INTRODUCTION

Ecosystems are defined as areas with living organisms interacting with each other and with their physical environment. They are dynamic entities shaped by natural processes and disturbance agents (including succession, fire, insects, and floods). Ecosystems occur at various scales, with smaller systems nested within larger ones. Ecosystem diversity is defined as the variety of ecosystem types, which includes their composition, structure, and processes).

Ecosystem sustainability is defined as saving all of the ecological pieces, managing them within the physical and biological capabilities of the land, and not irreversibly affecting (impacting) an ecosystem's resilience, resistance to change, or ability to meet the needs of future generations. In order to accomplish this goal, ecosystem diversity in the form of terrestrial ecosystems, aquatic ecosystems, and riparian areas and wetland ecosystems is used in the planning process as the primary method of emphasizing the ecological conditions necessary in order to support sustainable ecosystems of native plant and animal species.

Most of the analysis in this DLMP/DEIS occurs at the subregion scale, using the planning area (the SJPL) as the associated analysis unit. Major vegetation types are the primary landscape-scale ecosystems used to analyze historical, current, and foreseeable future ecological conditions within the planning area. (Additional information about the SJPL, relative to the ecoregion scale, can be found in the Ecological Units section; the landscape-scale (land-type association ecological units) can be found in the Analysis of the Management Situation (AMS) document.)

The historic range of variability (HRV) is used as an important concept for management throughout the planning area. HRV describes the range of ecological conditions (including vegetation structure and natural disturbance regimes) that occurred within the planning area during the reference period. The reference period includes the period of indigenous settlement from approximately A.D. 500 to the late 1800s, when broad-scale climatic conditions were similar to those of today, but when Euro-American settlers had not yet introduced the sweeping ecological changes (including timber harvesting, livestock grazing, fire suppression, water diversions, dams, and roads) that have greatly altered many Rocky Mountain landscapes. HRV information allows a comparison of whether or not current ecological conditions within the planning area are similar, or dissimilar, to the HRV conditions that occurred within the planning area in the past. The intent is not to manage the planning area according to HRV conditions. The intent is to use HRV conditions as a context in order to help formulate attainable and sustainable desired conditions that meet a variety of management needs.

Within the context of ecosystem management, plant species are evaluated, and provided for. By protecting the composition, structure, and function of the major vegetation types within the planning area, the assumption is that a variety of species representing a majority of the native flora and fauna found within those ecosystems would be sustained. A species-approach, focused on the specific needs of individual species, would be implemented for those plant species that are rare or endemic, at risk of decline, or are not adequately covered by the ecosystem management approach. These species include federally listed species, Candidate species, R2 Regional Forester's Sensitive Species, BLM Sensitive Species, BLM Special-Status Species, and SJPLC Highlight Species.

LEGAL AND ADMINISTRATIVE FRAMEWORK

LAWS

- ***The National Forest Management Act of 1976***: This act states that forest plans must "provide for the diversity of plant and animal communities."
- ***The National Environmental Policy Act of 1969***: This act promotes efforts that would prevent or eliminate damage to the environment and biosphere, and enrich the understanding of the ecological systems and natural resources important to the nation.
- ***The Endangered Species Act (ESA) of 1973***: This act authorizes the determination and listing of species as endangered and threatened. Section 7 of the ESA requires Federal agencies to ensure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat.

REGULATIONS AND POLICIES

- ***FSM Manual 2670.22***: This manual directs the USFS to develop and implement management practices to ensure that sensitive species do not become threatened or endangered due to USFS actions.
- ***BLM Manual 6840***: This manual directs the BLM to seek opportunities to conserve and improve special-status species and habitats for native animals and wildlife in the development of land use plans.

AFFECTED ENVIRONMENT

EXISTING CONDITIONS AND TRENDS

Terrestrial Ecosystems are defined as ecosystems that occur in relatively dry, upland landscape positions. Major vegetation types are used to describe the terrestrial ecosystem diversity within the planning area (described below), and include information on their current condition, trends, and HRV (See Figure 3.6.1).

Development stages of the major vegetation types are used to further describe ecosystem diversity within the planning area. They are extensions of the Wildlife Structural Stages (WSS) found in the SJPL R2VEG database. In addition to tree size and crown cover, development stages include other structural and compositional components important to ecosystems and native biota. The young development stage generally correlates with WSS 2 (Seedling-Sapling); the mid-development stage generally correlates with WSS 3 (Sapling-Pole); and the mature development stage generally correlates with WSS 4 (Mature). The old-growth development stage was developed from attributes identified by Mehl (1992).

HRV information associated with fire, insects and disease, and vegetation seral stages comes from the RMLANDS report "Historic Range of Variability in Landscape Structure, and Wildlife Habitat of the SJNF" (McGarigal and Romme 2005), and from the Landscape Condition Analysis for the South Central Highlands Section, southwestern Colorado and northwestern New Mexico (Romme et al. 2006). RMLANDS (the landscape model that simulates changes in vegetation over time under the historic reference period disturbance regimes) attempts to gain a quantitative understanding of HRV within the planning area. It compliments the Landscape Condition Analysis (Romme et al. 2006). RMLANDS results and conclusions are based on a simulation model. This model, like any model, is an abstract and simplified representation of reality.

TERRESTRIAL ECOSYSTEM DESCRIPTIONS

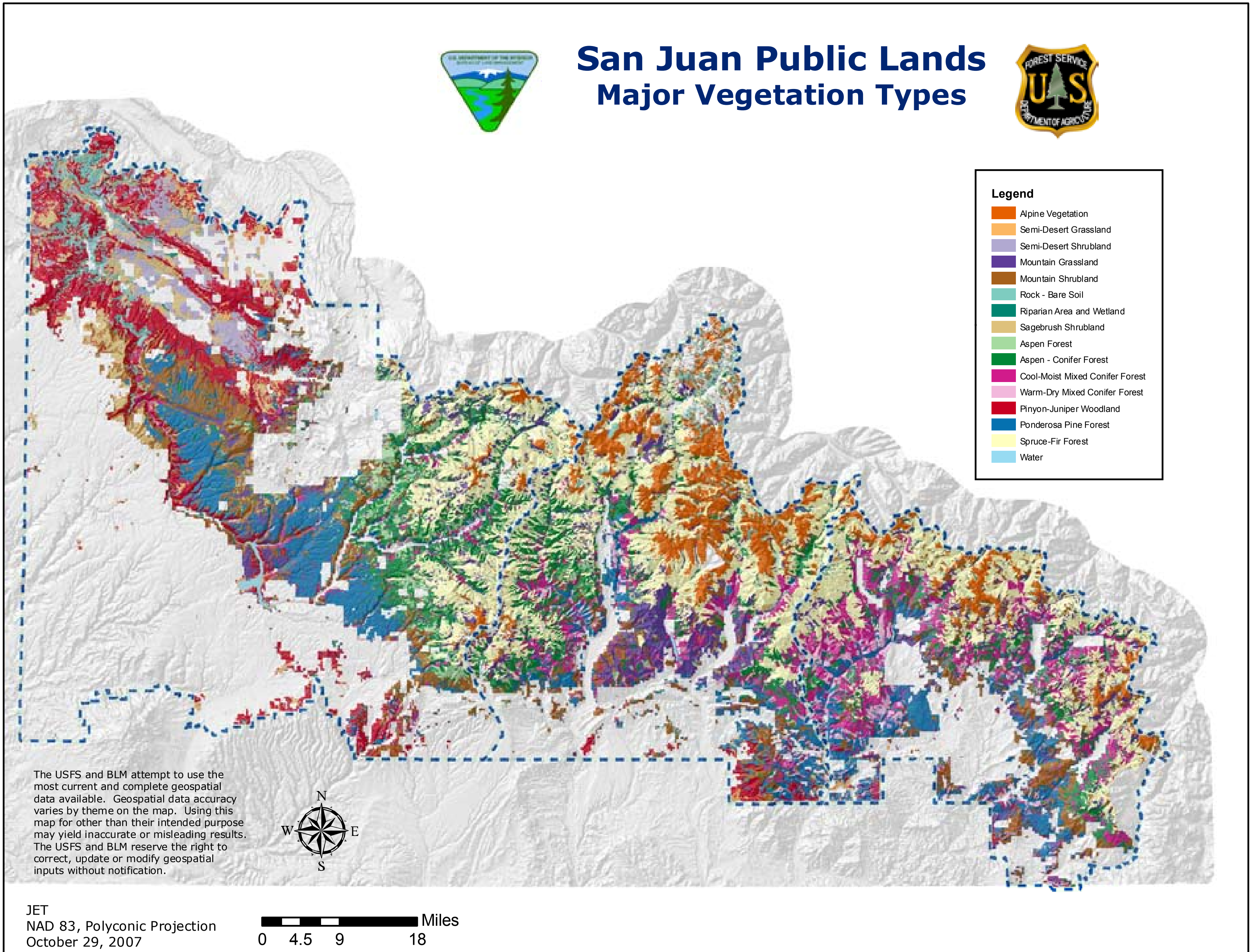
Spruce-Fir Forest Type

The spruce-fir forest type is dominated by Engelmann spruce and subalpine fir trees. This forest type occurs throughout SJPL on mountain and mesa landscapes in the subalpine climatic zone at elevations ranging from about 9,000 to 11,800 feet. There are about 519,000 acres of this type within SJPL, which is about 14 percent of the total acreage.

