 1987; Eddleman 1987; West and Van Pelt 1987) that provides food for both livestock and wildlife has and continues to occur in many of these stands. Most authors conclude that trees will continue to dominate more area without some major environmental change or management action. Improved management or complete elimination of livestock grazing will not change this situation (Bowns 1990).

Mountain/Plateau Grasslands

The mountain/plateau grasslands analysis region consists of noncontiguous areas of moderate to high elevation grassland scattered through the northern, central, and southern Rocky Mountains, and the Palouse grasslands of the Columbia Plateau (Figure 2-2 and Figure 2-3). It is one of the least extensive analysis regions BLM administers in the EIS area.

The mountain grasslands occur as part of the vegetation mosaic created by the highly complex environment of the Rocky Mountains. They occur at elevations ranging from 3,000 to over 9,000 feet where annual precipitation varies from 8 to 30 inches (Garrison 1977, Mueggler and Stewart 1980), at least half of which usually falls during the growing season. These grasslands occupy a variety of topographical positions, from level areas or valley floors, to alluvial benches and foothills, to steep mountain slopes. Soil characteristics vary accordingly, ranging from deep and loamy, to poorly drained or fairly dry and rocky, or mildly alkaline to mildly acidic (Mueggler and Stewart 1980). The grass component of these communities is usually the most productive, followed by forbs, and then shrubs. Important grasses in these communities include bromes, bluegrasses, oatgrasses, sedges, wheatgrasses, fescues, needlegrasses, hairgrasses, reedgrasses, bentgrasses, and junegrass. The forb component varies with site, latitude, and management, and is diverse throughout the region. Shrubs that occur in these communities include big sagebrush, fringed sagebrush, silver sagebrush, rabbitbrushes, snakeweed, shrubby cinquefoils, wild roses, horsebrush, and prickly pear (Mueggler and Stewart 1980).

The Palouse grasslands characterize the part of the analysis region in eastern Oregon, Washington, and western Idaho. Precipitation of these grasslands is about 18 to 24 inches annually, and elevations range from 2,000 to 3,000 feet. Important dominants include bluebunch wheatgrass, Idaho fescue, Sandberg wheatgrass, and rough fescue. Many introduced species have adapted well to the region, and perennial native vegetation replaces them slowly or not at all after disturbance (Branson 1985). These exotic species include Kentucky bluegrass, a perennial, and annuals such as cheatgrass, medusahead, soft chess, rattlesnake brome, filaree, and Klamath weed.

Between the mountain and Palouse grasslands, the most extensive vegetation changes since European settlement have occurred in the Palouse grasslands, where extensive cultivation, overgrazing, and introduced plants have dramatically reduced the extent of native vegetation (Branson 1985). Many of the introduced species are Mediterranean annuals that are well adapted to grazing and the predominantly winter precipitation regime, which is why the native species cannot readily displace them.

Plains Grasslands

The plains grasslands analysis region is the western part of the Great Plains and stretches from eastern Montana through eastern Wyoming, Colorado, and New Mexico (Figure 2-2 and Figure 2-3). This grassland forms a broad, flat belt of land that slopes gradually eastward from the eastern foothills of the Rocky Mountains, composed of tall, mixed, or shortgrass communities, with the latter the most extensive in the EIS area.

The short grassland communities stretch from southeastern New Mexico through eastern Colorado to southeastern Wyoming. Annual precipitation varies from 11 to 20 inches, and elevations are from about 6,000 feet on the western edge to 3,000 feet on the eastern edge (Wright et al. 1980). Dominant grasses are buffalograss and blue grama, with smaller amounts of threeawns, lovegrass, tridens, sand dropseed, side-oats grama, tobosa, galleta, vine mesquite, and bush muhly. Forbs are seldom a major component, except during wet years (Wright et al. 1980). Dominant woody plants include honey mesquite, shinnery oak, sand sagebrush, snakeweed, yucca, and fourwing saltbush, cholla, and prickly pear (Wright et al. 1980).

The mixed grass communities stretch from northeastern Wyoming through North and South Dakota and eastern Montana. Precipitation varies from 20 to 28 inches, increasing from west to east. Elevation ranges from about 3,000 feet at the western edge to 900 feet in Texas (Wright et al. 1980). Sedges and cool season grasses, such as needlegrasses, wheatgrasses, and fescues, dominate the communities of Montana and North and South Dakota. Warm-season grasses, particularly blue grama, are also part of these communities, and increase in dominance going south. Other important grasses in mixed grass communities include green needlegrass, prairie sandreed, needle-and-thread grass, junegrass, sand dropseed, buffalograss, side-oats grama, threeawns, silver beardgrass, sand bluestem, plains lovegrass, and vine mesquite (Brown 1982, Wright et al. 1980). Shrub species found in these communities include juniper, silver sagebrush, silver buffaloberry, sumac, wild rose, and rabbitbrushes, yucca, snakeweed, cholla, and winterfat. (Brown 1982, Mueggler and Stewart 1980). Forbs may be an important component of these communities. Common species include goldeneye, groundsel, sunflowers, primrose, globemallow, asters, scurf pea, coneflower, and bricklebush (Brown 1982).

Tall grass communities in the plains grassland are restricted to certain soil types and areas where grazing history has not been severe (Brown 1985). This type is much more extensive in the true prairie of the midwest. Tall grass communities are dominated by big bluestem, little bluestem, Indian grass, switchgrass, and side-oats grama. Associated shrubs include shinnery oak, sandsage, yucca, and mesquite (Brown 1985).

The plains grasslands evolved with grazing by native herbivores, and many of the grasses are well adapted to grazing. Climate is generally believed to be the dominant factor controlling these grasslands, but periodic fire was also an important factor in limiting woody vegetation to mosaics or a savanna situation (Wright et al. 1980). Fire suppression has led to the establishment of fire disclimax associations of shrubs in some areas (Brown 1982). In general, the plains grassland has not been subject to the extensive type conversions from fire suppression and other human activities that have occurred in some of the other native grasslands.

Coniferous/Deciduous Forest

The coniferous/deciduous forest analysis region is a composite of the many high-elevation evergreen conifer and deciduous forest types that occur throughout the northern, central, and southern Rocky Mountains, as well as the mountains of the Upper and Lower Basin and Range Provinces, the Colorado Plateau, and the Columbia Plateau (Figure 2-2 and Figure 2-3). Species dominance varies with altitude, latitude, slope aspect or other topographical position, soil characteristics, and climatic regime. BLM administers small acreages of these diverse forest types in every State in the EIS area. Important forest communities included in this analysis region are climax ponderosa pine, seral ponderosa pine, Douglas-fir, Douglas-fir mixed with other conifers, aspen, lodgepole pine, cedar-hemlock, and spruce-fir.

Climax ponderosa pine exists at the lower elevations and on the warmer, drier sites of the analysis region. The lower contact is typically with pinyon-juniper woodland or chaparral-mountain shrub communities. Upper elevation contacts are usually with mixed conifer types. Ponderosa pine is the largest western forest type (Brown 1985) and occurs in every State in the EIS area. Old growth ponderosa forests are often park-like, with scattered old trees interspersed with groups of young trees. There is typically a well-developed herbaceous understory. Stands were probably kept open by light fires that periodically burned through the understory. Older trees tolerate fire well, but young trees are easily killed (Daubenmire 1952). In the absence of frequent understory fires that historically occurred, many stands of ponderosa pine are now dense and stagnant, with thickets of understory reproduction (Wright and Bailey 1982).

On more mesic sites, ponderosa pine will be replaced by other, less fire-tolerant species without understory fires. In northeast Oregon and central Idaho, ponderosa pine is seral to grand fir and Douglas-fir. Ponderosa pine is associated with western larch and Douglas-fir in central and northeast Washington, northern Idaho, and western Montana, where it grades into more moist western larch and Douglas-fir forests at higher elevations or more northerly aspects. Because ponderosa pine and western larch are the most fire resistant western trees, infrequent underburns would favor these species over Douglas-fir or grand fir (Wright and Bailey 1982).

The Douglas-fir zone occurs in the northern and central Rocky Mountain regions, from eastern Washington, Idaho, western Montana, and northwestern Wyoming, generally between the ponderosa pine and spruce-fir zones (Wright and Bailey 1982). Ponderosa pine, western larch, aspen, and lodgepole pine are common seral species in this zone (Wright and Bailey 1982). Associated understories may be dominated by bunchgrasses on the most xeric sites, or may be composed of a sparse shrub layer mixed with grasses and forbs (Wright and Bailey 1982).

Douglas-fir is more often mixed with other conifer species types in the southern Rockies. This mixed conifer zone is dominated by Douglas-fir in association with white fir, blue spruce, or Englemann spruce. Mature mixed-conifer forests are often dense, with high litter accumulations that inhibit understory growth (Brown 1985). This type may extend into much drier areas, following canyons, ravines, and north-facing slopes, existing as islands in the midst of more xerophytic vegetation (Daubenmire 1952).

Quaking aspen is the most widely distributed native North American tree species (DeByle et al. 1985). Its range coincides closely with Douglas-fir. Aspen may form extensive pure stands or be a minor component of other forest types. Aspen is a clonal species; that is, its extensive root system gives rise to shoots that form new trees that are genetically identical to the parent. The clone consists of all the genetically identical stems. Aspen clones may persist for thousands of years (DeByle et al. 1985). A stand may be composed of one or many clones. Fire is responsible for the abundance and even-aged structure of most stands throughout the West. Without human intervention, fire appears to be necessary for the continued well-being of aspen on most sites (DeByle et al. 1985), and most stands will die out or be replaced by conifers without disturbance.

Lodgepole pine occurs primarily in the central and northern Rocky Mountain regions of Colorado, Wyoming, Montana, Utah, Idaho, and Oregon. At higher elevations, it gives way to spruce-fir forest. Lodgepole pine forms dense, often pure stands with little understory. Fire plays an important role in the maintenance of these forests. The Rocky Mountain lodgepole pine contains some proportion of closed cones that retain seeds but quickly release them after fire or cutting (Lotan et al. 1981). Lodgepole pine colonizes burned areas, frequently replacing previous stands of lodgepole pine. Without fire, lodgepole pine may eventually be replaced by ponderosa pine, Douglas-fir, Englemann spruce, cedar-hemlock, or Englemann spruce/subalpine fir stands. Lodgepole pine may persist as a climax species on sites too cold for Douglas-fir or ponderosa pine, too dry for spruce-fir, or too wet or infertile for other coniferous species (Wright and Bailey 1982).

In the EIS area, cedar-hemlock occurs in northern Idaho and northwestern Montana where the westerlies carry oceanic influence as far inland as the continental divide. The zone is characterized by higher precipitation than the other conifer zones, and summer heat is adequate (Wright and Bailey 1982). Dominant trees are western hemlock and western redcedar. Grand fir is climax dominant in the southern portions of the region. Douglas-fir and western white pine are common associates. Understory in this zone is a rich growth of shrubs and herbs (Wright and Bailey 1982).

The spruce-fir forest type is dominated by Englemann spruce and subalpine fir. Limber pine and bristlecone pine are common associates on steep, rocky, and southern exposures. Douglas-fir, aspen, lodgepole pine, blue spruce, and white bark pine are also found in this zone. These species often form dense stands with little herbaceous understory because of shading and considerable litter accumulation. Aspen generally becomes dominant after fire or other disturbance (Brown 1985).

Fire exclusion in any of these forest types adapted to high frequencies of understory fires can lead to accumulations of understory dead woody fuels, as well as the establishment of trees that provide fuel ladders between the surface fuels and the tree crowns, and it has substantially altered forest succession in some forest types (Barrett 1988, Stark 1977). Fire exclusion on forests with long stand replacement cycles results in increased fire hazard because flammability increases over much greater contiguous areas of forest and younger, less flammable stands are no longer present. For example, lodgepole pine stands that have had time to develop an understory of Englemann spruce and subalpine fir are much more flammable than before those species became established. Complete fire protection will allow less fire-tolerant species to replace more fire-tolerant species, as well as permit coniferous species to take over most sites presently dominated by aspen (DeByle et al. 1985).

Riparian Vegetation Communities

Riparian communities occur in all analysis regions, although they make up the least extensive vegetation type in the 13 Western States, with less than 1 percent of the total area (Cooperrider et al. 1986). Because of their productivity and other values, they are critically significant and have received continuous intensive use since presettlement times (Branson 1985). It is estimated that 70 to 90 percent of the natural riparian ecosystems have been lost because of human activities, and as much as 80 percent of the remaining areas are in unsatisfactory condition and are dominated by human activities (Cooperrider et al. 1986).

Riparian community descriptions do not easily fit into the analysis region format because they are controlled by different environmental factors than those that control the upland areas. The presence of water, the increase in humidity, and the modification of temperature within riparian areas allow upland vegetation to exist at significantly lower elevations; riparian-related blue spruce is an excellent example. Riparian zones are also much more complex than their adjacent uplands (Thomas et al. 1979), making them much more difficult to categorize.

There are several classification systems attempting to categorize all riparian vegetation communities; most of them are too complex for this type of general analysis. The classification system proposed by Dick-Peddie and Hubbard (1977) is appropriate for this EIS.

The Alpine Riparian Sub-formation is limited to riparian areas or above timberline. Typical plant species are shrubby willows, sedges, rushes, spikerush, marsh marigold, and Koenigia. This community occurs rarely on public lands and is not likely to be affected by any actions proposed in this EIS. The alpine riparian communities are limited to a few isolated mountain ranges within the sagebrush, pinyon-juniper, mountain/plateau grasslands, and coniferous/deciduous forest analysis regions.

The Montane Riparian Sub-formation contains three sub-series communities: the willow-alder series, blue spruce series, and the mixed-deciduous series. The willow-alder series includes several species of willow and alders, bog birch, water birch, dogwood, aspen, currant, geranium, cinquefoil, cow parsnip, and sedges. The vegetative community will be most closely associated with the mountain/plateau grasslands and coniferous/deciduous forest analysis regions. The blue spruce series contains the blue spruce and combinations of Douglas-fir, subalpine fir, white serviceberry, carex, grasses, and geranium. This series is also associated with the mountain/plateau grasslands and coniferous/deciduous forest as well as higher elevation sagebrush, chaparral-mountain shrub, and pinyon-juniper regions. The mixed-deciduous series includes a variety of communities of willow-dogwood, alder-willow, boxelder-ash-walnut, sycamore, and hackberry associations. Also found with these associations are junipers, ash, western oaks, cottonwoods, maple, and others. This series can be found in all analysis regions and includes a wide variety of understory vegetation.

The Arroyo-Floodplain Riparian Sub-formation contains the arroyo scrub series and the floodplain (bosque) series. The arroyo series occurs only in the driest riparian situations, generally with only seasonal flooding. It may not be considered true riparian by some classification systems, or may be considered xeroriparian (Warren and Anderson 1985). Most of the species are also found in the uplands, but reach a much larger size in the drainages because of the presence of flood or subsurface water. The associations occurring in this series are the greasewood, rabbitbush, desert willow-bricklebush, and the burroweed-four-winged saltbush associations. In addition to the named species, others found are big sagebrush, seepwillow, desert broom, arrowweed, and the nonnative saltcedar. This series occurs primarily in the sagebrush, desert shrub, and southwest shrubsteppe analysis regions. The floodplain (bosque) series includes the cottonwood, cottonwood-willow, mesquite, arrowweed-seepwillow, mixed bosque, and saltcedar associations. This series is also widely occurring, allowing for a large variety of subdominate understory vegetation. The cottonwood-willow association may be found in virtually all of the analysis regions. Saltcedar, a rapidly spreading exotic, is also wide ranging and may be commonly found in all but the coniferous/deciduous analysis regions. The mesquite, arrowweed-seepwillow, and mixed bosque associations occur primarily in the desert shrub and southwestern shrubsteppe regions.

In the eastern portions of the plains grassland region, the riparian vegetation takes on some of the characteristics of the upland deciduous forests. In Oklahoma the riparian tree species decrease in height and vigor in the transition from the moist east to the arid west. Typical species also change. In the east, baldcypress, sweetgum, sycamore, river birch, and black gum are common. In the central region, elms, hackberry, walnut, black locust, and honey locust are dominant, but are secondary species in the east. In the west, cottonwood, willow, elm, and boxelder are common, but are smaller and more widely spaced than in the east (Brinson et al. 1981).

The history of riparian areas is one of wide-scale development and abuse. While a small number of western riparian areas have improved since the settlement of the West, such as the South Platte River (Branson 1985), most have undergone a significant reduction in quantity and quality. The lower Colorado River is a prime example. In historic times there were an estimated 5,000 acres of pure cottonwood stands along the Colorado. By the mid-1970s this had been reduced to about 500 acres. There are still 2,800 acres of cottonwood-willow stands, but these are heavily invaded with exotic saltcedar. The average removal rate of all riparian vegetation has been estimated at nearly 3,000 acres a year (Ohmart and Anderson 1982). The low elevation riparian communities have had the heaviest impacts, while mountain communities have not changed as dramatically (Brinson et al. 1981). Major impacts have been through land clearing for agriculture and settlements, irrigation projects and related water management, and flooding under impoundments. The overall assessment of riparian vegetation in the Western States is similar to the dramatic reduction that has occurred nationwide. Of an estimated 120 million acres of potential riparian habitat, less than 20 percent remains (Brinson et al. 1981).

Within the scope of this EIS, two aspects of historical change in riparian vegetation are important. Past-land use practices in livestock grazing, fire management, and timber harvest have had a significant effect on the current status of riparian areas. Most of the riparian areas still in existence are in poor condition because of past management (Cooperrider et al. 1986). Excessive quantities of plant biomass have been removed from riparian areas by livestock grazing and timber harvest for the past 100 years or more. The remaining riparian communities are often relict tree stands, unable to reproduce under existing management. In addition to damaging the riparian communities, past management has also degraded much of the associated upland vegetation areas, resulting in unsatisfactory condition watersheds in addition to the poor condition riparian areas (Brinson et al. 1981). The end result of the past abuses are riparian areas that are only remnants of the potential plant community, with surrounding watersheds that are unstable and need changes in management before riparian objectives can be met.

The second problem is still occurring and causes the need for most of the proposed vegetation treatments within riparian areas included in this document. This is the spread and apparent naturalization of saltcedar. Saltcedar is an exotic tree/shrub, introduced from Eurasia as an ornamental. It has adapted extremely well to the Southwest and is spreading north into most of the States included in this EIS. From its introduction in 1820 it had spread to 10,000 acres in 1920, 900,000 acres in 1961, to probably 1.3 million or more acres in the 1970s (Branson 1985). Because of its prolific seed production and its ability to resprout after attempted control, saltcedar has been nearly impossible to control and impossible to eradicate. However, continuing control efforts are appropriate because of competition with better quality riparian plant species.

Climate

Because climate is the driving force for vegetation growth and a key factor in erosion, specific climate conditions dictate vegetation management methods. The study region is made up of four main climatic types. The coastal Pacific Northwest is a temperate oceanic climate type. The deserts of central and southern Nevada; southwest Utah; northwest, western, and southern Arizona; and southern New Mexico are a subtropical, hot desert climate type. The mountainous regions of the Cascade and Rocky Mountains are a highland climatic type. The rest of the study region (where most nondesert BLM-administered lands are located) is a continental, cold steppe climate type.

Temperatures vary mostly with latitude, elevation, moisture, and to a lesser extent, local microclimate. At higher elevations, freezing temperatures are possible throughout the year.

Annual precipitation is highly variable, primarily because of the orographic effect of local topography. Snowfall is possible at higher latitudes and elevations throughout the year, with snow accumulation increasing with elevation.

Upper-level winds prevail from the west and southwest, but ground-level winds often reflect local terrain. For example, the diverse and rugged terrain in mountainous areas results in complex wind flows and surface winds. Synoptic (pressure gradient) winds may be channeled or forced around hills, but without strong gradient flows, diurnal upslope/downslope winds predominate. Upslope winds usually occur on sunny mornings when the air at higher elevations heats rapidly and rises. Downslope winds occur when the air near the ground cools, becomes dense, and sinks downward along drainages.

The extent to which vertical and horizontal mixing takes place is related to the atmospheric stability and mixing depth. Unstable conditions normally result from strong surface heating (typical of summer afternoons), producing vertical winds. Neutral conditions reflect a breezy, well-mixed atmosphere. Stable conditions (enhanced by rapid radiative cooling and downslope drainage, etc.) produce the least amount of dispersion.

Although atmospheric mixing varies throughout the study area, dispersion is normally good in spring and summer, but is limited in winter. Inversions are formed under stable conditions, trapping pollutants within a layer of air. Moderate summer inversions are typical during the evening and dissipate at dawn. Winter inversions are stronger and last longer. Inversions are enhanced by weak pressure gradients, cold clear nights, snowcover, and lower elevations.

The temperate oceanic climate type is dominated by moist, onshore winds. As a humid climate, precipitation is reliable and abundant; snow is found only at higher elevations. Evaporation is minimal. Seasonal temperature extremes are moderated by the warm North Pacific ocean current. Summer temperatures are cooler than other locations at similar latitudes; winter temperatures are milder. Given the high latitude, growing seasons are relatively short. The air is normally well-mixed, but valley inversions may form.

The subtropical, hot desert climate type is continental and very dry. Precipitation is minimal and highly variable. As a result, the desert is characterized by sunny days, clear nights, high evaporation, and large diurnal and seasonal temperature changes. Summer temperatures are among the highest in the world, and winter temperatures are mostly mild to cool. Wind may be caused by pressure gradients or local heating differences. Air is unstable during the day, but night-time inversions are common.

The highland climatic type is dominated by its mountainous topography. This complex topography causes considerable variation in site-specific temperature, precipitation, and surface winds. Precipitation is greatest on the windward side, with amounts increasing dramatically with elevation. Temperatures are much colder than lowlands at similar latitudes, and may become frigid when cold air drains into mountain valleys. Diurnal up- and down-valley winds predominate. Mountain inversions may form and last for several days.

