THE WESTERN HERITAGE ALTERNATIVE

A Sustainable Vision for the Public Lands and Resources of the Great Divide,
Managed by the Rawlins Field Office of the BLM

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THE WESTERN HERITAGE ALTERNATIVE

The Western Heritage Alternative provides a balanced approach to managing the many multiple uses in the Great Divide planning area, protecting sensitive wildlife habitats and important landscapes while allowing traditional uses, both public and corporate, to continue in ways that are compatible with maintaining healthy ecosystems. In previous years, land management has been grossly unbalanced, with virtually 100% of the planning area has been open to minerals leasing. As a result, a rapid and uncontrolled spread of gas fields and strip mines has overrun a large proportion of our public lands in the planning area. Under this Alternative, industrialization would proceed at a measured and well-managed pace, and oil and gas development would not be the pre-eminent land use everywhere. Sensitive and declining wildlife species would be protected and restored where necessary, the most treasured landscapes would be protected for the public benefit, important game species would be given the conditions to thrive, clean water and air would be safeguarded, and heavy industry would be allowed to continue in a manner that renders it most compatible with other multiple uses and the public interest as a whole. This Alternative is a long-term vision for the future of our public lands, balancing short-term profitability against long-term public benefits, and ensuring that a high quality of life will be available for the region's people and wildlife. The Western Heritage Alternative is founded on the principles of protecting the most sensitive lands from heavy-handed uses, and in places where industrial use is appropriate, doing it right so that other resources and values are not squandered in the process.

ECOSYSTEM MANAGEMENT

This alternative is based on the concept of ecosystem management, under which all activities permitted within the bounds of the Rawlins Field Office would be managed under the framework of maintaining fully functioning ecosystems and viable populations of native plants and wildlife. Inherent to this alternative is the philosophy that human (and even industrial) uses of the public lands of the Great Divide are not necessarily incompatible with protecting wildlife, water and air quality, treasured landscapes, and recreational uses. According to the BLM's own Rangeland Reform publication, "The most effective way to address the challenge of restoring rangeland ecological condition is to manage the land in accordance with the principles of ecosystem management" (BLM 1993, p. 3). A keystone to maintaining ecosystem health is to maintain sufficient habitat to guarantee the viability of all native species broadly distributed throughout the Great Divide planning area. The BLM should adopt this philosophy as an ironclad requirement in the new RMP. We further urge the BLM to adopt an Ecosystems Management approach to all permitted activities and projects in the planning area.

Sagebrush Habitats

Sagebrush steppe is the dominant plant community type found on lands managed by the Rawlins Field Office. This area is one of the last bastions of the sagebrush steppe, and although large expanses have been badly fragmented by oil and gas projects like the Continental Divide – Wamsutter projects, large expanses of essentially untouched sagebrush grassland still remain in the Great Divide area. The sagebrush steppe ecosystem is home to many rare or declining wildlife species, including the ferruginous hawk, sage grouse, burrowing owl, white-tailed prairie dog, swift fox, black-footed ferret, and mountain plover. The fact that south-central Wyoming is perhaps the last major stronghold of the sagebrush steppe ecosystem and the species that are dependent on it presents a compelling reason that the new RMP should allow development and human use in a way that promotes the persistence of large blocks of intact sagebrush steppe rather than allowing the continued fragmentation of sagebrush habitats until only a few tatters of sagebrush steppe remain.

The natural role of grazers in the sagebrush steppe found in the planning area in pre-settlement times is a subject of some controversy, with very little factual evidence to go on. Miller et al. (1994) postulated that pre-settlement sagebrush steppe conditions were likely typified by sagebrush cover of 5-10% in drier Wyoming big sagebrush sites and 10-20% in more mesic mountain big sagebrush sites, with a strong component of long-lived perennial grasses and forbs in the understory, western wheatgrass formed a heavy sod on the level areas. And yet other authorities assert that Intermountain shrubsteppes lack adaptations that evolved to accommodate heavy grazing levels, such as sod-forming grasses, dung beetles, and nitrogen-fixing species beyond biological soil crusts, which are sensitive to livestock trampling, unlike the Great Plains, which evolved with large herds of bison (Mack and Thompson 1982, Heiken 1995). And taking a different perspective on the evolution of the sagebrush steppe, West (1996) argued that sagebrush steppe evolved with the large browsers of the Pleistocene. The Pleistocene megafauna would have included steppe bison, saiga antelope, primitive horses, and other grazers similar in their ecological impacts to domestic livestock. Given the controversy over the degree of grazing pressure on sagebrush steppes in pre-settlement times, the potential sensitivity of these sagebrush landscapes to heavy grazing warrants a high degree of vigilance against overgrazing on individual allotments, and this vigilance should be formalized in RMP standards and guidelines.

Despite the controversy over the evolution of the sagebrush steppe, there is broad acceptance throughout the scientific community that current levels of livestock grazing are much higher than natural levels of wildlife grazing in pre-settlement times. Miller et al. (1994) asserted that prior to the settlement of the West,

> "Grazing impacts by large herbivores in the sagebrush steppe were probably light, with heavy grazing limited to localized areas. Grazing was also probably seasonal, with animals moving up in elevation as the warm season ensued. Grazing by large and small mammals, birds and insects was also likely characterized by cyclic extremes of heavy and light grazing" (p.113).

Although sagebrush steppe ecosystems once dominated the western landscape, most of this landscape has been altered by human activity (Braun et al., in press). West (1996) reported that more than 99% of the sagebrush steppe has been impacted by livestock. Miller et al. (1994) described the situation as follows:

> "Since settlement, approximately 150 years ago, changes in plant and animal composition have occurred at unprecedented rates across the region. The introduction of cattle, sheep, horses and aggressive alien plant species, cultivation, elevated CO2 levels, altered fire frequencies, recreation, mining and demands for water, interacting with a gradual change in climate, have had a cumulative effect on the landscape. It is well documented that overgrazing by domestic livestock was a major factor in altering this large semi-desert region, causing dramatic changes in vegetation composition" (p. 101).

But Miller et al. also maintained that in some cases, light to moderate grazing can be compatible with sagebrush landscapes. Thus, the primary thrust of this alternative with regard to grazing is to prevent overgrazing that damages sagebrush ecosystems.

Several sagebrush-dependent species are sensitive to overgrazing. Baker et al. (1976) classified sage grouse, sage thrasher, sage sparrow, and Brewer's sparrow as sagebrush obligates, while green-tailed towhee and vesper sparrow were classified as near obligates. Bock et al. (1993b) reviewed the impacts of livestock grazing on birds, and reached the following conclusion: "All of these factors lead us to conclude that there is an urgent need for protection, restoration, and long-term study of shrubsteppe ecosystems (including their avifaunas) dominated by native perennial grasses, cryptogams, and moderate densities of shrubs, as we suspect these ecosystems existed prior to introductions of domestic livestock" (p. 304). Weins (1973) found that Brewer's sparrows were more abundant on lightly grazed and winter-grazed plots than on heavily-grazed plots. The maintenance of sagebrush steppes for the viability of sensitive species requires that overgrazing be prevented.

The spatial pattern and density of sagebrush stands in pre-settlement times, and the effects of grazing on these patterns, is also a subject of controversy. According to West (1996), "Sagebrush increases in abundance following excessive livestock grazing combined with lower fire frequency and drought" (p. 331). A primary effect of grazing is the reduction of fine fuels, which would be expected to lead a longer fire-free interval (Miller et al. 1994). Cattle grazing can cause an increase in both sagebrush (Brotherson and Brotherson 1981) and rabbitbrush (Brotherson and Brotherson 1981). But Baker et al. (1976) rejected the hypothesis that overgrazing has led to widespread sagebrush expansions, stating that "little evidence is available to support the widely held belief that present sagebrush ranges are the result of past overgrazing on most sagelands" (p. 165). And Johnson (1986) compared photographs taken in the 1870s with corresponding photographs from the 1970s and concluded, "While it is clear that changes in sagebrush density have occurred, it is equally clear that there has been no major shift in sagebrush distribution as a result of [livestock] use" (p. 231). And fall grazing by domestic sheep can actually reduce sagebrush density, as sheep browse heavily on sagebrush at this time of year (West 1996). Clearly, there is broad disagreement in the scientific community regarding the range of natural variability of sagebrush steppe ecosystems, and in light of this uncertainty, a conservative approach to sagebrush steppe is warranted, and radical alterations to sagebrush steppe distribution, plant composition, and architecture should be discouraged in the new RMP.

There are many areas of the Great Divide where sagebrush steppe is in good condition, and it behooves the BLM to manage for the persistence of large blocks of healthy sagebrush. Rosentreter (1997) recommended that relict shrubsteppe areas in good to excellent range condition be maintained in that state. According to West (1996),"It is much cheaper and satisfying to prevent such semi-natural areas from slipping over the brink of irreversible trends toward desertification than trying to rehabilitate or restore areas that have already been seriously degraded" (p. 341). We urge the BLM to adopt this conservative approach to land management in the sagebrush steppe habitats.

Juniper Woodlands

Juniper woodlands are a minor but interesting component of the desert ecosystems in the Great Divide area. They are chiefly found in the southern reaches of the Washakie Basin, along the Powder Rim, Red Creek Rim, and Cherokee Rim. Miller and Wigand (1994) reviewed the literature on juniper woodland distribution throughout the West. They noted that in the late 1800s, the wetter climate of the Little Ice Age, together with fire suppression and grazing, may have caused juniper expansion. Young and Evans (1981) noted that junipers younger than 50 years of age are highly susceptible to wildfire, and postulated that juniper expansion is a direct result of fire suppression. But Miller and Wigand (1994) noted, "Historic expansion occurred primarily within the more mesic sagebrush steppe communities rather than downslope into the drier Wyoming big sagebrush (*Artemesia tridentata spp. wyomingensis*) communities as it did during the prehistoric past" (p. 472). Thus, as the juniper woodlands of the Great Divide region abut Wyoming big sagebrush communities, it is unlikely that current distribution of juniper woodlands in the Great Divide area represent an unnatural or aberrant state of affairs.

Some hypothesize that juniper woodlands can have a measurable effect on the hydrology of the lands where they are found, but this hypothesis is poorly supported by scientific evidence. In Oregon, Wigand (1987) studied pollen records and concluded that juniper woodlands expanded with the onset of greater precipitation and high water tables from 4000-2000 B.C. Conversely, drought causes contraction of juniper woodlands (Miller and Wigand 1994). This suggests that the distribution of juniper woodlands is at least in part dependent on changes in climate. Eddleman and Miller (1982) found that junipers have a significant effect on the upland hydrologic cycle through increased interception of rain and snow and increased transpiration, but that impacts to subsurface flow to riparian aquifers were questionable. Belsky (1996) asserted that pinyon-juniper removal does not increase water yield, and that juniper removal does not always result in increased forage production. With these findings in mind, and given the biological importance of juniper woodlands (discussed in detail under the Proposed Powder Rim ACEC section), intensive management of or reductions in juniper woodland habitat types is not warranted.

Fire in Sagebrush Steppe

Fire is a natural process which confers many benefits to ecosystems in arid lands. Young and Evans (1981) pointed out that it is very difficult to reconstruct fire histories in juniper woodland and sagebrush steppe habitats. Gruell (1985) researched the journals of frontier travelers, and turned up only a single record of wildfire from the Rawlins Field Office, near present-day Fort Steele. He found, "There is a dearth of reports [of fires] from sparsely vegetated regions in the drier, sagebrush valleys" (p. 102). Thus, it would appear that wildfires are uncommon in the sagebrush steppes of the Red Desert.

Fires in high desert ecosystems do not appear to have negative effects on biological soil crusts. In areas dominated by rabbitbrush, less-productive sites where lichens are an important ground cover tend not to burn and form refugia during and after shrubsteppe fires, sustaining plants that subsequently colonize burned areas in the wake of fires (Rosentreter 1984). Johansen et al. (1982) reported that burns decreased the densities of soil algae, but the composition of algal floras remained remarkably similar. These researchers concluded that "it is likely that burning with rests of several years between would not significantly modify the algal communities" (p.600). Thus, fire is unlikely to threaten the long-term viability of biological soil crusts.

Fire in Coniferous Forests

Wildfire is widely acknowledged to be the primary architect of patch dynamics in coniferous forest ecosystems. Fires are an integral (an some would argue, necessary) ecosystem process in the coniferous forests that make up a small fraction of BLM lands in the Great Divide area, chiefly along the flanks of the Medicine Bow Mountains as well as isolated ranges such as the Shirley, Seminoe, and Ferris Mountains. Fire increases landscape diversity and determines patterns of forest succession on a landscape scale (Romme and Knight 1982, Romme and DeSpain 1989, Morrison and Swanson 1990). Subalpine forest landscape patterns are driven by large, infrequent fires, while lowland woodlands of Douglas fir and ponderosa pine are characterized by frequent, smaller, lower-intensity fires that do not affect the forest canopy (Veblen 2000). But due to political opposition to forest fires throughout the 20th century, the natural role of fire in maintaining ecosystem function has been largely ignored. Hutto (1995, p.1042) summed up the political landscape as follows: "The importance of stand-replacement fires in this forest system should give the maintenance of such fires a high priority in land-management goals but, instead, the historical effort has been to eradicate such fires from these systems."

Dillon and Knight (in prep.) found that presettlement fire history in subalpine areas on the neighboring Medicine Bow National Forest was characterized by many small fires punctuated by a few widespread fires, a pattern that has been corroborated by Kipfmueller and Baker (2000). Baker and Kipfmueller (2001) concluded that although the Medicine Bow landscape was strongly influenced by fire, it contained large patches of connected forest with few high-contrast edges. On the stand level, fire-free intervals on the subalpine forests of the MBNF were found to be 300-600 years (Romme and Knight 1982). It is important to note that fire patterns and frequency are not constant across landscapes, and may vary widely on a regional scale (Morrison and Swanson 1990, Wallin et al. 1996). Dillon and Knight (in prep.) hypothesized that wildfires have always been less frequent in the Medicine Bow Mountains than in Yellowstone.

In lowland ponderosa pine forests, Arno (1980) noted that fire return intervals ranged from 5 to 20 years, while maximum fire-free periods for individual trees ranged from 20 to 31 years. In cases where ponderosa pine forms open savannas, unnaturally dense stands of ponderosa pine have resulted from fire suppression (Aplet 2000, Dillon and Knight in prep) as well as cattle grazing (Madany and West 1983, Belsky and Blumenthal 1997). The flammulated owl, an old-growth ponderosa obligate, requires open canopies for foraging (Reynolds and Linkhart 1987b). The reduction of ponderosa pine savannas due to fire suppression has likely had negative impacts on this species. However, it is important to note that there are some cases where ponderosa pine naturally forms dense stands that experience infrequent, stand-replacement fires (Shinneman and Baker 1997).

A number of natural factors can affect fire frequency and intensity. Fire can be encouraged by drought, windthrow events, or forest pathogen outbreaks (Tinnin 1984, Rogers 1996). Successional stage also affects susceptibility to fire. Zimmerman and Laven (1984) suggested that for lodgepole pine, very young and very old stands are the most susceptible to stand-replacement fires. Romme and DeSpain (1989) found that lodgepole pine stands become more susceptible to fire as they approach 300 years of age. Koch (1996) suggested that mountain pine beetle outbreaks created the fuel needed to sustain large fires, thus driving the patch dynamics in some parts of the northern Rockies. It is important to note that climactic conditions are the primary factor in determining the timing and extent of large-scale wildfires; fuel loads are a secondary factor (DellaSala et al. 1995, Dillon and Knight in prep.).

Fire can have a corresponding effect on other natural agents that drive patch dynamics. Fires provide temporary immunity from beetle outbreaks (Veblen et al. 1994), and wipes out dwarf mistletoe (Zimmerman and Laven 1984, Hawksworth and Johnson 1989, Kipfmueller and Baker 1998). Thus, the interrelationship between fires and other natural landscape disturbances is often a complex one.