Some spruce-fir forests succeeded from aspen-dominated forests that were established following stand-replacing fires. Others formed through the establishment of Engelmann spruce and subalpine-fir trees that initially colonized sites following disturbance events. Some may have succeeded from cool-moist mixed-conifer forests.

Spruce-Fir HRV: During the reference period, the fire-return interval for stand-replacement fire in the spruce-fir forest type in the planning area was longer than 200 years (Romme et al. 2006). The frequency of RMLANDS-simulated wildfires in the spruce-fir forest type during the reference period displayed a mean return interval range of 266 to 329 years. Late-lying snowpacks and frequent summer rains kept fuels too wet to burn throughout most of the growing season. During the long intervals between fires, the disturbance regime of individual spruce-fir stands was dominated by chronic fine-scale processes involving insects, fungi, and wind that killed individual trees or small groups of trees (Veblen et al. 1989; Lertzman and Krebs 1991; Veblen et al. 1991b; Roovers and Rebertus 1993). In the rare dry years when weather and fuel conditions were suitable for extensive burning, large portions of spruce-fir forests were burned during severe stand-replacing events. Given the long fire-return intervals that naturally characterize these forests, the current fire-disturbance regime of the spruce-fir forest type is within the HRV for fire-return intervals.

Figure 3.6.1 – Major Vegetation Types



Currently, most of the spruce-fir forest type within the planning area is in the mature and old-growth development stages. This correlates well with the RMLANDS simulations that suggest that the planning area contains fewer early-seral spruce-fir forests than that which existed under the simulated HRV. RMLANDS simulations suggest that the HRV seral stage distribution for the spruce-fir forest type fluctuated markedly over time, and may be characterized as a shifting mosaic of successional stages.

Table 3.6.1 - Current Acreage of the Spruce-Fir Forest Type by Development Stage

DEVELOPMENT STAGE	ACRES	PERCENTAGE (%) OF TOTAL
Young	8,230	1.5
Mid	32,848	6.5
Mature	360,804	70
Old-Growth	117,343	22

Within the next 50 years, natural succession will convert some lands currently classified as the aspen-conifer forest type to the spruce-fir forest type. This process, however, would be gradual and may not substantially change the number of acres of these forest types within that time. Barring large-scale disturbance, succession within the next 50 years may also impact the development stages of the spruce-fir forest type, moving more lands into the mature and old-growth stages. Wildland fire may reduce the acreage of the spruce-fir forest type, if large fires burn across the higher-elevation landscapes within the planning area (with the result that many of these lands would then convert to aspen forests following stand-replacement fire).

Aspen-Conifer Forest Type

The aspen-conifer forest type is dominated by aspen trees. Conifer trees are common, displaying greater than or equal to 20% canopy cover. This type occurs throughout the planning area on mountain and mesa landscapes at elevations ranging from approximately 8,000 to 11,200 feet. They are associated with the subalpine and montane climate zones. There are approximately 236,700 acres of this type within the planning area (which is approximately 6.3% of the total acreage).

Aspen-Conifer HRV: Fire was the most important agent of disturbance in the aspen-conifer and aspen forest types (hereafter referred to as aspen forests) during the reference period (Romme et al. 2006). The fire-return interval for all fires in planning area aspen forests during the reference period was approximately 140 years (Romme et al. 2006). The frequency of RMLANDS-simulated wildfires in the aspen forests during the reference period displayed a mean return interval of 110 years. The aspen forests within the planning area have relatively long fire-return intervals; therefore, the current fire-disturbance regime of planning area aspen forests is within the HRV for fire-return intervals.

Currently, most of the aspen forests within the planning area are in the mature development stage. RMLANDS indicated that, currently, the planning area contains more late-seral aspen forests and fewer early-seral aspen forests than that which existed under the simulated HRV. The HRV seral stage distribution for the aspen forests has fluctuated markedly over time, and could be characterized as a shifting mosaic of successional stages.

Table 3.6.2 – Current Acreage of Aspen Forests by Development Stage

DEVELOPMENT STAGE	ACRES	PERCENTAGE (%) OF TOTAL
Young	1,780	1
Mid	102,233	31
Mature	224,170	68

The broad-scale geographic and elevational distributions, as well as the floristic composition of aspen forests during the reference period were probably similar to what is seen today (Romme et al. 2006). There undoubtedly has been a decrease in aspen abundance within the planning area during the latter half of the Twentieth Century as the result of fire exclusion and succession. This has allowed some aspen forests to succeed to conifer forests, however, the decrease has been minimal and has occurred gradually. Compared to the reference period, the proportion of older aspen stands has increased and the proportion of younger aspen stands has decreased due to the low fire frequency and to the relatively low levels of logging. Currently, the young aspen forests occurring as the result of timber harvesting lack the abundant snags and fallen logs that were common in the young aspen stands of the reference period following fire.

Within the next 50 years, natural succession will convert some lands currently classified as the aspen-conifer forest type to the spruce-fir and cool-moist mixed-conifer forest types. This process, however, would occur gradually. Thus, the aspen forests may not disappear from the landscapes in which they occur, at least not during this planning period, or for many future decades. Barring large-scale disturbance, succession within the next 50 years may also impact the development stages of the aspen forests, moving more lands into the mature stage. Future clear-cut harvests and wildfire in aspen forests may maintain some aspen forests, change some older aspen forests to younger aspen forests, and change some of the aspen-conifer forest type to the aspen type.

Aspen Forest Type

The aspen forest type within the planning area is dominated by aspen trees. Conifer trees are absent or are displayed as very minor components. This forest type occurs throughout the planning area on mountain and mesa landscapes at elevations ranging from about 8,000 to 11,200 feet. They are associated with the subalpine and montane climate zones. There are approximately 1,500 acres of this type within the planning area (which is approximately 2.4% of the total acreage).

Aspen HRV: Current conditions and trends associated with aspen forests are discussed above, under the aspen-conifer forest type.

Cool-Moist Mixed-Conifer Forest Type

Within the planning area, the cool-moist mixed-conifer forest type is dominated by white-fir and Douglas-fir trees. This forest type occurs on mountain and mesa landscapes at elevations ranging from approximately 8,500 to 10,000 feet. They are associated with the montane and subalpine climate zones. There are approximately 215,500 acres of this type within the planning area (which is approximately 5.7% of the total acreage).

Some cool-moist mixed-conifer forests succeeded from aspen-dominated forests that were established following stand-replacing fires. Others formed when white-fir and Douglas-fir trees initially colonized a site following a disturbance event. Some may have succeeded from the warm-dry mixed-conifer type, where the less shade-tolerant ponderosa pine component decreased as the more shade-tolerant Douglas-fir and white-fir components increased in abundance. The selective harvesting of ponderosa pine trees from warm-dry mixed-conifer stands resulted in some cool-moist mixed-conifer forests.

Cool-Moist Mixed Conifer HRV: Stand-replacement fire was the most important type of disturbance in cool-moist mixed-conifer forests during the reference period (Baker and Veblen 1990; Veblen et al. 1994; Romme et al. 2006). The frequency of RMLANDS-simulated wildfires in the cool-moist, mixed-conifer forest type during the reference period displayed a mean return interval range of 144 years. Late-lying snowpacks and frequent summer rains kept fuels moist throughout most of the fire season in most years; therefore, cool-moist mixed-conifer stands persisted for many decades, or even centuries, without fire. When fires finally did occur during prolonged dry periods, a high-intensity, stand-replacing event occurred. Given the long fire-return intervals that naturally characterize these forests, the current fire disturbance regime of the cool-moist mixed-conifer forest type is within the HRV for fire-return intervals.

Cool-moist mixed-conifer forests are subject to three different insect disturbance processes: the Douglas-fir beetle, the spruce beetle, and the spruce budworm. The frequency of RMLANDS-simulated epidemics in these forests during the reference period displayed a mean return interval of 381 years for spruce beetle, 90 years for spruce budworm, and greater than 800 years for Douglas-fir beetle.

Currently, most of the cool-moist mixed-conifer forest type is in the mature and old-growth development stages. This correlates well with the RMLANDS determination that the planning area contains more late-seral cool-moist mixed-conifer forests and fewer early-seral cool-moist mixed-conifer forests than that which existed under the simulated HRV. RMLANDS simulations suggest that the HRV seral stage distribution for this forest type fluctuated markedly over time and may be characterized as a shifting mosaic of successional stages.