The continental, cold steppe climate type is typified by low to moderate precipitation, which occurs mostly in summer. The amount of precipitation varies greatly from year to year. Evaporation is moderate to high.

Temperatures vary widely from cold winters and hot summers. There are four distinct seasons (spring occurs suddenly and warms quickly), but the timing and duration of the seasons vary by latitude. Pressure gradient (synoptic) winds predominate. Extremely frigid conditions and blizzards can occur, but severe weather conditions, such as floods and damaging hail, are rare. Tornadoes occasionally occur in the easternmost portion of the study area. Winter inversions are common and may last for several days.

The following climate analysis region descriptions are necessarily broad generalizations of very complex climatic conditions (USDA 1972.) Table 2-2 provides monitored data for specific locations within each analysis region. However, this data cannot be extrapolated throughout the analysis region. Figure 2-4 shows annual average precipitation throughout the study area. Site-specific monitoring is necessary to determine local climatic conditions.

Sagebrush

Average annual precipitation ranges from 8 to 20 inches, resulting mostly from summer convective thunderstorms. In northern and central Nevada, southeastern Oregon, eastern Washington, and southwest Idaho, very little precipitation falls in the summer months. Most precipitation occurs in the winter, falling as snow at all but the lowest elevations. January temperatures range from an average minimum temperature of 10° Fahrenheit (F) to an average maximum temperature of 40° F. July temperatures typically average from 50° F (minimum) to 90° F (maximum). Frost-free periods normally last 6 months.

Table 2-2

Climatic Data

Station	Vegetation Type	Elevation (ft; mean sea level)	Annual Mean Temp (°F)	Annual Mean Prec (")	Frost-Free Days
Ely, NV	Sagebrush	6,253	44.3	8.3	146
Las Vegas, NV	Desert Shrubland	2,162	65.7	3.9	319
El Paso, TX	SW Shrubsteppe	3,920	63.3	7.9	310
Payson, AZ	Chaparral/Mtn Shrub	4,902	55.5	21.0	222
Moab, UT	Pinyon Juniper	3,965	55.9	8.2	240
Billings, MT	No/central Plains	3,567	47.5	13.2	212
Amarillo, TX	Southern Plains	3,590	58.7	19.7	253
Rock Springs, WY	Mtn/plat Grass/Mead	6,741	42.7	7.8	170
Flagstaff, AZ	Southern Forests	6,993	45.6	18.3	155
Missoula, MT	No/central Forests	3,200	43.2	12.8	184
Olympia, WA	Pacific NW Forests	190	50.8	52.4	283

Note. Even though they are outside the EIS study area, El Paso, and Amarillo, Texas are listed because they are representative of the vegetation type climate.

Source: U.S. Department of Commerce (1965).

Desert Shrub

Average annual precipitation is less than 8 inches, which may occur anytime throughout the year. January temperatures range from average minimum temperatures of 25° F to an average maximum temperature of 55° F. July temperatures typically average from 60° F (minimum) to 105° F (maximum). Frost-free periods normally last 10 or 11 months.

Southwestern Shrubsteppe

Average annual precipitation varies from 8 to 16 inches, occurring mostly between spring and fall. January temperatures range from an average minimum temperature of 25° F to an average maximum temperature of 60° F. July temperatures typically average from 60° F (minimum) to 95° F (maximum). Frost-free periods normally last 9 to 11 months.

Chaparral-Mountain Shrub

Climatic conditions are highly variable; chaparral and mountain shrubs occur where there is limited water but sunny conditions with a tolerance for wide temperature ranges. Average annual precipitation is 12 to 20 inches, occurring mostly in the spring and early summer (growing season). January temperatures range from an average minimum temperature of 25° F to an average maximum temperature of 50° F. July temperatures typically average from 50° F (minimum) to 95° F (maximum). Frost-free periods normally last 5 to 8 months.

Pinyon-Juniper

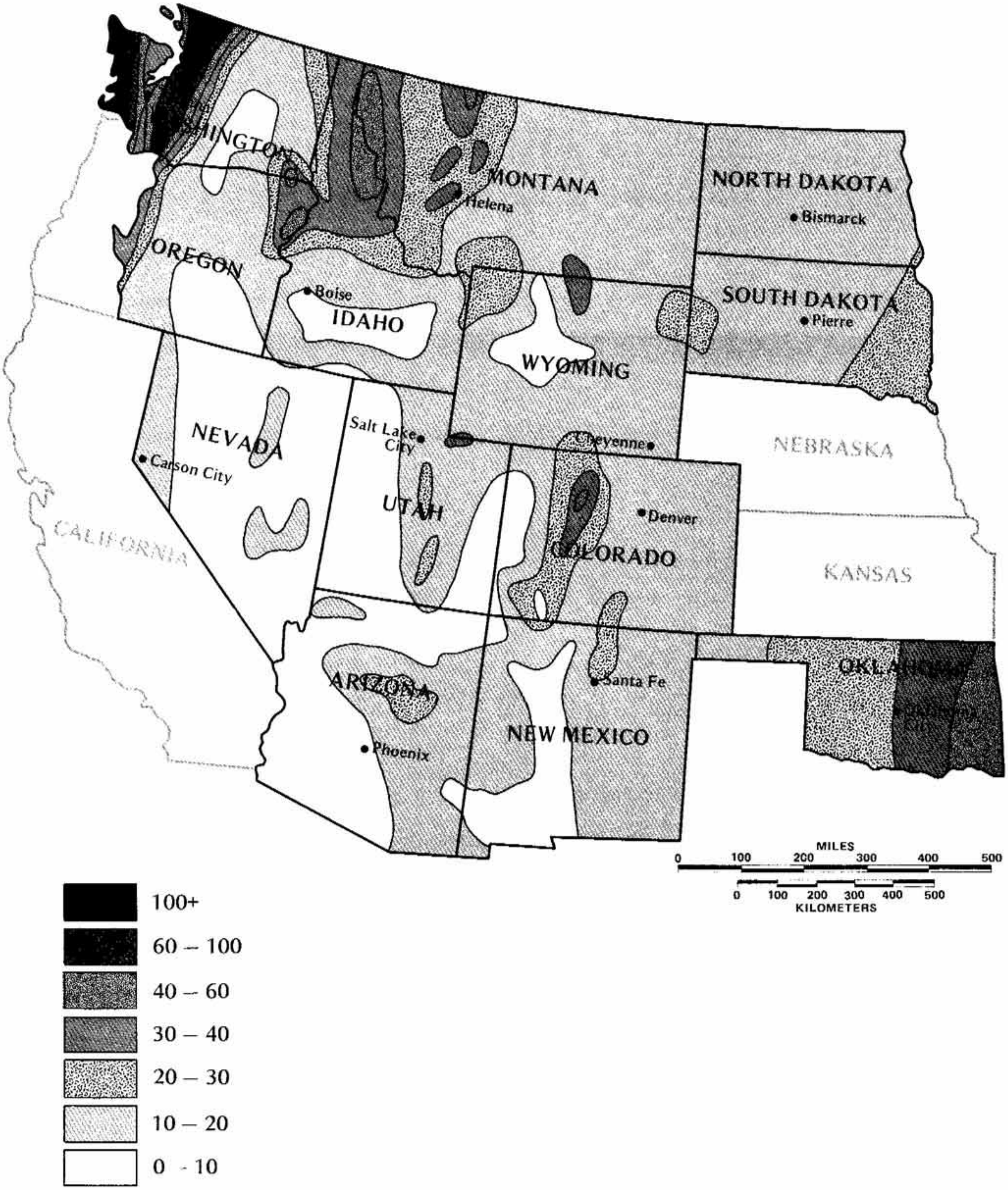
Climatic conditions are highly variable; pinyon and juniper trees grow where there is limited water but sunny conditions with a tolerance for wide temperature ranges. Average annual precipitation is normally 12 to 20 inches, occurring mostly in the summer due to convective thunderstorms. January temperatures range from an average minimum temperature of 15° F to an average maximum temperature of 50° F. July temperatures typically average from 50° F (minimum) to 90° F (maximum). Frost-free periods normally last 3 to 7 months.

Mountain/Plateau Grasslands

Climatic conditions are highly variable; average annual precipitation is normally 8 to 16 inches, occurring throughout the year. January temperatures range from an average minimum temperature of 0° F to an average maximum temperature of 32° F. July temperatures typically average from 50° F (minimum) to 85° F (maximum). Frost-free periods range from 2 to 5 months.

Plains Grasslands

Plains grassland vegetation occurs from the Canadian Border to eastern New Mexico and West Texas. Although precipitation amounts are fairly uniform, temperature conditions vary north and south of Colorado.



Source: Satterlund, Widland Watershed Management (John Wiley & Sons, 1972).

Figure 2-4
Average Annual Precipitation in the States in the Study Area

In the central and northern plains grasslands, average annual precipitation is 14 to 18 inches, occurring mostly from spring to fall as a result of convective thunderstorms. Winter precipitation is snow. January temperatures range from an average minimum temperature of 0° F to an average maximum temperature of 32° F. July temperatures typically average from 50° F (minimum) to 85° F (maximum). Frost-free periods normally last 7 months.

In the southern plains grasslands, average annual precipitation is 14 to 20 inches (but fluctuates considerably from year to year), occurring mostly from late spring to fall. Winter precipitation is relatively light snow. January temperatures range from an average minimum temperature of 20° F to an average maximum temperature of 50° F. July temperatures typically average from 65° F (minimum) to 95° F (maximum). Frost-free periods normally last 9 months.

Coniferous/Deciduous Forest

Coniferous and deciduous forest vegetation occurs in the mountains throughout the study area and along the coastal Pacific Northwest. There are three distinct forest regions: the southern Rocky Mountains (including the ponderosa pine forest of the Mogollon Rim), the northern and central Rocky Mountains, and the coastal Pacific Northwest. Microclimatic conditions make forest climates highly variable.

In the southern Rocky Mountains, average annual precipitation is 16 to 20 inches, occurring mostly from mid-summer to fall. January temperatures range from an average minimum temperature of 10° F to an average maximum temperature of 45° F. July temperatures typically average from 45° F (minimum) to 85° F (maximum). Frost-free periods normally last 3 to 7 months.

In the northern and central forests, average annual precipitation varies from 20 to 55 inches (depending mostly on elevation) and occurs mostly as snow from fall to spring (summers are dry). January temperatures range from an average minimum temperature of 0° F to an average maximum temperature of 32° F. July temperatures typically average from 40° F (minimum) to 85° F (maximum). Frost-free periods normally last 2 to 4 months.

In the Pacific Northwest, average annual precipitation ranges from 20 to 100 inches, occurring during the fall, winter, and spring; summers are dry. January temperatures range from an average minimum temperature of 20° F to an average maximum temperature of 45° F. July temperatures typically average from 50° F (minimum) to 80° F (maximum). Frost-free periods normally last 4 to 8 months. Higher elevations are wetter and colder.

Air Quality

The existing air quality throughout much of the study area is unknown; little monitoring data are available for most pollutants. However, in the undeveloped regions of the Western United States, ambient pollutant levels are expected to be near or below the measurable limits. Locations vulnerable to decreasing air quality from extensive development include immediate operation areas (milling operations, powerplants, and so on) and local population centers (automobile exhaust, residential wood smoke, and so on) Noise levels are site-specific and vary continuously. Rural noise levels should average 30 to 50 decibels A-weighted (dbA), with occasional peak levels to 90 dbA.

National ambient air quality standards (Table 2-3) limit the amount of specific pollutants allowed in the atmosphere: carbon monoxide, lead, nitrogen dioxide, ozone, sulfur dioxide, and particulate matter (total suspended particulates and inhalable particulates). State standards include these parameters, but may also be more stringent. The standards protect public health (primary standards) and welfare (secondary standards).

For many years, the particulate matter standard included all size ranges of particles (thus called total suspended particulates). Measured values were dominated by fugitive (wind blown) dust particles, which are larger than those produced in combustion processes, settle relatively quickly, and are a minimal threat to health. The Environmental Protection Agency (EPA) recognized these limitations and established new standards for particulates less than 10 microns in diameter, commonly called inhalable particulates and abbreviated PM10. The total suspended particulates (TSP) standards will be phased out over time.

Areas that consistently violate Federal standards because of human activities are classified as "nonattainment" areas and must implement a plan to reduce ambient concentrations below the maximum pollution standards. Under EPA's "Fugitive Dust Policy," areas that violate the TSP standards, but lack significant industrial particulate sources and have a population less than 25,000, are designated as "unclassified" (neither "attainment" nor "nonattainment"). "Unclassified" areas are generally exempt from having to follow the Clean Air Act offset provisions, retrofit controls, and new source control requirements established for "nonattainment" areas.

Through the Clean Air Act Amendments of 1977, Congress established a system for the Prevention of Significant Deterioration (PSD) of "attainment" and "unclassified" areas. Areas are classified by the additional amounts of nitrogen dioxide (NO_2), sulfur di-

Table 2-3

Federal Air Quality Standards (micrograms per cubic meter)

Pollutant	Averaging[1] Time	Ambient[2] Primary	Ambient[2] Secondary	Increment[3] Class I	Increment[3] Class II	Increment[3] Class III
Carbon Monoxide	8 hours	10,000	10,000	—	—	—
	I hour	40,000	40,000	—	—	—
Lead	Quarterly	1.5	1.5	—	—	—
Nitrogen Dioxide	Annual (Arith.)	100	100	2.5	25	50
Oxidants (Ozone)	I hour	235	235	—	—	—
Sulfur Dioxide	Annual (Arith.)	80	—	2	20	40
	24 hours	365	—	5	91	182
	3 hours	—	1,300	25	512	700
Total Suspended Particulates	Annual (Geom.)	75[4]	60[4]	5	19	37
	24 hours	260[4]	150[4]	10	37	75
Inhalable Particulates	Annual (Arith.)	50	50	—	—	—
	24 hours	150	150	—	—	—

[1] Short-term standards (those other than Annual and Quarterly) are not to be exceeded more than once each year, except the Federal ozone and PM10 standards. The "expected number of days" with ozone or PM10 levels above the standard is not to be exceeded more than once per calendar year.

[2] Ambient standards are the absolute maximum level allowed to protect either public health (primary) or welfare (secondary).

[3] Incremental (Prevention of Significant Deterioration) standards are the maximum incremental amounts of pollutants allowed above a specified baseline concentration.

[4] Federal TSP standards were superseded by the Federal PM10 standards, effective July 31, 1987. The TSP standards will be phased out over time.

Note: States may set standards more stringent than the Federal standards.

Sources: National Primary and Secondary Ambient Air Quality Standards (40 CFR 50 et seq., as revised, July 1, 1988). Requirements for Preparation, Adoption and Submittal of Implementation Plans (40 CFR 51.166, as revised, July 1, 1988).

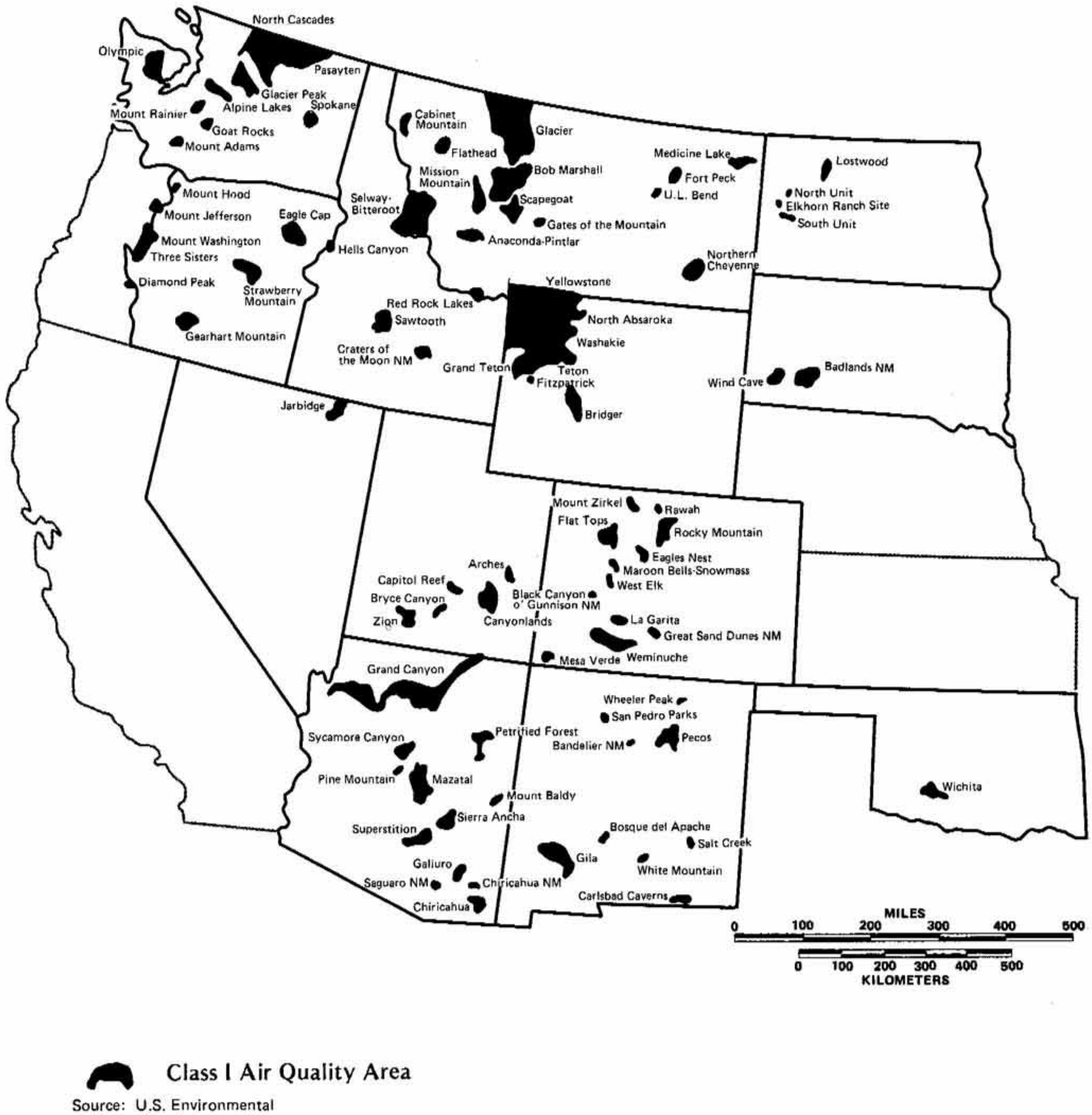
oxide (SO_2), and TSP degradation that would be allowed. PSD Class I areas, predominantly National Parks and certain Wilderness Areas, have the greatest limitations; virtually any degradation would be significant (Figure 2-5). Areas where moderate, controlled growth can take place were designated as PSD Class II. PSD Class III areas allow the greatest degree of degradation.

PSD Class I regulations also address the potential for impacts to Air Quality Related Values (AQRVs). These AQRVs include visibility, odors, and impacts to flora, fauna, soils, water, and geologic and cultural structures. A possible source of impact to AQRVs is acid precipitation.

Most of the study area has been designated as either "attainment" or "unclassified" for all pollutants. All BLM-administered lands are classified PSD Class II. Table 2-4 identifies by State the number of suspected and known "nonattainment" areas for each pollutant.

Particulate matter concentrations are expected to be higher near industrial areas, towns, and unpaved roads. Inhalable particulate levels are high in areas with significant combustion sources (urban areas, industrial facilities, residential wood smoke). Thirty-five areas are believed to exceed the Federal standards, and 43 areas are conducting monitoring to determine whether the standards are exceeded.

Similarly, TSP levels may be high because of wind-blown dust in arid locations, or from combustion sources. Eighty-four areas exceed the public health standard: 92 areas exceed the public welfare standard.



Source: U.S. Environmental Protection Agency, 1979.

Figure 2-5
Air Quality Class I Areas of the States in the Study Area

High sulfur dioxide concentrations occur primarily near coal-fired powerplants, smelters, refineries, or other industrial facilities that process materials containing sulfur. Thirty-one areas exceed the public health standard; 33 areas exceed the public welfare standard.

Two locations exceed the nitrogen dioxide standards: central Denver, Colorado; and Boise-Ada County, Idaho.

High carbon monoxide and ozone concentrations are associated mostly with transportation fuel and exhaust gases, and hydrocarbon processing (refineries). The study area contains 29 carbon monoxide and 30 ozone "nonattainment" areas.

Since the introduction of lead-free gasoline, lead concentrations have decreased significantly. Only Shoshone County, Idaho, and Bernalillo, Eddy, and Lea Counties, New Mexico, exceed the Federal standards.

Eighty-five PSD Class I areas have been designated in the study area. Most are located in the mountainous regions, but many may be found at lower elevations. Table 2-5 identifies the number of PSD Class I areas by managing agency for each State.

Visibility and acid precipitation are monitored at isolated locations in the study area.

The following analysis region descriptions are necessarily broad generalizations of very complex air quality conditions. Because this information cannot be extrapolated throughout each analysis region, site-specific monitoring is necessary to determine local conditions.