Interior forest birds are adapted to wildfire; Taylor (1973) found that interior species returned to burned landscapes 25 years after the blaze. Burns are preferred foraging areas for elk (Roppe and Hein 1978, Davis 1977) and deer (Campbell et al. 1977). Old growth stands may persist through burns (Morrison and Swanson 1990). Burns benefit small mammal species (Campbell et al. 1977). A regular cycle of natural wildfire is important for maintaining fire-dependent species such as black-backed woodpecker (Hutto 1995, Hansen and Rotella 2000) and Lewis' woodpecker (Linder

1994). Although some nutrients are lost during fire, calcium and magnesium levels in the soil may be higher in burned areas (Campbell et al. 1977).

Gorte (1995) noted that damage from wildfires is typically overstated, and offered the following synopsis:

> " Mature conifers often survive even when their entire crowns are scorched; a few species, notably lodgepole pine and jack pine, are serotinous--their cones will only open and spread their seeds when they have been exposed to the heat of a wildfire. Grasses and other plants are often benefitted by wildfire, because fire quickly decomposes organic matter into its mineral components (a process that, in the arid West, may require years or decades without fire), and the flush of nutrients accelerates plant growth for a few growing seasons. Few animals are killed by even the most severe wildfires; rather, many animals seek out burned sites for the newly available minerals and for the flush of plant growth. And erosion is typically far worse along the fire control lines than from the broad burned areas."

Thus, contrary to traditional agency dogma, wildfires offer many ecological benefits and positively affect long-term forest health. The view that wildfires are a threat to our forest is a byproduct of an ignorance that, in light of the wealth of scientific knowledge now available to forest managers, should no longer be countenanced.

Human-caused fires

Before the settlement period, Native Americans intentionally set fires to clear away forest and drive game animals (Veblen 2000). Barrett and Arno (1982) found empirically that areas that received heavy use by Native Americans had fires much more frequently than similar remote areas. Thus, presettlement wildfires would have occurred more often than would be expected from natural causes (Gruell 1983, Arno 1983). Arno (1983) went as far as to suggest that natural fires alone may not sufficiently maintain the disturbance mosaic of forested ecosystems in presettlement times, due to the added influence of fires set by indigenous peoples. In the 1800s, the arrival of settlers and explorers sparked a marked increase in wildfires. Prospectors set fires to make prospecting easier (Veblen 2000); in the Medicine Bow, Laramie, and Sierra Madre ranges, widespread fires have been linked to fur trappers (von Ahlefeldt and Speas 1996) and the activities of woodstoves, sawmills, and railroad sparks (Dillon and Baker, in prep.). It is likely that the widespread fires of this period have given rise to a modern forest that differs radically from the natural forest conditions of presettlement times.

The Effects of Fire Suppression

A number of studies suggest that the federal policy of fire suppression has been very effective at reducing the number and extent of natural wildfires over the past century (e.g., Barrett and Arno 1982, Baker 1994). Baker (1994) found that fire suppression during the 20th century reduced natural wildfires even in roadless parts of the Medicine Bow National Forest. Many ponderosa pine forests are adapted to frequent, low-intensity fires that do not "crown out." Fire suppression in park-like stands of ponderosa pines has led to unnatural increases in stand density and the development of ladder fuels, increasing the likelihood of stand-replacement fires (Arno 1980). Huff et al. (1995, p.36) noted that "[i]t has long been recognized that fire exclusion has allowed unnatural fuel accumulations to occur..." In the montane zone (where stand- replacement fires are the norm), fire suppression has radically increased fire intervals, leading to patch coalescence and reduction in heterogeneity and spread of forest types (Veblen 2000). This policy has translated directly to a marked increase in large-scale wildfires in recent decades (Agee 1997). In this way, past fire suppression policies has disrupted natural patterns and processes, resulting in a more flammable forest.

Fire suppression also leads to more homogeneous forests that are more susceptible to the spread of dwarf mistletoe (Kipfmueller and Baker 1998) and parasitic insects (Schmid and Mata 1992, Veblen 2000). Zimmerman and Laven (1984, p. 123) stated that "...a continuation of this policy [fire exclusion], in the absence of alternative methods of regulation, will allow rapid and progressive dwarf mistletoe spread and proliferation." On the MBNF, the irruption of mountain pine beetles in ponderosa pine forests in the Laramie Peak area noted by von Ahlefeldt and Speas (1996) may have been a direct result of fire suppression. Thus, while outbreaks of mistletoe and beetles are normal in the Medicine Bow, fire suppression has upset the natural balance of outbreaks and has resulted in a forest where these outbreaks are less localized and more widespread.

Yellowstone National Park makes a useful case study for the ecological effects of fire suppression in an unmanaged landscape. In Yellowstone National Park, Romme and Knight (1982) found that fire suppression has led to denser coniferous forests, a decrease in aspen, and an increase in sagebrush in meadow areas. Houston (1973) attributed the spread of forests and reductions in grasslands to fire suppression. Thus, the long-term absence of fire resulted in fundamental changes in landscape pattern. As a result of fire suppression, the mosaic of stands aged until old, flammable stands dominated the landscape, leading to the widespread fires of 1988 (Romme and DeSpain 1989). Thus, fire suppression by itself may destabilize the natural cycles that determine landscape pattern.

In sum, fire suppression has been a disastrous policy from a number of perspectives. It has destabilized the pattern of insect and disease outbreaks, making forests more susceptible to widespread (rather than localized) outbreaks of insects, parasites, and diseases. It has altered natural patterns of succession and landscape structure. And in the end, fire suppression has fundamentally changed forest characteristics in a way that makes widespread wildfire more likely than ever before. Modern science has demonstrated irrefutably that fire suppression is ecologically unsound and ultimately counterproductive; the time has come to abandon this misguided policy in favor of a managed natural fire approach.

A Natural Fire Policy

There is little evidence to suggest that pursuing a let-burn policy on the on BLM lands would lead to catastrophic wildfires. DeSpain and Sellers (1977) pointed out that during the early years of the let-burn policy in Yellowstone, most wildfires were small. This would likely be the case on the forests surrounding the Medicine Bow as well, particularly because the vast majority of stands on the forest are young and not fire-prone (Dillon and Knight in prep.), in contrast to the Yellowstone forests. Since stand conditions in this region make it less susceptible to extensive wildfire, now is an excellent time to initiate a natural fire policy, so that a more natural mosaic of stand ages and fuel loadings can develop before vast sweeps of the forest become acutely susceptible to fire. Even in the wake of the 1988 Yellowstone fires, Manfredo et al. (1990) found that a majority of the public supports let-burn and prescribed fire policies, both nationally and in Wyoming. Finally, according to Gorte (1995), "most fire experts agree that, because of fuel types and loadings, topography, and temporary weather conditions...some fires simply cannot be stopped and some cannot even be influenced." With the help of federal programs to educate the public on the benefits of natural fire, the natural fire policy would likely be viewed by the surrounding communities as a beneficial policy over the long term.

Fuels Management

There has been a great deal of attention given to the buildup of fuels on public lands during recent years. Many timber harvest programs have been put forward under the guise of fuels management. However, the use of salvage logging, clearcutting, and thinning to reduce fuel loads do little to reduce the odds of large-scale fire, because fire behavior is modulated by climactic conditions, not fuel loads (DellaSala et al. 1995). In addition, large-scale wildfire is an integral part of the subalpine forest ecosystem, and thus the buildup of fuels in subalpine forests is a natural occurrence that is necessary to maintain natural cycles of forest succession. Huff et al. (1995) also stated that heavy fuel accumulations are a natural occurrence in some forest types. Thus, thinning of subalpine forests to reduce fuels is a pointless and counterproductive effort, and should be avoided except at the urban-forest interface.

Forest thinning and clearcutting have been advocated in recent years for reducing wildfire risk by reducing standing biomass and creating firebreaks. DellaSala et al. (1995) point out that fires spread readily through clearcuts and firebreaks when weather conditions are dry and windy, and the opening of forest canopies can speed the drying of flammable materials. On a national scale, studies show that logging does not decrease the acreage of forest burned in a given year. Gorte (2000a) found that "acres burned in any particular year appear to be at most weakly related to the volume of timber harvested," and went on to note that "for 1980-1999 and 1987-1999, ...*fewer* acres burned in association with lower timber harvests, contrary to the hypothesis" (emphasis in original). Finally, Gorte (1995) noted that "there appears to be very little research documenting widespread reduction in wildfire damages from fuel treatment."

But because only the large boles are removed and fine fuels remain, logging does little to reduce fire risk. According to Gorte (2000a), "[t]imber harvesting removes the relatively large diameter wood that can be converted into wood products, but leaves behind the small material, especially twigs and needles. The concentration of these 'fine fuels' *increases* the rate of spread of wildfires" (emphasis in original). Gorte (2001) noted that "the limbs and tree tops -- "slash" -- left after logging can exacerbate wildfire risks...timber sales may have limited utility for removing small-diameter and low quality trees, because of the buyer's need to process and sell the biomass at a profit." The same limitation applies to thinning to reduce fire risk. Gorte (2000b) reached the following conclusion: "Mechanical treatments are generally most effective at eliminating fuel ladders, but as with timber cutting, do not reduce the fine fuels on the sites without additional treatment (*e.g.*, without prescribed burning)." Similar conclusions were reached by the Sierra Nevada Ecosystem Project (SNEP 1997):

> "Timber harvest, through its effects on forest structure, local microclimate, and fuels accumulation, has increased fires severity more than any other recent human activity. If not accompanied by adequate reduction of fuels, logging (including salvage of dead and dying trees) increases fire hazard by increasing surface dead fuels and changing the local microclimate. Fire intensity and expected fire spread rates thus increase locally and in areas adjacent to harvest." Thus, non-prescribed-fire fuel reduction programs may actually *increase* the risk of high-intensity wildfires.

In some ponderosa pine forests at low elevations, stands which formerly were thinned by periodic ground fires have grown unnaturally dense as a result of fire suppression. Some experts believe that mechanical thinning may be required before fire can be returned to its natural role in ponderosa pine forests (e.g., Covington 1993, Aplet 2000). However, Sackett et al. (1993) demonstrated that thinning could be accomplished effectively through prescribed burning, even in dense stands. Under this alternative, prescribed fire will be used preferentially for thinning ponderosa pine stands. Any thinning should emphasize harvest of smaller trees that serve as ladder fuels and retain the largest members of the forest overstory, following the recommendations of Romme et al. (2000). Before ponderosa pine stands are treated by any form of thinning, historical records should be searched and on-site research needs to be conducted to ascertain whether or not an open-canopy savanna was the presettlement condition of the stand.

Soils

In arid lands like those of the Great Divide, soils are often thin and of low productivity to start with. According to the Society for Range Management, sustainability for grazing depends mainly on conservation of the soil (Thurow and Taylor 1999). In a study in the Curlew Valley on the Idaho-Utah border, James and Jurinak (1978) found that soil nitrogen limits plant growth in Great Basin shrubsteppe ecosystems. Livestock grazing is the land use that potentially has the most widespread effects on soils. According to Miller et al. (1994), "Long term heavy grazing can gradually deplete soil nutrients. The greatest loss of nutrients may result from alteration of plant community structure which influences overland flow, erosion, infiltration rates, and nutrient turnover rates." Thus, to protect the soil, overgrazing must be prevented. It is imperative that land management practices in the Great Divide area protect soil productivity in order to ensure the productivity of the ecosystems that the soils support.

The U.S. Department of Agriculture (1898) characterized soils in the Red Desert as follows:

> "Probably all the soils of the region must be characterized as saline, but the absolute amount of salts present in any particular locality depends to a great extent upon the conformation of the surface. Through long-continued processes of leaching some formations have lost and others have gained in salt content. Flats and basin-like depressions, receiving drainage from the slopes, have become more and more heavily impregnated. The rainfall is too limited to carry much of this salt away, so it is found incrusting the banks of the creeks and the margins and beds of the dry or shallow lakes. Some of the abrupt slopes where heavy winter snowdrifts lie are fairly free from injurious salts, and, judging from the appearance of the vegetation, have nearly normal mountain soil" (pp. 13-14).

Hawkins and O'Brien (2001) further noted that soils in the Little Snake watershed are highly erodible, with Muddy Creek being a particularly heavy contributor of fine sediments to the system. Thus, in the Great Divide area, special attention is needed to maintaining natural patterns of erosion and soil loss and preventing accelerated rates of either.

It is likely that current levels of erosion and soil loss in the Great Divide exceed pre-settlement levels. Raindrop splash and sheet erosion are the largest causes of soil loss worldwide (Pimintel et al. 1995). Mannering (1981) found that the average rate of soil loss across the nation is 1 mm per year. And while soil erosion rates of 1 mm/yr. are generally considered "acceptable" by land managers, soil formation usually occurs at less than 0.1 mm/year (Thurow and Taylor 1999). Pimintel et al. (1995) asserted that a $5 per hectare investment in erosion control on rangelands would leverage $5.24 in saved costs for each dollar spent. Some have advocated cattle trampling as a means of breaking up soil microtopography and decreasing water runoff. But Weltz and Wood (1986b) found that livestock trampling reduces microtopography rather than increasing surface roughness. Livestock grazing can influence soil compaction, erosion, and water infiltration rates. Erosion increases with increasing grazing levels, while soil infiltration rate decreases (Jones 2000).

Weltz and Wood (1986b) found that erosion increases with grazing intensity, regardless of grazing system.

The effects of livestock use on water infiltration has been studied for many different grazing regimes. Abdel-Magid et al. (1987a) found that trampling could halve the soil infiltration rate. In a separate study, Abdel-Magid et al. (1987b) found that there was no clear pattern between grazing systems in terms of effects on water infiltration rate, and that hypothetical benefits from short-duration grazing breaking up physical soil crusts were not realized. Gifford and Hawkins (1978) noted that infiltration rates for ponderosa pine communities on granitic soils recover fully after 6 years, while infiltration rates on grasslands were still recovering after 13 years of rest from grazing. According to Gifford and Hawkins (1978), moderate and light grazing both negatively affect infiltration rate, but are difficult to differentiate from each other on the basis of impacts on infiltration rate; heavy grazing has a significantly greater impact than either. Bohn and Buckhouse (1985) found that infiltration levels increased in control exclosures, indicating recovery from previous heavy grazing.

Soil compaction is a severe impact, since plant productivity is impaired on compacted soils (Clary 1995). Various grazing systems have been heralded as solutions to the impacts of livestock use on soils. For intensive grazing systems, one study found that effects on soil compaction and decreased water infiltration are greater during the winter months, when plants are dormant (Warren et al. 1986). Bohn and Buckhouse (1985) posited that rest-rotation grazing favored retention of hydrological parameters of soils, but found that soils subjected to deferred-rotation and season-long grazing showed a decrease in infiltration and an increase in compaction and sediment production. But Weltz and Wood (1986a) found that moderate continuous grazing was superior to heavy continuous grazing and short duration grazing in terms of lowering the increase in soil compaction. In the end, stocking rates probably have more influence on soil parameters than grazing system type.

Soil compaction, whether from livestock, vibroseis trucks, off-road vehicles, or heavy equipment associated with energy development, can remain long after activities have ceased. The findings of Knapp (1992) suggest that 100-130 years are required for complete loosening to occur for abandoned roads. The speed of recovery will be faster in areas of high precipitation and frequent freeze-thaw cycles, and slower in areas that are more arid or which have fewer freeze-thaw cycles. We urge the BLM to adopt standards that minimize soil compaction in the first place, rather than putting the emphasis on reclaiming damaged soils after the fact.

According to the Wyoming Standards for Healthy Rangelands, adopted statewide by the BLM in 1997, Standard #1 prescribes stable soils with good infiltration rates and minimal runoff. It prescribes a number of possible indicators including water infiltration rates, soil compaction, erosion, soil micro-organisms (which might include biological soil crusts), vegetative cover, and bare ground/litter. This standard was further elucidated to achieve adequate energy flow and nutrient cycling through the system. FLPMA requires the BLM to harmonize its management with state policies and directives, and we urge the BLM to do so with regard to maintaining soil quality. We urge the BLM to develop clear and practical standards and guidelines under its new RMP to achieve the goals set forth in the Wyoming Standards for Healthy Rangelands, and apply these standards not only to grazing but to all other activities permitted by the Rawlins Field Office.