Table 3.6.3 – Current Acreage of the Cool-Moist Mixed-Conifer Forest Type by Development Stage

DEVELOPMENT STAGE	ACRES	PERCENTAGE (%) OF TOTAL
Young	151	0.5
Mid	21,172	10
Mature	170,092	79
Old-Growth	24,122	11

Within the next 50 years, natural succession will convert some lands currently classified as the aspen-conifer forest type to the cool-moist mixed-conifer forest type. This process, however, would be gradual and may not substantially change the acreage of those types within the 50 years. Barring large-scale disturbance, succession within the next 50 years may also impact the structural stages of the cool-moist mixed-conifer forest type, moving more lands into the mature and old-growth stages. Wildland fire may reduce the acreage of the cool-moist mixed-conifer forest type, if large fires burn across he higher-elevation landscapes within the planning area (as many of these lands would then convert to aspen forests following stand-replacement fire).

Warm-Dry Mixed-Conifer Forest Type

Within the planning area, the warm-dry mixed-conifer forest type is dominated by ponderosa pine, white-fir, and Douglas-fir trees. This forest type occurs on mountain and mesa landscapes in the montane climate zone at elevations ranging from approximately 7,500 to 9,000 feet. They occur on warmer and drier sites, usually at lower elevations, when compared with the cool-moist mixed-conifer type. There are approximately 93,600 acres of this type within the planning area (which is approximately 2.5% of the total acreage).

Some warm-dry mixed-conifer forests succeeded from the Gambel oak-dominated shrublands that were established following stand-replacing fires. Some formed when white-fir, Douglas-fir, or ponderosa pine trees initially colonized a site following a disturbance event. Others may have succeeded from the ponderosa pine type due to succession and fire suppression, which, in turn, may have increased the abundance of white-fir and Douglas-fir.

Warm-Dry Mixed-Conifer HRV: Fire and insect outbreaks were the two most important kinds of disturbances in warm-dry mixed-conifer forests during the reference period (Romme et al. 2006). When all fires are considered, the median fire interval for the warm-dry mixed-conifer forest type during the reference period ranged from 18 to 28 years (Grissino-Mayer et al. 2004). The frequency of RMLANDS-simulated wildfires in warm-dry mixed-conifer forests during the reference period displayed a mean return interval of 57 years.

During the reference period, most of the warm-dry mixed-conifer forests within the planning area appear to have been composed of relatively open stands dominated by large ponderosa pine, Douglas-fir, and white-fir trees. This kind of stand structure occurred, in part, as the result of recurrent fires of relatively low to moderate intensity. These fires apparently killed few of the mature trees (thanks to their thick bark), but probably killed most of the small understory trees and some shrubs. Occasionally, under conditions of severe and prolonged dry weather, the warm-dry mixed-conifer stands were subjected to intense crown fires that killed even the mature trees (Fule et al. 2003; Romme et al. 2006).

Warm-dry mixed-conifer forests were subject to three different insect disturbance processes during the reference period: the pine beetle, the Douglas-fir beetle, and the spruce budworm. The frequency of RMLANDS-simulated epidemics in warm-dry mixed-conifer forests during the reference period displayed a mean return interval of 133 years for spruce budworm, 695 years for Douglas-fir beetle, and 410 years for pine beetle. Currently, most of the warm-dry mixed-conifer forest type within the planning area is in the mature development stage. RMLANDS simulations suggest that the planning area contains more late-seral warm-dry mixed-conifer forests and less old-growth warm-dry mixed-conifer forests than that which were observed under the simulated HRV. The RMLANDS simulations also indicated that the HRV seral stage distribution for the warm-dry mixed-conifer forest type fluctuated markedly over time and may be characterized as a shifting mosaic of successional stages.

Table 3.6.4 – Current Acreage of the Warm-Dry Mixed-Conifer Forest Type by Development Stage

DEVELOPMENT STAGE	ACRES	PERCENTAGE (%) OF TOTAL
Young	100	0.5
Mid	7,807	8.5
Mature Open	59,326	4.5
Mature Closed	17,077	77
Old-Growth	9,319	10.0

Within the planning area, many of the warm-dry mixed-conifer forests have been dramatically altered during the last century. This is the result of logging, livestock grazing, and fire exclusion introduced by Euro-American settlers in the late 1800s (Romme et al. 2006). Logging eliminated the large, old ponderosa pine, Douglas-fir, and white-fir trees. Livestock grazing changed the herbaceous species composition and decreased the abundance of the bunchgrasses that had previously carried surface fire through these forests. Fire suppression eliminated the frequent, low-intensity fires of the previous centuries. Many warm-dry mixed-conifer forests within the planning area that formerly burned every 18 to 28 years have not experience a fire for more than 100 years, which puts those forests outside their HRV for fire intervals (Romme et al. 2006; Grissino-Mayer et al. 2004). The combination of fire exclusion, livestock grazing, and selective logging that removed the large trees has created an unusual stand structure in many warm-dry mixed-conifer forests within the planning area (Romme et al. 2006). Old-growth warm-dry mixed-conifer forest stands that were common during the reference period are now uncommon. The large, old ponderosa pine, Douglas-fir, and white-fir trees are mostly gone, and the current stands are now dominated by relatively small, young trees. White-fir, in particular, has increased in abundance during the long fire-free period of the Twentieth Century. During the same time, the establishment of new ponderosa pine and Douglas-fir trees has tapered off, or stopped, in many stands due to the dense stand conditions (Wu 1999).

Within the next 50 years, natural succession will convert some lands currently classified as the mountain shrubland type to the warm-dry mixed-conifer forest type. This process, however, would be gradual and may not substantially change the acreage of those types within the 50 years. Succession within the next 50 years may also move more warm-dry mixed-conifer forests into the mature and old-growth development stages. Wildland fire use (WFU) may reduce the acreage of the warm-dry mixed-conifer forest type, if large fires burn across the landscapes of the planning area, and many warm-dry mixed-conifer forests may convert to mountain shrublands following stand replacement fire.

Ponderosa Pine Forest Type

Within the planning area, the ponderosa pine forest type is dominated by ponderosa pine trees. This forest type occurs on mountains, hills, and mesas in the lower montane climate zone at elevations ranging from approximately 7,000 to 8,500 feet. Gambel oak is a major component of these forests, occurring in most stands. Arizona fescue and mountain muhly are important bunchgrasses that occur in these forests. There are approximately 411,500 acres of this type within the planning area (which is approximately 10.9% of the total acreage).

Some ponderosa pine forests succeeded from Gambel oak-dominated shrublands that were established following stand-replacing fires. Others formed when ponderosa pine trees initially colonized a site following a disturbance event.

Ponderosa Pine HRV: Fire and mountain pine beetle outbreaks were the two most important kinds of disturbance in ponderosa pine forests during the reference period (Romme et al. 2006). The median fire interval for the ponderosa pine forest type during the reference period ranged from 12 to 30 years (Grissino-Mayer et al. 2004). The frequency of RMLANDS-simulated wildfires in ponderosa pine forests during the reference period displayed a mean return interval of 30 years for low-mortality ground fire. Some ponderosa pine stands did not burn frequently and, in fact, did not burn for centuries.

During the reference period, most of the ponderosa pine forests within the planning area appear to have been characterized by frequent low-intensity fires. The fires played a key role in maintaining open stand structures with large clumped trees, as well as abundant herbaceous growth in the open areas between clumps (Grissino-Mayer et al. 2004; Romme et al. 2006; Brown and Wu 2005). These fires probably consumed grass, dead leaves, and dead woody material. They also probably resulted in the mortality of small pines and the aboveground portions of shrubs and herbs, but rarely killed large trees or belowground parts of shrubs and herbs. However, not all ponderosa pine stands had this kind of structure (Grissino-Mayer et al. 2004), as it appears that there was considerable variability in the density and structure of ponderosa pine forests (Romme et al. 2006). In at least some places, there were dense stands of relatively small trees, similar to the condition of many ponderosa pine stands today (Shinneman and Baker 1997; Brown et al. 1999; Veblen 2000; Ehle and Baker 2003).
RMLANDS simulations determined that the mean return interval between pine beetle epidemics in a ponderosa pine forest during the reference period was 251 years. Between outbreaks, the beetles persisted at low endemic levels, killing an occasional tree, but having little impact on the forest as a whole. The intensity and extent of recent mountain pine beetle outbreaks has likely been influenced by Twentieth Century conditions (including fire exclusion and unusually high tree densities); however, it is likely that relatively comparable beetle outbreaks also occurred in ponderosa pine forests during the reference period (Baker and Veblen 1990).

Currently, most of the ponderosa pine forest type within the planning area are in the mature development stage. RMLANDS simulations suggest that the planning area currently contains more late-seral ponderosa pine forests and less old-growth ponderosa pine forests than that which were observed under the simulated HRV. The simulation also indicated that the HRV seral-stage distribution for the ponderosa pine forest type fluctuated markedly over time and may be characterized as a shifting mosaic of successional stages.