Sagebrush

With few isolated major industrial facilities and even fewer major cities, this analysis region has the best air quality in the study area. Particulate matter concentrations may be high occasionally because of transitory windblown dust. Reno, Nevada, on the

Table 2-4

Number of Suspected and Known Nonattainment Areas in the Study Area

State	PM10				Nonattainment Pollutant					
	Group		TSP		SO_2		NO_2	CO	03	PB
	I	II	1'	2'	1'	2'				
Arizona	6	7	10	10	10	10	—	5	6	—
Colorado	6	11	11	8	—	—	1	4	1	—
Idaho	4	1	6	6	3	3	1	—	—	1
Montana	6	6	11	11	5	8	—	4	—	—
Nevada	2	1	11	11	6	6	—	3	3	—
New Mexico	1	8	7	9	6	4	—	3	4	2
North Dakota	—	—	2	2	—	—	—	—	—	—
Oklahoma	—	1	6	8	—	—	—	1	6	—
Eastern Oregon	1	2	1	2	—	—	—	—	—	—
South Dakota	—	1	1	2	—	—	—	—	—	—
Utah	2	—	1	1	1	1	—	1	1	—
Washington	6	2	8	9	—	—	—	5	6	—
Wyoming	1	1	1	4	—	—	—	—	—	—
Study Area Totals	**35**	**41**	**76**	**83**	**31**	**32**	**2**	**26**	**27**	**3**

NAAQS - National Ambient Air Quality Standards
PM10 I - Inhalable Particulate Matter NAAQS (less than 10 microns in size); Group I Area (high probability of not attaining the standards)
PM10 II - Inhalable Particulate Matter NAAQS (less than 10 microns in size); Group II Area (monitoring required to determine attainment status)
TSP 1' - Primary (public health) Total Suspended Particulate NAAQS
TSP 2' - Secondary (public welfare) Total Suspended Particulate NAAQS
SO_2 1' - Primary (public health) Sulfur Dioxide NAAQS
SO_2 2' - Secondary (public welfare) Sulfur Dioxide NAAQS
NO_2 - Nitrogen Dioxide NAAQS
CO - Carbon Monoxide NAAQS
03 - Ozone (photochemical oxidant) NAAQS
PB - Lead NAAQS

Source: 40 CFR 52 et seq. (Revised as of July 1, 1988).

Table 2-5

Number of PSD Class 1 Areas in the Study Area

State	USDA-Forest Service	USDI-National Park Service	USDI-Fish and Wildlife	Tribal Governments
Arizona	8	4	—	—
Colorado	8	4	—	—
Idaho[1]	3	2	—	—
Montana[2]	7	2	3	3
Nevada	1	—	—	—
New Mexico	5	2	2	—
Eastern Oregon[3]	11	1	—	—
South Dakota	—	2	—	—
Utah	—	5	—	—
Washington	5	3	—	1
Wyoming[4]	5	2	—	—
Study Area Totals	**53**	**27**	**5**	**4**

[1] Hells Canyon Wilderness is also in Eastern Oregon. Selway-Bitteroot Wilderness is also in Montana. Yellowstone National Park is also in Montana and Wyoming.

[2] Selway-Bitteroot Wilderness is also in Idaho. Yellowstone National Park is also in Idaho and Wyoming.

[3] Hells Canyon Wilderness is also in Idaho.

[4] Yellowstone National Park is also in Idaho and Montana.

Source: Bureau of National Affairs, Inc. (1989).

west, and Salt Lake City, Utah, on the east, have high concentrations of particulate matter, carbon monoxide, and ozone (Salt Lake City also has high levels of sulfur dioxide).

Desert Shrub and Southwestern Shrubsteppe

Las Vegas, Nevada, and Phoenix, Arizona, have high particulate matter, sulfur dioxide, carbon monoxide, and ozone concentrations associated with urban industrial and transportation pollution sources. Rural areas generally have good air quality, which may occasionally be degraded by pollution from urban areas (including Southern California), isolated powerplants, copper smelters, and (under certain meteorologic conditions) industrial facilities in northern Mexico.

Chaparral-Mountain Shrub and Mountain/Plateau Grasslands

These analysis regions are distributed throughout the study area and do not exhibit unique air quality characteristics. High TSP concentrations may occur because of wind-blown dust, but other elevated air pollution concentrations are limited to locations near industrial or urban development.

Pinyon-Juniper

Albuquerque, New Mexico, is the only major urban area in this analysis region. High concentrations of particulate matter, carbon monoxide, ozone, and occasionally lead may be found there. Like the sagebrush analysis region, rural areas have some of the best air quality in the Nation. Local degradation caused by isolated powerplants and occasional high concentrations of TSP as a result of wind-blown dust may occur. Ozone levels may also be intermittently high, but the cause is unknown. Elevated ozone concentrations may be a result of long-range transport from urban areas, subsidence of stratospheric ozone, or photochemical reactions with natural hydrocarbons. The true reason for elevated ozone values is uncertain.

Plains Grasslands

High concentrations of particulate matter, nitrogen dioxide, carbon monoxide, and ozone are present in Denver, Colorado. Most of the rural areas have good air quality, except for moderate degradation near industrial facilities. High TSP concentrations as a result of wind-blown dust are common.

Coniferous/Deciduous Forest

Air quality is generally good throughout the Rocky Mountains. Isolated areas with high winter inhalable particulate concentrations are common because of a combination of residential wood-burning and mountain valley inversions. Boise, Idaho, has elevated particulate matter and nitrogen dioxide concentrations.

In the Pacific Northwest, the Seattle-Tacoma, Washington, area has high particulate matter, carbon monoxide, and ozone levels. Because of the extensive amount of forest and agricultural burning that occurs, elevated concentrations of inhalable particulates are seasonally common.

Geology and Topography

The geology of the EIS program States varies considerably. The 13 Western States extend from the high plains in the East where thick alluvial deposits overlie fractured sedimentary rocks, across the granitic and metamorphic rocks of the Rocky Mountains and the thick sedimentary sequences in the Wyoming Basin and Colorado Plateau, to the thick lava sequences of the Columbia Plateau and the thick alluvial valley fills and bedrock ridges of the Basin and Range region in the West (Figure 2-3).

Western lands contain a variety of metals and minerals, in addition to coal, oil shale, and oil and gas reserves. Other geologic resources include geothermal deposits, radionuclides, and building materials (such as sand, gravel, clay, pumice, and stone).

The topography of the Western States varies from the nearly level or gently rolling lands of the Great Plains to the steep and rugged regions of the Rocky Mountains. Elevations range from near sea level in the deserts of the Southwest to above 14,000 feet in the alpine habitats of the Rockies. The plateau areas have been subjected to stream incision and show extensive local relief (for example, the Grand Canyon and Snake River Canyon). The mountains have been uplifted and folded and also show evidence of stream dissection. Alluvial deposits occur along the courses of major rivers and streams in valleys, including the arid and semi-arid basins of the Southwest.

Sagebrush

The sagebrush analysis region occupies many of the valley areas in the Basin and Range region between the Rocky Mountains on the east and the Sierra Nevadas on the west, as well as portions of the Columbia Plateau, the northern Colorado Plateau, and the Wyoming Basin (Garrison et al. 1977). Elevations vary from 2,000 feet above sea level along the Snake River Plain to as much as 7,000 feet above sea level in the Basin, Range, and Colorado Plateau regions (Hunt 1973). Much of this intermountain area is characterized by numerous separated sediment-filled interior basins, with only a small portion of these basins draining to the sea. Except for the Snake River and its tributaries in the Snake River Plain, streams in this region are generally intermittent. In Nevada, the discontinuous ranges of the Basin and Range provinces rise steeply and disrupt the semiarid, sagebrush-covered valleys.

Desert Shrub

The desert shrub analysis region is a composite of various desert shrublands and includes the salt flats of the Great Salt Lake, the southwestern desert plains and plateaus, the western one-third of the Great Basin, the eastern edge of the Great Basin, parts of Wyoming and Big Horn Basins, and parts of the Colorado Plateau (Garrison et al. 1977). Extremely arid continental deserts lie south of the Rocky Mountains. This analysis region includes parts of the American Desert in Arizona, Nevada, and Utah, and several isolated, small desert basins in eastern Oregon, southern Idaho, and western Colorado and Wyoming. The topography is characterized by extensive plains from which isolated mountains and buttes rise abruptly. Elevations range from near sea level to 11,000 feet above sea level in some mountain ranges. The few larger permanent rivers include the Colorado, Shoshone, and Snake Rivers. In much of the region, dry washes fill with water only after infrequent rains.

Southwestern Shrubsteppe

The southwestern shrubsteppe analysis region occurs south of the Rocky Mountains. This region is made up of relatively large blocks of almost-level desert plains isolated between roughly parallel low mountains of the Sonoran Desert, the Big Horn, and the Maricopa ranges in Arizona, and across the Mexican Highlands through southern Arizona and New Mexico. This analysis region occurs at a lower altitude than the pinyon-juniper ecosystem and is often referred to as the semidesert grass-shrub type (Garrison et al. 1977). In this region, materials eroded from the mountains have formed broad alluvial fans that coalesce into large plains. Consolidated and semi-consolidated rocks predominate in this region.

Chaparral-Mountain Shrub

The chaparral-mountain shrub analysis region occupies mountain areas beginning at 5,000 feet in northern latitudes to 6,500 feet in southern latitudes. This region occurs as a narrow transition area between the arid lower elevation zones, similar to the desert shrub, southwestern shrubsteppe, and sagebrush ecosystems, and those of the higher precipitation, higher elevation regions. The chaparral-mountain shrub analysis region is generally a transition zone between the pinyon-juniper and coniferous/deciduous forest ecosystems. Slopes in these regions range from moderate to steep. The geology varies from the sedimentary rocks of the southwestern Colorado Plateau to the faulted igneous metamorphic ranges of the Basin and Range provinces, and the lower slopes of the Rocky Mountains.

Pinyon-Juniper

The pinyon-juniper analysis region occupies the mid elevations in the Upper and Lower Basin and Range Provinces with its intermingled basins and mountains, and areas within the Colorado Plateau, where it is often adjacent to sagebrush and chaparral-mountain shrub areas. Juniper usually occupies rockier and rougher terrain than sagebrush (Garrison et al. 1977). While sagebrush is common on the plains, terraces, and gentle portions of plateaus, the pinyon-juniper region tends to occupy the upslope contiguous sites of eroded and rough dissections.

Mountain/Plateau Grasslands

The mountain/plateau grasslands consist of noncontiguous areas of moderate to higher elevation grassland scattered through the northern, central, and southern Rocky Mountains, and the Palouse grasslands of the Columbia Plateau. They occur at elevations ranging from 3,000 to 9,000 feet and occupy a variety of topographical positions from level areas or valley floors, to alluvial benches and foothills, to steep mountain slopes.

Plains Grasslands

The plains grassland region, also known as the Great Plains, occurs on a broad belt of high land that slopes gradually eastward and down from an altitude of 3,000 feet at the western edge to an altitude of 900 feet in Texas, where it gives way to the prairie ecosystem. The plains grasslands region is characterized by rolling plains and tablelands of moderate relief and includes the areas known as the Great Plains and Wyoming Basin. The most striking feature of the region is the phenomenal flatness of its interstream areas, which make up a great expansive flood plain or alluvial slope (Forb 1963).

Coniferous/Deciduous Forest

Coniferous and deciduous forests occur throughout the Rocky Mountains and higher elevations (above 8,000 feet) of the Colorado Plateau, the Upper and Lower Basin and Range Provinces, and the Columbia Plateau. The forests may occur on steep mountainsides or canyon walls, or on relatively level plateaus of sufficient elevation. Topographical variation plays an important role in the occurrence of this zone. For example, north-facing slopes maintain cooler temperatures and retain more moisture than do south-facing slopes. Coniferous forests may find suitable growing conditions on north-facing slopes, while directly opposite on a south-facing slope, oakbrush or sagebrush, which tolerate drier conditions, will be found. This leads to very patchy distribution in some areas. Coniferous and deciduous forests may also extend below customary elevational limits in narrow, high-walled canyons that shade the bottom and promote cold-air drainage.

Soils

Soils in the program area are quite diverse, ranging from the arid salty soils of the southwest and clayey glaciated plains of Montana to the loamy intermountain valleys and rocky, often barren, alpine regions of the Rocky Mountains.

Soil development and formation is controlled by five soil-forming factors: (1) climate, in which temperature and precipitation are the most influential forces in the soil-forming process; (2) living organisms, particularly native vegetation, as well as animals and microorganisms; (3) nature of the parent material, including texture, structure, and chemical and mineralogical composition; (4) topographic location, which can quicken or delay the climatic factor; and (5) the length of time materials are subjected to the weathering process (Brady 1974).

These interrelated factors have contributed to the identification of five major soil orders (Figure 2-6) in the 13 Western States:

> Entisols are mineral soils that lack profile development (soil horizons) and are often called "young soils" because of this lack of pedogenic maturation. Entisols can include recent alluvium, sands, soils on steep slopes, and shallow soils. They can be quite productive; however, shallow depth, high clay content, and low plant

available moisture can limit the productivity of these soils. Entisols primarily support rangeland vegetation; but in areas of higher precipitation, they will support trees. Entisols predominate in eastern Montana and western Colorado.

Inceptisols are mineral soils that have some profile development and have at least one horizon. These are also "young soils" but have experienced higher weathering and soil-forming processes than the Entisols. These soils represent an extensive variety of settings, and no description can generalize this order. Inceptisols may form from sandstone or volcanic ash on steep mountain slopes or depressions, on top of mountain peaks, or next to rivers. In the northwest, these soils provide not only some of the best timber-producing lands, but also support rangelands. Inceptisols are the dominant soils in northern Idaho and parts of Washington.

Aridisols are mineral soils that have developed in dry regions, are light colored, low in organic matter, and may have accumulations of soluble salts and lime. The lower the precipitation, the more likely these accumulations are to be near the surface. The vegetation found on Aridisols are important contributors to the western livestock industry. These soils predominate in central Wyoming, southern Idaho, across Nevada, and much of Arizona.

Mollisols are mineral soils that have thick, dark-colored surface horizons rich in organic matter, and are very fertile. They have developed primarily under grassland vegetation used extensively for livestock grazing on the western public lands. Mollisols are one of the most productive soils in the EIS area. They are predominant in North and South Dakota, northern Montana, and eastern Oregon.

Alfisols are mineral soils that have developed in cool, wet regions, usually under a forest canopy, and have significant accumulation of clay. These soils are generally quite productive and are important producers of commercial timber. Alfisols occur in the mountains of western Montana, western Wyoming, and central Colorado.

Sagebrush

In Washington and eastern Oregon, the sagebrush analysis region consists mainly of Mollisols with black, friable, organic surface horizons and a high pH. In the Great Basin and part of the Wyoming Basin, soils of this region are Aridisols with pedogenic horizons, a low organic matter content, and accumulations of various salts in some places. The remaining soils of the sagebrush region on the Colorado Plateaus province are Aridisols and Mollisols. Aridisols dominate the basin and lowland areas and are dry throughout most of the year; Mollisols are found at higher elevations and are rich in organic matter. Basicity of Mollisols is high, and the soils remain soft when dry. Narrow bands of Entisols lie in stream flood plains. Salt flats, as well as playas, are extensive in the lower parts of the basins that have interior drainage.

Desert Shrub

The soils of the desert shrub analysis region are primarily Aridisols, found in the Great Basin and on southwestern desert plains and plateaus. They are low in organic matter but may support vegetation suitable for livestock grazing. Entisols as well as Aridisols may be found in the Wyoming basin and on the Colorado Plateaus. Entisols occur on some of the older alluvial fans and terraces, as well as in the better drained basins of the desert region.

Southwestern Shrubsteppe

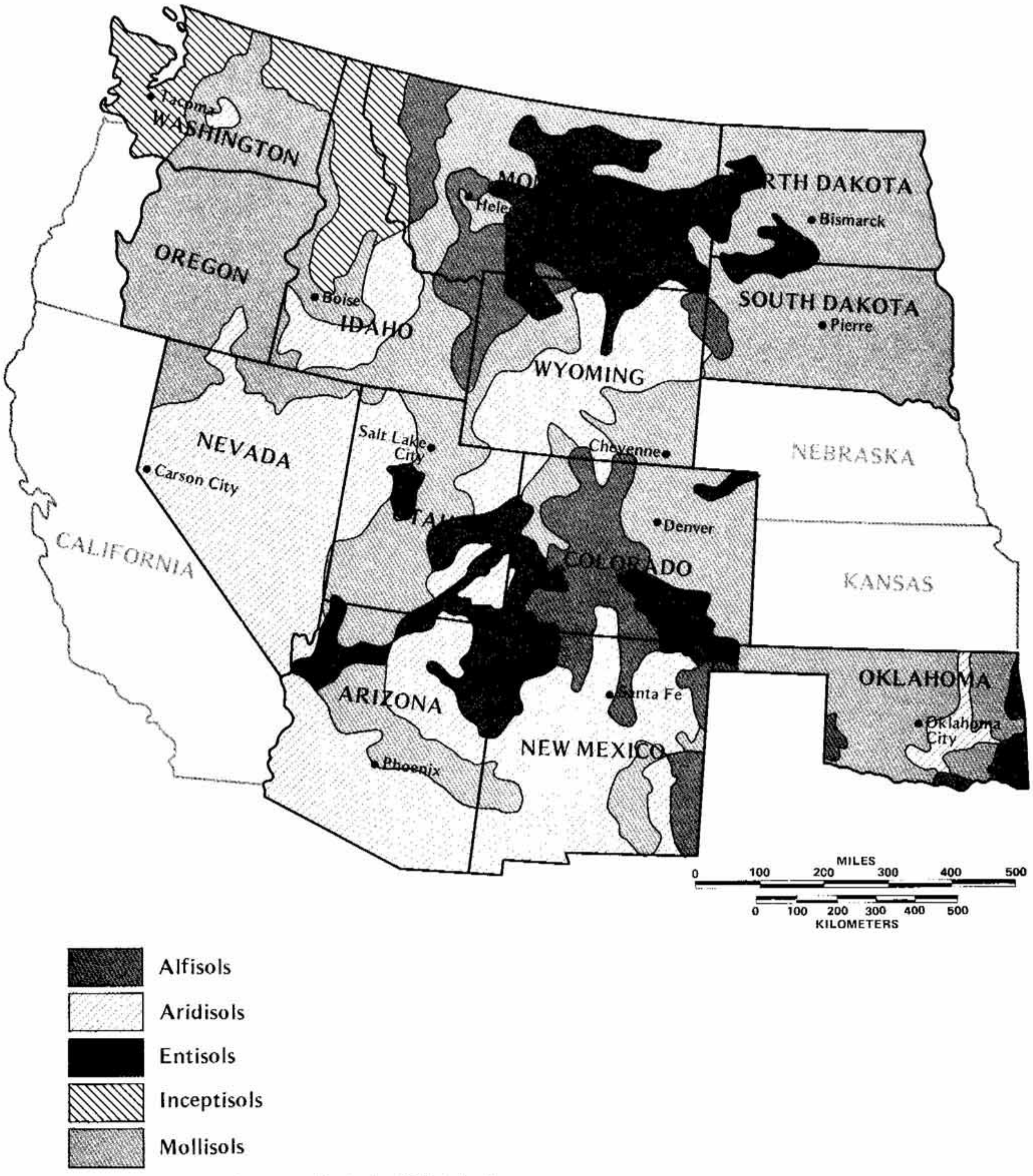
The soils of the southwestern shrubsteppe analysis region are typically Aridisols. The region's excessive heat and low rainfall are the primary mechanisms for Aridisol formation. Organic matter is present, although in low amounts. In local areas where conditions permit, Mollisol and Entisol soils have developed.

Chaparral-Mountain Shrub

In the Rocky Mountains, the chaparral-mountain shrub analysis region contains Mollisols that may have a subsurface horizon of clay. In the southern edge of the Basin and Range province and the upper Gila Mountains, Aridisols that have a low content of organic matter, and a horizon of accumulated clay may be found.

Pinyon-Juniper

In the Basin and Range province, the pinyon-juniper analysis region includes Aridisols, which have a moderate-to-low organic matter content and may have accumulations of carbonates. In the Colorado Plateaus, the woodland contains Aridisols; Entisols, which have no pedogenic horizons; and Mollisols, which have an organic surface horizon and a high pH.



Source: Buckman, H.O. and MN.C. Brady, 1969. The Nature and Properties of Soils. The MacMillian Company, Collier-MacMillan Limited, London.

Figure 2-6
Major Soil Orders of the States in the Study Area

Mountain/Plateau Grasslands

Aridisols, which can be found in all basins and lowland areas, as well as in the deserts and plains, are the dominant soil type of the plateau analysis region. Some Entisols are found in narrow bands in the Colorado Plateau stream flood plains; Aridisols and Mollisols with developed horizons are located in central Colorado. In the Yellowstone River area of south-central Montana, the grassland soils are Entisols with no horizon development. Soils in the grasslands of the northern Rocky Mountains are Mollisols. Mollisols are also the principal soils of the Columbia Plateau's foothills or Palouse hills.

Plains Grasslands

Soils in the plains grasslands analysis region are varied. Mollisols and Entisols are found from the Canadian border to the southern boundary of the region in Texas. The Wyoming basin has extensive alluvial deposits in stream flood plains and in fans at the foot of mountains.

Coniferous/Deciduous Forest

Soils of the coniferous/deciduous forest analysis region vary tremendously. Soils along the western edge of the Columbia Plateau and the east slope of the Cascade Mountains include Mollisols, Inceptisols, and Entisols. At the northern edge of the Columbia Plateau and in much of the northern Rocky Mountains, these forests occur primarily on Inceptisols. Soils of the rest of these areas are largely Alfisols and Entisols. In the middle and southern Rocky Mountains, coniferous forests occur on Mollisols, Entisols, and Alfisols. Coniferous forests in the Gila Mountains are largely Mollisols.