Biological Soil Crusts

Although little-known in the Great Divide area until recently, biological soil crusts (also known as cryptobiotic or cryptogamic soils) are a critically important component of soil systems in arid shrubsteppe ecosystems. Biological soil crusts typically consist of complex communities of bacteria, blue-green algae, microfungi, green algae, mosses and other bryophytes, and lichens (Belnap et al. 2001). Fungal hyphae can be important components of biological soil crusts (States et al. 2001). Wyoming biological soil crusts in several sites were found to be dominated by lichens (States and Christensen 2001). Biodiversity Conservation Alliance's own records for the Rawlins Field Office, including the Great Divide and Washakie basins, indicate the widespread presence of soil crusts dominated by mosses and closely associated with the bases of sagebrush. We found that soil crusts within exclosures in the Great Divide area often are well-developed, while neighboring areas subjected to livestock trampling showed little crust development.

Biological soil crusts confer many benefits on shrubsteppe ecosystems. Campbell et al. (1989) summarized the critical role of biological soil crusts as follows:

> "By allowing a natural soil cover to form, erosional processes are brought under control. This retains the soil in place as well as improves its quality as a soil bank for possible future changes in climate or irrigation. Silting in the watershed downstream is reduced, which may have important consequences for the longevity of reservoirs and hydroelectric projects. Dust storms threatening neighboring inhabited or agriculturally used regions are also reduced. Therefore, land management should not merely be restricted to the maintenance of areas of *direct* economic importance, but must include prevention of soil erosion by preservation, if not rehabilitation, of microbial soil crusts" (p. 217-218).

Biological soil crusts act as "living mulch" by retaining moisture and discouraging weed invasion (Belnap et al. 2001). According to Rychert et al. (1978), "Blue-green algae crusts and/or blue-green algae-lichen crusts can fix significant amounts of atmospheric nitrogen in desert soils, and are probably responsible for a major input of nitrogen into desert ecosystems." Snyder and Wullstein (1973) implicated free-living blue-green algae as the primary nitrogen fixers in crusts, and noted that lichens also fix nitrogen. These researchers concluded, "Cryptogams may be important to the nitrogen supply of higher plants, particularly at the seedling stage" (Ibid., p. 263). The crusts serve to stabilize the soil surface, to reduce erosion and to increase water retention and infiltration" (p.30). Algal sheaths serve to increase the water-holding capacity of the soil by retarding the speed of dehydration (Campbell et al. 1989).

Wilshire (1983) pointed out that biological soil crusts reduce soil erosion. In cool deserts, biological soil crusts tend to form pedicelled or roughened surfaces and dramatically reduce runoff while aiding infiltration of rain and meltwater into the soils (Belnap et al. 2001). Campbell et al. (1989) noted that soil crusts reduce the amount of sediment loss during flash flood events. They also provide desert soils with substantial protection from the effects of wind erosion (Belnap 2001). Thus, erosion would be expected to increase in areas where biological soil crusts have become degraded.

Numerous experts have warned about the negative effects of soil crust destruction. According to Belnap (1995):

> "Maintaining soil stability and normal water and nutrient cycles in desert systems is critical to avoiding desertification. These particular ecosystem processes are threatened by trampling of livestock and people, and by off-road vehicle use. Soil compaction and disruption of cryptobiotic soil surfaces (composed of cyanobacteria, lichens, and mosses) can result in decreased water availability to

> vascular plants through decreased water infiltration and increased albedo with possible decreased precipitation. Surface disturbance may also cause accelerated soil loss through wind and water erosion and decreased diversity and abundance of soil biota. In addition, nutrient cycles can be altered through lowered nitrogen and carbon inputs and slowed decomposition of soil organic matter, resulting in lower nutrient levels in associated vascular plants."

Physical disturbance, through damaging soil crusts, has been shown to cause long-term nutrient losses from soils in arid regions (Evans and Belnap 1999). Soil disturbances can reduce soil nitrogen fixation by 30-100%, and thus surface disturbances may have serious impacts on nitrogen fixation in cold desert ecosystems (Belnap 1996). Thus, the widespread destruction of biological soil crusts can have long-term impacts on soil and plant productivity, and the BLM must incorporate into its land management directives standards which prevent these impacts from occurring..

Biological soil crusts are quite sensitive to trampling from livestock, and significant reductions in soil crust cover have consistently been found in trampled areas (Belnap 1985). In controlled experiments, nitrogen levels in plants have been shown to be higher in untrampled versus trampled sites (Belnap 1995). Trampled areas also have higher infestation levels of exotic grasses (Belnap 1995). Biological soil crusts are more susceptible to destruction when dry than they are when moistened (Belnap et al. 2001). Crusts which are destroyed by trampling during the dry season may never recover (Anderson et al. 1982a). According to Belnap et al. (2001), "Managing for healthy biological soil crusts requires that grazing occur when crusts are less vulnerable to shear and compressional forces," in effect, when crusts are likely to be moist for sandy soils and when they are likely to be dry for soils with high clay content. Crusts are fairly resistant to trampling in grassland systems where crusts evolved with grazers, while arid and semi-arid ecosystems (as are found in Wyoming's Red Desert and Shirley Basin) typically evolved with few grazers and thus are highly susceptible to trampling damage (Belnap and Eldridge 2001).

Vehicle use has a much greater impact on soil crusts than do foot and livestock traffic. Compressional and shear forces are greater for vehicles than for trampling by foot or hoof traffic (Belnap and Eldridge 2001). Webb (1983) found that shear forces generated by tires are greatest at the surface and less noticeable with increasing depth; these forces are highest for knobby or treated tires. Belnap and Gillette (1997) found that even a single pass by a wheeled vehicle damaged biological soil crusts to the extent that the potential for wind erosion of the soil was radically increased. Areas with intact soil crusts that are not susceptible to wind erosion often are subjected to wind erosion following damage by vehicles or ungulates (Belnap and Gillette 1998). The sensitivity of biological soil crusts to off-road vehicle travel make it imperative that the BLM restrict vehicles to designated roads and trails.

Full recovery from compaction and soil destabilization is estimated to take several hundred years (Belnap 1995). One study in Utah found that chlorophyll levels (a measure of blue-green algae) recovered fully after 40 years, lichens would recover in 45-85 years, while mosses would take over 250 years to recover fully following removal (Belnap 1993). However, the ability of biological soil crusts may be predicated on microsite characteristics. In the foothills of southern Idaho, biological soil crusts showed statistically significant levels recovery 10 years after livestock removal for Wyoming big sagebrush and mountain big sagebrush community types, while low sagebrush sites on windswept ridges and alluvial fans failed to show any significant recovery (Kaltenecker et al. 1999). And the initial burst of soil crust recovery slows long before full recovery occurs. Anderson et al. (1982b) reported that on a Utah winter range, cryptobiotic soil crust increased from 4% to

15% in the first 14-18 years following removal of grazing, but only an additional 1% in the next 20 years.

Long-term damage to soil crusts leads to long-lasting reductions in soil productivity. For instance, disturbance of cold desert soils in Utah led to major decreases in soil nitrogen that remained statistically significant even 32 years after the disturbance had ceased (Evans and Belnap 1999). For the long-term health of rangelands and wildlife habitats, the recovery of biological soil crusts should be fostered to enhance the health of rangelands throughout the planning area.

Sensitivity to disturbance makes biological soil crusts an excellent indicator of environmental degradation. According to Belnap et al. (2001), biological soil crusts are good indicators of long-term environmental condition, because they are influenced little by short-term climate factors. Moss and lichen cover can be visually estimated, but the amount of cyanobacteria and/or blue-green algae cannot be quantified through visual measurements (Belnap 1993). The BLM should protect a series of relatively undisturbed relict sites as a rangeland reference (after Belnap et al. 2001), and use these to measure departure of rangeland health from an undisturbed state. We recommend standardized survey methods (after Rosentreter and Eldridge 2002) be used to monitor biological soil crusts at least at a coarse scale within each grazing allotment, with permanent fixed-area plots established and exclosure areas providing controls at each site.

Riparian Areas

Riparian areas are of critical importance in a biological sense, due to their high productivity and diversity of life forms. Riparian areas are important corridors for the movements of animals and dispersal of plants, and the high diversity of microsites and the complex, high-frequency disturbance related to flooding and channel movements leads to greater species diversity in riparian areas over upland sites (Gregory et al. 1991). Franzreb (1987) observed that riparian habitats are centers of bird diversity and abundance in ecosystems throughout the West. According to Bock et al. (1993b), “Migratory landbirds inhabiting riparian vegetation in western North America are particularly vulnerable to disturbance” (p. 299). In Wyoming, 19% of reptile species, 55% of amphibians, 21% of birds and 20% of mammals are dependent on riparian habitats (Gerhart and Olson 1982). Thus, riparian areas of high biological concern should receive special protection under the new RMP, which should include explicit standards to manage these areas to achieve Properly Functioning Condition as outlined in the Rangeland Reform practices currently in force for all BLM lands.

The maintenance of natural hydrographic patterns and processes is crucial to maintaining riparian communities. According to Ohmart (1996), “Natural floods play a vital role in the functioning and health of riparian systems” (p. 249). Thus, BLM activities with the potential to alter streamflows or retard flooding should be avoided.

Livestock Grazing and Riparian Habitats.

Livestock overgrazing is one of the principal concerns when maintaining riparian areas in Properly Functioning Condition. In the Great Divide area, overgrazing in riparian areas has been documented in the past. For McKinney Creek, Oberholtzer (1987) reported, “Livestock have unrestricted access to the stream and eroding banks are common” (p.18). Armour and Elmore (1994) reported, “Problems from overgrazing are particularly acute in the West, where lush vegetation is confined to stream corridors. Livestock tend to concentrate in these areas, especially in the hot seasons, where they can overgraze and damage habitat” (p. 11). According to a 1988 report by the U.S. General Accounting Office, an overwhelming majority of riparian habitat in the West was in degraded condition (GAO 1988a). Ohmart (1996) reported, "my experiences are that almost all riparian areas are in unacceptable condition" (p. 257). In a study in Colorado's North Park, Schulz and Leininger (1990) found that after 29 years, a grazing exclosure held 5.5 times more woody plant cover, larger and older willows, twice as much leaf litter, and one-fourth the bare ground of the surrounding grazed riparian area.

Due to more succulent vegetation and easy access to water, cattle often concentrate in riparian areas, leading to heavy damage to these important habitats. In Oregon, Bryant (1982) found that cattle used riparian zones disproportionately, regardless of aspect, during early summer, while use of uplands increased in late summer. Armour and Elmore (1994) summarized potential impacts of grazing in riparian areas as follows: "Damage includes (1) loss of riparian vegetation by changing the composition and quantity of streamside vegetation and altering channel morphology, (2) lowering the groundwater table and decreasing summer stream flows, and (3) increasing summer water temperatures and winter icing." p. 11. The BLM's grazing policies and practices should discourage the concentration of cattle in the riparian zone.

Numerous studies have found that livestock grazing in riparian areas reduces woody vegetation (Green and Kaufman 1995). In the Ferris Mountains, Hubert et al. (1985) found that abundance of riparian shrubs, overhanging vegetation, and overhanging bank cover were negatively correlated with grazing intensity. Kauffman et al. (1983) found that after herbaceous vegetation is depleted by grazing, cattle turn to browsing, which sometimes exceeded 100% of the current year's growth. Taylor (1986) found that riparian bird counts were 5-7 times higher on exclosure versus grazed transects, and 9-11 times higher than on heavily grazed and dredged transects. According to Giesen and Connelly (1993), livestock grazing in riparian areas should be managed or eliminated to minimize destruction of hardwood shrubs and trees needed for sharp-tailed grouse winter habitat. Under the new RMP, standards should be put in place to protect healthy woody vegetation in riparian areas, and to restore it in areas that have become degraded.

The pattern of grazing may have a significant effect on efforts to maintain riparian areas in Properly Functioning Condition. Bryant (1985) found that season-long grazing had the greatest negative impact on riparian vegetation. Late season grazing may result in less disturbance to riparian communities (Green and Kaufman 1995). Clary (1995) made the following recommendation for grazing in riparian areas: "If utilization guidelines are used, those rates that do not exceed 30% of the annual biomass production will likely maintain production the following year" (p.24). Riparian areas should be the focus of monitoring efforts, as these areas can become ecologically impaired before upland habitats begin to show signs of damage.

Methods of Protecting Riparian Habitats

Placing salt blocks in upland areas is not an effective means of drawing cattle use away from riparian areas. Bryant (1982) found that salt placement and alternate water sources did not influence cattle preference for riparian habitats, and came to the following conclusion: "These cattle used the salt when convenient but did not alter behavior patterns to obtain it" (p. 784). Thus, the BLM should not rely on the placement of salt blocks as a means to draw livestock away from riparian habitats.

The use of riders to herd cattle away from riparian zones has been shown to be an effective method to achieve the restoration of degraded riparian zones. According to Kauffman and Kreuger (1984), "The most successful riparian management alternative on public lands to date has been intensive livestock management by permit holders…Herding livestock on a somewhat daily basis has been successful in limiting the number of livestock that visit streambottoms and improving utilization of upland areas" (p.435). On Huff Creek, a tributary of the Thomas Fork in western Wyoming, deferring grazing until August and providing a range rider to move cattle out of the riparian zone resulted in a 377% increase in trout population, improvement in bank stability, and 214% increase in cover (GAO 1988a). Interpreting the results of this project, the U.S. General Accounting Office concluded, "The study noted that careful control of the cattle herd by the range rider was essential for success" (Ibid., p.28). But Roath and Kreuger (1982) found that some cattle concentrated exclusively in riparian areas, and that cattle establish individual home ranges and herding them away from these ranges will not prevent their rapid return.

A change in grazing regime may also lead to the restoration of Properly Functioning Condition in some cases. Bryant (1985) found that while rest from grazing showed the greatest increase in riparian vegetation, short-duration grazing elicited a threefold increase in vegetation in riparian areas. Productivity was enhanced when no more than 70% of the forage was removed annually (Ibid.).

Rest from grazing can also result in the restoration of degraded riparian zones. According to Ohmart (1996), "The best way to manage riparian habitats is not to graze them" (p. 270). For example, in Bone Draw, a tributary of the Big Sandy River, removal of grazing resulted in "expansion of the riparian zone, stream bank water recharge and stabilization, extension of perennial water flows, and improved sage grouse, antelope, and waterfowl habitat. Also, as a result of the project, trout weighing up to 4 pounds were making an annual spring run of up to 100 miles of the Big Sandy and Green Rivers and into Bone Draw" (GAO 1988a, p. 56). In eastern Oregon, Case and Kaufman (1997) found significant increases in the structure and density of riparian hardwoods after only 2 years following livestock removal. Rickard and Cushing (1982) found that a small spring stream in sagebrush steppe in eastern Washington recovered its willow vegetation within 10 years following the cessation of grazing. Brady (1989) found that after a 16-year absence of grazing, the plant community achieved a rich and diverse balance, with increases in plant diversity and overall vegetation cover. For optimal riparian zone recovery, Case and Kaufman (1997) recommended complete protection from grazing for the first 5-10 years following livestock removal.

Recovery of riparian areas may be rapid following cessation of grazing. In their eastern Oregon study, Case and Kaufman (1997) found that following removal of cattle after more than a century of heavy grazing, riparian shrubs and trees recovered quickly both inside and outside game exclosures. This indicates that riparian areas can recover even while grazing by wild ungulates continues, when an area is rested from domestic livestock grazing. In a study in Canyonlands National Park, Kleiner (1983) found that after ten years following removal of grazing, annual grasses has substantially decreased and biological soil crusts had increased. Clary et al. (1996) found that removal of grazing and reduction to moderate levels allowed streamside willows to recover, while heavy grazing prevented willow recovery. In this study, spring grazing regimes promoted willow recovery much more than autumn grazing.