Table 3.6.5 – Current Acreage of the Ponderosa Pine Forest Type by Development Stage

DEVELOPMENT STAGE	ACRES	PERCENTAGE (%) OF TOTAL
Young	636	0.1
Mid-Open	29,118	7
Mid-Closed	837	0.2
Mature-Open	344,596	83
Mature-Closed	25,172	6
Old-Growth	11,087	2.7

Within the planning area, many of the ponderosa pine forests have been dramatically altered during the last century due to logging, livestock grazing, and fire exclusion introduced by EuroAmerican settlers in the late 1800s (Romme et al. 2006). Logging eliminated the large, old ponderosa pine trees. Livestock grazing altered herbaceous plant species composition, which decreased the highly palatable bunchgrasses (including Arizona fescue and mountain muhly), and helped to eliminate fire as a dominant ecological process in ponderosa pine forests (especially as livestock grazed the grasses and forbs that formerly carried light fires through these forests). Through most of the Twentieth Century, fire suppression eliminated the frequent low-intensity fires of the previous centuries. Many ponderosa pine stands within the planning area that formerly burned every 12 to 30 years have not experience a fire for more than 100 years. This puts these stands outside their HRV for fire intervals (Romme et al. 2006; Grissino-Mayer et al. 2004). In addition, white-fir, a shade-tolerant species, has increased in some stands due to dense stem conditions and fire exclusion.

The impacts described above have created an unnatural stand structure in many ponderosa pine forests within the planning area. The large, old ponderosa pine trees from the reference period have mostly been harvested. Many stands now have a relatively uniform stand structure, which is dominated by medium-sized trees that are 70 to 100 years old. Due to livestock grazing (and because they cannot tolerate the shade and deep organic litter on the forest floor provided by the dense ponderosa pine stands), many herbaceous plant species have been greatly reduced in numbers or have even been locally extirpated (Romme et al. 2006). The strong clumping pattern and the old-growth forests of the reference period have been largely lost in many of today's dense stands (Romme et al. 2006).

The consequences of the current stand structure in many of the existing ponderosa pine forests within the planning area include increased risk of destructive wildfires (fires that burn much hotter and are more destructive than they were during the reference period). This is due to the abnormal fuel conditions that have accumulated during more than 100 years without fire (Covington and Moore 1994). These fires are increasingly difficult to control (Moir et al. 1997). The high stem density and small tree size make these forests vulnerable to outbreaks of insects and disease, with the most serious threat being the mountain pine beetle (Schmid and Mata 1996). Other consequences related to the current stand structure include a lack of ponderosa pine regeneration and reduced biological diversity.

Within the next 50 years, natural succession will convert some lands currently classified as the mountain shrubland type to the ponderosa pine forest type. This process, however, would be gradual and may not substantially change the acreage of those types within the 50 years. Succession within the next 50 years may also move more ponderosa pine forests into the mature and old-growth development stages. Wildland fire may reduce the acreage of the ponderosa pine forest type, if large fires burn across the landscapes of the planning area, and many ponderosa pine forests may convert to mountain shrublands following stand-replacement fire. Pinyon-Juniper Woodland Type - Within the planning area, the pinyon-juniper woodland type is dominated by pinyon-pine/Utah juniper and Rocky mountain juniper trees. This forest type occurs on mountains, hills, and mesas in the semi-arid climate zone at elevations ranging from approximately 5,500 to 7,500 feet. There are approximately 442,800 acres of this type within the planning area (which is approximately 11.8% of the total acreage).

Pinyon-Juniper HRV: During the reference period, proportions and patch sizes of pinyon-juniper woodlands probably fluctuated over time. More, and larger, patches of early successional stages probably occurred during dry periods, while more, and larger, patches of late successional stages probably occurred during wet periods. Although proportions varied with climatic fluctuation, at a broad scale, every stage was probably represented somewhere in the landscape (McGarigal and Romme 2005). If pinyon-juniper woodlands escaped fire for many centuries, they developed old-growth characteristics (including a dense, multi-storied canopy with ancient living and dead trees) (Floyd et al. 2004). When fire did occur in old and mature pinyon-juniper stands during the reference period, it tended to be severe and stand-replacing (Erdman 1970; Floyd et al. 2000).

The major agents of natural disturbance in pinyon-juniper woodlands during the reference period included fire, insects, and fungal diseases. Bark beetles and the black stain root fungus often interacted in a manner that produced a phenomenon of "pinyon decline." The impacts of fire, beetles, and fungus were manifest at multiple scales, ranging from large burns or regional insect outbreaks to small fires or localized outbreaks that created canopy gaps within otherwise continuous woodland (McGarigal and Romme 2005).

Currently, most of the pinyon-juniper woodland type within the planning area is in the mid-development stage.

Table 3.6.6 – Current Acreage of the Pinyon-Juniper Woodland Type by Development Stage

DEVELOPMENT STAGE	ACRES	PERCENTAGE (%) OF TOTAL
Young	987	0.5
Mid	412,440	93.1
Mature	29,336	6.5

Within the planning area, the pinyon-juniper woodland type has been greatly altered in some places during the last 120 years due to livestock grazing and mechanical tree removal (Romme et al. 2006). Legacies of the heavy grazing include changes in species composition (including some palatable species that likely have been locally extirpated). Mechanical tree reduction (chaining) during the 1950s and 1960s converted many pinyon-juniper woodlands to shrubland or grassland types and, in the process, fragmented many of the woodlands (Knight et al. 2000).

Within the next 50 years, natural succession will convert some lands currently classified as the mountain shrubland type to the pinyon-juniper woodland type. This process, however, would be gradual and may not substantially change the acres of pinyon-juniper woodlands within the 50 years. Succession within the next 50 years may also impact the development stages of the pinyon-juniper woodland type, moving more lands into the mature and old-growth stages. WFU may reduce the acreage of the pinyon-juniper woodland type, if large fires burn across the landscapes of the planning area, and pinyon-juniper woodlands may convert to mountain shrublands following stand-replacement fire.

Mountain Shrubland Type

Within the planning area, the mountain shrubland type is a diverse, shrub-dominated type that occurs on mountains, hills, and canyon slopes at elevations ranging from approximately 6,000 to 9,000 feet. This type occurs as relatively pure stands of Gambel oak, or as a mix of Gambel oak and other deciduous shrubs (including mountain mahogany, serviceberry, and chokecherry). It occurs on upland sites with well-drained soils, and is often found on steep slopes with southerly aspects. It is found in association with pinyon-juniper, ponderosa pine, and warm-dry mixed-conifer vegetation types, in the lower montane and montane climate zones. There are approximately 443,300 acres of this type within the planning area (which is approximately 11.8% of the total acreage).

Mountain Shrubland HRV: Fire was the major disturbance agent for mountain shrublands, and many of the fires originated in adjacent pinyon-juniper woodlands (Floyd et al. 2004). Large fires occur under conditions of high wind and prolonged drought. The median interval between successive fires for the mountain shrubland type in Mesa Verde National Park is about 100 years (Floyd et al. 2004). The frequency of RMLANDS-simulated wildfires in mountain shrublands during the reference period displayed a mean return interval of 73 years. Currently, the mountain shrubland type displays a variety of conditions, with much of it being in a later-seral stage dominated by large old shrubs. Stands recently treated for fuels reductions are in an early-seral stage dominated by young shrubs.

Within the next 50 years, natural succession will convert some lands currently classified as the mountain shrubland type to the ponderosa pine forest, warm-dry mixed-conifer forest, or to the pinyon-juniper woodland types. This process, however, would be gradual and may not substantially change the acreage of those types within the 50 years. WFU, management-ignited fire, and fuels-reduction projects in mountain shrublands may perpetuate the mountain shrubland type.

Sagebrush Shrubland Type

Within the planning area, the sagebrush shrubland type is a sagebrush-dominated type that occurs on hills, mesas, and valley floors at elevations ranging from approximately 5,000 to 9,000 feet. This type occurs on moderately well to well-drained soils in the semi-arid and lower montane climate zones. There are approximately 202,200 acres of this type within the planning area (which is approximately 5.4% of the total acreage).

Sagebrush Shrubland HRV: There is little information pertaining to the condition of sagebrush shrublands within the planning area during the reference period. Most fires in sagebrush shrublands are high-severity and stand-replacing. The frequency of RMLANDS-simulated wildfires in sagebrush shrublands during the reference period displayed a mean return interval of 55 years.

RMLANDS simulations for the sagebrush shrubland type suggested that, in general, the current planning area contains fewer sagebrush shrublands than under the simulated HRV. Sagebrush shrublands that have a high cover of cheatgrass, a low cover of native grasses, and an increased fire frequency are likely outside their HRV for fire frequency and species composition (Korb 2004).

Much of the sagebrush system in western Colorado is in poor condition (Winward 2004). Major impacts to the sagebrush type include a loss of understory grass and forb production and diversity; a reduction of surface litter (and the resulting loss of organic matter being incorporated into the upper soil horizons); an increase in bare ground and soil erosion; and out-of-balance sagebrush densities, canopy cover values, and age class ratios (Winward 2004). Livestock grazing in the sagebrush shrubland type occurring within the planning area since the reference period has decreased native grasses, and increased non-native annuals (including cheatgrass). Cheatgrass often increases following fire, which may lead to increased fire frequency, which may, in turn, further increase cheatgrass.