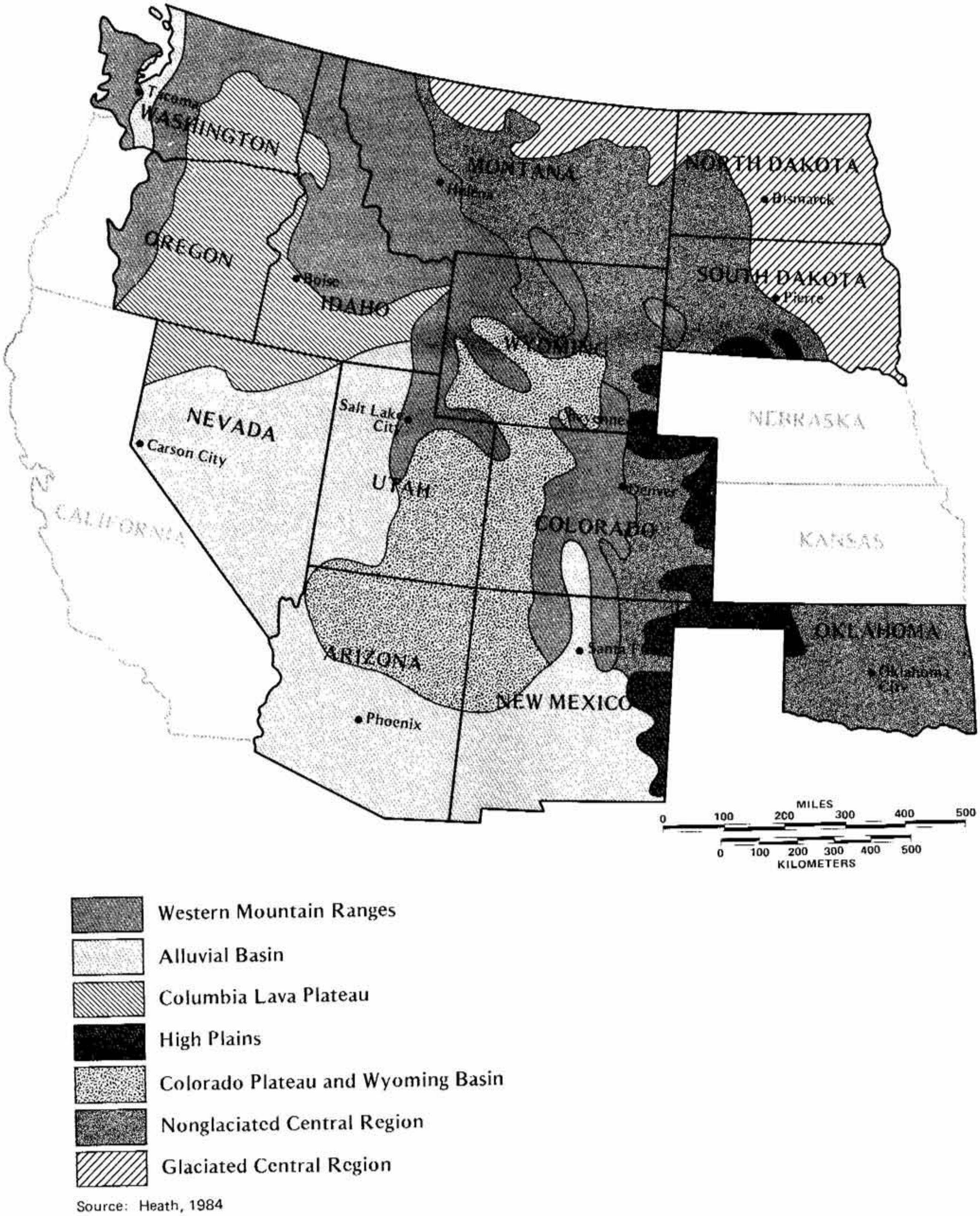
Aquatic Resources

Water availability varies greatly in the Western States, from abundant in the mountains to extremely scarce in the desert. Mountainous areas have natural lakes and large, deep reservoirs. Water supply is low to moderate in the tall- and shortgrass prairies. Surface lakes, shallow wells, and streams are used for irrigation and livestock watering. Intermittent waters, such as prairie potholes, are important breeding grounds as well as migration stops for waterfowl and other wetland species. Many areas of the southwest and intermountain areas are characterized by low precipitation and may have limited water sources. Surface water for irrigation and livestock comes from the numerous reservoirs on major rivers, smaller streams and lakes, ponds, and springs.

The ground-water resources of the BLM lands include outcropping, unconsolidated geologic formations with unconfined water tables (including alluvial valley deposits), and confined aquifers (generally consolidated rock) overlain by relatively impermeable formations (Figure 2-7, Table 2-6). Confined aquifers receive recharge from the surface where they are exposed, typically in upland, mountainous areas. Because of the overlying low permeability formations and the lack of infiltration from precipitation, confined aquifers in the EIS region rarely receive recharge in the lower elevation plateaus and desert plains (Table 2-7). Unconfined aquifers may have water tables ranging in depth from near the surface to more than 100 feet, as recharge from the surface may be minimized by extensive evapotranspiration and low precipitation input. Water tables of unconfined aquifers may approach and intersect the surface along the channels of major permanent streams in the alluvial aquifers. Ground water may be abundant in those valleys where deep alluvium increases aquifer storage capacity. Where available, ground water is used for agricultural irrigation, livestock watering, and population water supplies. Ground water is used extensively in the West as a domestic water supply ranging from 90 percent of the population in Arizona, Idaho, Nevada, and New Mexico to less than 50 percent in Colorado, Oklahoma, and Oregon. These water sources vary in depth and aerial extent, and it is not uncommon for BLM lands to be above or near them.

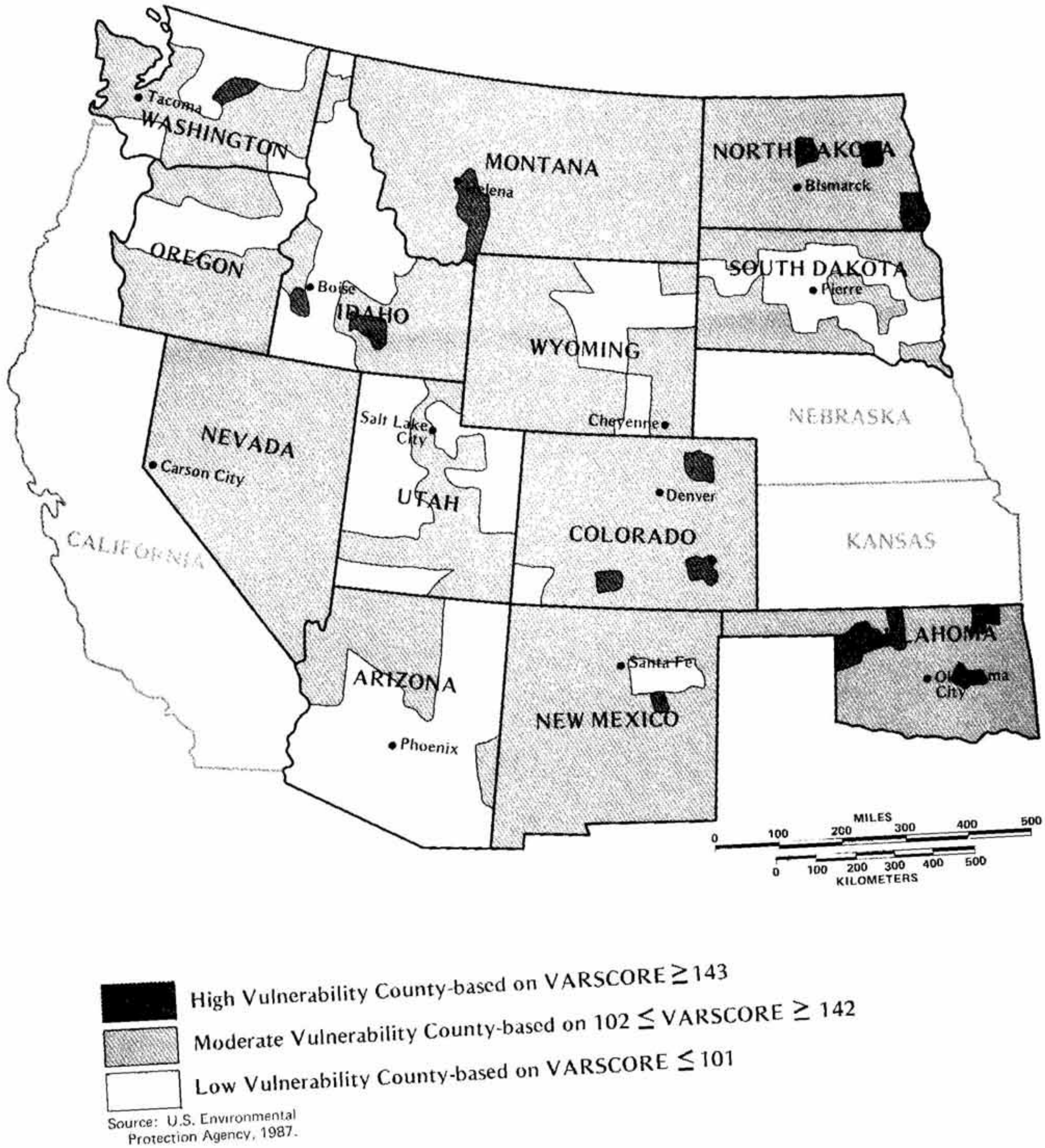
Recent ground water studies have shown a greater number of water supplies to be contaminated with pesticides. Generally, shallower supplies are at greater risk than deeper ones. Contaminants have been shown to include a number of insecticides and herbicides. It is generally recognized that these pesticide contaminants originate from agricultural lands and poor application practices.

The EPA in response to the concern for ground water contamination developed a rating system to delineate ground-water contamination vulnerability. This system, known as DRASTIC (Aller et al. 1985), has been used nationwide and uses factors of depth to water, net recharge, aquifer media, soil media, topography, impact to unsaturated zone, and gross hydraulic conductivity to identify potential vulnerability areas. Figure 2-8 shows those vulnerability areas for the EIS area. Most of the areas in Figure 2-8 are in the low and moderate vulnerability category. However, the information presented in EPA (1987) was constructed with very general data and may over or underestimate vulnerability. For example, areas having higher than normal recharge patterns would not be identified. Such areas would have a higher vulnerability than is shown on Figure 2-8. Care should be taken to make sure the DRASTIC system is applied properly at the site-treatment level.



Source: Heath, 1984

Figure 2-7
Ground-water Regions of the States in the Study Area



Source: U.S. Environmental Protection Agency, 1987.

Figure 2-8
Categories of Ground-water Vulnerability of the States in the Study Area

Table 2-6

Summary of the Principal Physical and Hydrologic Characteristics of the Ground-Water Regions of the States in the Study Area

	Components of the System											Characteristics of the Dominant Aquifers																		
												Water-Bearing Openings					Composition		Storage and Transmission Properties						Recharge and Discharge Conditions					
	Unconfined Aquifer			Confining Beds		Confined Aquifers			Presence and Arrangement			Primary			Secondary		Degree of Solubility		Porosity			Transmissivity			Recharge			Discharge		
	Hydrologically insignificant	Minor aquifer or not very productive	Dominant aquifer	Hydrologically insignificant	Interlayered with aquifers	Hydrologically significant	Not highly productive	Multiple productive aquifers	Single unconfined aquifer	Two interconnected aquifers	Complex interbedded sequence	Pores in unconsolidated deposit	Pores in semiconsolidated rocks	Tubes and cooling cracks in lava	Fractures and faults	Solution-enlarged openings	Insoluble	Mixed soluble and insoluble	Large (greater than 0.2)	Moderate (0.01-0.2)	Small (less than 0.01)	Large (greater than 2,500 $^2day^{-1}$)	Moderate (250-2,500 m^2day^1)	Small (25-250 m^2day^1)	Uplands between streams	Losing streams	Leakage through confining beds	Springs and surface seepage	Evaporation and basin sinks	Into other aquifers
Western Mountain Ranges	—	X	—	X	—	—	X	—	—	X	—	X	—	—	X	—	X	—	—	X	—	—	—	X	X	X	—	X	—	—
Alluvial Basins	—	—	X	—	X	—	—	X	—	—	X	X	—	—	—	—	X	—	X	—	—	X	—	—	—	X	—	—	X	X
Columbia Lava Plateau	—	X	—	—	X	—	—	X	—	—	X	X	—	X	X	—	X	—	—	—	X	X	—	—	—	X	—	X	—	—
Colorado Plateau and Wyoming Basin	X	—	—	—	X	—	—	X	—	—	X	—	X	—	X	—	X	—	—	—	X	—	—	X	X	—	X	X	—	—
High Plains	—	—	X	X	—	X	—	—	X	—	—	X	—	—	—	—	X	—	X	—	—	X	—	—	—	X	—	X	—	—
Nonglaciated Central Region	—	X	—	—	X	—	—	X	—	—	X	—	X	—	X	X	—	X	—	—	X	—	X	—	X	—	X	X	—	X
Glaciated Central Region	—	X	—	—	X	—	—	X	—	—	X	X	X	—	X	X	—	X	—	X	—	—	X	—	—	—	X	—	—	X

Source: Heath, 1984.

Table 2-7

Common Ranges on the Hydraulic Characteristics of Ground-Water Regions of the States in the Study Area

		Common Ranges in Hydraulic Characteristics of the Dominant Aquifers							
		Transmissivity		Hydraulic Conductivity		Recharge Rate		Well Yield	
Region	Geologic Situation	m^2 day^{-1}	ft^2 day^{-1}	m day^{-1}	ft day^{-1}	mm yr^{-1}	in. yr^{-1}	m^3 min^1	gal min^1
Western Mountain Ranges	Mountains with thin soils over fractured rocks, alternating with narrow alluvial and, in part, glaciated valleys	-100	5-5,000,000	0.0003-15	0.001-50	3-50	0.1-2	0.04-0.4	10-100
Alluvial Basins	Thick* alluvial (locally glacial) deposits in basins and valleys bordered by mountains	20-20,000	2,000-200,000	30-600	100-2,000	0.03-30	0.001-1	0.4-20	100-5,000
Columbia Lava Plateau	Thick sequence of lava flows interbedded with unconsolidated deposits and overlain by thin soils	2,000-500,000	20,000-5,000,000	200-3,000	500-10,000	5-300	0.2-10	0.4-80	100-20,000
Colorado Plateau and Wyoming Basin	Thin* soils over fractured sedimentary rocks	0.5-100	5-1,000	0.003-2	0.01-5	0.3-50	0.01-2	0.04-2	10-1,000
High Plains	Thick alluvial deposits over fractured sedimentary rocks	1,000-10,000	10,000-100,000	30-300	100-1,000	5-80	0.2-3	0.4-10	100-3,000
Nonglaciated Central region	Thin regolith over fractured sedimentary rocks	300-10,000	3,000-100,000	3-300	10-1,000	5-500	0.2-20	0.4-20	100-5,000
Glaciated Central region	Thick glacial deposits over fractured sedimentary rocks	100-2,000	1,000-20,000	2-300	5-1,000	5-300	0.2-10	0.2-2	50-500

Note: All values are rounded to one significant figure.

* An average thickness of about 5 was used as the break point between thick and thin.

Source: Heath, 1984.

Sagebrush

Surface Water

Water resources associated with sagebrush communities generally are limited because of the low precipitation in much of this region. Streams and rivers typically originate in higher elevation zones and flow through more arid sagebrush regions. Stream systems that are relatively stable (without incised channels) in soils with good water-holding capacity can store large quantities of water during episodes of overbank flooding, resulting in local ground-water development. This stored water is later released when upstream supplies are limited. Incised streams may often not provide significant localized ground-water systems and often result in ephemeral conditions. Other perennial or intermittent surface streams may be present because of significantly large ground-water systems. Other natural surface water sources are springs and seeps supplied by a range of ground-water systems. Some may provide very persistent water from year to year, while others may dry up in late summer or during drought periods. Ponds and lakes seldom occur naturally in sagebrush regions and are more often associated with spring and reservoir development.

Water quality is generally acceptable for most wildlife and livestock use, with pH above 7.0, high alkalinity, and elevated dissolved solids (greater than 200 milligrams per liter (mg/L). Usually, temperature and sediment are the limiting water quality criteria for fisheries. Temperature extremes respond to the air temperature, topographic and vegetative shading, and the associated ground-water system. Sediment sources include adjacent rangeland, stream banks, and in-channel deposits. Sediment also causes a problem for agriculture by filling diversions, ponds, and canals.

Sagebrush watershed systems routinely undergo extreme flooding. Unprotected areas without vegetation can yield large amounts of water. Where runoff water is concentrated, erosional rills and eventual gully systems can develop, impeding transportation, draining ground water, and producing problems with aesthetic quality.

Water use in sagebrush regions is limited because of the limited water supply. Typical uses include livestock and wildlife watering, irrigation, domestic use, passive and active recreation, and fisheries.

The Basin and Range region is the driest in the United States, with large parts of it being classified as semiarid and arid. Annual precipitation in the valleys in Nevada and Arizona ranges from 4 to 16 inches. Most of the ground-water resources receive their recharge from rainfall on adjacent, higher elevation mountains and ridges. Surface streams originate in these higher rainfall areas and flow through the sagebrush region. Because of the very thin cover of unconsolidated material in the mountains in the Basin and Range areas, precipitation runs off rapidly down the valleys and out onto the fans, where it infiltrates into the alluvium. The center of many basins consists of flat-floored, vegetation-free areas onto which ground water may discharge and on which overland runoff may collect during intense storms.

Precipitation in the sagebrush portion of the Columbia Plateau provides generally small and marginal sources of water. The Columbia, Snake, and Colorado Rivers are the principal surface waters and provide hydroelectric power, as well as reservoir resources. The water sources of the Columbia and Snake Rivers are especially important because they support the extensive irrigation projects that support agricultural crops and livestock in this area.

Ground Water

Ground-water resources in the sagebrush analysis region consist of areas within the central and northern Basin and Range Region, the western Columbia Plateau, most of the Wyoming Basin, and portions of the Colorado Plateau. Ground water is a major source of water in the Basin and Range region. Many of the valleys in this region have been developed for agriculture. Because of the dry climate, agriculture requires extensive irrigation. This irrigation water is obtained from ground-water wells drawing from the sand and gravel deposits in the valley alluvium.

The Colorado Plateau and Wyoming Basin areas are dry, sparsely populated regions in which most water supplies are obtained from the perennial streams that flow from the bordering mountains. Thin unconsolidated deposits of alluvium capable of yielding small-to-moderate supplies of ground water occur along valleys and major streams. Less than 5 percent of the water needs are supplied by ground water, and the development of even small ground-water supplies requires detailed knowledge of the rock units and their structure, as well as the chemical quality of the water.

Mineralized or saline water (greater than 1,000 mg/L of dissolved solids) is widespread as a result of the solution of gypsum and halite beds, especially within lower elevation shales and siltstones. Freshwater (less than 1,000 mg/L dissolved solids) occurs only in the most permeable sandstones and limestones. Because of the large surface relief and dip of the aquifers, wells even for domestic or small livestock must penetrate to depths of a few hundred yards in much of the area. Water is plentiful in the Snake River area of the Columbia Plateau and is used extensively for irrigation (USDA 1981). Small reservoirs supply additional water for irrigation and recreation; a few terminal lakes are used mainly for recreation. In the Colorado Plateau, the sandstone deposits provide the principal sources of ground water in the region and contain water in fractures developed along bedding planes and across the beds in interconnected pores (Heath 1984). Much of the Columbia Plateau is in the rain shadow east of the Cascades, and as a result, receives only 8 to 48 inches of precipitation annually. The areas that receive the least rain in the Plateau are the sagebrush regions immediately east of the Cascades and the plains area of the Snake River.

Recharge to the ground-water system depends on several factors, including the amount and seasonal distribution of precipitation and the permeability of surficial materials. Most precipitation occurs in the winter and thus coincides with the cooler, nongrowing season when conditions are most favorable for recharge. Considerable recharge also occurs by infiltration of water from streams that flow onto the plateau from the adjoining mountains. Discharge from the ground-water system occurs as seepage to streams, as spring flow, and by evapotranspiration in areas where the water table is at or near the land surface. The famous Thousand Springs and other springs along the Snake River canyon in southern Idaho are among the most spectacular displays of ground-water discharge in the world. The alluvial valley fill deposits in the Basin and Range area also provide a major source of water for agriculture. Elsewhere in this region, ground-water supplies are limited and largely untapped. Shallow wells commonly contain large amounts of salt.

Desert Shrub

Surface Water

Annual precipitation in this region averages between 5 to 10 inches, although some desert areas may average less than 4 inches of annual precipitation. Surface water resources are limited because of the meager rainfall, which is only 20 percent of the frost-free season evaporation potential (Garrison et al. 1977). Like the sagebrush ecosystem, the few larger surface streams that flow through the desert shrub ecosystem originate in higher rainfall, higher elevation foothills and mountain areas. The large surface streams have many dams and reservoirs to help supply irrigation water for agriculture in this region, particularly the Colorado, Snake, and Gila Rivers. The Colorado River has acquired a higher salinity in recent years, so careful evaluation of present and future watershed management practices will determine the magnitude and duration of this water quality issue. The water resources of this region offer a unique habitat to wildlife in an otherwise arid region.

Surface water is very important in these areas and is usually dependent upon water originating from higher elevation watersheds or large ground-water systems. Perennial river systems are uncommon. Most watershed drainages are ephemeral, flowing only during periods of extreme precipitation. Where river systems are absent, the only permanent source of water occurs as seeps, springs, and wells. Other water sources resembling ponds are supplied by occasional precipitation and occur naturally and artificially. Flooding occurs in winter, spring, and summer; flash flooding is common in summer.

Surface water quality is generally poor, limited by high dissolved solids, sediment, and high temperature. Surface drinking water supplies are limited to supporting wildlife and livestock.

Riparian habitats are usually limited to those areas having perennial surface water. Stream channels are generally low gradient with fine-textured substrates. Typical riparian vegetation consists of saltcedar, certain species of cottonwood and willow, and grass-like species.

Ground Water

The absence of extensive surface water resources emphasizes the importance and dependence upon the ground-water resources in this region. Irrigation water is obtained from large springs in Nevada and local wells in various areas. These water sources are also used to supply livestock with drinking water year-round. Ground-water quality is variable; however, most potable water systems make use of these subsurface supplies. The ground water of this region, like portions of the sagebrush region, is concentrated in the alluvial valley deposits and sedimentary basin fills. Extensive ground-water withdrawals from these alluvial deposits result in their compaction and consequent subsidence in the ground surface. In areas of southern Arizona, more than 13 feet of subsidence have been observed (Heath 1984). Additionally, the dependence on ground-water resources in this ecosystem has been aggravated by the need to preserve unique and critical ground-water pools and habitats, such as that of the desert pupfish.