Aquatic Systems

The BLM must take a hard look at maintaining aquatic ecosystems from top to bottom. This should include monitoring of and concern for not only fish species of concern (discussed under *Native Fishes*) but also aquatic invertebrates and plants. Harding et al. (1998) reported that preservation of entire watersheds may be key to maintaining aquatic biodiversity, beyond merely protecting riparian buffer strips. The new RMP should include a comprehensive strategy for limiting impacts to aquatic systems, including numeric standards on levels of hydrographic change (through both depletions and additions), change in water quality (both turbidity and chemical composition), and aquatic indicator species that can serve as the "canary in the coal mine," triggering changes in management activities before an ecological disaster can occur.

The maintenance of natural levels of silt in waterways is an important consideration when managing aquatic habitats. Berkman and Rabeni (1987) found that siltation decreased the distinction between pool, riffle, and run habitat, adversely affecting benthic insectivores. Activities which can radically increase siltation include road-building, energy development, strip mining, clearcutting, and overgrazing.

Riparian vegetation is an important source of nutrient inputs to aquatic ecosystems, provides shade, and filters sediment and debris from entering stream systems (Kauffman and Kreuger 1984). Riparian vegetation causes soil aggradation (buildup) and raises the water table, which can turn intermittent streams into permanently flowing streams (Elmore and Beschta 1987). Thus, the maintenance of riparian habitats is also key to maintaining fully functioning aquatic systems.

Grazing affects aquatic systems by increasing siltation, increasing water temperatures, creating wider, shallower channels, reduction in vegetation and overhanging banks that yield cover to fishes (Kauffman and Kreuger 1984). Rinne (1988) found that overall biomass of stream macroinvertebrates was greater in grazed stream sections, but that sensitive taxa were entirely eliminated from grazed stream reaches. Harding et al. (1998) reported that past impacts to riparian areas remained a strong predictor of aquatic diversity long after riparian areas recovered, and "large-scale and long-term agricultural disturbances in a watershed limit the recovery of stream diversity for many decades" (p. 14844). The ecological problems associated with impacts to aquatic ecosystems make the maintenance of riparian areas in Properly Functioning Condition even more crucial.

Healthy streams have a deep and narrow cross-section, with roots of trees and shrubs to provide bank stability (Ohmart 1996). In a study on the northern flank of the Ferris Mountains, Hubert et al. (1985) found that stream channel widening and shallowing increased with increasing grazing intensity. Parker et al. (1985) reported that grazing in riparian areas, along with climate change and beaver removal, was a factor in accelerating erosional downcutting of stream channels and the lowering of water tables. Siekert et al. (1985) found that summer and fall grazing in Wyoming's Bighorn Basin had the effect of making intermittent stream channels wider and shallower, but spring grazing did not cause stream channel degradation. But Marlow and Pogacnik (1985) found that streambank damage was greater when soils were saturated, and cautioned that spring grazing should be deferred until riparian soils had dried. Because there is no uniform trend, seasonal timing of grazing should be examined on a case-by-case basis.

Riparian vegetation can increase fish population numbers and viability. Wesche et al. (1985) asserted that riparian vegetation contributes significantly to the amount of cover available in smaller trout streams, and increases the carrying capacity of these streams. Stuber (1985) found that trout populations were higher inside grazing exclosures, and estimated that fishing opportunities inside the exclosure were roughly double that of grazed stream reaches. Damage to aquatic systems due to overgrazing often has long-lasting impacts. On the north slope of the Ferris Mountains, Hubert et al. (1985) found that while riparian vegetation recovered rapidly following exclosure construction, brook trout populations were very slow to recover. Thus, in order to maintain healthy fisheries, the BLM must maintain healthy riparian areas.

Cattle concentrations along streams can significantly increase the bacterial contamination of waterways. In an arid setting, Buckhouse and Gifford (1976) found that fecal choliform in intermittent waterways did not increase due to cattle grazing, and that only the feces themselves and an area 1 m around them are subject to contamination. These researchers concluded that "unless the feces in or adjacent to a streambed there is little danger of significant bacterial contamination resulting from livestock grazing on semiarid watersheds similar to those included in this study" (Ibid., p.112). In a study in the Colorado Front Range, Johnson et al. (1978) found that grazing by cattle in the riparian zone significantly elevated the fecal choliform and fecal streptococci counts in the stream. After removal of the cattle, fecal streptococci and fecal choliform counts dropped to insignificant levels. Atwill (1996) noted that calves are readily infected with cryptosporidium and shed the oocysts, but asserted that the evidence for role of cattle in spreading cryptosporidium is unproven. The BLM should monitor levels of contamination in heavily grazed areas, particularly near human settlements and important recreation areas.

Groundwaters

The BLM must prevent impacts to both the quantity and quality of groundwaters, in order to preserve ecosystem and economic values such as wellwaters, springs and seeps, and inputs to stream systems. In the desert environment managed by the Rawlins Field Office, the availability of surface- and groundwater is perhaps the linchpin holding the entire ecosystem together. Hyporheic, or groundwater, systems have their own unique faunas and nutrient dynamics. Hyporheic communities include both detritovores and predators, all living in the waters that flow far underground. Boulton et al. (1991) reported that hyporheic communities include both detritovores and predators; during this study, copepods, ceratopoginid larvae, nematodes, water mites, and oligochaete worms were collected within 2 days of rehydration in previously dry hyporheic sediments.

Groundwater and surface streams are intimately interconnected from a hydrologic standpoint; groundwater in the upper layers upwells directly into stream and river channels or into floodplain springbrooks (Brunke and Gonser 1997). Groeneveld and Griepentrog (1985) found that the depletion of subsurface aquifers led to the decline of riparian vegetation, which in turn in turn led to increased bank erosion. These researchers concluded, "The slow drainage by aquifers which intersect streamcourses serves to maintain channel flow during dry periods and to support the plant species which structure the productivity and character of the riparian ecosystem. This balance may be particularly sensitive to alteration" (p. 44). Benson (1953) found that water inputs to the Pigeon River, Michigan through groundwater upwelling actually controls populations of brook and brown trout by determining the location of spawning habitats. Boulton et al. (1991) recommended that analysis of hyporheic communities should be included in analyses of stream ecosystems.

Groundwater supports its own unique biological component of microorganisms and detritus which contributes important nutrient inputs into streams and rivers at upwelling zones, sustaining high levels of aquatic biodiversity (Brunke and Gonser 1997). Ford and Naiman (1989) found that nutrients, particularly carbon and nitrogen, carried by groundwater are important inputs to stream systems, and that these nutrients are rapidly utilized within the hyporheal zone (sub-sediment) or at the sediment/water interface. Hyporheic fungi and bacteria are an important food source for aquatic invertebrates, some of which may also inhabit the hyporheic zone (Barlocher and Murdoch

1989). Dissolved organic carbon in groundwater is rapidly immobilized upon reaching the hyporheic zone of streams. According to Fiebig and Lock (1991), "We conclude that groundwater can contribute substantial amounts of DOC [dissolved organic carbon], both high and low molecular weight, to a stream ecosystem. The stream bed is the site at which much of this material could be initially immobilized and made available to the stream trophic structure" (p.45).

Some groundwater aquifers may be as much as 35,000 years old, with negligible modern recharge (e.g., Phillips et al. 1986). If such aquifers are the source of well water, springs, or surface streams, then their depletion through activities such as coalbed methane extraction will potentially have long-term effects including (but not limited to) the desertification of entire watersheds, the loss of wildlife populations dependent on water sources, and the long-term degradation of downstream rivers and streams in communication with the depleted aquifer.

Managing for Biodiversity

The maintenance of biodiversity must occur on a regional scale. In some cases, individual projects may not measurably decrease plant and animal diversity on a local scale, but if rare species with specialized habitat requirements disappear from the landscape, the overall regional biodiversity goes down. This relationship is particularly important when considering the effects of broad-scale habitat conversion and fragmentation. According to Sisk and Battin (2002), "Historically, biologists and planners have focused on alpha (local) diversity, which is often high near habitat edges. As conservation planning has shifted to larger areas, and scientists have assessed regional and global patterns in biodiversity, the focus on species diversity has shifted to the gamma (regional) level, which may be lower in fragmented landscapes due to the loss of edge-avoiding species" (p. 32). Thus, the new RMP should include a standard requiring the maintenance of appropriate habitat to support the viability of all native species throughout their native habitats.

Preserving the biodiversity of rodents is an important consideration in maintaining the prey base for carnivores and raptors, and in maintaining overall ecosystem function. In the Great Divide Basin, rodents consume 3.3% of net annual primary productivity (Maxell 1973). According to Maxell (1973), rodent diversity increases with increasing plant cover diversity; sagebrush grasslands and late-successional communities had the highest rodent diversity. Germano and Lawhead (1986) found that rodents increased in abundance with increasing patch complexity. Dwarf shrews were observed in the Savery Creek reservoirs project area (WGFD 1984). Golden-mantled ground squirrels (*S. lateralis wortmani*) occur almost exclusively in limber pine type within the Great Divide Basin, while kangaroo rats were restricted to sand dunes and montane voles were limited to riparian vegetation near springs and seeps (Maxell 1973). The BLM should investigate population trends of rare or declining rodents and manage to protect their viability.

SPECIES OF SPECIAL CONCERN

The use of disturbance-sensitive indicator species to monitor the impacts of human activities is done by the Forest Service, and holds great promise on BLM lands as well. According to Rothwell (1993),

> "[The use of indicator species] can and should be done in rangelands. As an example, pronghorn and sage grouse, although strongly dependent on shrubs, require a wide variety of seasonal habitats, and gross management can be directed at their needs. On a finer scale, species such as the Brewer's sparrow or sage thrasher could be used to direct management for shrubby habitats while species like the grasshopper sparrow, vesper sparrow, or lark bunting could be used to direct management for grassy areas or grassland types. Similarly, mule deer and

> sharp-tailed grouse can be the focus for macro habitat management in mountain foothills while the towhees and species that require more open habitats can guide micro management" (p. 399).

Rothwell added, "The goshawk and pine marten are also often included [as indicator species] because they are sensitive to and indicators of quality of forested habitats" (p. 399). We encourage BLM to monitor population trends of species sensitive to management activities as a means to tell when adaptive management changes are required.

In addition to such indicator species, there are a number of species on the BLM Sensitive Species List, the WGFD Species Watch List, watch lists of globally imperiled and locally rare species tracked by the Wyoming Natural Diversity Database, and federally listed species under the protection of the Endangered Species Act, all of which merit special conservation concern and attention. These species are of special concern because they are currently rare, are experiencing significant declines in overall population or distribution, or both. Some are at risk for global extinction. The new RMP must include standards that guarantee the viability, an if needed, the recovery of these species.

WGFD (1998) has set forth recommendations for allowing habitat-disturbing activities and mitigation for these activities if allowed. Federal Candidate Species and Native Species Status 1 and 2 receive a mitigation category of "Vital," for which habitat directly limits populations and restoration may be impossible; habitat function must be maintained if habitat modification is allowed to occur. In the Rawlins Field Office, species in this category include mountain plover, common loon, bald eagle, yellow-billed cuckoo, pygmy shrew, Townsend's big-eared bat, boreal toad, roundtail chub, sturgeon chub, hornyhead chub, bluehead sucker, flannelmouth sucker, Colorado River cutthroat trout, and black-footed ferret. Habitats such as Crucial Winter and Crucial Winter Relief Ranges also receive a mitigation category of "Vital."

Native Species Status 3 receive a mitigation category of "High," for which WGFD recommend no net loss of habitat function through enhancement of degraded habitat when a habitat disturbing project is proposed. In the Rawlins Field Office, species in this category include the American white pelican, American bittern, merlin, peregrine falcon, long-billed curlew, Caspian tern, Forster's tern, Lewis' woodpecker, western scrub-jay, juniper titmouse, bushtit, Scott's oriole, dwarf shrew, black-tailed prairie dog, white-tailed prairie dog, plains pocket mouse, Great Basin pocket mouse, silky pocket mouse, swift fox, and wood frog. Big game winter-yearlong ranges and parturition areas also fall under the "High" reclamation category, demanding non net loss of habitat function. Furthermore, for Endangered or Threatened Species such as the Wyoming toad, WGFD recommends exclusion of any habitat impacting activity. For these species, "The Commission recognizes that some wildlife or wildlife habitats are so rare, complex and/or fragile that mitigation options are not available. Total exclusion of adverse impacts is all that will ensure preservation of these irreplaceable habitats" (Ibid., p. 4). We concur wholeheartedly, and point out that FLPMA carries a legal requirement for the BLM to manage its lands in accord with state directives such as the WGFD Mitigation Policy.

Finally, there are a number of species that through game animal status or other reasons are of high importance to the public, and the new RMP must also maintain the viability of these species throughout the Great Divide area.

Passerine Birds

The maintenance of avian biodiversity is best approached at the ecosystem scale. Germano and Lawhead (1986) found that bird diversity was highest in pinyon-juniper scrub and lowest in grassland, with sagebrush and shadscale-greasewood showing intermediate values. In one study, bird diversity was positively correlated with vertical habitat diversity but not patch heterogeneity (Germano and Lawhead 1986). The new RMP should have as one of its goals to maintain the viability and distribution of all avian species native to the region.

The western populations of the yellow-billed cuckoo have been classified as Threatened under the ESA, and Hunter et al. (1987) classified the yellow-billed cuckoo as a partial riparian obligate. According to Laymon and Halterman (1987), the yellow-billed cuckoo is native to willow-cottonwood woodlands less than 1300 m in elevation, larger than 10 hectares in extent, and wider than 100m. Yellow-billed cuckoos use willows for nesting but cottonwoods for feeding (Ibid.). The Wyoming Natural Diversity Database has records of yellow-billed cuckoo within the Rawlins Field Office boundaries. The new RMP should include provisions to monitor cottonwood gallery woodlands for yellow-billed cuckoo, and to manage these woodlands for retention and recolonization of this bird.

Welch (2002) compared paired plots throughout the West and concluded that the burning of sagebrush reduces avian abundance and diversity. Birds found only in unburned sagebrush sites included American kestrel, Brewer's sparrow, broad-tailed hummingbird, sage grouse, mountain bluebird, sage sparrow, sage thrasher, and Swainson's hawk, while burrowing owl was among bird found only on burned sites (Welch 2002). Prescribed burn projects should be conducted in a manner that does not threaten the viability of sagebrush obligate passerines.

Sharp-tailed Grouse

In Wyoming, Columbian sharp-tailed grouse are a species of upland shrub habitats. In western Idaho, Saab and Marks (1992) found that sharp-tailed grouse preferred big sagebrush habitats characterized by moderate vegetative cover, high plant species diversity, and high structural diversity. But in the western Sierra Madres where sharp-tails occur in Wyoming, Klott and Lindzey (1993) found that sharp-tailed grouse broods occurred most often in mountain shrub and sagebrush-snowberry habitat types. Marks and Marks (1987) found that sharp-tailed grouse show little affinity for edge habitats, and stated, "Columbian sharptails need large expanses of relatively unmodified native grass-shrubland" (p. 40). Saab and Marks (1992) added, "Maintenance of shrubsteppe communities in advanced seral stages is especially important for conservation of summer habitat in the Intermountain region" (p.172). Mountain and riparian shrubs have been found to be highly important habitat components for winter food and year-round escape cover (Marks and Marks 1987). Both wintering areas and lek sites for the rare sharp-tailed grouse have been documented in the vicinity of Savery Creek (WGFD 1984).