Semi-desert Shrubland Type

Within the planning area, the semi-desert shrubland type occurs on hills, mesas, alluvial flats, and valley floors at elevations ranging from approximately 4,500 to 7,600 feet. This type occurs in the semi-arid climate zone in association with semi-desert grassland and sagebrush shrubland vegetation types. Soils are mostly well drained, but some sites near drainages have a higher water table and flood intermittently. There are approximately 93,800 acres of this type within the planning area (which is approximately 2.5% of the total acreage).

These shrublands are dominated by shadscale saltbush, winterfat, fourwing saltbush, rubber rabbitbrush, spiny hopsage, greasewood, and basin big sagebrush. Herbaceous cover and bare soil occupy the space between shrubs. Biological soil crusts are often major components in semi-desert shrublands, forming crusts on the ground surface that contribute to soil stability, nutrient supply (organic matter and nitrogen), and biological diversity (Ladyman and Muldavin 1996).

Semi-desert Shrubland HRV: There is little information pertaining to the condition of semi-desert shrublands within the planning area during the reference period. Historically, fires were rare in semi-desert shrublands due to the lack of vegetation cover (West and Young 2000). Semi-desert shrublands that have a high cover of cheatgrass, a low cover of native grasses, and increased fire frequency are likely outside their HRV for fire frequency and species composition.

Livestock grazing in the semi-desert shrubland type since the reference period has decreased native grasses and increased non-native annuals (including cheatgrass). Cheatgrass, a non-native annual, often increases following fire, which may lead to increased fire frequency, which, in turn, may further increase cheatgrass. In addition to livestock grazing, other disturbances (including those associated with transportation corridors, mining, seismic exploration and drilling for oil and gas, and recreation) have resulted in the deterioration of much of this vegetation type (Blaisdell and Holmgren 1984; Kram et al. 2005).

Mountain Grassland Type

Within the planning area, the mountain grassland type occurs as openings in forest-dominated landscapes. It occurs on upland sites with well-drained soils in mountain and mesa landscapes. This type is associated with the lower montane, montane, and subalpine climate zones at elevations ranging from approximately 7,500 to 11,600 feet. There are approximately 298,700 acres of this type within the planning area (which is approximately 7.9% of the total acreage).

Mountain Grassland HRV: There is little information pertaining to the mountain grasslands within the planning area during the reference period. The following description is based on the best reference sites available within the planning area, as well as throughout the South Central Highlands section. During the reference period, many of the mountain grasslands within the planning area displayed high diversity and cover of herbaceous species (especially native bunchgrasses like Arizona fescue and Thurber fescue). Forest litter amounts were high, due to the abundance of plant material associated with the robust bunchgrasses. Soils had thick, organic matter-rich surface horizons. Structural conditions displayed a relatively closed canopy, reflecting the high density and well-distributed arrangement of the bunchgrasses. The bunchgrasses provided the fine fuels necessary for fires that ignited in the adjacent forests to burn through the grasslands (Touchan et al. 1993). Since ponderosa pine and warm-dry mixed-conifer forests were characterized by frequent low-intensity fires throughout the reference period (Romme et al. 1998; Touchan et al. 1996), it can be assumed that frequent fires also played a major role in maintaining the composition, structure, and function of the adjacent Arizona fescue mountain grassland type during the reference period.

Since the reference period, livestock grazing has had profound impacts on the composition, structure, and function of grassland ecosystems in the western United States (Fleischner 1994; Wuerthner 1992; Belsky and Blumenthal 1997), including those of the planning area. Many grasslands of the Thurber fescue type, and a few grasslands of the Arizona fescue type, have experienced limited livestock grazing and display characteristics similar to those of the reference period.

Within the planning area, some grasslands of the Thurber fescue type, and most of the grasslands of the Arizona fescue type, have experienced intensive livestock grazing since the reference period, and, as a result, have changed substantially. The dominant bunchgrasses have been extirpated in many areas, and the abundance and distribution of remaining bunchgrasses have been reduced in others. Invasive species, and native-increaser species, have taken the place of the bunchgrasses. This change in species composition has altered the structure of these grasslands from tall, bunchgrass-dominated community types to short, sod-dominated or forb-dominated types. Additional livestock-related changes to some mountain grasslands within the planning area include the reduction of forest litter, an increase in bare soil, an increase in soil erosion and compaction, a decrease in the amount of organic matter available for nutrient cycling, changed successional pathways, and the less likelihood of low-intensity fires carrying through these grasslands.

Livestock grazing may continue to be a threat to mountain grasslands within the planning area. This is because cattle tend to spend a disproportionate amount of their time in this vegetation type. The attainment of desired conditions, and the implementation of design criteria (described in allotment management plans and in the DLMP/DEIS), should help minimize adverse impacts to these ecosystems.

Some of the substantially altered mountain grasslands within the planning area are unlikely to improve much on their own, even if livestock are removed. This is because the native bunchgrasses needed for natural reproduction and recruitment of new individuals appear to be gone. Major ecological restoration is needed, which likely includes eliminating exotics and undesirable natives, and incorporating mechanical manipulation (including ripping or plowing), fertilization, seeding with native species, and mulching.

Semi-desert Grassland Type

Within the planning area, the semi-desert grassland type occurs on hills, mesas, alluvial flats, and valley floors, at elevations ranging from approximately 4,500 to 7,600 feet. Common native grass species of these grasslands include needle-and-thread, Indian ricegrass, galleta, bottlebrush squirreltail, blue grama, purple threeawn, sand dropseed, and alkali sacaton. This type occurs in association with semi-desert shrubland and sagebrush shrubland vegetation types. It occurs mostly on well-drained soils in the semi-arid climate zone. There are approximately 303,100 acres of this type within the planning area (which is approximately 8.0% of the total acreage).

Semi-desert Grassland HRV: There is little information pertaining to the condition of semi-desert grasslands within the planning area during the reference period. Southwestern grasslands today (including semi-desert grasslands) share general differences from their pre-Euro-American settlement conditions. Historically, they were more diverse in plant and animal species composition, more productive, more resilient, and better able to absorb the impact of disturbances (Fletcher and Robbie 2004). Fire most often occurred in semi-desert grasslands when adjacent shrublands burned. Since historically fires were rare in semi-desert shrublands due to the lack of vegetation cover (West and Young 2000), it can be assumed that fires in the adjacent semi-desert grasslands were also rare. When fires did occur, they were of low intensity. They were, however, adequate to keep shrubs from expanding into them (Fletcher and Robbie 2004). Semi-desert grasslands that have a high cover of cheatgrass, a low cover of native shrubs and grasses, and increased fire frequency are likely outside of their HRV for fire frequency and species composition.

Livestock grazing in the semi-desert grassland type since the reference period has decreased native grasses, and increased non-native annuals (including cheatgrass). Cheatgrass, a non-native annual, often increases following fire, which can lead to increased fire frequency, which, in turn, can further increase cheatgrass.

Alpine Type

Within the planning area, alpine ecosystems occur on mountain landscapes at elevations above approximately 11,500 feet. The alpine climate zone is characterized by short cool growing seasons, long cold winters, snow, high wind, and intense light. Rock outcrop and talus slopes are common. Climate, geomorphologic processes, and on-going disturbances (including nivation, solifluction, and frost action) are major factors influencing the distribution of biota in alpine ecosystems. Diverse geology and topography (including glacial features) add to the complexity and diversity of the alpine type. There are approximately 186,400 acres of this type within the planning area (which is approximately 5.0% of the total acres).

Alpine HRV: There is little information pertaining to the condition of the alpine type within the planning area during the reference period, or about the historic condition and processes of alpine tundra in general (Baker 1983). During the reference period, most alpine ecosystems within the planning area most likely looked much like they do today, except where known impacts have occurred.

Domestic sheep and cattle have grazed many areas of alpine tundra in the Rocky Mountains since Euro-American settlement. Where sheep have congregated, they have caused trampling, trail-cutting, and erosion. The impacts associated with past livestock grazing are still present in some places. Mining, roads, and recreation impacts are also present in places. Recreation impacts (including those related to backpacking, alpine skiing, climbing, and sightseeing) may cause adverse impacts primarily from trampling vegetation and erosion. Recreation impacts are likely to increase due to the increased use of these lands. Global warming may reduce the extent of alpine tundra through the encroachment of spruce-fir forests.

Special Status Plant Species

Within the planning area, plant species that are rare or endemic, at risk of decline, or not adequately covered by the ecosystem management approach include federally listed species, Candidate species, R2 Regional Forester's Sensitive Species, BLM Special Status Species including Sensitive Species, and SJPL Highlight Species. Federally listed species are those species listed by the USDOI, the USFWS, or the National Oceanic and Atmospheric Administration National Marine Fisheries Service as threatened or endangered under the ESA. R2 Regional Forester's Sensitive Species are those plant and animal species identified by a Regional Forester for which population viability is a concern, as evidenced by significant current or predicted downward trends in population numbers or density, and significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution (FSM 2670.5).