Southwestern Shrubsteppe

Water resources in the southwestern shrubsteppe region are very limited because of the low precipitation. Surface water is very important in these areas and is usually dependent upon water originating from higher elevation watersheds or large ground-water systems. Perennial river systems are uncommon. Most watershed drainages are ephemeral, flowing only during periods of extreme precipitation.

Where river systems are absent, the only permanent source of water occurs as seeps, springs, and wells. Other water sources resembling ponds are supplied by occasional precipitation and occur naturally and artificially.

Surface Water

The surface water of this region is generally limited to ephemeral streams that are present only immediately after thunderstorms. The southwestern shrubsteppe region typically receives less than 7 inches of precipitation annually. In addition, there are larger rivers that cross the southwestern shrubsteppe, such as the Pecos and Rio Grande, and the upper reaches of the Gila River, but these are dependent upon the greater rainfall and runoff received in their headwater reaches in the Rockies to traverse this arid region year-round. Although these water resources may be temporally and/or spatially limited, they are quite significant because they provide vital sources of water for wildlife and livestock in a relatively arid environment. Reservoirs along these major rivers also provide surface water habitats and irrigation resources. Areas of this analysis region are used as rangeland, except where converted to irrigation farming. Flooding occurs in winter, spring, and summer; flash flooding is common in summer.

Surface water quality is generally poor, limited by high dissolved solids, sediment, and high temperature. Surface drinking water supplies are limited to supporting wildlife and livestock.

Riparian habitats are usually limited to those areas having perennial surface water. Stream channels are generally low gradient with fine-textured substrates. Typical riparian vegetation consists of saltcedar, certain species of cottonwood and willow, and grass-like species.

Ground Water

The ground-water wells of this analysis region are similar to those of the other regions that occur in the Basin and Range region. The alluvial valley deposits are tapped for their ground-water resources in the southwestern shrubsteppe region and provide most of the water for the area's agricultural practices, industry, and population centers. Significant ground-water resources occur within the thick alluvial sequences that drape from the southern perimeter of the Colorado Plateau and the southern Rocky Mountains.

Chaparral-Mountain Shrub

Surface Water

Surface water resources of the chaparral-mountain shrub region are limited. Because this region generally occurs adjacent to higher elevation areas, it receives more precipitation than lower elevation desert regions, sometimes more than 28 inches annually. The milder temperatures associated with the higher elevations also help to offset the oppressive heat that occurs in the lower elevation regions. Precipitation often occurs in association with thunderstorms, and despite the high runoff and "flash" flooding in ephemeral washes caused by the sloping nature of the chaparral-mountain shrub lands, the dense vegetation of deciduous and evergreen trees and understory brush generally reduce significant slope erosion. Those surface water streams that flow through this region typically have their headwaters established in the nearby mountains. The annual rainfall, the potential evapotranspiration, and the sloping character of this region reduce the establishment of any large surface water bodies, lakes, or ponds.

Ground Water

The chaparral-mountain shrub analysis region occurs between the ground-water recharge areas along the upland ridges and mountains and the lower lying basin and valley discharge areas. Depending upon local geological conditions, springs and seeps may be present and provide localized areas with water year-round. Although ground-water resources are limited, they may often be the only reliable source of water in this region because of the dependence of surface water streams on rain and snowfall conditions in the higher elevations during the winter months. In the chaparral-mountain shrub region, ground-water storage capacity is limited because of thin soils and shallow crystalline bedrock. Although fractured bedrock can provide increased ground-water storage, the best opportunities for ground-water resources exist in those areas that contain at least moderate thicknesses of hillside colluvium or areas underlain by permeable sedimentary or volcanic rock.

Pinyon-Juniper

Surface Water

In the pinyon-juniper analysis region, more than one-half of the annual precipitation occurs in winter;

consequently, there is a general deficiency of moisture throughout much of the year. Only several of the larger streams and their tributaries maintain a yearlong flow, and most of these have their headwaters in higher elevation regions, recharged by snowmelt in the mountains. Much of the water in the streams is stored in reservoirs and is used for irrigation and municipal water supplies. Small natural and artificial lakes at the higher elevations are used for fishing and other recreation.

Runoff from these areas can be extreme, resulting in deeply incised channels and large sediment supplies to downstream areas. Downward channel erosion is limited by bedrock. Surface runoff can be controlled by minimizing the extent of bare soil.

Water quality is generally poor because of high dissolved solids, sediment, and temperature. Use of the water is therefore limited to wildlife and livestock drinking water.

Riparian habitat is limited to areas having permanent water. Vegetation occurs mainly as grass and sedge components.

Ground Water

Ground water is limited and usually occurs only at great depth. Along the western slope of the Rocky Mountains and the Colorado Plateau, the pinyon-juniper region occurs between the higher elevation zones of ground-water recharge and the lower elevation ground-water discharge areas. Some water for irrigation is pumped from deep wells and is generally good quality. The water table in this region is dropping because of pumping in excess of the aquifer recharge. Like the chaparral-mountain shrub region, the ground-water storage capacity in the pinyon-juniper region is limited because of thin soils and shallow crystalline bedrock. Fractured bedrock can provide increased ground-water storage, but the often rugged and irregular topography does not provide much opportunity for ground-water resource development.

Mountain/Plateau Grasslands

Surface Water

In the Columbia Plateau, segments of the Snake and Columbia Rivers drain through the plateau grasslands areas. The more isolated mountain grasslands include areas of Montana, drained by the headwaters of the Missouri River and the upper reaches of the Yellowstone and Bighorn Rivers. This abundance of surface water is contrasted with the Colorado Plateau grasslands, which are more arid.

In this Colorado Plateau grassland region, water is scarce and the low precipitation and intermittent streamflow provide a small amount of water for agriculture. The Little Colorado River, the San Juan River, and the Rio Grande drain through the area but have their headwaters in the higher elevation pinyon-juniper and ponderosa pine areas. Numerous dams and reservoirs have been constructed to more efficiently manage surface water resources in this region. Water from the Navajo Lake in northern New Mexico is to be used for an irrigation project planned for the San Juan River Valley region.

Ground Water

Ground water is plentiful in some areas, although it has been noticeably decreasing over the past several years because of extensive use. Most recharge occurs in the winter during the snowmelt periods. In the Columbia Plateau, the fractured basalt groundwater system is recharged by precipitation and the infiltration of stream water on the plateau surface. In the Colorado Plateau, water moves down the dip of the sedimentary beds, away from the higher elevation recharge areas to discharge along the channels of major streams through seeps and springs, and along the walls of the canyon cut by the streams. The dependence on ground water for irrigation and livestock watering in the mountain/plateau grasslands region requires prudent management of this limited resource.

Plains Grasslands

Surface Water

The northern and eastern portions of this region contain many kettle lakes and prairie potholes that are important to wildlife. The southern sections have many playa lakes; most of these are intermittent, although some are moist year-round. The relatively few perennial streams are typically broad, sluggish, and silt-laden. Many ponds and small reservoirs have been constructed on intermittent streams, and large reservoirs have been constructed on larger rivers.

Water quality is generally good, capable of supplying any use. Some salinity problems can occur because of agricultural irrigation practices or where salts are allowed to accumulate near the soil's surface.

Stream channels are generally of low gradient in fine to moderately fine substrates. Woody vegetation, particularly cottonwood and willow play an important role in providing stability and cover. Slow moving streams, ponds, and bogs provide ideal conditions for sedge, tule, and willow development. Substrates can provide ideal fisheries habitat, except where excessive erosion may provide sediment that fills pools and covers gravel areas.

Ground Water

The High Plains region is underlain by alluvial materials derived from the Rocky Mountains, referred to as the Ogallala Formation, which forms one of the most productive and most intensively developed aquifers in the United States. Natural discharge from the aquifer occurs to streams and seeps along the eastern boundary of the plains.

The widespread occurrence of permeable layers of sand and gravel, which permit the construction of large-yield wells almost any place in the region, has led to the development of an extensive agricultural economy largely dependent on irrigation. Most of this water is derived from ground-water storage, resulting in a long-term continuing decline in ground-water levels in parts of the region of as much as 3 feet per year. In areas where intense irrigation has long been practiced, the depletion of ground-water storage is severe. The lowering of the water table has resulted in a 10- to 50-percent reduction in the saturated thickness of the High Plains aquifer in an area of 12,000 square miles (Heath 1984). Although the decline in the water table and reduction in the saturated thickness are cause for concern, from a regional standpoint the depletion does not represent a large part of the storage that is available for use. Future developments in High Plains ground-water resources should be oriented toward maintaining aquifer conditions to ensure water supplies for later use.

Coniferous/Deciduous Forest

Surface Water

Water is generally abundant in the central and northern sections of this region. Many of the larger surface streams that flow through these regions originate in the mountains. Natural lakes are common, and numerous large and deep reservoirs have been constructed on major rivers to provide water for irrigation, power, and domestic and municipal uses. Most natural lakes and ponds are relatively shallow and are rich in organic matter. Reservoirs are typically much deeper and colder, and are relatively nutrient poor.

Water quality in most cases is very good, suitable for any use. Typical total dissolved solids are below 100 mg/L and are regulated by the solubility of the geologic formations. Temperature and dissolved oxygen are suitable for cold water fisheries where topographic and vegetative shading provide solar radiation control.

Water use in the coniferous forest regions is limited to drinking water supplies for livestock, wildlife, and people. Occasionally, water is used during mining and construction.

Streams can be described in terms of erosional and depositional segments. Depositional segments generally have high gradients (greater than 0.01 feet per foot) with bedrock or course substrate, or depositional segment, with lower gradients and finer substrate. Erosional segments are often confined by the valley walls, and as a result, streamside vegetation is limited to conifers and whatever wetland vegetation can exist in the limited soil. Large organic debris may be important in providing aquatic habitat diversity. Depositional segments often provide highly productive wetland vegetation.

Ground Water

Ground water, relatively abundant in many valleys, is used for irrigation and livestock watering. In ridges and in intermountain basins, ground water is usually scarce. Water quality in the region is generally good, although salinity is a problem in the lower reaches of many major streams. Southern sections of this region and lower elevations have more moderate supplies of water. Ground-water supplies are limited.

Fish and Wildlife

No single Federal or State agency manages more fish and wildlife habitats than the Bureau of Land Management. The 158 million acres in this 13 State EIS area sustain an abundance and diversity of fish and wildlife resources. As population pressures restrict American wildlife habitats, the varied habitats on public land are becoming increasingly important in maintaining a national fish and wildlife heritage. The public lands provide a permanent or seasonal home for more than 3,000 species of mammals, birds, reptiles, fish, and amphibians.

Public lands provide significant portions of the habitat of many of the species that have made tremendous recoveries in their numbers since the turn of the century. One of the most dramatic increases in numbers has occurred with the pronghorn antelope. Public lands make up about 45 percent of the habitat of the pronghorn antelope in the West (BLM 1988). Approximately 288,000 currently occur on public lands in the EIS area (BLM 1988); in 1922-24 the entire U.S. population of pronghorns was estimated at only 13,000 head (Wildlife Management Institute 1980). BLM also manages 80 percent of the remaining habitat for the desert bighorn sheep (BLM n.d.). Their populations have been expanded dramatically in recent years through transplants and habitat and water developments, increasing in the mid-1980s to around 5,000 in the EIS area (BLM 1988). The public lands also provide habitat for many of the 78 endangered and threatened wildlife species that occur in these 13 States (50 CFR 17.11) (Appendix H). Wildlife habitat management on the public lands will continue to be significant to the recovery of many of these species.

With the tremendous variation of terrestrial habitats on public lands, from alpine mountain crests in Montana to near sea level, hot, arid deserts in southwestern Arizona, there is a comparable variety of wildlife species. Wildlife species range from mountain goats and grizzly bears to Gila monsters and javelina. For this document, however, the habitats found at the extreme limits of climatic situations do not lend themselves to the types of vegetation treatments analyzed in this EIS because of the tremendous limitations in growing conditions. Therefore, there will be few impacts to their wildlife communities, and it is unnecessary to discuss them in great detail. Likewise, there are small localized wildlife species (for example, most invertebrates) that can only be addressed in general terms because the impacts would be site-specific and would require careful consideration in the site-specific activity plans. The primary discussion in this affected environment chapter will be limited to those species that would most likely be affected on a general scale.

Perhaps the consistently most significant wildlife habitats on public lands are the riparian habitats. As a general practice the riparian areas will be avoided by the treatments proposed in this EIS; however, a few manual, herbicide, and burning treatments will be used in riparian areas primarily for the purpose of controlling exotic, undesirable vegetation.

Undisturbed riparian ecosystems normally provide abundant food, cover, and water, and often contain some special ecological features or combination of features that are not often found in upland areas. Consequently, riparian ecosystems are extremely productive, and have diverse habitat values for fish and wildlife. The importance of riparian ecosystems can be attributed to specific biological and physical features, including:

(1) Predominance of woody plant communities;

(2) Presence of surface water and abundant soil moisture;

(3) Close proximity of diverse structural features (live and dead vegetation, water bodies, nonvegetated substrates), resulting in extensive edge and structurally heterogeneous wildlife habitats;

(4) Distribution in long corridors that provide protective pathways for migrations and movements between habitats. (Brinson et al. 1982)

The wildlife group most directly affected by the quality of riparian habitat are the fisheries communities. The quality of fisheries habitat has a direct correlation to the health of the riparian community (AFS 1980). Riparian areas are also extremely significant to bird populations. Eighty-two percent of breeding birds in northern Colorado occur in riparian areas, and 51 percent of all bird species in the Southwestern States are completely dependent on riparian areas (Knopf et al. 1988). Riparian areas also attract a disproportionate number of migrating bird species. In comparison to surrounding uplands, riparian areas may attract up to 10 times the variety of bird species in the spring, and 14 times the numbers in the fall (Knopf et al. 1988). Other vertebrate species are also highly dependent on riparian areas (Knopf et al. 1988). Xeroriparian areas are also significant wildlife habitats and should receive special consideration in treatment planning. The significance of xeroriparian areas as wildlife habitats have been demonstrated for the full realm of desert wildlife species, from mule deer (Krausman et al. 1985) through the avian species (Johnson and Haight 1985).

The aquatic habitats are as diverse as the terrestrial habitats, ranging from portions of the Columbia and Snake River systems to isolated springs in the hot desert regions. Both anadromous and resident fish species occur, including introduced species as well as native species. Many aquatic stream environments do not easily lend themselves to divisions by analysis regions because they flow through several vegetation zones, with the headwaters in the higher elevations in coniferous or alpine regions and flowing down into grassland or desert regions, often within a few miles. Streams often have their headwaters on non-BLM-administered lands.

Fisheries will be divided into three categories for ease of discussion. Anadromous fisheries are cold water habitats used by fish species that migrate from the ocean up a fresh water stream to spawn, with the young returning to the ocean to mature. Typical anadromous species include the Pacific and coho salmon and the steelhead trout. Cold water resident fisheries are cold water habitats; streams are characterized by low water temperature, definite channel gradient, sand, gravel or rock substrate, strong currents, high oxygen content, low nutrient values, and lack of rooted aquatic vegetation (Smith 1966). The classification is less definite for lakes: generally the water temperature remains cold year-round (below 60° F), nutrient values are low, and aquatic plants are not abundant (USDI 1986x). Typical fish species in cold water habitats include the native cutthroat, Apache and Gila trout, native suckers and minnows, and the widely introduced rainbow, brook, and brown trout. Warm water fisheries are characterized by higher water temperatures, gentle channel gradients, soft bottom materials, slow currents, lower oxygen content, high nutrient values, and substantial rooted aquatic vegetation. Lakes often have similar characteristics, less channel features, and have at least one warm season exceeding the water temperature limits of cold water fish species (Smith 1966.) Typical warm water species include the bluegill, largemouth bass, crappie, catfish, squawfish, pupfish, and the exotic Asian carp (Cooperrider et al. 1986). More detail on the fisheries resources in the EIS area will follow the discussion of the analysis regions.

The invertebrate species on public lands are poorly studied, but are known to be numerous and very diverse due to the incredible variation of habitats managed by the BLM. Because of this diversity, the state of knowledge, and the scope of this document, it is not possible to cover the subject in detail. The invertebrate segment of the wildlife community will not receive any further discussion within the analysis region discussions that follow.

Following are the discussions of the general wildlife species and habitat relationships found on public lands within the analysis regions occurring in the 13-State EIS area.

Canada Thistle

Sagebrush

Because of its expanse, the sagebrush region is a very significant wildlife habitat, though it contains less species diversity than most other vegetation regions. Sagebrush is typically associated with the cold desert where some snow and cold weather occurs during the winters, which causes wildlife to use habitat areas in seasonal shifts. Also, sagebrush is commonly an elevational biotic zone with pinyon-juniper or conifer forest above and saltbush, greasewood, riparian, grassland, or other sagebrush flats below. As a result, sagebrush can be used as a singular habitat type or in conjunction with other vegetation habitat types.

As a singular habitat type, sagebrush is often monotypic over large areas. Few species find these large expanses as high-quality habitat. The best sagebrush habitat includes a mix of multi-age sagebrush with associated perennial bunch grasses and forbs, and interspersed with open wet meadows or riparian areas. Typical wildlife of open sagebrush include the sage grouse, sage thrasher, sage sparrow, sagebrush lizard (all named for the type of vegetation), black-tailed jackrabbit, pygmy cottontail, Ord's kangaroo rat, Great Basin kangaroo rat, deer mouse, Columbia ground squirrel, sagebrush vole, white-tailed prairie dog, badger, coyote, black-billed magpie, gray flycatcher, canyon wren, horned lark, burrowing owl, red-tailed hawk, ferruginous hawk, and several other raptors. Reptiles of the sagebrush region include the common garter snake, western rattlesnake, western skink, and sagebrush lizard. Pronghorn antelope can be very common in sagebrush type when the sagebrush is less than 24 inches tall, a variety of forbs and other forage are present, the stand is open (less than 50 percent cover), and water and other habitat components are available (Cooperrider et al. 1986). When sagebrush occurs in conjunction with broken terrain—especially rimrock—mule deer, golden eagles, prairie falcons, and in some areas, bighorn sheep or chukar partridge may commonly occur. In areas of limited rainfall and forage production, the thermal cover provided by sagebrush may be critical to deer and other wildlife survival (W. A. Molini, pers. comm. 19[illegible]).

As an elevational ecotone, the sagebrush vegetation zone is an extremely significant wildlife habitat. Along the slopes of many western mountain ranges, the sagebrush vegetation type, often in conjunction with scattered juniper and pinyon, commonly occurs below deep snow areas, making them suitable as wildlife (especially big game) winter ranges. Although most sagebrush and juniper species are low-quality forage, they are usually associated with high-quality browse species, such as bitterbrush, mountain mahogany, and cliffrose. Most critical western winter ranges have sagebrush as a significant portion of their vegetation component. In addition to the mule deer and elk, the large predators and scavengers also congregate on the winter ranges. Mountain lion, bobcat, coyote, bald and golden eagles, and ravens are winter residents of the sagebrush region.

Riparian areas or wet meadows are critical to the rearing of sage grouse broods (Call 1974). Riparian areas with large deciduous trees, such as cottonwoods, are the most significant for most nongame birds and raptors. Their variety and densities increase significantly in these multilayered riparian systems (Cooperidder et al. 1986). Of the 148 species of breeding birds in the Great Basin, only 17 (11 percent) do not use riparian areas (Ohmart and Anderson 1982). Riparian areas are also significant to big game. Pronghorn antelope use them extensively in summer (Cooperidder et al. 1986). Mule deer and elk also use riparian areas extensively for food, cover, and travel and migration corridors (Thomas et al. 1979). Riparian vegetation is also significant to the maintenance and quality of cold water stream fisheries. Numerous studies have documented the relationship of good condition riparian habitat to high-quality trout populations (Platts 1984).

Desert Shrub

The desert shrub analysis region consists of two major, but dissimilar, vegetation ecosystems. The saltbush-greasewood association is a cold desert community, very often a lower elevation or lower available moisture condition within the sagebrush analysis region. The second ecosystem is a hot desert association composed of the Mojave and Sonoran Deserts and is typified by creosotebush and creosotebush/bur sage vegetation communities.

The saltbush-greasewood association extends from southeast Oregon and western Nevada to the Bighorn Basin in Wyoming and the San Luis Valley in Colorado. Neither of these two vegetation communities are high-quality wildlife habitats, but in conjunction with adjacent vegetation communities, can provide valuable habitat diversity. Typical wildlife species using these habitats include desert kangaroo rats, little pocket mice, jackrabbits, horned larks, vesper sparrows, loggerhead shrikes, western whiptail and side-blotched lizards, and rattlesnakes. The pronghorn antelope may make extensive use of this type in conjunction with other vegetation types (Shelford 1963).

These vegetation communities are generally associated with saline basins and valley floors commonly within closed water basins. Permanent water is extremely scarce and natural fisheries resources are almost nonexistent. However, some very unique fisheries occur in permanent springs and marshes in the bottom of several isolated valleys.

The hot desert region includes southern Nevada, extreme southwestern Utah, and extreme western and south-central Arizona. The hot desert associations are much more diverse than either the saltbush-greasewood association or the sagebrush cold desert regions and contain some unique wildlife species. Hot deserts are typified by having evaporation rates far exceeding the annual rainfall; therefore, the native plants and animals are often extremely well adapted to surviving arid conditions. Several animals are present throughout this area. These include the bighorn sheep, mule deer, kit fox, spotted skunk, Merriam's kangaroo rat, rock squirrel, Harris' antelope squirrel, southern grasshopper mouse, Harris' hawk, zone-tailed hawk, Gambel's quail, white-winged dove, common ground dove, elf owl, Bendire's thrasher, phainopepla, Lucy's warbler, Abert's towhee, desert tortoise, sidewinders and other rattlesnakes, and several lizards (Shelford 1963).