Lekking and Nesting Habitats

Nielsen and Yde (1982) found that sharp-tailed grouse concentrate their use within one mile of lek sites during spring, summer, and fall, and wintered in coulees where hardwood shrubs were prevalent. In another study, all grouse nest sites were within 1.1 km of a lek site (Marks and Marks 1987). Geisen and Connelly (1993) reported that a 2 km buffer around a lek forms a 95% probability ellipse for relocating sharp-tailed grouse. Nielsen and Yde (1982) recommended protecting both wintering areas and areas within a mile of lek sites from heavy cattle concentrations, and to locate reservoirs at least a mile away from draws with abundant woody vegetation. According to Saab and Marks (1992), "Protecting habitats within 2.5 km of dancing grounds is critical for maintenance of summer habitat" (p. 172). Giesen and Connelly (1993) recommended the prevention of physical, mechanical, and audible disturbances, and vegetation manipulation, within the breeding complex (within 2 km of lek) during the sharp-tailed grouse breeding season (March-June).

Winter Habitats
Wintering habitats may be 2.6-20 km distant from lek sites (Giesen and Connelly 1993). Mountain shrub and riparian habitats are most important for wintering grouse (Marks and Marks 1987). Seeps may be important winter habitats when snow conditions were not conducive to burrowing (Marks and Marks 1987). According to Marks and Marks (1987), "Sharp-tailed grouse are well-adapted to harsh winter conditions. Nonetheless, their habitat requirements are narrower in winter than in any other time of year. For this reason, the availability of winter habitat is probably the most important factor in determining whether or not an area will support a population of sharptails" (p. 54). According to Giesen and Connelly, sharp-tailed grouse are limited in range by their winter dependence on deciduous trees and shrubs for food and cover.

Effects of Grazing on Sharp-Tailed Grouse
Nielsen and Yde (1982) found that lek site fidelity was so high that, although grouse avoided close proximity with cattle, they remained near the leks site even when it was subjected to heavy grazing. But Marks and Marks (1987) noted that grouse subjected to grazing left grazed areas and moved into ungrazed habitats, leading to larger home range size, and concluded that heavy grazing and agricultural development had caused the decline of the Hog Creek population. The presence of cattle at lek sites can interfere with breeding activity. According to Klott (1987), "I observed that the presence of livestock (cattle) on a lek in the spring (1986) appeared to disrupt normal activity (dancing and calling) in male Columbian sharp-tailed grouse" (p.61).

Kirsch et al. (1973) found that no sharp-tailed grouse leks were found near overgrazed pasture or hay meadows unless idle ground was nearby, and concluded that cattle grazing is deleterious to sharp-tailed breeding habitat. Even low levels of grazing were found to be deleterious, and these researchers concluded that "moderate to lightly grazed grasslands on the Refuge were of only limited importance to breeding sharp-tailed grouse" (p. 452). Saab and Marks (1992) made the following finding in western Idaho: "Overall, grouse selected vegetative communities that were least modified by livestock grazing" (p. 166). Based on their findings, these researchers concluded, "The success of attempts to improve their current status is dependent on reducing disturbances that may damage the natural diversity of shrubsteppe habitat (e.g., overgrazing by livestock and agricultural development)" (Ibid., p. 172). Klott and Lindzey (1990) also concluded that heavy livestock grazing in sharp-tailed brood habitat should be avoided. In a southern Idaho study, grouse subjected to grazing left grazed areas and moved into ungrazed habitats, leading to larger home range size (Marks and Marks 1987).

Industrial Use and Sharp-Tailed Grouse
Based on his study in the western Sierra Madre Range of Wyoming, Klott (1987) made the following observations on the potential threats to sharp-tailed grouse: (1) Block spraying adjacent to sharp-tailed leks led to abandonment of 2 lek sites. Thus, vegetation treatments near lek sites should be avoided. (2) Areas near sharp-tailed leks should be avoided for the purposes of strip mining. (3) Pump noise from oil and gas development may reduce the effective range of grouse vocalizations. For this reason, oil and gas development should be sited well back from lek sites.

Sage Grouse

Wyoming sage grouse populations are some of the largest left in the nation and are relatively stable (showing a 17% decline from 1985-1994); nonetheless, sage grouse populations have experienced major declines rangewide in recent decades (Connelly and Braun 1997). WGFD (2000) reported that since 1952, there has been a 20% decline in the overall Wyoming sage grouse population, with some fragmented populations declining more than 80%; Christiansen (2000) reported a 40% statewide decline over the last 20 years. These declines can be attributed to habitat loss (due to agriculture, mining and energy development, reservoirs, roads, and buildings), habitat fragmentation (due to fences, powerlines, roads, and reservoirs), habitat degradation (due to overgrazing, changes in fire regime, and mechanical and chemical sagebrush control efforts), drought, predation (the importance of which is controlled by the amount and quality of sage grouse habitat), and hunting (Braun 1998). It is crucially important that the new Great Divide plan provide for the maintenance and recovery of sage grouse populations, because this bird is headed for the Endangered Species List if population losses continue.

A number of raptors and medium-sized mammalian carnivores prey on sage grouse. Sage grouse nest predators include bobcats, golden eagles, red fox, badgers, common ravens, and coyotes (Heath et al. 1997). Hulet et al. (1986) found that the Uinta ground squirrel was the most important nest predator in their southern Idaho study area. The maintenance of appropriate habitat and adequate cover, particularly on nesting and brood-rearing habitats, is important to ensure that predation rates do not increase to abnormal levels. In addition to maintaining cover, it is important to avoid the construction of tall structures that serve as raptor perches and concentrate predation pressure, like powerlines and gas condensate tanks, near these habitats.

Sage Grouse Habitats

To ensure the viability of sage grouse populations, it is important to consider nesting, brood-rearing, and winter habitats (Call and Maser 1985). Connelly et al. (2000) proposed comprehensive guidelines regarding the management of sage grouse, focused around the conservation of breeding/nesting habitat, late summer brood-rearing habitat, and wintering habitat. We recommend that these guidelines be implemented in the forthcoming RMP, with the modification of a 3-mile NSO and no surface disturbance/vegetation treatment buffer for sage grouse leks in order to protect the leks themselves as well as adjacent nesting habitat.

Breeding and Nesting Habitats

Autenreith (1985) considered the lek site “the hub from which nesting occurs” (p. 52). Grouse exhibit strong fidelity to individual lek sites from year to year (Dunn and Braun 1986). During the spring period, male habitat use is concentrated within 2 km of lek sites (Benson et al. 1991). Young males may establish new leks in order to take part in breeding (Gates 1985). Because leks sites are used traditionally year after year and represent selection for optimal breeding and nesting habitat, it is crucially important to protect the area surrounding lek sites from impacts.

The maintenance of high-quality sagebrush steppe habitats, particularly nesting and wintering habitats, is necessary to maintain sage grouse viability on the landscape scale. Sage grouse are dependent on sagebrush steppe habitats, and sage grouse distribution is closely linked with the distribution of big sagebrush (McCall 1974). Numerous studies have shown that female sage grouse show strong fidelity to specific nesting areas from year to year (Berry and Eng 1985, Fischer et al. 1993, Lyon 2000). Fischer et al. (1993) concluded, “Because Sage Grouse hens appear to seek suitable habitat within a relatively small area, nest-area fidelity may reduce nesting if large areas of nesting habitat are destroyed” (p. 1040). Thus, it is important to foster sagebrush growth at levels useful to sage grouse and to avoid activities that destroy suitable sagebrush habitat.

The optimum height and cover of sagebrush for sage grouse nesting habitats varies from region to region. In their eastern Oregon study, Call and Maser (1985) reported that sagebrush between 30 and 60 cm made the best nesting habitat, while a range of 15-80 cm was suitable for nesting. In the foothills of the Sierra Madres, shrub height at nest sites averaged 22 cm (Klott and Lindzey 1989). In other studies, nesting habitat is typified by greater shrub height and shrub cover (Wallestad and Pyrah 1974, Sveum et al. 1998). Dunn and Braun (1986) found that grouse selected areas with taller shrubs and more homogeneous sagebrush densities, and closer distance to wooded or meadow edges. But in Idaho, Klebenow (1969) found that sage grouse did not nest in areas where sagebrush cover exceeded 35%. Within suitable nesting habitat, nest sites tend to be located under taller-than-average shrubs, particularly sagebrush (Hulet et al. 1986).

Mesic meadows and surface waters are focal points of sage grouse activity during certain times of year. Mesic sites associated with springs, seeps, and streams are critical for sage grouse on a yearlong basis, and assumes even greater importance as brood rearing habitat (Autenreith et al. 1982). Call and Maser (1985) stated, "We believe that free water is an essential component of sage grouse habitat", but noted that "[s]age grouse may do well in the absence of free water where they have access to succulent vegetation." (p. 4). Oakleaf (1971) found that the presence of surface water was an important factor that increased the value of meadows as grouse rearing habitat. Thus, management for sage grouse should include special emphasis on protecting wet meadows, springs, and seeps. Special provisions are outlined under the Western Heritage Alternative to protect these habitats.

Habitat attributes have a direct effect on sage grouse population dynamics. Connelly et al. (1991) found that nest success was higher for birds nesting below sagebrush (53%) versus other shrubs (22%), and hypothesized that avian predation was the key to nest success. In central Washington, Sveum et al. (1998) found that sagebrush cover at successful nest sites averaged 51%, and height averaged 64 cm, while at depredated nests cover and height averaged 70% and 90 cm, respectively. Wallestad and Pyrah (1974) found that sagebrush cover exceeded 15% for all nest sites, and cover of sagebrush was positively correlated with nest success. Several studies have shown that successful nest sites have greater cover of tall grass (Gregg et al. 1994, Sveum et al. 1998). With this in mind, Holloran (1999) recommended leaving residual grass heights greater than 12 cm following removal of livestock in autumn. Thus, not only sagebrush height and density but also understory grass cover are important to maintain in sage grouse nesting areas.

Early and Late Brood Rearing Habitats
Sage grouse may move some distance from nesting sites for early and late brood rearing. In western Wyoming, Lyon (2000) found that sage grouse moved an average of 1.1 km from the nest site for early brood-rearing, and late brood-rearing habitats averaged 4.8 km distant from the early brood-rearing areas. In Bates Hole, Holloran (1999) found that early brood rearing habitats are typified by decreased sagebrush cover and height and increased forb abundance, and movement to riparian sites occurred as uplands became dessicated. This pattern of movement and habitat selection is echoed in the findings of Oakleaf (1971). In western Wyoming, wet meadows, springs, seeps, and other green areas within sagebrush steppe were important for early brood-rearing, while late brood rearing focused on irrigated hay meadows, wet meadows, and drainage bottoms which remained green when early brood rearing habitats were withering (Lyon 2000). This researcher found that most recruitment loss occurred during the early brood rearing stage, and that this may

be a limiting factor in sage grouse populations (Ibid.). In Nevada, Oakleaf (1971) found that meadows with succulent forbs, while occupying only 2.3% of grouse home ranges during the brood rearing period, were disproportionately important as brood-rearing habitat. In central Washington, Drut et al. (1994b) found that during late brood-rearing, habitat use shifted from low sagebrush to big sagebrush sites, with heightened use of meadows and lakeshores. Brood-rearing habitats should thus be identified and managed to maximize sage grouse recruitment success.

The availability of forage with a high nutritional content is an important factor determining brood success. Broods require forbs, insects and cover for growth, concealment and shade (Autenreith 1985). The diet of sage grouse chicks is dominated by insects in the first week of life, with forbs becoming more important as time progresses (Call and Maser 1985). Oakleaf (1971) reported that succulent forbs dominated the diets of brood-rearing hens and juveniles until the chicks reached 11-12 weeks of age. Drut et al. (1994a) found that in the area with high sage grouse productivity, insects and forbs made up 80% of chicks' diets, while sagebrush buds made up 65% of diets in the area of low sage grouse productivity. These researchers reached the following conclusions: "Substantially lower consumption of forbs and invertebrates and increased reliance on sagebrush may affect chick growth and survival, which would be reflected in long-term differences in productivity between areas. Insects are a critical nutrition source for developing chicks" (p. 93). Dunn and Braun (1986) argued that meadows, as important forb-producing areas, should be preserved. Thus, the BLM should manage sage grouse brood-rearing habitat to maximize high-quality forage for chicks.

Wintering Habitats

Non-migratory sage grouse winter on their nesting and brood-rearing habitats, while migratory populations may travel some distance to winter on traditional wintering areas. For non-migratory populations, nesting habitat and wintering habitat are one and the same (e.g., Wallestad and Pyrah 1974). In a western Wyoming study, however, sage grouse were migratory and traveled at least 35 km to separate wintering grounds (Berry and Eng 1985). In Colorado's North Park, Beck (1977) found that grouse migrated 5-20 km away from breeding areas during winter. In a southeastern Idaho study, Connelly et al. (1988) found that some adult sage grouse moved more than 60 km to winter range, and some juveniles moved more than 80km, despite the availability of suitable wintering habitat nearby. In some cases, sage grouse may be widely dispersed during mild winters but concentrate during severe winters (e.g., Autenreith 1985).

Sage grouse may be keying in on several habitat variables when selecting appropriate wintering habitat. In the southern Red Desert, Kerley (1994) found that wintering sage grouse moved to tall sagebrush stands on steep south-facing slopes, where the sagebrush were exposed above the snow. Conversely, Beck (1977) found that in North Park, Colorado, 66% of sage grouse wintered on slopes of less than 5%, while only 13% of sage grouse use occurred on slopes greater than 10%. In Montana, Eng and Schladweiler (1972) found that 82% of winter sage grouse sightings occurred in canopy cover greater than 20%, and a preference was shown for dense stands on lands with little slope. The BLM must identify sage grouse wintering habitats within the planning areas an emplace strong measures to protect them from vegetation treatments and industrial projects.

Researchers appear to be unanimous in their recommendations that sage grouse winter habitat be protected from disturbance. Kerley (1994) recommended, "Because shrub stands used during winter (category 3 stands) make up a small proportion of available habitats, these patches on south facing slopes, as well as other traditional wintering sites, should not be treated [to remove or reduce shrubs]" (p.113). Connelly et al. (2000) concurred, recommending against habitat manipulation in sagebrush stands of 10-30% canopy cover heights of at least 25 cm to protect winter habitats. According to Beck and Braun (1980), “Areas of winter concentrations of sage grouse need to be documented and afforded maximum protection” (p. 564). Lyon (2000) recommended that sage grouse wintering habitats be placed off-limits to oil and gas development. Thus, in the Great Divide planning area, the BLM needs to rapidly identify sage grouse winter concentration areas and place the areas off-limits to surface disturbance and vegetation treatments.

Vegetation Treatments

Because the sage grouse is dependent on sagebrush, sagebrush treatments are likely to have major impacts on sage grouse population viability. Call and Maser (1985) asserted that the spraying of sage grouse nesting habitats is deleterious because it reduces nest cover from avian predators and suppresses forbs that are important in the sage grouse diet. According to Kerley (1994), “shrub stands of 20-40% cover are needed for successful nesting and this shrub coverage should be maintained on identified breeding complexes [within 3.2 km of leks]” (p. 113). Wamboldt et al. (2002) stated:

> “Natural or prescribed burning of sagebrush is seldom good for sage-grouse. This assessment recommends that fires within sage-grouse habitat be avoided in most cases, and should be allowed only after careful study of each local situation. The evidence also indicates that habitat loss due to fire may well be the most serious of all the factors contributing to the decline of sage-grouse” (p.24).

Heath et al. (1997) went even farther: “Based on our results, we recommend no reduction or control of sagebrush in areas containing between 18-30% live sagebrush canopy coverage within 4.5 km of leks” (p.50). According to Beck and Braun (1980),

> “At present we do not know the relative value of a small versus large strutting ground to the population. Therefore we should afford equal merit to all and strive to maintain the adjacent habitats, especially areas with sagebrush (<u>Artemesia</u>) suitable for nesting and brood rearing” (p. 563).

Call and Maser (1985) stated that spraying should not occur within the breeding complex (which they defined as within 2 miles of a lek), and should also be forbidden in known grouse winter ranges. Taking into account the negative effects of vegetation treatments on sage grouse nesting and lekking areas, and uncertainty in the overall extent of sage grouse nesting habitat surrounding lek sites in the Great Divide region, the BLM should prohibit vegetation treatments within ***3 miles*** of sage grouse lek sites.