BLM Special-Status Species are those species designated as federally endangered, threatened, proposed, or candidate under the ESA; those designated by the CDOW as State endangered or threatened; and BLM Sensitive Species (which are species under status review by the USFWS, species with numbers declining so rapidly that Federal listing may become necessary, species with typically small and widely dispersed populations, or species inhabiting ecological refugia or other specialized or unique habitats).

SJPL Highlight Species are those for which the responsible official determines management actions may be necessary in order to prevent listing under the ESA, or for which management actions may be necessary or desirable in order to achieve ecological or other multiple-use objectives.

Lists of USFS and BLM sensitive plant species were developed from guidance and criteria provided by the USFS Manual and by the BLM's Special-Status Species Management Manual (6840). (See Appendix M-O, Volume III, for tables containing USFS and BLM Sensitive Plant Species, and SJPLC Highlight Species.) Currently, the USFS and the BLM Sensitive Plant Species, and the SJPLC Highlight Species that occur within the planning area appear to have stable populations and trends.

ENVIRONMENTAL CONSEQUENCES

DIRECT AND INDIRECT IMPACTS

The impacts described below may occur in the future, when specific projects are identified and implemented. Impacts assume that direction and design criteria in the LMP, as well as stipulations listed in the DLMP/DEIS for oil and gas activity, would be followed and implemented. Design criteria, presented in Part 3 of Volume II, are environmental protection measures that would be applied to all alternatives at the project level in order to protect resources.

Management activities that alter major vegetation types and plant species within the planning area are those that would involve ground disturbance or vegetation removal. These may include oil and gas development, livestock grazing, timber harvesting, mechanical fuels treatments, fire management, recreation development, utility corridors, and solid minerals development. Most lands, and their associated vegetation types, and plant species may be unaffected by active management. This is because it would not occur in those areas. Lands impacted by active management may experience only minor impacts. These impacts may not result in a major change in their overall composition, structure, or function (except when aspen clear-cuts or WFU occur). Minor changes in structure may occur, and a short-term change in the abundance and distribution of plant species within a vegetation type may occur. However, the overall function of the vegetation types may remain mostly unaffected. The attainment of desired conditions and the implementation of design criteria described in the DLMP/DEBE may also help minimize impacts.

Impacts Related to Timber Harvesting

Clear-cut harvesting that occurs in the aspen forest type would involve cutting all trees within cut units. This would change the forest structure by removing the overstory and eliminating the canopy cover. Clear-cutting may stimulate aspen suckering, which is anticipated to be rapid and profuse, resulting in an abundance of aspen sprouts. A relatively even-aged, one-storied aspen stand would result, at least in the short term. This may change the cut units to an earlier seral stage. This may help meet the desired condition for the planning area to increase the amount of young aspen stands that currently are deficient. This may perpetuate aspen dominance in these cut units and perpetuate the existence of aspen patches within the planning area. Clear-cuts in the aspen type may not change the current plant species composition of the cut units, unless conifers are present in those areas (in which case, the conifer component would be eliminated, at least for the short term).

Aspen clear-cuts may occur within uncut aspen forests, or within previously harvested aspen project areas. The 10- to 40-acre clear-cuts would resemble patches created by small disturbance events like blow-down. These patches would be small, relative to patches that would be created as the result of large-scale fire events. Some clear-cuts may occur between, or adjacent to, old aspen clear-cuts in order to create a larger patch of relatively young aspen forest (through the consolidation of aspen clear-cuts). This would more closely mimic the larger aspen patches that were historically created by fire (Romme et al. 2006), and may help meet the desired condition for the planning area to increase the amount of large patches of young aspen forests.

Individual tree selection, irregular shelterwood, and other partial-cut harvesting methods may occur in spruce-fir, cool-moist mixed-conifer, warm-dry mixed-conifer, and ponderosa pine forest types. These methods would remove individual trees in order to open up the forest canopy cover, and to create openings that allow more sunlight to reach the forest floor (thereby facilitating the regeneration of shade-intolerant trees and herbaceous plants). The removal of trees would reduce the competition for water and soil nutrients, which may, in turn, benefit the growth of all remaining trees and herbs. These methods may result in negligible changes to the composition of the vegetation. This is because all tree species present before the treatments would remain after the treatments. The removal of white-fir trees from warm-dry mixed-conifer stands would decrease the abundance of white-fir; however, it may not eliminate it from the treated stands. Changes to the forest structure may be minor in most cases, because multiple tree size classes and canopy layers would remain.

Restoration harvesting methods in ponderosa pine and warm-dry mixed-conifer forest types would be similar to the partial-cut methods described above. This is because the forest canopy would be opened up, facilitating the regeneration of ponderosa pine and Douglas-fir trees. The openings may be larger than those associated with the partial cuts, with a maximum size of approximately 1 acre. Restoration harvests would be designed to mimic the open park-like conditions that were present on many sites during the reference period (Romme 2006). Generally, larger diameter trees would remain following treatments.

Group selection harvests may occur in spruce-fir, cool-moist mixed-conifer, warm-dry mixed-conifer, and ponderosa pine forest types. They would be designed to remove trees and to encourage regeneration of new trees. This method would be similar to the clear-cut method described above, in that all trees within cut units would be cut. This would completely remove the overstory and canopy cover. The difference would be in the size of the cut units (group selection harvests are 2 acres or less, whereas aspen clear-cuts range between approximately 5 and 40 acres). Group selection harvests may not change the overall composition of the larger stands that they are part of, unless they are designed to regenerate aspen from cut units dominated by conifers. These harvests may change development stages, which may create more stands with open canopies.

The more open canopy covers created by the partial-cut, restoration, improvement, and group selection harvesting methods in ponderosa pine and warm-dry mixed-conifer forests may help meet the desired conditions for the planning area to increase the amount of ponderosa pine and warm-dry mixed-conifer forests that have open canopies and display a Fire Regime Condition Class (FRCC) of 1. They may also lower the potential for high-intensity stand-replacing wildfires and lower the risk of epidemic insect and disease outbreaks within those stands and the landscapes in which they occur (both of which are desired conditions for the planning area). The newly created openings associated with these harvest methods in ponderosa pine and warm-dry mixed-conifer stands may increase the abundance and distribution of Gambel oak (which is a major competitor, quick to colonize openings created by timber harvesting). The additional establishment of these shrubs may reduce the regeneration potential of ponderosa pine trees, Douglas-fir trees, and herbaceous plants.

The timber harvesting methods described above may result in minor changes to the current understory composition of the vegetation types in which treatments occur. This is because the species currently present would remain. Sun-loving species may increase in abundance initially following clear-cutting, but shade-loving species may increase as the aspen canopy increases (Johnston and Hendzel 1985). The desire is that harvests in the ponderosa pine forest type would increase the amount of native bunchgrasses, particularly Arizona fescue, in those forests.

Timber harvesting activities (including cutting, skidding, decking, and loading trees, and piling logging slash) may impact plant species. This would include impacting Sensitive Species and SJPLC Highlight Species through habitat modification, direct mortality of individual plants, and through the establishment of invasive plant species that can compete with these species for habitat resources. Since most of these species do not occur on lands where timber harvesting would occur, they may not be impacted. Species that occur on these lands may not be impacted. This is because the project design would avoid, or minimize, impacts to known species, and to their habitat, within a project area.

DLMP/DEIS Alternatives: The impacts described above may occur, to varying degrees, under all of the alternatives. Alternative A would propose the most acres for timber harvesting, therefore, it may impact vegetation types and Sensitive Species and Highlight Species to a larger extent, when compared to the other alternatives. Alternative D may result in the next greatest impact on vegetation, followed by Alternative B. Alternative C may result in the least impacts to vegetation types, and to Sensitive Species and Highlight Species, due to timber harvesting activities. This is because it would propose the least number of acres for timber harvesting.

Alternative A may also have the greatest potential to result in positive impacts to vegetation types (through timber harvesting activities that open up canopy covers). This is because it would propose the largest number of acres for timber harvesting. Alternative D would propose the next highest amount of timber harvesting; therefore, it may have the next highest potential to create positive impacts to vegetation types, followed by Alternative B. Alternative C may have the least potential to create positive impacts on vegetation types (through timber harvesting activities that open up canopy covers). This is because it would propose the least amount of acres for timber harvesting.

Impacts Related to Livestock Grazing

Within the planning area, livestock grazing may occur in all vegetation types. Potential impacts to plant species and vegetation types from livestock grazing may include overgrazing and trampling of soils and plants. The significance of these impacts would depend upon timing, duration, and intensity of grazing. Livestock will graze (consume the leaves and shoots of plants) and sometimes overgraze (continued heavy grazing that exceeds the recovery capacity of the community) forage plants. This may decrease the photosynthetic abilities of the plants by decreasing the leaf areas necessary for performing this function (Heitschmidt and Stuth 1993, Caldwell et al. 1981). A reduction in photosynthesis would decrease the vigor and root reserves of these plants, and would decrease their chances for survival (by decreasing their ability to reproduce, compete, and withstand drought, disease, fire, insect impacts and grazing).