Like the uplands, the riparian habitats in the desert shrub region are extremely varied. Riparian areas are scarce, except along the Colorado River system drainages in Arizona, Utah, portions of Colorado, and Nevada; neither the saltbush desert nor the hot desert portions of the region have any significant quantity. Most of this riverine habitat has been severely depleted with the impounding and channelization of the rivers and has been heavily invaded by the exotic saltcedar. The river impoundment flooded pre-existing riparian areas, clearing the riparian bottomland and reducing the natural reproduction of native species. This allowed for significant invasions of exotic species, especially saltcedar (Ohmart and Anderson 1982). Consequently, the total area of riparian habitat is greatly reduced from predevelopment times, making the remaining riparian habitats very significant.

At the higher elevations and better quality areas of the saltbush desert, the riparian discussion in the sagebrush section will generally apply. But on the whole, the saltbush desert is very poorly watered and riparian areas are almost nonexistent. The hot desert portions of the analysis region are the Mojave and Sonoran Deserts; these areas are just as poorly watered and riparian areas are also rare. The most significant riparian habitats are related to the major river systems, or an occasional isolated side canyon, where the cottonwood-willow communities were historically dominant. This community has been reduced by nearly 50 percent on the lower Colorado River, and less than 20 percent of that remaining is good-quality habitat (Ohmart and Anderson 1982).

Southwestern Shrubsteppe

The southwestern shrubsteppe is historically a hot, arid, desert grassland. Past uses resulted in significant invasion by brushy vegetative species. These areas of brushlands fragmented and isolated the remaining areas of desert grassland. This resulted in reducing suitable habitat and numbers of the native grassland wildlife species, reducing their population viability. Many species have been lost (aplomado falcon, wolf, grizzly bear, black-footed ferret) and replaced by brushland species. Others have been reduced in numbers. The reduction in pronghorn antelope and Coues' whitetail deer and the increase in mule deer and javelina are examples of the species replacement process resulting from vegetation changes.

Wildlife species typical of the southwestern shrubsteppe include the bannertail kangaroo rat, black-tailed jackrabbit, badger, white-throated wood rat, pronghorn antelope, black-tailed prairie dog, Coues' white-tailed deer (in the western portion at higher elevations), scaled quail, Gambel's quail, lesser nighthawk, vermilion flycatcher, Chihuahuan raven, verdin, cactus wren, pyrrhuloxia, McCown's longspur, green toad, southern prairie lizard, round-tailed horned lizard, desert grassland whiptail, western hooknosed snake, Mexican black-headed snake, and massasauga. Desert bighorn sheep have been re-introduced into several historic habitats in this region.

Riparian communities in the southwestern shrubsteppe are similar to and are as significant as those in the hot deserts of the desert shrub region. Extensive channelization, impoundment, and phreatophyte clearing have occurred along the Rio Grande and Pecos Rivers (Ohmart and Anderson 1982). In their comparative study, Ohmart and Anderson found the riparian communities in the Chihuahuan desert to have a higher total number of bird species (322) and riparian-related species (273) than any of the other western deserts. The newly designated San Pedro (River) Riparian National Conservation Area is located in this region. It is one of the most significant wildlife habitats in the Southwest.

Yellow Starthistle

Chaparral-Mountain Shrub

This is the most widely scattered community and probably the least extensive. Included in this region are the mountain mahogany-Gambel's scrub oak communities of Nevada, Utah, and Colorado, and the Arizona interior chaparral vegetation communities of central and southeast Arizona and southwest New Mexico. Both of these communities can be excellent wildlife habitats, but the Arizona chaparral is especially prone to becoming too dense and limiting its availability to all but the smaller species. The mountain mahogany-scrub oak community is extremely valuable wildlife winter range, though its elevational range generally has sufficient snow depth to limit its usability to only the larger species, such as elk and moose, during deep snow periods. Mule deer may use this type year long or during all but the worst of the winter. Because of this use by big game species, this region is also valuable to large predators and carrion feeders.

The chaparral-mountain shrub analysis region has much diversity. Large mammals, including the mule deer, coyote, mountain lion, bobcat, and gray fox, are widespread in this analysis region. White-tailed deer and collared peccary appear in the southern parts. Black-tailed jackrabbit, striped skunk, and spotted skunk also occur. Ringtail cat is a predator adapted to thick cover in this region where it hunts for several different smaller mammals, including white-footed mice and brush mice. The wood rat is one of the most characteristic animals of this analysis region. Other small mammals include species of ground squirrels and mice.

Birds are numerous throughout the year in the brush types of the region; more than 50 resident species were identified in the scrub oak type in Utah.

Distinctive birds in the chaparral-mountain shrub analysis region include the wrentit and rufous-sided towhee. Other birds include the mountain quail, black-throated gray warbler, scrub jay, Bewick's wren, plain titmouse, acorn woodpecker, and saw-whet owl.

Reptiles that feed on insects, bird eggs, nestlings, and small mammals include the pinegopher snake; wandering garter snake; and night snake, which can be quite common, especially in the southern part of the analysis region.

The chaparral and mountain shrub regions are generally montane communities. Riparian areas are characterized by small mountain streams that flow through several other regions in addition to the chaparral and mountain shrub. As in all habitats, the riparian areas are a focus for wildlife because of the added diversity and high productivity of riparian communities. Many of these streams are habitat or potential habitat for native western trout and other native fishes and aquatic organisms.

Pinyon-Juniper

Past management practices have resulted in significant changes in the density of pinyon and juniper tree stands. The tree stand densities have increased, often to the detriment of more valuable vegetation species, lowering the quality of the wildlife habitat. This also has resulted in reducing the amount of high-quality edge vegetation habitat and replacing it with more monotypic vegetation. Current management is often aimed at reducing tree densities to improve associated forage species volumes and to recreate the lost edge habitat and habitat diversity. Dense stands of juniper may offer high-quality nesting and thermal cover, but little else. Pinyon stands may have similar values, but in addition produce pinyon nuts, which are an excellent wildlife food. As in the sagebrush region, this vegetation community provides a better wildlife habitat when it occurs in conjunction with other communities than when it occurs as an expansive habitat. Also like sagebrush, the size and shape of the openings created by vegetation treatment are critical to the future values of this vegetation type as quality wildlife habitat.

Not many wildlife species are solely dependent on the pinyon-juniper vegetation type. Some of the typical wildlife species are the mule deer, elk, desert kangaroo rat, pinyon mouse, bobcat, mountain lion, nesting red-tailed hawk, Swainson's and ferruginous hawks, golden eagles, wintering bald eagles, wild turkey, ash-throated flycatcher, western wood peewee, scrub jay, pinyon jay, Clark's nutcracker, and plain titmice. The reptiles of this analysis region are similar to those in adjacent desert and forest communities and include the striped whip snake, California king snake, horned lizard, sagebrush lizard, collared lizard, Great Basin rattlesnake, and western hooknosed snake. The evergreen oak-alligator juniper vegetation community in southeastern Arizona has several unique wildlife species associated with it, including the coati, the Ringtail cat, the black bear, Coues' white-tailed deer, wild turkey, Montezuma quail, band-tailed pigeon, whiskered owl, white-eared hummingbird, Strickland's woodpecker, gray-breasted jay, bridled titmouse, black-chinned sparrow, giant spotted whiptail, Mexican garter snake, and twin-spotted rattlesnake.

The riparian areas and upland relationships in the pinyon-juniper analysis region are very similar to that of the chaparral-mountain shrub region. The highest number of wintering bird species and second highest wintering bird densities recorded occurred in a riparian area adjacent to a juniper-oak woodland in an Arizona canyon (Brinson et al. 1981).

Mountain/Plateau Grasslands

This region contains many different wildlife habitats, from high mountain meadows to southern plateau grasslands. Also included in this variety are the edges of these grassland communities with numerous forest and brushland types.

On the Columbia Plateau, shrubs were originally of little importance. Cool-season bunchgrasses covered broad areas. Today, overgrazing has greatly changed the dominance of shrubs, such as sagebrush, saltbush, rabbitbrush, and bitterbrush (Shelford 1963). Pronghorn antelope are resident and mule deer and elk are winter visitors. Where there is a common boundary with the sagebrush analysis region, common animals include the black-tailed jackrabbit, pygmy cottontail, and various mice. At low to medium elevations, various subspecies of ground squirrels are present, as well as badgers. The pocket gopher is well distributed throughout the region. Predators include the bobcat, mountain lion, and coyote. Common birds include the scrub, pinyon, and Stellar's jays; Clark's nutcrackers; rock and canyon wrens; and dark-eyed juncos. Marsh hawks, American kestrels, and golden eagles are common raptors. Reptiles include the lesser earless and collared lizards, the western terrestrial garter snake, and the pine gopher snake.

On the Colorado Plateau, warm season bunchgrasses are found with sagebrush and blackbrush. Many of the animal species found here are also found in the other grasslands or desert shrub regions. Species include the ringtail, least chipmunk, desert wood rat, Utah white-tailed antelope squirrel, and black-tailed jackrabbit. Desert reptiles include sagebrush, collared, tree, and side-blotched lizards; pine gopher snake; and striped whip snake. Animals unique to the area include the Utah white-tailed prairie dog, plateau whiptail, Painted Desert glossy snake, and Mesa Verde night snake.

The riparian communities of this analysis region are diverse, ranging from high elevation alder and willow and blue spruce communities to mixed deciduous and cottonwood gallery forests at lower elevations. Because of the extreme diversity that riparian vegetation adds to the open, low-growing vegetation of the surrounding grassland, the wildlife habitat values are very high. In addition to the normal values of riparian habitats (such as increased habitat edge, a complex of foliage height diversity, increased insect communities, higher humidity, available water, and a totally different forage species availability from the surrounding uplands), in this region riparian vegetation also provides the thermal cover not available in the grasslands. The contrast in values between the riparian areas and the adjacent uplands is probably most dramatic in the grassland analysis regions than any of the others, making the riparian zone especially valuable to wildlife.

Plains Grasslands

The plains grasslands, both mixed and short, support a unique group of animals. Many grassland animals are burrowers; others are swift runners. Most of these species have keen eyesight and are quite gregarious, forming either large herds or enormous colonies (Shelford 1963).

Huge herds of American bison once migrated with the seasons across the central plains. Now, the pronghorn antelope is probably the most common large mammal, but mule deer and white-tailed deer are often abundant where brush is available, such as along stream courses. Burrowing rodents include ground squirrels, prairie dogs, pocket gophers, and pocket mice. Burrowing predators include the badger, kit fox, spotted skunk, and the endangered black-footed ferret. The white-tailed jackrabbit occupies the northern part of the ecosystem, and the black-tailed jackrabbit, the area south of Nebraska. The desert cottontail is widespread.

Birds in the plains grasslands include horned lark, killdeer, western meadowlark, sharp-tailed grouse, and burrowing owl. The prairie pothole region of the northern plains is nationally significant waterfowl habitat. Numerous species of ducks, geese, and shorebirds use these important wetland habitats, including federally listed threatened and endangered species, such as bald eagles, American peregrine falcons, whooping cranes, least terns, and piping plovers. Construction of stock ponds has created additional important duck habitat in the northern Great Plains.

Reptiles include the western hognose snake, great plains skink, and plains garter snake. Amphibians of the region include the plains spadefoot, great plains toad, and western box turtle.

In this analysis region most of the major waterways, and their associated riparian areas, have a west to east orientation. The typical vegetation of the plains riparian areas are the cottonwood and the cottonwood-willow communities in the west, and the mixed broadleaf communities in the east. These riparian corridors are travel routes for wildlife from mid-continent moving westward and for the mountain species moving east. The white-tailed deer, raccoon, opossum, and numerous birds extend into the west along the riparian areas. Historically, the grizzly bear and bighorn sheep extended eastward onto the plains along the riparian corridors and their associated breaks and canyons. The elk and mule deer are still in these areas.

The riparian areas are extremely significant wildlife habitats in the plains grasslands. They support unique wildlife species, such as the beaver, and are of utmost importance to migrating birds. Many migrating bird species move from riparian area to riparian area. The prairie potholes and manmade reservoirs are also significant on these migration routes. These locations on the northern plains are also very important for waterfowl production. With the development of the upland plains for agricultural purposes, the plains riparian areas are often the most significant remaining natural cover habitats for maintaining many of the native and introduced wildlife species of the prairies.

Coniferous/Deciduous Forest

The type of conifer forest found in a locality depends on the climate regime, rainfall, and soil development of the area. Important forest types include the ponderosa pine, Douglas-fir, and fir-spruce forests. Mule deer range throughout these forests, preferring rough terrain for cover and shrubs for food. Elk also occur widely, grazing in high mountain meadows in the summer and shrublands in the winter. The mountain lion is the chief predator on deer and elk. The black bear is an agile climber frequently found throughout the Rockies. Other animals found in western forests include the northern flying squirrel, a common, but rarely seen species; Abert's squirrel, common in the southern Rockies and closely associated with the Ponderosa pine; the red squirrel, which is found throughout the Rockies and prefers spruce-fir forests; and the widespread golden mantled ground squirrel. The porcupine and the beaver are the largest forest rodents.

Resident birds in this region include the pygmy nuthatch, Stellar's jay, sharp-shinned hawk, red-breasted nuthatch, mountain chickadee, Cassin's finch, northern flicker, dark-eyed junco, Swainson's thrush, western goshawk, and red-tailed hawk. Birds that are common during the summer include the western bluebird, yellow-rumped warbler, Williamson's sapsucker, western flycatcher, and western tanager. Three grouse species may also occur. The spruce grouse inhabits the higher elevation spruce and fir forests, the blue grouse uses mid and lower elevation forests, and the ruffed grouse is most common in riparian areas.

The region's common reptiles include the wandering garter snake, pine gopher snake, and western rattlesnakes. The most common amphibians include the Rocky Mountain toad and the common leopard frog of the Rocky Mountain States (Dickerson 1969).

The deciduous forest portion of the analysis region is primarily aspen forest and parkland. Aspen, being one of the most widespread plants in the world, is a very important wildlife habitat. Aspen groves are commonly associated with coniferous forest and mountain meadows and grasslands. They typically provide extensive edge and habitat diversity. Aspen stands also tend to have much more ground cover than the coniferous forests. Aspen leaves and new growth shoots are also very palatable to big game animals. The combination of these factors makes the aspen communities one of the most important habitats in the conifer forest analysis region.

Riparian areas in coniferous and deciduous forests frequently provide more edges within a small area than expected. In addition, there are many vegetative strata exposed in a stairstep fashion providing diverse nesting and feeding opportunities for wildlife, especially birds and bats. Bird species are commonly associated with specific, distinct layers of vegetation, so abundantly supplied by healthy riparian communities. Bird species also select between coniferous and deciduous vegetative volumes in distinct strata, providing added diversity (Thomas 1979). Other wildlife also are attracted to these riparian areas. In the northern and central Rocky Mountains, moose most commonly occur in riparian areas within the coniferous forest analysis region. In the Blue Mountains of Oregon, elk spent 40 percent of their time in riparian zones that only made up 7 percent of their habitat use area (Thomas 1979). Riparian areas are also commonly used as migration corridors during seasonal elevational migrations.

Fisheries Resources

Fisheries resources within the EIS area have been greatly affected by ecosystems outside the area. East of the Rocky Mountains, the Mississippi River provided a giant dispersal corridor for fishes across half the continent. Differing conditions in this large basin led to localized changes in fish communities, leaving a mixture of widespread and species of limited range adapted to localized conditions. To the west, other river systems flowed into the Pacific Ocean. In past geologic times these waters were connected to the Mississippi River system and fish crossed the divide. The Pacific Ocean also provided an alternative feeding ground and migratory route, and a high percentage of coastal species developed anadromous habits. Other river systems, like the Rio Grande and Colorado, became isolated. In these systems where stream habitats flowed from alpine cirques to arid, hot deserts, a fauna low in species but diverse in adaptations developed. Between the major river system are basins once connected to these river systems or to the oceans. As the basins dried, the fish species evolved to become adapted to smaller and smaller habitats, becoming increasingly isolated from other originally related species. A high degree of endemism resulted (BLM 1990).

Because of these origins a description of the fisheries resources of the EIS area, like the riparian habitats, does not logically coincide with the geographic analysis region format. The fisheries resources will be divided into three regions: Northwest, Mountain States, and Desert Southwest as organized in the Fisheries Habitat Management on Public Lands, A Strategy for the Future (BLM 1989) report. The Northwest region includes the states of Washington, eastern Oregon, and Idaho. This region includes an enormous anadromous fisheries resource. The anadromous fish habitats are the large river systems with direct ocean access. All streams in the EIS area are part of the Columbia River system including the Deschutes and John Day Rivers in Oregon, and portions of the Salmon, Snake, Little Salmon, and Clearwater Rivers in Idaho. Important anadromous fish species in the EIS portion of these three states are chinook and sockeye salmon, steelhead trout, Pacific and river lampreys, and historically the white sturgeon. Although remaining a significant economic resource, the salmonid anadromous fish population has declined by one-third since the 1870's.

Through recent efforts the population trends have turned upward, though will probably never reach historic levels again due to the significant loss of habitat from development of hydroelectric dams and other man-caused habitat degradation from agriculture, logging, mining, road building, channelization and other land uses. In the past 20 years the awareness of anadromous fisheries habitat problems have increased and progress is being made in improving habitats and correcting past management practices leading to the original degradation (BLM 1989). Resident fisheries in the Northwest were historically fishes of cold-water streams and mountain valley lakes. The most common species were the westslope, Yellowstone, and fine-spotted cutthroat trout, redbanded rainbow trout (Behnke 1979), and Dolly Varden trout, the mountain whitefish and suckers, western squawfish, chiselmouth, speckled dace and other minnows, and several species of sculpins (Eddy 1957). Man has introduced the coastal rainbow, eastern brook, golden trout, and German brown trout to these stream environments, and most lakes and reservoirs. Man-made features have also changed the fisheries habitats. Numerous dams on the main and tributary rivers have resulted in many reservoirs and small impoundments that have also been stocked with fish in addition to the natural populations. Many of these dams have also interfered with the natural stream migrations and eliminated streams as anadromous fisheries, at least for some species.

The white sturgeon has been trapped by many dams that still allow the salmon to migrate. Lake trout and kokanee salmon have also been added to many reservoirs and lakes. Also introduced are the warm water species like catfish and bullheads, small and largemouth bass, walleye, northern pike, black and white crappie, yellow perch, and numerous sunfish, as well as several minnows introduced as forage fish for the game species, and of course the carp. These introduced fish compete with the native species in many streams and lakes. Most native trout populations have been severely limited in major streams.

The Mountain region is composed of the states of Colorado, Montana, Wyoming, and parts of Nevada, Idaho, Utah, and New Mexico. Habitats are very similar to the Northwest region, being primarily cold water streams and mountain lakes, but lacking the anadromous salmon fishery. Native resident fish species are also very similar except for some different subspecies of the cutthroat trout (westslope, Yellowstone, Bonneville, Colorado River, greenback, Rio Grande, and Yellowfin), Arctic grayling, and native rainbow trout. The species associated with the non-headwater portions of the major river systems of the Missouri, Platte, Arkansas, and Rio Grande Rivers are much different fish, like the paddlefish, burbot, carpsucker, sicklefin chub, stonecat, sauger, and the Arkansas River darter (Eddy 1957). The situation of introduced fisheries is virtually the same as the Northwest region.

The Desert Southwest region includes the states of Arizona, Nevada, New Mexico, and Utah. The Colorado River system is the dominant drainage system for this region, with the Rio Grande and Pecos Rivers also being important in New Mexico. As discussed in the section on riparian vegetation, the historic stream conditions in the Desert Southwest region have been impacted. Free flowing habitats are very rare and even these have been heavily impacted by exotic fish species. The large rivers have become a series of impoundments and most of the smaller streams are either dry or have severely limited flows, generally in deeply incised channels. Also many fish were in isolated water sources, relicts of past geologic periods when they were contiguous with other water bodies.

The Southwestern fishes have been characterized as a depauperate fauna of relicts, monotypic genera, and much regional endemism (Miller 1961). Several species of fish are extinct (Parras roundnose minnow, Pahranagat spinedace, Spring Valley sucker, Leon Springs pupfish, Monkey Springs pupfish, Phantom shiner, Rio Grande bluntnose shiner, Grass Valley speckled dace, Las Vegas dace, Raycraft Ranch poolfish, Pahrump Ranch poolfish, Ash Meadows poolfish, Utah Lake sculpin, and Independence Valley tui chub), and many others are threatened or endangered.

Native resident species which are currently at low population levels are: Apache trout; Lahontan, Colorado River, Bonneville, Gila, and Rio Grande cutthroat trout; desert dace, 12 subspecies of Nevadan tui chubs, humpback chub, Sonoran chub, bonytail chub, Gila chub, Chihuahua chub, Yaqui chub, Pahranagat roundtail chub, Virgin River roundtail chub, Moapa roundtail chub, White River spinedace, Virgin River spinedace, Little Colorado spinedace, Big Springs spinedace, Moapa dace, spikedace, Yaqui beautiful shiner, Pecos bluntnose shiner, woundfin, Colorado squawfish, relict dace, Big Smokey speckled dace, Independence Valley speckled dace, Moapa speckled dace, Ash Meadows speckled dace, Clover Valley speckled dace, Preston speckled dace, Amargosa speckled dace, Meadow Valley speckled dace, Pahranagat speckled dace, loach minnow, White River sucker, Meadow Valley desert sucker, Zuni blue sucker, Wall Canyon sucker, cui-ui, June-sucker, razorback sucker, Yaqui catfish, Preston White River springfish, White River springfish, Moapa White River springfish, Moorman White River springfish, Railroad Valley springfish, Devil's Hole pupfish, Ash Meadows Amargosa pupfish, Warm Springs Amargosa pupfish, Pecos River pupfish, White Sands pupfish, Pahrump poolfish, Pecos gambusia, and Gila topminnow (Williams, et al. 1985).