Strip Mining

Coal mining can impact sage grouse populations through major local decreases in recruitment (Braun 1986); local distribution patterns and decreases in lek use are the principal effects, with disturbance, rather than habitat loss, being the primary factor (Remington and Braun 1991). Klott (1987) recommended that areas near sage grouse leks be avoided for the purposes of strip mining. We concur, and ask the BLM to withdraw lands within 3 miles of a sage grouse lek from lands suitable for surface mining under SMCRA.

Road Development

Road development can lead to lek abandonment (e.g., Braun 1986). In western Wyoming, Lyon (2000) found that for sage grouse leks within 3 km of oil and gas developments, grouse hens successful at raising their broods selected habitats farther from roads than unsuccessful hens. This finding indicates that habitats near roads experience reduced brood survivorship. Thus, we seek a moratorium on all road-building within 3 miles of a lek site.

Oil and Gas Development

Oil and gas development poses perhaps the greatest threat to sage grouse viability in the region. In a study near Pinedale, sage grouse from disturbed leks where gas development occurred within 3 km of the lek site showed lower nesting rates, traveled farther to nest, and selected greater shrub cover than grouse from undisturbed leks (Lyon 2000). According to Lyon (2000), impacts of oil and gas development to sage grouse include (1) direct habitat loss from new construction, (2) increased human activity and pumping noise causing displacement, (3) increased legal and illegal harvest, (4) direct mortality associated with reserve pits, and (5) lowered water tables resulting in herbaceous vegetation loss. Pump noise from oil and gas development may reduce the effective range of grouse vocalizations (Klott 1987). Thus, lek buffers are needed to ensure that booming sage grouse are audible to conspecifics during the breeding season. Connelly et al. (2000) recommended, "Energy-related facilities should be located >3.2 km form active leks" (p. 278). But Clait Braun (pers. comm.), the worlds most eminent expert on sage grouse, recommended even larger NSO buffers of 3 miles from lek sites, based on the uncertainty of protecting sage grouse nesting habitat with smaller buffers. Thus, areas within 3 miles of a sage grouse lek should be put under year-round "No Surface Occupancy" stipulations.

Livestock Grazing

Livestock grazing can influence sage grouse habitat suitability, particularly overgrazing which can reduce understory grasses below critical thresholds and alter the density of sagebrush. In their study on sage grouse in eastern Oregon, Call and Maser (1985) made the following basic assumption: "Where there are conflicts between sage grouse and livestock on public lands, it may be essential to give priority to sage grouse if they are to continue to exist on these areas" (p. 3). According to Autenreith et al. (1982), heavy livestock grazing during the sage grouse nesting or brood rearing seasons is deleterious. According to Gregg et al. (1994), "Land management practices that decrease tall grass and medium height shrub cover at potential nest sites may be detrimental to sage grouse populations because of increased nest predation....Grazing of tall grasses to <18 cm would decrease their value for nest concealment....Management activities should allow for maintenance of tall, residual grasses or, where necessary, restoration of grass cover within these stands" (p.165).

The potential conflict between livestock grazing and sage grouse is intensifies near water sources due to the importance of these areas to sage grouse. Heavy cattle grazing near springs, seeps, and riparian areas can remove grasses used for cover by grouse (Klebenow 1982). According to Call and Maser (1985), "rapid removal of forbs by livestock on spring or summer ranges may have a substantial adverse impact on young grouse, especially where forbs are already scarce" (p. 17). We support the BLM's current policy of fencing off natural springs and placing livestock water sources outside the fences rather than at the spring itself.

Holloran (1999) documented that livestock disturbance caused a sage grouse hen to abandon her nest in one case. Call and Maser (1985) noted that nest desertion is most prevalent in the vicinity of sheep bedgrounds, and reached the following conclusion: "There is no indication that livestock are a serious factor in the destruction of nests, although desertion of nests because of livestock activities is frequent under certain conditions" (p. 17). In addition, the presence of livestock in nesting habitats can cause problems for sage grouse. Livestock drives could also negatively impact sage grouse populations during the nesting season. According to Call and Maser (1985), "Hens abandon their nests with little provocation during the egg-laying period (mid-April through early May). Yearling hens are prone to abandon their nests even when disturbed during incubation. The impact of a livestock drive could, therefore, be great because yearling hens are usually the largest reproductive age class" (p. 18). For allotments where sage grouse nesting is known to occur, shifting on-off dates (if necessary) could minimize the chances of impacts to nesting sage grouse, and livestock drives should be routed to avoid sage grouse leks during the strutting and nesting seasons.

Off-Road Vehicle Use

Certainly, off-road vehicle use in sage grouse nesting habitats has negative consequences for the grouse. Call and Maser (1985) made the following recommendations concerning off-road vehicle use and sage grouse:

> "Organized motorcycle or four-wheel drive races across sage grouse nesting habitat, however, can cause substantial loss of production from direct destruction of nests, from abandonment of nests during egg-laying, from destruction of young chicks, or from all three. If sage grouse production is a management goal, then it is wise to postpone such races until after the first of September when the birds are old enough to fly out of harm's way" (p. 19).

We concur, and urge the BLM not only to avoid the proliferation of new roads and user-created vehicle routes in nesting habitats but also to schedule events away from nesting habitats and avoid scheduling them during the nesting period.

Insecticide and Herbicide Spraying

In addition to destroying the insects and forbs required by sage grouse broods, the spraying of insecticides and herbicides may cause direct mortality of sage grouse. In a Montana study, Wallestad (1975) found that treatment of 24% (751 acres) of suitable sagebrush habitat around one lek resulted in a 50% reduction of cocks, while treatment of 11% (640 acres) of suitable habitat around a second lek showed no change in sage grouse numbers; during the same time period, sage grouse numbers at control leks with no sagebrush treatment increased over 300%. Klebenow (1970) found that spraying of nesting habitat caused a long-term cessation of nesting activity in the area. Blus et al. (1989) found that the spraying of two types of insecticides over grouse was fatal to 78% of grouse, and hypothesized that insecticides have played a role in region-wide sage grouse declines. Standards should be issued preventing the spraying of insecticides in sensitive sage grouse habitats during periods where these habitats are occupied.

Lek Buffers

Current BLM nest buffers of ¼ mile for controlled surface disturbance and 2 miles for seasonal stipulations are grossly inadequate to maintain sage grouse viability in the Great Divide planning area. The lek buffer must be based not only on maintaining the lek but also the nesting habitat that surrounds the lek. In addition, seasonal prohibitions that prohibit only construction activities near leks are pointless: If roads or wells are built near leks during the off-season, the resulting regular vehicle traffic will have major negative impacts when the sage grouse are present, effectively circumventing any mitigative value of delaying construction activities.

As a rule, breeding and nesting activity are concentrated in the habitats adjacent to the lek site. In a Montana study, Wallestad and Schladweiler (1974) found that no male sage grouse traveled farther than 1.8 km from a lek during the breeding season. But following breeding, males may make long migrations to distant summer ranges (Connelly et al. 1988). Hulet et al. (1986) found that 10 of 13 hens nested within 1.9 miles of the lek site during the first year of their southern Idaho study, with an average distance of 1.7 miles from the lek site; 100% of hens nested within 2 miles of the lek site during the second year of this study, with an average distance from lek of 0.5 mile. In

Montana, Wallestad and Pyrah (1974) found that 73% of nests were built within 2 miles of the lek, but only one nest occurred within 0.5 mile of the lek site.

But in Bates Hole, Wyoming, Holloran (1999) found that average nesting distance from lek site was 3.25 km for adults and 5.27 km for yearlings. Wakkinen et al. (1992) cautioned that leks were poor predictors of sage grouse nest sites; although 92% of sage grouse nested within 3.2 km of a lek in this study, sage grouse did not necessarily nest near the same lek where breeding took place.

Lyon (2000) pointed out that quarter-mile lek buffers were insufficient to maintain the viability of grouse populations. Connelly et al. (2000) recommended that sage grouse habitat should be protected within 3.2 km of lek sites under ideal habitat conditions, within 5 km when habitat conditions are not ideal, and within 18 km where sage grouse populations are migratory. Furthermore, these researchers stated that in areas where 40% or more of the original breeding habitat has been lost, all remaining habitat should be protected.

But Beck (1977) cautioned that protection of lek sites only is insufficient to maintain sage grouse winter habitats. And Connelly et al. (1988) later cautioned, “Protection of sagebrush habitats within a 3.2 km radius of leks may not be sufficient to ensure the protection of year-long habitat requirements” (p. 116). And Braun (pers. comm.) recommended even larger buffers of 3 miles from lek sites where surface disturbance and vegetation treatments should be prohibited, based on the uncertainty of protecting sage grouse nesting habitat with smaller buffers. Thus, areas within 3 miles of a sage grouse lek should be put under year-round stipulations preventing habitat alterations.

Monitoring

The number of active sage grouse leks can be a useful index of sage grouse population trends (Emmons and Braun 1984). Autenreith et al. (1982) provide a sound monitoring protocol which the BLM should adopt to monitor sage grouse trends. Aerial lek surveys should be undertaken each spring to determine presence/absence of grouse on known lek sites and to locate new lek sites, and a subset of leks should be censused at regular intervals at dawn throughout the breeding season to gain an index of population trend. It is important to note that the number of grouse at a lek site can vary greatly from day to day (Beck and Braun 1980), so repeat censuses will be needed to establish a mean value. Emmons and Braun (1984) pointed out that timing of lek counts may affect number of grouse observed, as lek attendance is not constant and males commonly move between leks. These researchers recommended that four separate lek counts be taken for each lek, about 10 days apart. Brood counts should be undertaken 11-13 weeks after the peak of hatch using chick distress calls, and average number of chicks per hen should be derived, using both successful and nullparous hens.

Shorebirds and Waterfowl

Waterfowl and shorebirds are dependent to one degree or another on the maintenance of wetlands. Data from the Wyoming Natural Diversity Database indicate records for the following shorebird and waterfowl species of concern within the boundary of the Rawlins Field Office: common loon, Clark’s grebe, American white pelican, American bittern, white-faced ibis, ring-necked duck, bufflehead, snowy plover, upland sandpiper, long-billed curlew, Wilson’s phalarope, and three species of tern. According to WGFD (2002), observations of long-billed curlews suggest breeding activities north of the Seminoe Mountains and in the vicinity of the Pedro Mountains. WGFD (1995) recommended censusing waterfowl and shorebirds on all surface waters, and in particular getting counts of breeding pairs. The large number of sensitive or rare waterfowl and shorebirds found in the lands managed by the Rawlins Field Office make it imperative that the few wetlands found on these lands receive ample protection.

Mountain Plover

The mountain plover is proposed for listing as Threatened under the Endangered Species Act, and its rangewide decline appears to be continuing. Wyoming (along with Colorado and Montana) is one of three states that encompass the majority of plover's breeding population (USFWS 1999); approximately 1,500 birds are estimated to occur in Wyoming (Long 2001). On Mexican Flats, nesting plovers are associated with bare ground and prairie dog colonies amid scattered sagebrush; 8 nesting pairs were recorded in this area in 2000, and 23 birds were recorded after the nesting season in 2001 (Knopf, pers. comm.). In the Shirley Basin, several plover nesting concentrations have been identified atop low bluffs (Plumb, pers. comm). On the Foote Creek Rim, plover nesting population estimates have declined from 59 individuals in 1995 to 41 plovers in 1996, 31 in 1998, and 11 in 1999 (Johnson et al. 2000). Mountain plovers have been observed in the Savery Creek reservoirs project area (WGFD 1984). Plovers also nest in the Laramie Plains, primarily on arid plains and alkali flats (Laun 1957). Thus, mountain plover nesting activity is widely dispersed across the Great Divide planning area.

Habitat Requirements

Low or sparse vegetation is a key habitat requirement for nesting plovers. Habitat requirements for plover consist of short vegetation, bare ground, and flat topography; habitat associations found within the Great Divide area include plains, alkali flats, prairie dog towns, and low shrub communities, but rarely in association with surface water (Long 2001). Bare ground near objects such as rocks or dung are the nest sites of choice (Knopf and Miller 1994). Knowles et al. (1999) defined suitable habitat as "an area of at least 10 to 20 ha, with relatively level topography, and the vegetation is maintained at less than 10 cm…" Knopf and Rupert (1996) found that successful nesting plovers on the High Plains of northern Colorado used home ranges of 28-91 hectares of land. Plovers may move up to 2 km to early brood-rearing habitat immediately after egg hatching (Knopf and Rupert 1996). In the Wyoming Basins region, the availability of the low vegetation that constitutes high-quality plover habitat is largely based on low soil quality, low precipitation, and wind scour, and patches of high-quality habitat are likely to remain persistent from year to year (Beauvais et al. 1999).

Importance of Prairie Dogs to Plover Viability

Mountain plovers are often found closely associated with prairie dog colonies of all species. Kotliar et al. (1999) listed the mountain plover as a species that is dependent on prairie dog colonies for its persistence, with abundances higher on prairie dog colonies, habitat selection for prairie dog colonies, reproductive fitness higher on colonies, and population declines occurring when prairie dogs decline. An analysis of pre-settlement records of mountain plover occurrence in Montana indicates that this species was closely associated with prairie dog colonies even before the arrival of EuroAmerican settlers (Knowles et al. 1999). Knowles (1999) went so far as to state that prairie dog colonies are "necessary to provide suitable habitat for mountain plovers" on Montana's Great Plains, and termed prairie dogs "necessary for the long-term persistence of mountain plovers" in that region (Knowles 1999). This study also found that even small areas of active colonies are important plover habitat. In Wyoming, the distribution of plovers has been linked with the widespread occurrence of white-tailed prairie dogs (Oakleaf et al. 1996).

The reduction in prairie dog colonies has been directly implicated as an important cause of mountain plover declines rangewide. Knowles et al. (1999) found that the disappearance of prairie dogs due to plague and/or recreational shooting also led to abandonment of nesting habitat by plovers, and plover numbers increased on sites where prairie dog populations were expanding. According to the U.S. Fish and Wildlife Service (1999), “Further loss of prairie dog towns within the current breeding range of the mountain plover would be detrimental to plover conservation. Conversely, the conservation of the mountain plover can be enhanced by implementing strategies to increase the distribution and abundance of prairie dogs on breeding habitat” (p. 7594). Thus, the conservation of prairie dog colonies is a prerequisite to maintaining viable populations of mountain plover.

Effects of Management Activities and Industrial Development

Grazing and other activities detrimental to other species may benefit plovers in some cases. Areas of heavy grazing, whether by sheep, cattle, bison, or other ungulates, may be favorable for mountain plover nesting habitat (Knowles et al. 1999). Because the important effect is the creation of substantial areas with little or no vegetation, one may infer that heavy grazing by wild horses could also create favorable plover habitat. Wallis and Wershler (1981) noted that inadequate grazing may be detrimental to nesting plovers on the High Plains. But livestock grazing is far from universally beneficial to mountain plovers. Wallis and Wershler concluded that patchiness in grazing intensity was of greatest benefit, and that even distribution of cattle and uniform overgrazing may be detrimental to plover habitat. Winter and spring grazing create more favorable habitat conditions for mountain plover than does summer grazing (Knowles et al. 1999).

Other management activities may also influence plover viability. On the Great Plains of Colorado, where wildfires are a natural occurrence, prescribed burning has been shown to increase the attractiveness of habitat to nesting plovers (Svingen and Giesen 1999). Knowles et al. (1999) also stated, “prairie dog eradication, carefully regulated summer grazing of cattle, and agricultural conversion of rangelands all appear to be detrimental to mountain plover conservation.”