A decrease in the abundance, distribution and vigor of plant species related to livestock grazing may decrease the amount of ground cover (vegetation and litter) and soil organic matter, and increase the amount of bare soil (which would lead to soil compaction, run-off, and erosion). Ground disturbance may also result in conditions conducive to the establishment of invasive plant species that can compete with native species, which may lead to a reduction in the abundance and distribution of native species.

Livestock grazing in mountain grassland and semi-desert grassland types may result in a significant impact to the composition and structure of those communities (as cattle graze and potentially overgraze the highly palatable native bunchgrasses that occur in those types).

Within the planning area, livestock grazing in the alpine is primarily associated with sheep. Alpine areas have low primary productivity, short growing seasons, slow plant growth, and are difficult to revegetate; therefore, they are very sensitive to disturbances, such as livestock grazing, that can alter vegetation cover.

Livestock grazing may impact Sensitive Species and Highlight Species within the planning area. This may occur as the result of habitat modification, mortality of individual plants from grazing or trampling, and the introduction of invasive plant species that can compete with these species for habitat resources.

Livestock grazing practices within the planning area are designed to protect the ecological integrity of the ecosystems that are impacted by those practices. Adverse impacts are more likely to result if the timing, intensity, and duration of livestock grazing is not appropriate or sustainable. Impacts to vegetation types and plant species (including USFS and BLM Sensitive Species and SJPLC Highlight Species) related to livestock grazing are expected to be minor, if direction and design criteria described in the DLMP/DEIS and the allotment management plans are adhered to.

DLMP/DEIS Alternatives: The impacts related to livestock grazing may occur under all of the alternatives. Alternative D would propose the most suitable acres for livestock grazing; therefore, it may have the greatest potential to impact vegetation types and plant species (including Sensitive Species and Highlight Species), as described above, when compared to the other alternatives. Alternative A may have the next highest potential to impact vegetation types and plant species in relation to livestock grazing. This is because it would propose the next greatest amount of suitable acres, followed by Alternative B. Alternative C may have the least potential to impact vegetation types and plant species (including Sensitive Species and Highlight Species) due to livestock grazing, as described above. This is because it would propose the fewest suitable acres for livestock grazing.

Impacts Related to Oil and Gas Development

Oil and gas development activities (including the construction of well pads, compressor stations, pipelines, and roads) would occur primarily in the lower-elevation vegetation types (including sagebrush shrublands, semi-desert grasslands, semi-desert shrublands, mountain grasslands, pinyon-juniper woodlands, and ponderosa pine forests).

Oil and gas development activities may completely clear vegetation from well sites, resulting in clearing of native plant species and the loss of their habitat. This would change the composition and structure of the cleared sites for the 25- to 30-year life of the wells. In addition, oil and gas development may adversely impact old-growth ponderosa pine forests (which are rare in the planning area), especially if well pads and roads are located within them. Old-growth sites, however, would be avoided where practicable. Oil and gas development activities that result in ground-surface disturbances (including roads) may also provide sites for the invasion and establishment of invasive plant species.

When oil and gas extraction is complete, all roads and pads constructed specifically for oil and gas development would be restored. This would include contouring, plowing, mulching, fertilizing, and seeding. Ultimately, the objective would be to restore the vegetation composition and structure of developed sites. However, that would not occur on sites where vegetation took decades, or even centuries, to develop.

Oil and gas development activities may impact Sensitive Species and Highlight Species within the planning area due to habitat modification, mortality of individual plants, and the introduction of invasive plant species that can compete with rare species for habitat resources. Project design and design criteria that avoid, or minimize, impacts to known species, or to their habitat, within an oil and gas development project area would be implemented; therefore, there may be no impacts (or negligible impacts) to Sensitive Species, Highlight Species, and/or to their habitat.

DLMP/DEIS Alternatives: The impacts described above may occur, to varying degrees, under all of the alternatives. Alternative A would propose the largest number of "standard-lease" acres and the fewest number of "no surface occupancy" acres; therefore, it may have the greatest impacts to vegetation types, as well as to Sensitive Species and Highlight Species, when compared to the other alternatives. Alternative D may have the next greatest impacts. Alternatives B and C may result in the fewest impacts to vegetation types, as well as to Sensitive Species and Highlight Species, related to oil and gas development. This is because they would propose the least amount of "standard-lease" acres. The No Leasing Scenario would have no ground-disturbing effects, so it would have no adverse direct or indirect effects to vegetation types and sensitive and highlight plant species.

Impacts Related to Fire

Impacts related to fire on plant species and vegetation types within the planning area may vary, depending upon such factors as fire intensity and severity, fuel loads, weather conditions, moisture content of fuels and soils, and topographic features (including slope and aspect).

High-intensity WFU and wildfire could occur in all vegetation types. Fires are unpredictable in terms of frequency and location. This is because they depend upon natural fire starts. As a result, it is hard to predict the positive or adverse impacts that fire may have on vegetation types, plant species, and/or the landscapes in which they occur. High-intensity WFU and wildfire usually result in stand replacement, and in at least short-term loss of all the above-ground vegetation. Stand replacement would change vegetation to an earlier seral stage; change the vegetation type, in some cases (including coniferous forests changing to aspen forests or coniferous forests and woodlands changing to mountain shrublands), or change the development stage of the vegetation type. All of these factors would alter the vegetation pattern of the landscapes in which they occur. Native shrubs and herbs may survive these fires, except where severe soil burning occurs. Invasive plant species may increase, since they are often competitors for space following fire.

High-intensity WFU and wildfire in the spruce- fir and cool-moist mixed-conifer forest types would result in the creation of young conifer forests or aspen forests. High-intensity WFU and wildfire in aspen forests would result in young aspen forests. High-intensity WFU and wildfire in warm-dry mixed-conifer and ponderosa pine forests, pinyon-juniper woodlands, and mountain shrublands would usually result in young Gambel oak-dominated mountain shrublands. Low-intensity management-ignited fire, low-intensity WFU, and low-intensity wildfire could occur in all vegetation types. However, they are more likely to occur in warm-dry mixed-conifer and ponderosa pine forest types. Low-intensity fires, which burn close to the ground and not in tree crowns, may burn shrubs, herbs, small trees, and the litter layer. Low-intensity fire would usually not change the species composition, or the development stage, of the vegetation types in which they occur.

In the warm-dry mixed-conifer and ponderosa pine forest types, low-intensity management-ignited fire, WFU, and wildfire may help seeds reach mineral soil. This would increase their chances for germination, as well as for the regeneration of ponderosa pine, Douglas-fir trees, and herbs. These fires would temporarily reduce competition from Gambel oak and other abundant shrubs. Gambel oak and other sprouting shrubs, however, may return and may even increase. Since many warm-dry mixed-conifer and ponderosa pine forest stands within the planning area have not experienced fire for many decades, the reintroduction of low-intensity fire may have a beneficial impact on these vegetation communities, as well as on the native species within them (including the native bunchgrasses Arizona fescue and mountain muhly).

WFU, management-ignited fire, and wildfire in the grassland and shrubland vegetation types may include high or low-intensity fires. High-intensity fire would change the vegetation to an earlier seral stage. It would not, however, change the species composition in most of these vegetation types (with the exception of most sagebrush shrublands whose sagebrush species do not resprout following fire). Low-intensity fire may not change the vegetation to an earlier seral stage or change the species composition in most of those vegetation types. Fire, which can spread into the mountain grassland type from adjacent, high fire-frequency ponderosa pine and mixed-conifer forests (Romme et al. 1998), may reduce litter, recycle nutrients to the soil, stimulate new herbaceous growth, and restrict woody plant establishment (McPherson 1995).

Additional impacts to vegetation types, as well as to Sensitive Species and Highlight Species, related to fire may include those associated with fire-suppression efforts (including the creation of firelines, trails, roads, and camps that remove vegetation and expose mineral soils). Such activities may result in localized soil erosion and compaction, and may increase invasive plant species. Stabilization and rehabilitation efforts designed to protect and sustain plants and ecosystems, and restore them to pre-burn conditions, may include seeding, ripping, water-barring, and the installation of erosion-control devices. These efforts may result in short-term impacts to soils and plants. Design criteria described in the DLMP/DEIS would be implemented in order to minimize these impacts. Fire suppression resulting in fire exclusion has resulted in, and could continue to result in, changes to natural fire frequencies. This may especially be the case in the ponderosa pine and warm-dry mixed-conifer types (whose fire frequencies are relatively short). Impacts associated with fire exclusion may alter an ecosystem's structure and species diversity (as described in the Affected Environment section for the ponderosa pine and warm-dry mixed-conifer forest types).

Relative to their surroundings, and to the associated vegetation types, many native plants have evolved under specific fire regimes. Therefore, fire may be important in sustaining some of these species. Fire may help meet vegetative desired conditions and objectives.