The introduced fish species include most of those of the other two regions plus several more warm water species, including: grass carp; fathead minnow; red shiner; bigmouth and smallmouth buffalo; flathead, blue, and channel catfish; mosquitofish; spotted, white, and striped bass; tilapia; sailfin mollies and several other aquarium species escapees.

The general view of the fisheries resources in the Northwest and Mountain regions, except for the large river reservoirs, is one of apparently intact systems, while in the Desert Southwest, the view is of totally artificial fisheries.

Cultural Resources

The BLM defines cultural resources to include both properties and traditional lifeway values (BLM 1988e). Properties consist of anything that shows evidence of having been made, used, or altered by humans. A traditional lifeway value is the quality of being useful in or important to the maintenance of a specified social or cultural group's traditional systems of religious belief, cultural practices, identity, or social interaction. In some cases, a traditional lifeway value may be associated with a property while in others in may be independent of a property or definable location.

Prehistoric cultural properties are those left by the groups that have lived in the Western United States since the first human migration to the western hemisphere at least 12,000 years ago. The historic period began with the European migration to the New World in 1492, and the associated end of traditional cultures caused by the spread of Euro/American culture across the United States.

In the western United States, the spread of Euro/American culture did not begin until 1539 in the Southwest and significant destruction of traditional cultures did not begin until the 1600 and 1700's. In other areas, such as the Pacific Northwest and the Great Basin, the historic era did not begin until the 1800's and traditional cultures were not significantly effected before the middle to late 1800's.

Traditional lifeway values may be associated with properties from either the prehistoric or historic eras. When the value is associated with the prehistoric era it is also associated with Native American traditional values, traditional land uses, and/or religious beliefs and may be subject to the requirements of the American Indian Religious Freedom Act (42 U.S.C. 1996). Values associated with the historic era are not necessarily associated with Native Americans, but can be associated with other social or cultural groups.

Prehistoric Era

The distribution and composition of vegetation communities changes through time in response to changes in climatic patterns, and this leads to changes in the distribution and nature of prehistoric cultural resources. In addition, natural processes, such as erosion and deposition, effect the evidence available for understanding successively earlier prehistoric cultures. Thus, the discussion of prehistoric resources is divided into early, middle, and late time periods. The early period covers the time from about 10,000 B.C. to 6,000 B.C., the middle period from 6,000 B.C. to about 1 A.D., and the late period from about 1 A.D. to 1492.

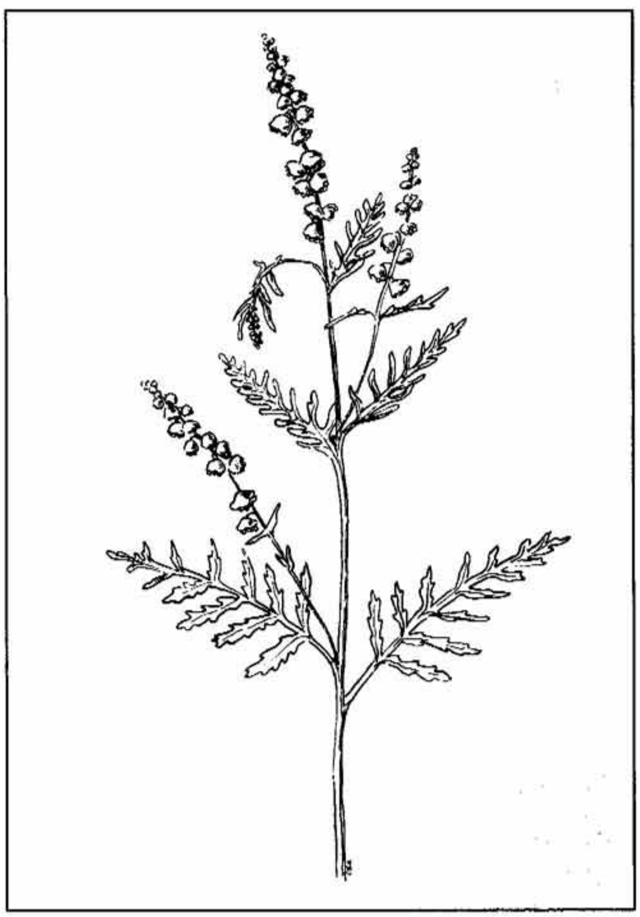
Early Period

Cultural resources from the early prehistoric period are not likely to be found in high elevation vegetation regions (such as the coniferous/deciduous forest or pinyon-juniper regions), or in other regions where topography precludes significant soil deposition, there is no major water source, or high concentrations of big game could not be supported.

Most sites from this period are interpreted as kill sites and contain extinct animal bones associated with stone tools (lance points, blades, scrapers, knives, and flake tools) used for killing and butchering. Early period campsites also are known. In addition to stone tools, campsites include hearths, broken and charred food bones, stone tool chipping debris, and hammerstones.

Middle and Late Periods

Prehistoric cultural resources from the middle and late periods are likely to be dense in vegetation analysis regions with exploitable resources, such as fish, game, and edible plants and nuts. Consequently, the pinyon-juniper, southwestern shrubsteppe, Columbia Plateau riparian areas, and plains grasslands analysis regions are expected to contain more cultural resources than other regions lacking abundant resources. Many other significant cultural



Common Ragweed

resources, however, (quarries, rock art sites, and rockshelters) are associated with variables other than vegetation. The occurrence of cultural properties may therefore be more accurately described for the vegetation analysis regions as they occur within the following major physiographic regions:

- Great Basin—Nevada, southeastern Oregon, southern Idaho, and northwestern Utah
- Columbia Plateau—Oregon and Washington east of the Cascades, and central Idaho
- Plains—eastern Montana, eastern and central Wyoming, northern and eastern Colorado, North and South Dakota, and Oklahoma
- Southwest—northern and central Arizona, New Mexico, southern Utah, and southwestern Colorado

Great Basin. The sagebrush and desert shrub regions in the Great Basin are expected to contain a moderate density of middle to late prehistoric cultural resources. Most would likely be found near water sources; however, some scattered winter camps should be found in sheltered areas. The pinyon-juniper region should contain a high density of cultural resources with an emphasis on temporary camps, storage facilities, and winter camps at lower elevations.

Middle period sites are characterized by projectile points used on spears, dense stone flake debris from making the points, rough stone tools (such as hammerstones), and masses of fire-cracked rocks from pit roasting and stone boiling. Ground stone plant milling tools (such as mortars and pestles) are common, and perishable artifacts (bone and wood tools, baskets, sandals, cordage, and so on) are found. Other sites are expected to include lithic scatters (tool making or resource exploitation), storage facilities (rock rings and caches), quarry sites, temporary camps, plant processing sites with ground stone tools), and hunting sites with dense concentrations of projectile points and flakes.

Late period artifacts of the Great Basin do not differ much from those of the middle period. Smaller projectile points characterize this period as bows and arrows replaced the spear. In the southern Great Basin, ceramics are found and function as a temporal marker for the period.

Columbia Plateau. The sagebrush, mountain/plateau grasslands, and desert shrub regions in the Columbia Plateau were exploited for root crops, grasses and shrubs during the middle to late prehistoric periods, so the density of cultural sites is expected to be low. The coniferous/deciduous forest region was exploited for berries and hunting; therefore, the density of resources in this region is also expected to be low. Within all the analysis regions, rivers and other permanent water sources would be expected to have dense cultural resources.

Salmon bones, freshwater mussel shells, and plant remains from the middle period have been found in refuse sites along rivers. Ground stone plant milling tools are common, and projectile points suggest the use of the spear thrower. By the late period bows and arrows replaced the spear, as evidenced by the smaller projectile point sizes that have been found. Otherwise, the cultural properties from the middle and late periods are not significantly different.

Plains. The plains grasslands region was exploited for edible plants and big game during the middle and late prehistoric periods. Hunting sites, gathering sites, and temporary camps are likely to be scattered throughout the region. The mountain/plateau grasslands region was used for hunting and is expected to have only sparse cultural resources. In all regions in the Plains, cultural resources should be more dense around permanent sources of water.

Middle period artifacts include freshwater mussel shells, which have been found in refuse sites along rivers. Projectile points are common, as are ground stone milling tools. Perishable artifacts include coiled and twined basketry, cordage, and an extensive bone toolkit with awls, needles, tubes, spatulas, flakers, and wrenches. Plain paddle and anvil pottery are characteristic of late period artifacts.

Southwest. The desert shrub and southwestern shrubsteppe regions in the southwest contain dense prehistoric cultural resources where mesquite and associated exploitable resources occur. In all vegetation regions of the Southwest, river valleys and other permanent water sources should contain dense cultural resources associated with horticulture.

Cultural properties of the middle period from this area are similar to those found in the Great Basin: projectile points, ground stone milling tools, and perishable artifacts, such as coiled and twined baskets, cordage, sandals, nets, reed flutes, and wooden fire drills. Burnt and broken bones, and carbonized plant remains are found in refuse sites. Painted pottery, ceramic figurines, rock art, and ritual artifacts characterize the late period.

Historic Era

The early historic era was similar to the prehistoric era and did not become distinct until significant Euro/American migration to the West began. In the end, the traditional peoples were eliminated, assimilated, or isolated from the mainstream of the historic era.

The placement of historic cultural resources is governed by the resources extracted in response to eastern demand for raw materials and used as exchange for manufactured goods. Logging occurred primarily in the coniferous/deciduous analysis region; pinyon-juniper forests were a principal source of wood and charcoal for mines; and ranches and farms providing crops and livestock spread across valleys in the plains grasslands, sagebrush, southwestern shrubsteppe, and desert shrub regions. Cities and towns developed along lines of communication, such as rivers, trails, and roads.

Historic cultural resources cannot be further discussed by vegetation region. It is therefore difficult to predict the nature, distribution, and significance of historic cultural resources at this programmatic level; they will be assessed in BLM's local investigations of site-specific plans.

Ethnohistoric and Modern Era. The historic era blends into contemporary times in ways that preserve elements of traditional and historic cultures and lifeways. For example, Native Americans have continued traditional religious beliefs and practices and in many cases have maintained treaty rights to exploit traditional plant gathering areas and hunting rights. Other groups, such as Mormon ranchers, have also maintained traditional cultural beliefs and practices. These traditional lifeway values (BLM 1988e) can include maintaining access to vegetation communities, such as pinyon-juniper woodlands, to: (1) gather traditional foods; or (2) gather materials to make culturally significant artifacts; or (3) gather traditional plants for medicinal and religious uses. These values can also include maintaining a traditional landscape that embodies religious symbolism or is used for religious practices and may include maintaining a historic landscape that exemplifies a historic lifeway such as ranching or mining.

The distribution and nature of traditional lifeway sites will be the same as the historic or prehistoric period to which the value is attached. However, these areas will differ from historic and prehistoric properties, in that, traditional lifeway values may be associated with large diffuse areas rather that pinpointed sites.

Recreation and Visual Resources

Recreation Resources

The Bureau of Land Management manages public land and water resources for their wildlife, scenic, archeological, and historical values. These values, in turn, enhance the quality of wilderness and outdoor recreational opportunities. The Bureau's recreation program contributes to the tourist economies of the Western States and helps satisfy the growing public demand for outdoor recreation by providing opportunities on BLM-administered lands.

As with cultural resources on public lands, BLM is also responsible for maintaining an up-to-date inventory of recreation values, uses, and opportunities needed for input into and monitoring of resource management plans, recreation area management plans, and other specific planning, management, and reporting of recreational issues and concerns. Level I inventories are the base level inventories conducted on all public lands administered by BLM. Level II inventories are carried out for Special Recreation Management Areas (SRMAs) and other significant areas. The information in Level II inventories is more precise and varied in scope than the Level I inventories. Level III inventories are usually one-time reports, created in response to particular projects involving large expenditures. To be considered recreationally important, a resource must have high value for one or more recreation activities (BLM Manual 8310). Most of the recreational activities on BLM lands are resource-dependent and include hunting, fishing, sightseeing, collecting, water sports, winter sports, off-road vehicle use, and other specialized activities that are dependent on natural and cultural features found on public lands (Table 2-8).

Intensive recreation management is focused on 352 developed recreation areas and sites, constituting approximately 5 percent of BLM-administered lands. Less than 1 percent of the total acreage considered in this EIS consists of intensively managed, developed recreation areas and sites.

Most BLM public lands are managed as Extensive Recreation Management Areas (ERMAs). Management action in these areas consists primarily of providing basic information and access. ERMAs are areas where dispersed recreation occurs and where visitors have the freedom of recreational choice with minimal regulatory constraint. Significant public recreation issues or management concerns are limited in these areas, and nominal management, consistent with the Bureau's stewardship responsibility, suffices.

Special Recreation Management Areas are areas where special or intensive recreation management is needed. There are two types: congressionally recognized and administratively recognized. Examples of congressionally recognized areas are Wild and Scenic Rivers, parts of the national trail system, national recreation areas, and wilderness areas. Administratively recognized areas are those where issues or management concerns may require special

Table 2-8

Estimated Recreation Hours on BLM-Administered Lands in the Study Area

State	Amount and type of recreation use (thousands of visitor hours)											
	Land-based											
	Motorized Travel			Site-based			Water-based			Snow and Ice-based		
	Off-Road Vehicle	Other	Non-motorized Travel	Camping	Hunting	Other	Fishing	Boating	Other	Winter Sports	Total
Arizona	1,010	119	237	29,052	2,356	1,262	538	1,598	519	2	36,693
Colorado	929	2,669	626	3,642	5,974	621	1,538	1,245	26	222	17,492
Idaho	1,012	1,106	857	4,235	1,781	1,142	2,071	1,338	495	961	14,998
Montana, North Dakota, and South Dakota	1,929	1,756	493	3,234	2,061	289	1,711	438	56	322	12,289
Nevada	2,943	1,912	1,361	5,600	2,660	830	1,871	234	155	99	17,665
New Mexico and Oklahoma	2,389	822	718	2,979	2,855	1,588	1,176	772	51	2	13,352
Oregon[1] and Washington	794	6,500	1,101	12,137	6,063	2,505	7,287	3,637	948	537	41,509
Utah	3,151	6,419	4,677	8,450	3,655	1,758	488	4,998	105	182	33,883
Wyoming	345	1,076	308	1,842	3,090	1,545	1,325	264	24	335	10,154
TOTAL HOURS	**14,502**	**22,379**	**10,378**	**71,171**	**30,495**	**11,540**	**18,005**	**14,524**	**2,379**	**2,662**	**198,035**
Percent of Total	**7.3**	**11.3**	**5.2**	**35.9**	**15.4**	**5.8**	**9.1**	**7.3**	**1.2**	**1.3**	

[1] Data are for the State of Oregon. However, only eastern Oregon is included in the BLM program.

Source: U.S. Department of the Interior, Bureau of Land Management 1990, Table 33.

or intensive recreation management. Included in this category are those areas where visitor use may cause user conflicts, visitor safety problems, or resource damage. These more intensively used areas require direct supervision of recreational activities and of cooperative commercial and Bureau-regulated recreation operations. These high-use areas are usually identified through the Bureau's land-use planning process. Most SRMAa require vegetation treatment to maintain their appearance and to protect visitors from hazards and/or the adverse effects of poisonous plants.

Visual Resources

Visual resources consist of the land, water, vegetation, animals, and other natural or manmade features visible on public lands. Highways, rivers, and trails of the area pass through a variety of characteristic landscapes where natural attractions, such as mountain vistas, can be seen and where cultural modifications exist. Vast acreages of grass, shrub, and mountainous land provide scenic views. Particular areas of the west provide unique visual qualities and require effective management to preserve and protect them for future generations.

Individual areas of the public lands possess a variety of visual values and consequently warrant different levels of management. The BLM must therefore systematically identify and evaluate the site-specific visual values and determine an appropriate level of management. These visual values are identified through the Visual Resource Management (VRM) inventory (BLM Manual 8410-1) and are considered with other resource values in the Resource Management Planning (RMP) process.

Visual management objectives are established in RMPs in conformance with the land-use allocations made in the plan. These area-specific objectives provide the standards for planning, designing, and evaluating future management projects. The contrast rating system (BLM Manual 8431) provides a systematic means to evaluate the approved VRM objectives. It also provides a means to identify mitigating measures that can be taken to minimize adverse visual impacts. The VRM system, therefore, provides a means to identify visual values; to establish objectives through the RMP process for managing these values; and to provide timely inputs into proposed potentially surface-disturbing projects to ensure that these objectives are met.

The VRM system is designed to separate the existing landscape and a proposed project into their features and elements and to compare each part against the other to identify those parts that are not in harmony. These features include the basic design elements of form, line, color, and texture to describe the landscape and the surrounding environment. Modifications in a landscape that repeat the landscape's basic elements are said to be in harmony with their surroundings, while those that differ markedly may contrast and stand out from the natural landscape in unpleasing, nonharmonious ways. The information generated through the VRM system is to be used as a guide for field managers to decide on the amount of visual change that is acceptable and to minimize potential visual impacts.

So that visual resources can be considered when planning management, some public lands have been assigned visual resource management (VRM) classes according to scenic quality, sensitivity level, and distance zone criteria. VRM classes provide objectives designed to mitigate adverse impacts of land management practices on scenic values (BLM Manual 8400-1). VRM maps and narratives derived from inventories and evaluations of visual resources on public lands may be examined in many BLM District Offices.

Livestock

Livestock use levels are established by the Secretary of the Interior and administered through the issuance of leases and permits. On-the-ground management is commonly carried out through the development and implementation of allotment management plans (AMP). AMPs are documents that prescribe the manner in and the extent to which livestock grazing is conducted and managed to meet multiple-use, sustained-yield, economic, and other needs and objectives as determined through land use plans.

BLM lands in the States within the EIS program area are used for livestock grazing by cattle, horses, sheep, and goats. The EIS area had approximately 4.3 million head of livestock on BLM lands during 1988 that grazed on about 153 million acres of land, consuming more than 10.1 million animal unit months of forage (BLM 1988). Livestock grazing in the EIS area has been analyzed in detail by 144 site-specific grazing EISs and associated Land Use Plans.

Wild Horses and Burros

Some of the wild horses and the burros that roam the sagebrush and desert shrub regions of the American West may be descended from the animals that accompanied and escaped from the Spanish conquistadors and Jesuit missionaries during their explorations in the 16th and 17th centuries. However, most wild horses and burros are the progeny of animals that escaped or were released during the settlement of the American West during the late 19th and early 20th centuries. Horses were an integral part of early western life. Burros also played an important role, especially with their ability to transport supplies for early prospectors and miners. Although these animals are not native to North America, they are considered "living symbols" of the historic and pioneer spirit of the West.

Under protection of the Wild Free Roaming Horse and Burro Act of 1971, the population has grown and the existence of these animals is not threatened. One of the major objectives of the Act is to keep populations at a level that will achieve and maintain a thriving natural ecological balance on the public lands. Periodic removal of the animals is the primary method at present for achieving this goal.

Management of wild horses and burros is constrained by the Act, which states that animals are to be managed at the minimum feasible level and that they may not be relocated to areas where they did not occur when the Act was passed in 1971. At the end of FY 1988, there were approximately 38,000 wild horses and 5,000 burros on almost 200 herd areas on BLM-administered public lands in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, and Wyoming. Land-use plans completed by the end of FY 1988 called for the maintenance of approximately 27,000 wild horses and 3,700 wild burros on these herd areas.

Under normal circumstances, the diet of wild horses is composed almost exclusively of grasses. Burros have a more diverse diet, composed of grasses, herbs, and shrubs. Neither animal migrates great distances during seasonal movements within each herd area.

Special Status Plant and Animal Species

An estimated 45 of the federally listed threatened and endangered species are known to occur on public land in the 13 Western States (BLM 1988). Any action that may affect these species is subject to formal consultation with the U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act. Within the EIS area, at least 6 million acres of land (terrestrial, wetland, and riparian) and 1,800 miles of streams, lakes, or reservoirs provide important habitat for these species. The State threatened and endangered species lists contain other species in addition to those on the Federal list, and special cooperative habitat management activities are given priority to ensure their continued survival. BLM gives sensitive species special consideration to ensure that their populations do not decline to the point where listing as threatened or endangered becomes necessary.

Desert Larkspur

The discussion below serves as only an example of the possible special status species that could occur in the analysis regions. For a complete list of special status animals and plants, see Appendix H.

Sagebrush

The sagebrush analysis region is significant to the recovery of the grizzly bear and black-footed ferret. Several special status fish species are present in the sagebrush region: Borax Lake chub, cui-ui, desert dace, White River spinedace, Railroad Valley springfish, Lost River sucker, Warner sucker, and the Lahontan cutthroat trout. Federally listed threatened arthropods include the Oregon silverspot butterfly. Special status plants include the spineless hedgehog cactus and Welsh's milkweed.

Desert Shrub

Endangered or threatened species of the hot deserts include Sanborn's long-nosed bat, Sonora pronghorn antelope, Yuma clapper rail and the desert tortoise (Utah and Nevada only). Federally endangered and threatened fish species include the woundfin, bonytail chub, and Gila topminnow, Sonora chub, desert pupfish, Pahranagat roundtail chub, Ash Meadows speckled dace, Pahrump killifish, Ash Meadows amaragosa pupfish, Devil's Hole pupfish, Warm Springs pupfish, Big Spring spinedace, Hiko White River springfish and White River springfish. Special status plants found in the desert shrub ecosystem include the Brady pincushion cactus, Mesa Verde Cactus, Jones cycladenia, Peebles Navajo cactus, San Rafael cactus, Ash Meadows blazing star, Ash Meadows sunray, and the Ash Meadows gumplant. The Ash Meadows naucorid (butterfly) is also found in this region.

Southwestern Shrubsteppe

Endangered or threatened species found primarily in the southwestern shrubsteppe region include Sanborn's long-nosed bat; jaguarundi; ocelot; northern aplomado falcon; Chihuahua chub; Pecos gambusia; loach minnow; desert pupfish; spikedace; Gila topminnow; Soccoro isopod; and in the Rio Yaqui drainage of southeastern Arizona, the Yaqui catfish, Yaqui chub, beautiful shiner, and Yaqui (Gila) topminnow. Special status plants found in the shrubsteppe ecosystem include the McKittrick pennyroyal, Nellie cory cactus and the bunched cory cactus, and Sneed's pincushion cactus.