Oil and gas development in nesting concentration areas is a direct threat to mountain plover population viability. The U.S. Fish and Wildlife Service found that the Seminoe Road Coalbed Methane project “is likely to adversely affect the proposed mountain plover,” stating that wellfields are likely to become an “ecological trap,” attracting feeding plovers to roadways where they become susceptible to vehicle-related mortality, or alternately increased vehicle traffic could drive plovers away from preferred nesting areas (Long 2001). The USFWS (1999) added that vehicle traffic on roads could lead to stress and chick abandonment. These officials noted that any human disturbance that significantly modifies adult behavior could cause death to chicks, which can die in as little as 15 minutes due to exposure to sun at temperatures greater than 81° F. Long (2001) noted that construction equipment and permanent structures inherent to oilfield development constitute a radical increase in raptor perches that could result in increased predation pressure. In addition to these problems, wellfield development can lead to increased invasion rates of non-native weed species, which can have serious impacts on plover nesting habitat by decreasing the availability of bare ground (Good et al. 2001).

Wind-power developments can be equally harmful to plover nesting habitats. According to Johnson et al. (2000), nesting plovers abandoned the southern third of the Foote Creek Rim during wind farm construction activities in 1998, abandonment of the southern half of the Foote Creek Rim in 1999, and overall reductions in use of this area heavily impacted by roads and wind turbines during previous years, was likely related either to construction activities or reduced habitat effectiveness due to the presence of roads, trenches, or other project-related impacts.

The BLM has historically mapped and surveyed for plover nesting areas on a catch-as-catch-can basis, limiting efforts to lands slated for imminent development projects. A broader and more comprehensive survey of nesting plovers by trained personnel is needed throughout the planning area. The Wyoming Game and Fish Department has made the identification of plover nesting areas one of its highest conservation priorities (Oakleaf et al. 1996). Wind speeds greater than 18 m.p.h., as well as precipitation or sunny days warmer than 86 degrees F, can radically decrease census effectiveness, as these weather conditions cause plover to crouch in the lee or shade of shrubs and essentially become invisible (Knowles et al. 1999). Depending on climate shifts from year to year, abundant vegetation associated with favorable growing conditions can decrease plover observation distance from 400m to 100m at the same site (Knowles et al. 1999). In Montana, surveys must be completed prior to mid-July fledging dates, and observability is higher during courtship and brood-rearing periods than it is during incubation of eggs (Knowles et al. 1999).

Raptors
Raptor populations are on the rebound following declines based largely on insecticide spraying, predator poisoning programs, and shooting in the 1960s and 1970s. Raptors of special concern include the golden eagle, prairie falcon, peregrine falcon, ferruginous hawk, merlin, and burrowing owl. Because they require large natural areas for survival, raptors may be good umbrella species for the protection of entire ecological communities (Burnham and Holroyd 1995).

Importance of Cliff Habitats
Cliffs provide important nesting substrates preferred by a broad spectrum of raptors. A study near Medicine Bow, Wyoming found that cliffs provided the single most important nesting habitat for raptor species in the region, and 93% of all prairie falcon nests were found on cliffs, despite the comparative rarity of this landform in the Medicine Bow area (MacLaren et al. 1988). In a Utah study, prairie falcons and golden eagles nested exclusively on cliff sites (Smith and Murphy 1982). Thus, in terms of value to nesting raptors, areas with cliff topography may be of heightened conservation importance.

Importance of Prairie Dogs to Raptor Populations
Prairie dogs can be an important mainstay of raptor diets. In a study near Medicine Bow, Wyoming, white-tailed prairie dogs made up 38% of the biomass in the diets of prairie falcons, 18% for golden eagles and red-tailed hawks, and 22% of ferruginous hawk diet biomass (MacLaren et al. 1988). Prairie dog colonies are also important to the survival of raptor populations on their wintering areas. Jones (1989) studied winter raptor aggregations on the High Plans of Colorado "Aggregations of ferruginous hawks, red-tailed hawks, and bald eagles were frequently observed in the vicinity of prairie dog colonies." p. 256. In this study, golden eagles, ferruginous hawks, and red-tailed hawks were observed taking prairie dogs, while bald eagles and northern harriers competed for the captured prairie dogs. Declines in prairie dog colonies as a result of a plague epidemic resulted in a more than 60% decline in wintering bald eagles, ferruginous hawks, and red-tailed hawks (Ibid.). Numbers of wintering ferruginous hawks also declined dramatically following a crash in prairie dog populations in New Mexico (Cully 1991). Thus, full recovery of prairie dog populations would be the optimal outcome for maintaining and recovering raptor populations.

Effects of Management Activities and Development on Raptors
The primary impact to raptor populations is direct disturbance of raptors on the nest, leading to reductions or loss of viability for eggs or nestlings. Disturbance of nesting raptors may cause nest abandonment, damage to the eggs, subject eggs or nestlings to cooling, overheating, or dehydration

leading to mortality, prevent young nestlings from receiving sufficient feedings to remain viable, and cause premature fledging (Parrish et al. 1994). Thus, the BLM should establish adequate nest buffers (on the order of 2 miles in diameter) around nest sites, preventing all construction of developments (such as wells and roads) that would lead to future disturbance of nesting raptors through focusing human activities in these areas. Seasonal restrictions are insufficient; a well or road constructed outside the nesting season is still likely to lead to nest abandonment or reductions in recruitment due to disturbance from vehicle traffic that does occur during the nesting period.

The overall landscape-scale effects of widespread industrialization threaten the viability of raptor populations through habitat loss and fragmentation. Nest buffers currently in force are unlikely to safeguard the viability of native raptors in the Great Divide; a more conservative approach is needed in order to safeguard raptor viability in this region. White and Thurow (1985) stated: "We would prefer to see ecosystems kept intact (cf. Wagner 1977) rather than divided into isolated islands set aside for nesting raptors, because aspects of general land use other than restricted areas also affect the health of raptor populations" (p. 21). Thus, not only should nest buffers be implemented, but the overall integrity of the landscape should be maintained (or improved in areas where it is currently degraded) in order to better provide for raptor viability.

Powerline Corridors

Powerline towers are likely to concentrate raptor nesting and perching activities, to the potential detriment of prey species. Transmission towers may be particularly attractive as nest sites for ravens, and Steenhof et al. (1993) reported that 133 pairs of ravens had colonized transmission towers on a single stretch of powerline in Idaho during its first 10 years of existence. Gilmer and Wiehe (1977) found that nest success for ferruginous hawks was slightly lower for transmission towers than other nest sites, and noted that high winds sometimes blew tower nests away. Steenhof et al. (1993) also found that transmission tower nests tended to be blown down, but found that nest success was not lower on towers for ferruginous hawks and was significantly higher on towers for golden eagles. In North Dakota, Gilmer and Stewart (1983) found that ferruginous hawk nest success was highest for powerline towers and lowest for nests in hardwood trees. Thus, although powerlines can be designed to minimize impacts to raptors, these corridors should be sited more than 2 miles away from prairie dog colonies and sage grouse leks to prevent major impacts to these sensitive prey species.

Effects of Livestock Grazing

Effects of livestock grazing on raptors vary by species. Kochert (1989) examined the effects of livestock grazing on raptors and found that grazing can decrease the amount of nesting substrate, change populations of rodents (causing declines in many groups), and alter the vulnerability of prey species. He further pointed out that few prey species tolerate intensive long-term overgrazing. Bock et al. (1993b) reported that golden eagles probably respond positively to grazing in shrubsteppe habitats, but ferruginous hawks, Swainson's hawks, red-tailed hawks, and northern harriers probably respond negatively. It is likely that overgrazing is the greatest threat to those raptors sensitive to grazing impacts.

Golden Eagles

Golden eagles, their nests and young are strictly protected under the Bald Eagle Protection Act (16 USC 668a-d). This species is very popular with the wildlife viewing public, and conversely has historically suffered from shooting as well as poisoning directed at terrestrial predators. The maintenance of viable golden eagle populations should be an important consideration in the new RMP.

Conservation efforts should focus on protecting nest sites and important foraging areas, such as prairie dog colonies. Golden eagles are highly territorial. Even when surface-disturbing activities such as strip mining are located away from golden eagle nest sites, the destruction of important foraging habitats, such as prairie dog colonies, within the territory of nesting pairs can be a major problem for the viability of nesting golden eagles (Tyus and Lockhart 1979). In New Mexico, plague-related declines in prairie dog abundance from 30 per hectare to less than 1 per hectare triggered a decline in the nesting population of golden eagles (Cully 1991). Thus, golden eagle protection is linked with the maintenance and recovery of prairie dog colonies.

Ferruginous Hawks

The ferruginous hawk has been experiencing declines across the continent for the past 30 years, although Wyoming is often viewed as a stronghold for the species. The ferruginous hawk has been petitioned for listing under the Endangered Species Act in the past, and more recently it has been identified by the Wyoming Game and Fish Department as a Species of Special Concern (Oakleaf et al. 1996).

Prey Base

The ferruginous hawk has been identified as a species dependent on prairie dogs, and ferruginous hawk populations have shown declines in response to prairie dog population declines (Kotliar et al. 1999, and see Jones 1989). Olendorff (1993) pointed out that prairie dogs and ground squirrels were the most important prey in some areas, while hares and rabbits predominated the ferruginous hawk diet in others. In several studies from central Utah, ferruginous hawks were found to be highly dependent on jackrabbits as prey, and hawk population fluctuations were closely tied to the rise and fall of jackrabbit populations (Woffinden and Murphy 1977, Smith and Murphy1978). The proximate cause of this hawk population decline was linked to a decrease in nesting effort and an increase in nomadism in ferruginous hawks following the jackrabbit decline (Woffinden and Murphy 1989). In southeastern Idaho, a jackrabbit population crash was also implicated in a decline of the ferruginous hawk population (Powers 1976).

In contrast, a study on the Canadian high plains found that ferruginous hawk population density and fledging success were consistently correlated with the abundance of Richardson's ground squirrels, and negatively correlated with poisoning efforts (Schmutz and Hungle 1989). On the plains of South Dakota, thirteen-lined ground squirrels dominated the ferruginous hawk diet, while meadowlarks, pocket gophers, and jackrabbits also played important roles (Blair and Schitoskey 1982). In southwestern Idaho, Steenhof and Kochert (1985) found that ferruginous hawks were heavily dependent on Townsend's ground squirrels, and that squirrel declines linked to drought resulted in depressed nest success for the local ferruginous hawk population.

Within the Great Divide planning area, ferruginous hawks have a fairly diverse diet. In a study near Medicine Bow, MacLaren et al. (1988) found that jackrabbits contributed 48% to the ferruginous hawk diet biomass, white-tailed prairie dogs 22%, and Wyoming ground squirrels 16%.

Secondary prey may attain paramount importance during prey declines, droughts, and other stochastic events. Secondary prey species become critical to maintaining hawk population numbers when primary prey species crash (Olendorff 1993). Smith and Murphy (1978) found that ferruginous hawk diets shifted increasingly to rodents as jackrabbits became scarce. Thus, it is important to maintain both primary and secondary prey bases to guarantee ferruginous hawk viability over the long term.

Nesting Habits

Ferruginous hawks use the same nest from year to year and also build alternate nests within the same territory (Smith and Murphy 1978). In the Centennial Valley of Montana, where cliffs and suitable ground nesting sites are unavailable, ferruginous hawks commonly nest in aspens and willows (Restani 1991). In eastern Washington, ferruginous hawks nested primarily on basalt outcrops and in junipers (Bechard et al. 1990). In central Utah, Smith and Murphy (1978) noted cliff, rock outcrop, and tree nest sites (particularly juniper). Also in Utah, Smith and Murphy (1982) found that ferruginous hawks nested most often in junipers (53% of nest sites) but also used rock outcrops (24%) and ground nests (14%). A subsequent study in the same region found 66% of nests in juniper trees, 32% on rock outcrops, and 2% on the ground (Woffinden and Murphy 1983). In North Dakota, small clumps or rows of hardwood trees were the most common ferruginous hawk nest sites, while ground nests atop rugged moraines made up 22% of the nest sites and powerline towers accounted for 18% of ferruginous hawk nests (Gilmer and Stewart 1983). On the plains of South Dakota, Blair and Schitoskey (1982) found that all ferruginous hawks built ground nests, most of them in rough terrain. Similarly, in southeastern Idaho, all ferruginous hawk nests were ground nests built atop bluffs with the exception of a single juniper nest (Powers 1976).

Ferruginous hawks will also nest on man-made structures. Niemuth (1992) documented ferruginous hawks nesting on the roof of an abandoned shed as well as on an idle center-pivot irrigation apparatus in Wyoming.

Ground-nesting ferruginous hawks can be quite susceptible to predation. Foxes and coyotes have been documented as important predators of ferruginous hawk ground nests (Blair and Schitoskey 1982). The availability of elevated topographical features may be important to nest success for this species.

Effects of Development

Ferruginous hawks are among the most sensitive of all raptor species, and are prone to nest abandonment if disturbed (Parrish et al. 1994). Nest abandonment, egg mortality, parental neglect, and premature fledging are common results of disturbing ferruginous hawk nests (White and Thurow 1985). Smith and Murphy (1978) noted that increased human access is a primary threat to the viability of ferruginous hawk nest success. For their central Utah study, these researchers found that “in all instances of nesting failure where the cause could definitely be determined, humans were at fault” (p. 87). White and Thurow (1985) found that walking disturbance and vehicle use had the greatest effect on ferruginous hawk nest success, while vehicle use had the greatest flushing distance. Instead of becoming habituated, most hawks in this study increased their flushing distances with repeated disturbance (Ibid.). In addition, disturbed nests averaged one less offspring fledged per nest when compared to undisturbed control nests. Oakleaf et al. (1996) pointed out that the cumulative effects of oil and gas development may impact large areas of ferruginous hawk habitat.

White and Thurow (1985) recommended quarter-mile nest buffers during years of prey abundance, but noted that sensitivity to disturbance increased when prey were scarce, and recommended that nest buffers be "considerably larger" during years of prey scarcity. Although Olendorff (1993) recommended buffer zones of only ½ mile for ferruginous hawk nests, he recommended much larger buffers during periods of prey scarcity. Because it is impractical to move roads away from nest sites when prey bases decline, the appropriate way to ensure the persistence of ferruginous hawks at traditional nesting sites is to use large buffers within which ground-disturbing activities are prohibited. Cerovski et al. (2001) reviewed the issue of appropriate nest buffers and recommended a 1-mile buffer, kept free from human disturbance. Thus, under this Alternative, **1-mile buffers** prohibiting surface disturbance should apply to ferruginous hawk nest sites as well as all other raptor nest sites.

Burrowing Owl

Nationwide, the burrowing owl is a species on the decline. As of 1997, over half of the agencies across North America tracking burrowing owl population trends reported declining populations, while none reported increasing populations (James and Espie 1997). Burrowing owl populations are highly susceptible to stochastic disturbances such as drought, and thus may decline more rapidly than would be predicted on the basis of demographic factors alone (Johnson 1997). In Wyoming, data suggest an overall population decline, with 17.5% reoccupancy of historic sites, but the spotty quality of historical data makes comparisons difficult (Korfanta et al. 2001). The burrowing owl has been identified as a species of concern by both the BLM and the Wyoming Game and Fish Department.

Dependence on Prairie Dog Colonies

Burrowing owls are in a select group of wildlife most closely tied to prairie dog colonies, and prairie dog burrows are preferred nest sites for burrowing owls. Thompson (1984) reported that owls preferred abandoned prairie dog burrows in the early stages of succession. Green and Anthony (1989) found that nest burrows lined with dung were less susceptible to predation, perhaps explaining this unusual behavioral attribute. On the Great Plains, Sidle et al. (n.d.) found that burrowing owls actively selected for active prairie dog towns, and showed much lower usage of towns that had been decimated by plague, shooting, or poisoning. Desmond and Savidge (1999) found that burrowing owl nest success was positively correlated with density of active prairie dog burrows, and recommended preserving prairie dog colonies to maintain the viability of burrowing owl populations. And in the Columbia Basin, where prairie dogs are absent, burrowing owls nested in badger burrows, but as a result were subjected to badger predation (Green and Anthony 1989). Thus, the ongoing loss of prairie dog colonies has undoubtedly been a prime factor in the decline of the burrowing owl.