DLMP/DEIS Alternatives: The impacts described above may occur under all of the alternatives. The impacts to vegetation types and plant species from fire may be similar under all of the alternatives. This is because the number of acres proposed for treatment would be similar under all of the alternatives.

Impacts Related to Mechanical Fuels Treatments

Mechanical fuels treatments would primarily occur in the warm-dry mixed-conifer and ponderosa pine forest types, the pinyon-juniper woodland type, and the mountain shrubland types. The impacts resulting from mastication and thinning methods may include cutting trees and shrubs, which, in turn, may change the forest structure of the treated vegetation by creating openings in the forest canopy. Species composition changes may be minor. Small trees with a dbh of 9 inches or less would be targeted for removal. In order to achieve fuels reduction objectives, the post treatment structure of some stands may be outside the HRV for the vegetation type associated with those stands.

Equipment used for mechanical fuels treatments may disturb the ground surface (this is because they can crush, uproot, and cause mortality to herbs). However, these treatments are not expected to change the current understory composition of the vegetation types in which the treatments occur. Gambel oak would quickly sprout in the newly created openings in all of the vegetation types previously mentioned, if it is present before the cutting. Not all shrubs would be cut, allowing for diversity in shrub size and age. Mastication treatments that crush and grind up trees and shrubs into small chips and spread it out on site would create a deep wood chip layer on the ground surface that may adversely impact herbaceous growth.

Mechanical fuels treatments in ponderosa pine and warm-dry mixed-conifer forests would open up the canopy cover of those forests. This may help meet desired conditions for more of these forests to display open canopies. Mechanical fuels treatments may impact Sensitive Species and Highlight Species within the planning area due to habitat modification and to the direct mortality of individual plants (from the equipment used for mastication and thinning of trees and shrubs). Mastication treatments that crush and grind up trees and shrubs into small chips and spread it over a site would create a deep wood chip layer on the ground surface that may impact herbaceous growth (including the growth of Sensitive Species and Highlight Species, if present). Project design would avoid, or minimize, impacts to known species and their habitat; therefore, there may be negligible impacts to Sensitive Species, Highlight Species, and/or to their habitat.

DLMP/DEIS Alternatives: The impacts described above may occur under all of the alternatives. Impacts to vegetation types and plant species from mechanical fuels treatments, as described above, may be similar under all of the alternatives. This is because the numbers of acres proposed for treatment would be similar under all of the alternatives.

Impacts Related to Recreation

Recreational uses that impact vegetation types may include off-road motor vehicles, camping, hiking, mountain biking, horseback riding, as well as those associated with ski areas. These uses may disturb the ground surface, which, in turn, may crush, uproot, and cause mortality to native plants and destroy their habitat. Generally, however, they may result in minor impacts to the vegetation type that they are associated with because these activities occur on only a small percentage of the planning area.

Recreational uses may impact Sensitive Species and Highlight Species within the planning area due to direct mortality or habitat modification (because of trampling or related to the construction of trails, campgrounds, and/or facilities). Project design and design criteria that would avoid, or minimize, impacts to known species or their habitat within a new recreation project area would be implemented; therefore, there may be negligible impacts to Sensitive Species and Highlight Species and/or to their habitat.

DLMP/DEIS Alternatives: The impacts described above may occur under all of the alternatives. Impacts to vegetation types and plant species from recreation may be similar under all of the alternatives. This is because the number of acres proposed for treatment would be similar under all of the alternatives.

Impacts Related to Solid Minerals Development and Utility Corridors

Solid minerals development activities, and the creation of utility corridors, may disturb the ground surface. This would be due to the equipment operation involved in these activities, which may, in turn, crush, uproot, and cause mortality to native plants and destroy their habitat. These impacts may be minor, because these activities would occur on only a small percentage of the planning area.

Solid minerals development, and utility corridor activities, may result in the mortality of Sensitive Species and Highlight Species (and destroy their habitat). Project design would avoid, or minimize, impacts to known species and/or to their habitat; therefore, there may be few, if any, negligible impacts to these species and/or to their habitat.

DLMP/DEIS Alternatives: The impacts described above may occur under all of the alternatives. The impacts to vegetation types and plant species from solid minerals development and utility corridors may be similar under all of the alternatives. This is because the number of acres proposed for treatment would be similar under all of the alternatives.

CUMULATIVE IMPACTS

Over the next 20 years, natural ecological processes (including fire, insects, and succession) may have the greatest influence on the ecosystems and general ecology within the planning area. Wildfire, such as the Missionary Ridge Wildfire of 2002, can quickly change the composition, structure, and function of ecosystems on thousands of acres. Insect epidemics, such as the ips beetle that recently killed many of the pinyon-pine trees within the planning area, may likewise result in major impacts. The relatively slow, but steady, changes of natural succession are less dramatic, but vast acres of the aspen forest type within the planning area are slowly succeeding to coniferous forests.

Historic timber harvesting activities have affected ((impacted) the composition and structure of a relatively small percentage of the forest vegetation types within the planning area. In some landscapes where extensive harvesting has occurred, the composition and structure of the vegetation types, and the resulting landscape patterns, have changed, especially where clear-cuts have occurred. Harvesting in the ponderosa pine and warm-dry mixed-conifer forests have eliminated many of the large old ponderosa pine and Douglas-fir trees, which, in turn, has resulted in a current lack of old-growth stands in those forest types. Clear-cuts in higher-elevation spruce-fir forests resulted in a lack of regeneration on some sites for decades. However, most of those sites are now restocked with trees. Foreseeable future timber harvests may occur. However, their extent over the next 20 years may be minor, relative to the almost 2.5 million acres within the planning area. The impacts related to harvesting may result in minor impacts to the composition, structure, and function of the vegetation types treated, as well as to the overall ecosystem diversity within the planning area.

Historic impacts related to mechanical fuels treatments have primarily occurred in the ponderosa pine forest and in the pinyon-juniper woodland types (where trees and shrubs were thinned and canopy covers were opened up). Treatments on some pinyon-juniper sites did not mimic the natural ecological processes that occurred in these woodlands during the reference period, and moved them outside the HRV for stand structure. Foreseeable future mechanical fuels treatments may occur, and may impact the composition, structure, and function of pinyon-juniper woodlands (including old-growth sites, as these ecosystems would be targeted for treatments).

Historic impacts related to oil and gas development primarily occurred in sagebrush shrublands, semi-desert grasslands, semi-desert shrublands, pinyon-juniper woodlands, and ponderosa pine forests. These adverse impacts included the complete removal of vegetation from well pads and roads, which, in turn, resulted in the mortality of native plant species and the loss of their habitat. This completely changed the composition and structure of the cleared sites, which will remain devoid of vegetation for the 25- to 30-year life of the wells. Foreseeable future oil and gas development may occur, and may adversely impact the vegetation types (as described above). This development may adversely impact old-growth ponderosa pine forests (which are rare in the planning area).

Historic impacts related to fire management primarily occurred in ponderosa pine forests, and were mostly associated with low-intensity management-ignited fires that burned on the ground surface (and, thus, had little impact on the composition and structure of those forests). Within the planning area, high-intensity WFU has only occurred to a limited extent, and has not had a major impact on vegetation types. Foreseeable future fire management activities may occur, and may continue to be focused on low-intensity management-ignited fire in ponderosa pine forests, which may, in turn, result in minor impacts to those forests and to the landscapes in which they occur. WFU may also occur in the future. However, it would occur only to a limited extent. Therefore, it may result in minor impacts to the vegetation types within the planning area.

Adverse impacts related to livestock grazing began around the turn of the century, as livestock grazed, and overgrazed, rangelands. This resulted in changes to plants and soils on many lands. The greatest impacts occurred to the mountain grassland, semi-desert grassland, sagebrush shrubland, semi-desert shrubland, ponderosa pine forest, pinyon-juniper woodland, and riparian area and wetland ecosystem vegetation types. Historic impacts related to livestock grazing included a decrease in the abundance and distribution of native bunchgrasses (including Arizona fescue and Thurber fescue) and willows within the planning area. These impacts, described above, are still present in many places. Livestock grazing may continue into the foreseeable future within the planning area; therefore, additional adverse impacts to vegetation types, as well as to their associated plants and soils, may occur.

Historic impacts related to recreation, solid minerals development, and utility corridors were localized and relatively small in extent. However, many of these impacts are still present . Foreseeable future impacts to vegetation types resulting from those activities are expected. However, they are expected to be minor in extent, and may result in minor impacts to the vegetation types within the planning area.

Past management activities have resulted in negligible impacts to Sensitive Species and Highlight Species. Foreseeable future management activities within the planning area are likely to continue to have negligible impacts on Sensitive Species and Highlight Species. This is because these species, and their habitats, would be avoided, whenever possible. There may be no adverse cumulative impacts to Sensitive Species and Highlight Species within the planning area.

The attainment of desired conditions, and the implementation of design criteria described in the DLMP/DEIS, may help minimize the impacts associated with all of the activities addressed above.