Chaparral-Mountain Shrub

No endangered or threatened animal species appear to be limited to the chaparral-mountain shrub communities. Some special status plants occur in this analysis region, including the Arizona agave, Arizona cliffrose, and the Arizona hedgehog cactus.

Pinyon-Juniper

None of the endangered or threatened animal species are especially dependent on the pinyon-juniper habitat; however, the Kuenzler hedgehog cactus, Knowlton cactus, Todsen's pennyroyal, and Zuni fleabane are found primarily in this analysis region.

Mountain/Plateau Grasslands

Endangered or threatened wildlife in the mountain/plateau grasslands include the black-footed ferret, Utah prairie dog, bald eagle, whooping crane, and American peregrine falcon. Federally threatened or endangered aquatic species include the Colorado River Squawfish, humpback chub, bonytail chub, woundfish, and Gila top minnow.

Plains Grasslands

The black-footed ferret, Wyoming toad, and the Higgin's Eye pearly mussel are federally listed endangered species in the plains grasslands. Bald eagles, American peregrine falcons, whooping cranes, least terns, and piping plovers also are found in this region.

Coniferous/Deciduous Forest

The Arizona and Gila trouts inhabit small areas of the coniferous/deciduous forest region. Special status mammals include the grizzly bear, gray wolf, and the woodland caribou.

Wilderness and Special Areas

BLM administers more than 416,000 acres of federally designated wilderness lands in Arizona, Utah, Idaho, Montana, New Mexico, Oregon, and Washington. As of September 30, 1987, the EIS program area had 635 wilderness study areas (WSAs) covering about 17.5 million acres (BLM 1988). The EIS area also has many sites designated as Areas of Critical Environmental Concern (ACEC), Research Natural Areas, Outstanding Natural Areas, National Natural Landmarks, and congressionally designated National Conservation areas.

BLM uses the Area of Critical Environmental Concern designation to highlight public land areas where special management attention is necessary to protect and prevent irreparable damage to important historic, cultural, and scenic values; fish or wildlife resources; or other natural systems or processes. The ACEC designation may also be used to protect human life and safety from natural hazards. BLM identifies, evaluates, and designates ACECs through its resource management planning process. Allowable management practices and uses, mitigation, and use limitations, if any, are described in the planning document. Under current guidelines, ACEC procedures also are used to designate Research Natural Areas, Outstanding Natural Areas, and other natural areas requiring special management attention.

The Bureau also cooperates with the National Park Service in implementing the National Natural Landmark Program as it applies to BLM-administered lands. Through the National Natural Landmark Program, the Park Service designates significant examples of the Nation's ecological and geological heritage.

As of the end of fiscal year 1987, BLM had designated 163 ACECs encompassing more than 1.5 million acres in the 13 Western States. There were also 127 Research and Outstanding Natural Areas and 35

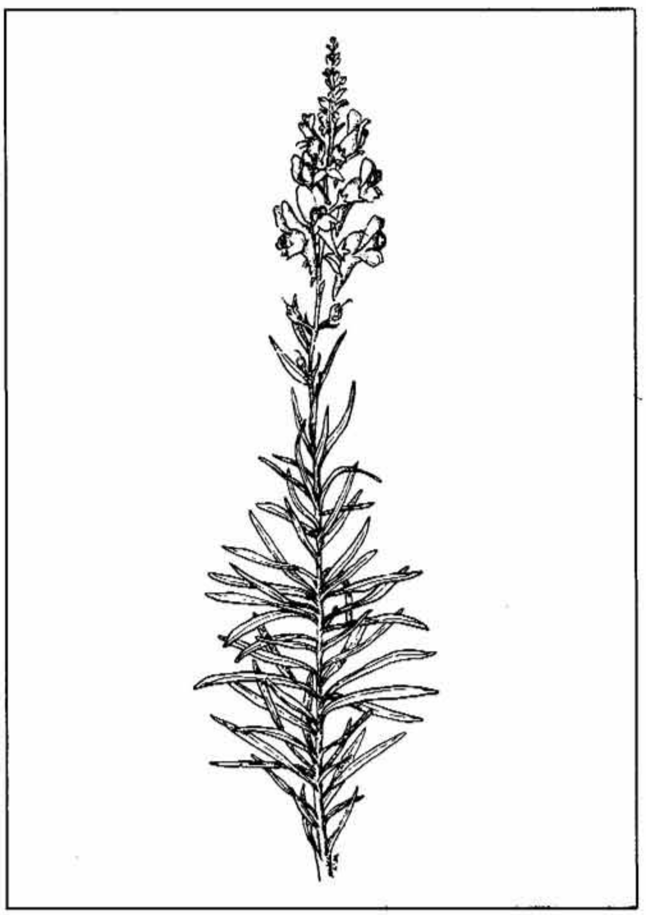
National Natural Landmarks on more than 1 million acres (BLM 1988).

Human Health and Safety

Background Health Risks in the Program States

This section discusses background human health risks of injuries, cancer, and other diseases for people living in the States that are included in the BLM Vegetation Treatment program. As is true for the United States as a whole, people in these States are exposed to risk from automobile accidents and many other injuries; contaminants in the air, water, and soil; chemicals in the diet; and various diseases. Occupational risks may be different from those that face the general public, depending on the work environment. Some of these risks can be quantified, while lack of data allows only a qualitative description of others. For some risks, information is available for the United States as a whole, but not specifically for the program States. In such cases, it is assumed that the United States data apply to conditions in the program States.

Sources of information for this section include detailed discussions by the Centers for Disease Control (CDC) of the 10 leading work-related diseases and injuries, as determined by the National Institute for Occupational Safety and Health (NIOSH) (USDHHS 1987), summaries of vital statistics for the BLM program States (U.S. Census Bureau 1987), the National Research Council's Regulating Pesticides in Food—The Delaney Paradox (NRC 1987) and Injury in America (NRC 1985), and Calabrese and Dorsey's Healthy Living in an Unhealthy World (Calabrese and Dorsey 1984). Except for certain infectious, notifiable diseases, little statistical information is available on nonfatal conditions, including cancer, that either are cured or are not the primary cause of mortality.



Yellow Toadflax

Risk of Diseases

Disease Incidence

According to the Centers for Disease Control (USDHHS 1987), clear causal links have been established between certain occupations and specific illnesses. For example, asbestosis among insulation and shipyard workers has been linked to their exposure to asbestos, and pneumoconiosis among coal miners has been linked to the inhalation of coal dust. Occupational exposures to some metals, dusts, and trace elements, as well as carbon monoxide, carbon disulfide, halogenated hydrocarbons, nitroglycerin, and nitrates, can result in an increased incidence of cardiovascular disease. Occupational exposure to lead and ionizing radiation may lead to reduced male fertility. Female laboratory and chemical workers show a higher rate of miscarriage than the general population. Neurotoxic disorders can arise from exposure to a wide range of chemicals, including some pesticides. Dermatologic conditions, such as contact dermatitis, infection, trauma, cancer, vitiligo, urticaria, and chloracne, have a high occurrence in the agricultural, forestry, and fishing industries, with 2,233 reported cases in 1984 and an incidence rate of 28.5 per 10,000 workers.

Disease Mortality

The mortality rates for the BLM program States are listed in Table 2-9, with some of the leading causes of death. Cerebrovascular and cardiovascular diseases are the leading causes of death in all States.

Table 2-9

Mortality per 100,000 Population and Causes of Death in BLM Program States in the Study Area

		Cause of Death			
		Diseases			
State	All	Cerebrovascular and Cardiovascular Disease	Chronic Respiratory Disease	Cancer	Accidents
Arizona	771.5	295.5	41.4	173.8	47.8
Colorado	625.7	238.5	34.9	124.4	40.1
Idaho	708.7	301.8	35.4	141.2	48.4
Montana	815.0	330.6	41.7	174.9	50.7
Nevada	772.3	306.7	39.4	180.4	43.9
New Mexico	672.8	233.3	32.9	131.7	56.9
North Dakota	821.6	381.7	26.6	177.5	33.1
Oklahoma	900.8	415.2	32.5	185.5	46.4
Oregon[1]	889.7	383.1	40.5	200.6	45.9
South Dakota	932.6	438.5	33.2	192.5	46.3
Utah	550.1	226.7	21.2	92.6	38.6
Washington	782.8	328.0	35.8	180.0	37.9
Wyoming	642.9	247.0	31.4	116.3	52.0

[1] Data are for the State of Oregon. However, only eastern Oregon is included in the BLM program.

Note: Data are for 1985.

Source: U.S. Department of Commerce, Bureau of the Census, 1987.

Risk From Injuries

Injury Incidence

Seventy million Americans incur nonfatal injuries every year. Among those less than 45 years old, injuries are the leading cause of hospitalization (NRC 1985).

NIOSH estimates that in the United States about 10 million traumatic work-related injuries occur annually (USDHHS 1987). Several chronic injuries are directly linked to the type of work done. For example, vibration syndrome affects up to 90 percent of workers using chippers, grinders, chain saws, jackhammers, or other handheld power tools, causing blanching and reduced sensitivity in the fingers (USDHHS 1987). Noise-induced hearing loss affects 17 percent of U.S. production workers who are exposed to noise levels of 80 decibels or more on a daily basis (USDHHS 1987).

Injury Mortality

Approximately 140,000 Americans die from injuries annually. Of the 94,072 deaths from unintentional injury in 1982, 47.5 percent were caused by motor vehicle accidents; 12.8 percent, falls and jumps; 6.8 percent, drowning; 3.7 percent, poisoning; and the other 29.2 percent, a wide variety of causes (NRC 1985). Injuries are the primary cause of death among young adults and children. From the ages of 15 to 24, injuries cause almost 80 percent of the fatalities (NRC 1985). Injuries cause about 10,000 occupational fatalities per year. Some of the causes include highway motor vehicle accidents (34.1 percent in 1980 to 1981), falls (12.5 percent), industrial vehicle or equipment accidents (11.4 percent), and fires (3.4 percent). Workers in the mining and quarrying industry had the highest rate of traumatic deaths, at 55 per 100,000 workers. Agriculture had a rate of 52 deaths per 100,000 workers, while trade had only 5 deaths per 100,000 workers (USDHHS 1987).

Risk of Cancer

Cancer Incidence

Nationwide, the chance of developing some form of cancer during one's lifetime is about 1 in 4 (Calabrese and Dorsey 1984, NRC 1987). The causes of cancer development are many, including occupational exposure to carcinogens, environmental contaminants, and substances in food. In the United States, one-third of all cancers have been attributed to tobacco smoking (Chu and Kamely 1988). It is estimated that work-related cancers account for anywhere from 4 to 20 percent of all malignancies (USDHHS 1987); however, it is difficult to quantify the information because of factors such as long intervals of time between exposure and diagnosis, personal behavior patterns, job changes, exposure to other carcinogens, and difficulties in documentation.

Cancer Mortality

Based on the data in Table 2-9, cancer accounted for 9 to 20 percent of 1985 fatalities in the BLM program States. These figures are reflective of the national cancer mortality figures in which cancer accounted for 19 percent of 1985 deaths in the United States (USDC 1988).

Social and Economic Resources

Social Resources

The EIS program area is more sparsely populated than the rest of the United States, and a greater proportion of the residents live in rural areas. These Western States have an average of 22 people per square mile, compared to the national average of 68 per square mile (Table 2-10). Four of the program States—Montana, North and South Dakota, and Wyoming—are among the least densely populated in the western area, with between 5 and 10 people per square mile. Washington and Oklahoma have the highest population density, with 67 and 48 inhabitants per square mile, respectively. The rural population is 32 percent, significantly greater than the national average of 26 percent (USDC 1984). Approximately 5 percent of the region's inhabitants are rural farm residents.

Table 2-10

Population Distribution and Density of the States in the Study Area

State	Population (1986) Total (thousands)	Rank	Distribution (1980) (Percent) Urban Total	Rural Total	Farm	Density (1986) Per Square Mile Land Area
Arizona	3,319	2	83.8	16.2	0.5	29.2
Colorado	3,267	4	80.6	19.4	2.0	31.5
Idaho	1,002	8	54.0	46.0	7.3	12.2
Montana	819	10	52.9	47.1	7.4	5.6
Nevada	963	9	85.3	14.7	0.7	8.8
New Mexico	1,479	7	72.1	27.9	1.5	12.2
North Dakota	679	12	48.8	51.2	15.9	9.8
Oklahoma	3,305	3	67.3	32.7	4.3	48.1
Oregon	2,698	5	67.9	32.1	3.0	28.0
South Dakota	708	11	46.4	53.6	16.3	9.3
Utah	1,665	6	84.4	15.6	1.3	20.3
Washington	4,462	1	73.5	26.5	2.0	67.1
Wyoming	507	13	62.7	37.3	4.1	5.2
Average:						
Western States			67.7	32.3	5.1	22.1
United States			73.7	26.3	2.5	68.1

Sources: U.S. Department of Commerce, Bureau of the Census 1987, Table 21; and U.S. Department of Commerce, Bureau of the Census 1984, Table 2.

Economic Resources

In 1980, agriculture, forestry, fisheries, and mining industries accounted for nearly 10 percent of all employment in the 13 Western States (Table 2-11). In Wyoming more than 20 percent of the workers depend on these industries for jobs, while in Nevada only 3 percent are employed in these resource-based industries.

Domestic livestock operations based on public lands play a vital role in the economic prosperity of many communities in the Western States. Many residents earn their livelihoods in livestock production and meat processing industries or are employed in industries using byproducts to make leather, pet food, textiles, and other commodities. Others are employed by businesses that supply goods and services to these industries and by railroads and trucking firms that move products to markets across the country.

Sagebrush

More than 90 percent of all land in the sagebrush region is rangeland (USDA 1981). A large part of the land not federally owned is private farms and ranches. Irrigation is practiced where water is available and soils are suitable. The Snake River and its tributaries irrigate more than 25 percent of this region, supporting some of the most productive agricultural lands in the Western United States. Small acreages are used to grow feed crops and some wheat. Peas, beans, and sugarbeets also are grown.

Livestock production is the primary agricultural activity on the vast BLM lands in this region. In the Snake River Plain, opportunities exist to increase forage production with improved management and conditions. Open forests on high mountain slopes also provide important habitats for wildlife and livestock grazing.

Desert Shrub

Approximately 75 percent of the desert shrub analysis region is owned by Federal and local governments. The remainder is in private ownership and consists mostly of farms and ranches. Livestock grazing is an important component of this analysis region. Citrus fruit, dates, grapes, sugarbeets, many kinds of vegetables, small grains, hay, and pasture grasses are grown.

Southwestern Shrubsteppe

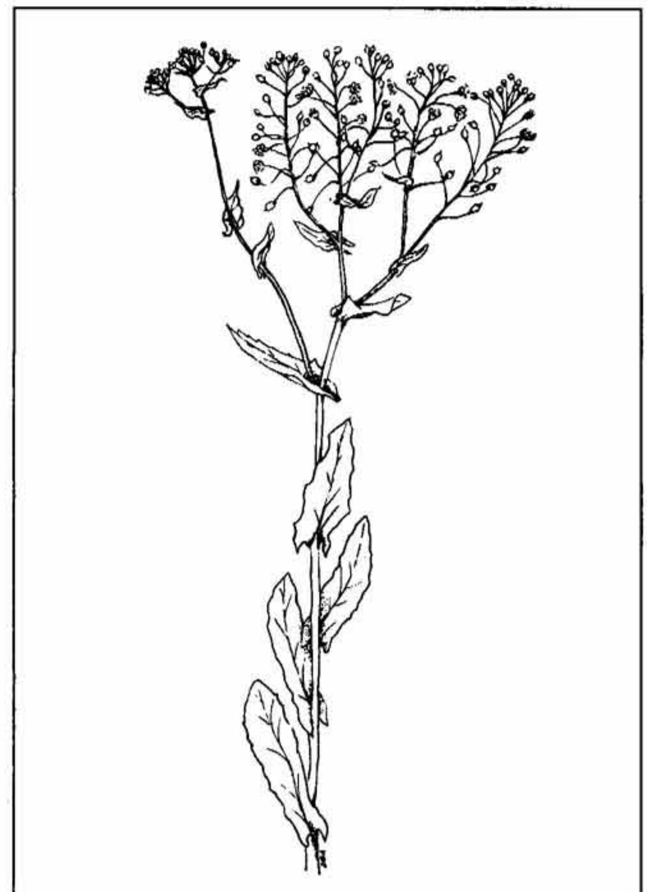
Use of land area in the southwestern shrubsteppe region is dependent upon the local development of ground-water resources. In those areas with water-well development, irrigation farming is practiced. Much of the area is used as rangeland for grazing livestock.

Chaparral-Mountain Shrub

The interior and southwestern portions of the chaparral-mountain shrub region are largely used for livestock grazing. Lands in these places that are suitable for crops are most often used for producing forage crops.

Pinyon-Juniper

The pinyon-juniper ecosystem is used for grazing and wood products, such as Christmas trees, fence posts, and cord wood.



Hoary Cress

Table 2-11

Employment by Industry in the States in the Study Area

State	Agriculture, Forestry, Fisheries, and Mining		Construction		Manufacturing		Transportation and Communications		Retail and Wholesale Trade		Business, Finance, Insurance, and Real Estate		Repair and Personal Services		Professional Services		Public Administration		TOTAL
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	
Arizona	59,396	5.3	90,381	8.1	161,302	14.5	73,779	6.6	246,094	22.1	77,266	6.9	108,227	9.7	223,845	20.1	72,980	6.6	1,1 13,270
Colorado	78,817	5.8	107,063	7.9	192,305	14.1	108,668	8.0	298,526	21.9	96,725	7.1	127,966	9.4	274,880	20.2	77,067	5.7	1,362,017
Idaho	43,959	11.5	26,718	7.0	53,455	13.9	28,789	7.5	84,795	22.1	20,755	5.4	33,901	8.8	68,544	17.9	22,736	5.9	383,652
Montana	43,360	13.2	23,035	7.0	24,286	7.4	29,417	9.0	73,862	22.5	16,162	4.9	25,161	7.7	71,057	21.6	21,976	6.7	328,316
Nevada	12,033	3.0	31,428	7.9	23,353	5.9	30,265	7.6	75,379	18.9	23,884	6.0	121,430	30.5	55,103	13.8	25,691	6.4	398,566
New Mexico	47,514	9.3	42,769	8.4	37,737	7.4	37,362	7.4	105,553	20.8	26,445	5.2	58,336	11.5	109,492	21.5	43,030	8.5	508,238
North Dakota	47,516	17.4	18,999	7.0	15,877	5.8	20,935	7.7	63,801	23.4	12,493	4.6	17,741	6.5	61,280	22.5	13,978	5.1	272,620
Oklahoma	114,171	8.9	92,856	7.2	214,779	16.7	96,043	7.5	269,426	20.9	68,873	5.3	99,492	7.7	253,144	19.7	79,073	6.1	1, 287,857
Oregon	55,001	4.8	73,250	6.4	222,017	19.5	81,621	7.2	256,497	22.5	71,228	6.3	86,975	7.6	234,834	20.6	57,002	5.0	1,138,425
South Dakota	51,018	17.2	17,464	5.9	28,555	9.6	18,005	6.1	65,256	22.0	13,856	4.7	20,415	6.9	65,061	21.9	17,049	5.7	296,679
Utah	32,414	5.5	41,797	7.1	92,557	15.8	43,979	7.5	123,835	21.1	34,316	5.9	45,792	7.8	120,804	20.6	50,427	8.6	585,921
Washington	72,723	4.1	122,396	6.8	349,977	19.5	139,132	7.8	394,733	22.0	111,485	6.2	152,137	8.5	363,768	20.3	88,003	4.9	1,794,354
Wyoming	43,857	20.2	22,282	10.3	11,821	5.4	19,946	9.2	41,867	19.3	8,794	4.0	16,859	7.8	39,546	18.2	12,402	5.7	217,374
TOTAL	**701,779**		**710,438**		**1,428,021**		**727,941**		**2,099,624**		**582,282**		**914,432**		**1,941,358**		**581,414**		**9,687,289**
Average	**53,983**	**9.7**	**54,649**	**7.5**	**109,848**	**12.0**	**55,995**	**7.6**	**161,510**	**21.5**	**44,791**	**5.6**	**70,341**	**10.0**	**149,335**	**19.9**	**44,724**	**6.2**	

Source: State Demographics, Dow Jones-Irwin 1983.

Plains Grasslands

The plains grasslands region is considerably more arid than the tallgrass region to the east. Progressing west and south within this region, livestock grazing on native as well as improved rangeland becomes increasingly important. To the east and where sufficient moisture exists for agriculture, the principal crops are wheat, grain sorghum, sugarbeets, soybeans, corn, and other feed grains. Cotton is also grown in irrigated areas in the southern part of the region.

Mountain/Plateau Grasslands

Most of the mountain/plateau grassland region is used for grazing sheep and cattle; much of the grazing land is federally owned. Irrigated croplands are found along the valleys of major streams. Alfalfa, grain, corn, and hay for livestock feed are the main crops; but fruits, vegetables, and other cash crops are also grown. Land-use problems resulting from declining water tables and short supply of irrigation water are common. Overgrazing contributes to the invasion of brushy vegetative species and gully erosion.

Coniferous/Deciduous Forest

A large percentage of the coniferous/deciduous forest region is federally owned; the remainder is farms, ranches, and other privately owned land. Lumber is a principal industry, and large tracts of land in the Rockies are controlled by commercial timber companies. Forests and woodland areas provide important wildlife habitats and grazing for livestock. Mining occurs in Idaho, western Montana, and the Cascade Mountains. Cropland accounts for only a small part of the acreage in this region.