In the Great Divide area, the ties of burrowing owls to prairie dogs vary by region. Thompson (1984) found that burrowing owls near Casper were associated with white-tailed prairie dogs, while near Torrington they were associated with black-tailed prairie dogs. But in eastern Wyoming, fewer than half of the nesting burrowing owls were associated with active prairie dog towns (Korfanta et al. 2001).

Hunting Habits

Burrowing owls hunt most actively during the twilight hours (Thompson 1984). In the Columbia Basin, pocket mice are the primary mammalian prey (Green and Anthony 1989). In Wyoming, insects are the most frequent prey item, but small mammals dominate the dietary biomass (Thompson 1984). Due to the importance of insects (particularly grasshoppers) in the diets of burrowing owls, the widespread use of pesticides would most likely result in impacts to burrowing owl viability.

Effects of Livestock Grazing
Bock et al. (1993b) reported that burrowing owls probably respond positively to grazing in grassland habitats, but negatively in shrubsteppe habitats. The BLM should bear these trends in mind when drafting individual Allotment Management Plans.

Monitoring
As a BLM Sensitive Species, annual monitoring efforts should be directed at burrowing owls to gain an index of population trend. Haug and Didiuk (1993) reported that 57% of burrowing owls responded to recorded calls in their study, and that the "tall and white" stance adopted in response to calls made detection easier. These researchers recommended a series of three surveys at 5-7 day intervals during the nesting season to monitor population trends. These monitoring protocols should be established as requirements under the new RMP.

Prairie Dogs
Virtually the entire area managed by the Rawlins Field Office is habitat for either the white-tailed or black-tailed prairie dog. Collectively, all species of prairie dogs have been reduced to only 2% of their historical range (Miller et al. 1990). White-tailed prairie dogs have declined to 8% of their native range in North America, and the survival of remaining populations is threatened by habitat destruction and modification, sylvatic plague, recreational shooting, poisoning, oil, gas, and mineral extraction, fire suppression, overgrazing, off-road vehicle use, noxious weeds, and climate change (Center for Native Ecosystems et al. 2002). In Wyoming, the white-tailed prairie dog occupies less than 2% of the suitable habitat for the species (Center for Native Ecosystems et al. 2002). For Wyoming's Great Divide Basin, Maxell (1973) noted, "Most active prairie dog towns were located some distance from the main thoroughfares in the Basin, probably due to human predation in the form of varmint hunters" (p.85). In the Great Divide area, prairie dog colonies are radically reduced from historic distributions, and are in need of protection and recovery.

Prairie Dogs are Ecosystem Regulators
Prairie dogs are fundamental regulators of ecological processes within the area occupied by active colonies. According to Miller et al. (1990), "Prairie dogs have been implicated as ecosystem regulators that influence primary productivity, species composition, species diversity, soil structure, and soil chemistry by their burrowing and grazing" (p. 765). Hansen and Gold (1977) concluded, "This study, compared with previous research, provides evidence that blacktail prairie dgs [sic] are an important ecosystem regulator as they disturb the soil, increase plant diversity (Gold 1976), increase animal diversity, and cause a decrease in primary production of the areas they use." p. 213. Agnew et al. (1986) labeled prairie dogs as ecosystem regulators, maintaining shortgrass habitats. As regulators of ecosystem processes, prairie dogs are keystone species in shrubsteppe and grassland habitats.

On the High Plains, Ingham and Detling (1984) found that root-eating nematodes were more abundant and root biomass lower on a heavy-grazing prairie dog site, while available soil nitrogen was higher on the prairie dog colony. Holland and Detling (1990) subsequently found that nitrogen mineralization was highest in active prairie dog colonies and lowest in uncolonized grassland. Root biomass is lower within prairie dog colonies that on uncolonized sites (Holland and Detling 1990). In Wyoming's Shirley Basin, Schloemer (1991) found that prairie dog burrowing improves growing conditions for sagebrush by increasing snow entrapment, water infiltration, and deep percolation. Kotliar et al. (1999) concurred that the prairie dog clearly functions as a keystone species in the ecosystems it inhabits, creating habitat through its burrow networks, altering vegetation patterns, and providing an important prey base.

The Prairie Dog Ecosystem is Crucial to Many Wildlife Species
According to Miller et al. (1990), "Ecologically, the prairie dog ecosystem is an oasis of species diversity on the arid plains" (p. 764). Sharps and Uresk (1990) found that 134 vertebrate wildlife species are associated with prairie dog colonies in western South Dakota. In a comparative study which incorporated Wyoming sites, Clark et al. (1982) found that white-tailed colonies showed a greater number of associated vertebrate species (83 species) than either black-tailed or Gunnison prairie dogs; larger towns had a greater species diversity than smaller towns.

Agnew et al. (1986) found that avian density and species richness were significantly greater on High Plains prairie dog colonies. On the High Plains, Hansen and Gold (1977) found that desert cottontails were abundant on prairie dog towns but scarce elsewhere. O'Meila et al. (1982) found that rodent biomass (excluding prairie dogs) was almost twice as great on prairie dog towns than off; this higher rodent abundance was echoed in the results of Agnew et al. (1986). Goodrich and Buskirk (1998) demonstrated that badgers have a heavy dependence on white-tailed prairie dogs in Wyoming. The importance of prairie dogs as prey for raptors has been noted in many studies (e.g., Tyus and Lockhart 1979, Campbell and Clark 1981, MacLaren et al. 1988, Jones 1989, Cully 1991, Kotliar et al. 1999).

Many rare and declining species, notably black-footed ferret, mountain plover, burrowing owl, ferruginous hawk, and swift fox are dependent on prairie dogs for their own persistence (Kotliar et al. 1999). Based on study of the last remaining wild ferret population that was extirpated near Meteetsee, Forrest et al. (1985) reported that black-footed ferrets are confined almost exclusively to prairie dog colonies. In Wyoming, other species associated with white-tailed prairie dogs that are of particular note due to special status or management concern include the eastern short-horned lizard, northern plateau lizard, Great Basin gopher snake, midget faded rattlesnake, prairie falcon, merlin, sage grouse, burrowing owl, sage thrasher, Brewer's sparrow, sage sparrow, swift fox, and pronghorn (Clark et al. 1982).

Habitat Selection and Colony Attributes
In the Red Desert, Maxell (1973) found that prairie dogs were restricted to sagebrush-grass communities with shrub height less than 12 inches and cover less than 40%, on loam and clay textured soils. In the Shirley Basin, Orabona-Cerovski (1991) found that average plant cover on towns was 38%, with high amounts of bare ground. These preferences should be borne in mind when evaluating habitats for potential prairie dog recovery efforts.

The spatial distribution of prairie dog colonies is an important conservation priority. Clark et al. (1982) made the following observation for white-tailed prairie dogs in Wyoming: "Prairie dog colonies were found clumped in suitable habitat, and nearby colonies served as sources for colonizing animals" (p. 579). The dispersal ability of the white-tailed prairie dog is not great; Orabona-Cerovski (1991) found that less than 1% of juvenile males and 3% of juvenile females dispersed more than 200m from their natal burrows. Thus, maintaining a few isolated colonies is by far inferior to maintaining colony complexes with a high degree of connectivity to facilitate dispersal.

Clark et al. (1982) found that burrow densities for white-tailed prairie dogs averaged 25.8/ha, versus 32/ha for the black-tailed and Gunnison. But Campbell and Clark (1981) found that individual white-tailed colonies were as large and dense as black-tailed colonies, but white-tailed colonies were even more numerous and dense on the landscape. This was probably related to site productivity rather than any intrinsic propensity to create dense colonies by either species, as the white-tailed site in this study was located on moist, high-quality soils while the black-tailed site was on drier uplands (Ibid.). Burrow densities in the Shirley Basin ranged from 50-190/ha (Orabona-Cerovski 1991). In the southern part of the Rawlins Field Office, Smith et al. (1981) found burrow densities ranging from 12/ha to 42/ha, with an average of 27/ha, while a later survey (Smith et al. 1982) found burrow densities ranging from 13-68/ha, with a mean of 36/ha.

The Myth of Prairie Dogs as Meaningful Competitors for Livestock Forage
Hansen and Gold (1977) noted that the diets of prairie dogs and cattle are broadly similar, and that prairie dogs do reduce the amount of available forage. But O'Meila et al. (1982) found that although prairie dogs reduced the available forage for cattle, cattle on prairie dog plots failed to show a statistically significant decrease in weight gain over control animals. These researchers concluded, “The statistically similar steer weight gain performances during the green-herbage period indicates that sufficient herbage was available to meet the demands of both steers and prairie dogs, even under a regime of heavy utilization” (p. 583). Knowles (1986) found a symbiotic relationship between livestock and prairie dogs: Prairie dogs selected areas disturbed by overgrazing to establish colonies, while livestock preferentially foraged on prairie dog colonies due to higher-quality of forage. Krueger (1986) found higher shoot nitrogen in prairie dog towns, indicating enhanced forage quality for all grazers.

Sylvatic Plague
Sylvatic plague is a major threat to the viability all species of prairie dog. Sylvatic plague has been documented in Sweetwater, Albany, Natrona, and Laramie Counties, and plague has been present continuously in the Shirley Basin since 1985 (Cully and Williams 2001). These researchers stated that “all 4 species of prairie dogs are highly susceptible to plague infections” (Ibid., p. 895). But plague outbreaks may spread more slowly in white-tailed colonies than in black-tailed colonies. According to Ubico et al. (1988), “The Meteetsee area has a short, cool summer season...a plague epizootic under these circumstances probably progresses more slowly over several years, although the end result of almost complete depopulation could be the same” (p. 404). Clark (1977) recorded a plague epizootic in a small colony of white-tailed prairie dogs in Wyoming that killed 85% of the colony. According to Cully and Williams (2001), the comparative low density of white-tailed prairie dog colonies slows the spread of plague, allowing the disease to persist for long periods of time, rather than wiping out a colony and dying out quickly as is the case with black-tailed prairie dogs. For black-tailed prairie dogs, Cully and Williams (2001) postulated that a 3 kilometer distance between colonies is enough to interrupt the spread of plague and assure the probable survival of neighboring colonies. There is currently no effective method to control the spread of plague in prairie dog colonies. Because prairie dogs in the Great Divide area are already stressed by endemic or epidemic levels of sylvatic plague, stronger conservation measures are needed to prevent impacts from activities that can in fact be controlled.

Conservation Measures
The ecological importance of prairie dogs, when paired with their low and declining population levels and imminent threats to colony viability, make the compelling case that strong measures must be put in place to protect and restore prairie dogs in the Great Divide planning area. Large prairie dog colonies, plus a half-mile buffer, should be withdrawn from all surface-disturbing activities with minerals leased only under "No Surface Occupancy” provisions.

Monitoring

Currently, the most recent comprehensive data on prairie dog distribution is from the 1980s; new colony surveys are needed to determine where conservation efforts should be focused and which colony sites require restoration efforts. Forrest et al. (1985) admonished, "All prairie dog colonies should be accurately and consistently mapped" (p. 28). Martin and Schroeder (1979) noted that aerial photography failed to identify many active colonies; these researchers recommended winter photography after snowfall as providing the best visibility of prairie dog colonies. The new RMP should require surveys to determine the spatial extent as well as periodic sampling protocols to index population trends within the major colonies.

Black-Footed Ferrets

The black-footed ferret was once found throughout the Great Divide area. Today, Wyoming's only reintroduced population resides in the Shirley Basin. Within the area managed by the Rawlins Field Office, wild ferret skulls have been found in the following locations: one in the Monument Lake area (Smith et al. 1981), two near the Haystacks, and three in the Hanna Basin (Martin and Schroeder 1979). According to Oakleaf et al. (1992), "The precarious status of black-footed ferrets is a direct result of habitat fragmentation through prairie dog (Cynomys spp.) eradication in the North American midwestern prairies" (p. i). Thus, ferret viability is closely tied to the population status of its prey species, prairie dogs.

Candidate Sites for Ferret Reintroduction

Based on minimum viable population estimates for ferrets, viable ferret populations require prairie dog colonies of at least 3000 hectares, with a 4000-6000 hectare size being a more optimal minimum (Forrest et al. 1985). These researchers recommended that only towns with burrow densities greater than 10/ha be considered "colonies" for the purpose of reintroduction, and that intercolony distances should not exceed 20 km to facilitate ferret interchange. Past studies indicate that there may be sites matching these criteria within the Great Divide planning area, and such sites would be of primary conservation concern.

Swift Fox

The swift fox was determined to be "warranted but precluded" for listing under the Endangered Species Act by the U.S. Fish and Wildlife Service in 1995 (60 Fed. Reg. 31663). The swift fox is listed as a Species of Special Concern by the Wyoming Game and Fish Department, and is protected from intentional take by state regulations (Oakleaf et al. 1996). This species has been listed as dependent on the prairie dog for its persistence, and that its populations decline when prairie dogs decline (Kotliar et al. 1999). After a substantial absence, small populations of swift fox recolonized their native range in Montana during the 1970s (Moore and Martin 1980). Swift fox are also found in the Shirley Basin, and their range expansions elsewhere are a hopeful sign that this species may begin a broad-based recovery within the Great Divide planning area.

Comparatively little is known about swift fox biology and habitat requirements. Swift foxes pair for life and have one litter per year (Kilgore 1969). Dens are complex warrens with multiple tunnels and entrances, and prairie dog burrows may be enlarged into swift fox dens (Kilgore 1969). Uresk and Sharps (1986) found that swift fox dens tend to be constructed on or near hilltops. In one study, swift fox home ranges averaged 32 km^2. The diet of swift fox in various parts of its range is dominated by prairie dogs, grasshoppers, and beetles (Uresk and Sharps 1986), small rodents, including prairie dogs (Kilgore 1969), mainly lagomorphs (particularly jackrabbits) with some prairie dogs (Zumbaugh et al. 1985), and may include carrion and plant matter (Hines and Case 1991).

Threats to Swift Fox Viability

According to Kahn et al. (1997), "Swift fox are frequently observed along roadways, which may increase the rate of animals being killed specifically by vehicles. Factors such as road density, miles traveled and driver speed may increase the rate of swift fox mortalities" (p. 17). Kilgore (1969) noted, "The chief mortality factors to which swift foxes are subjected are those associated with the activities of man. These foxes are frequently killed crossing highways and county roads, shot by hunters or farmers, and killed by farm implements" (p. 525). Swift fox are also particularly vulnerable to poisoning programs targeted at rodents or other carnivores (Kilgore 1969, Uresk and Sharps 1986). In their conference opinion on the Seminoe Road Coalbed Methane Project, the USFWS recommended that activities which might disrupt denning swift fox be prohibited between March 1 and July 31 (Long 2001). Denning areas should be identified and protected from any activities that threaten the viability of swift fox populations.

Beavers

Beavers are architects of stream ecosystem function. Ohmart (1996) asserted that beavers are a keystone species in small-order streams, creating habitats used by many other species. Beaver dams also are arbiters of fundamental hydrologic change, creating ponds, raising the water table, reducing stream velocities during flood events, and reducing the suspended solids in a stream (Parker et al. 1985). Maxell (1973) found evidence of beaver activity (but no beavers) along Lost Soldier Creek west of Bairoil. According to Oberholtzer (1987), beavers were active along Muddy Creek in 1955, but had disappeared by the 1980s. Parker et al. (1985) highlighted Muddy Creek as an example of erosional downcutting that resulted from beaver removal.

The restoration of beavers to their native habitats has many benefits for aquatic ecosystems. Apple (1985) reported that the restoration of beavers resulted in dissipation of streamflow energies and raising of water tables along Sage Creek in the Rawlins Field Office. In this study, the combination of beaver reintroduction and rest from grazing resulted in a 20% increase in avian species richness. We applaud the BLM's efforts to reintroduce beaver to streams where it once occurred.

Deer and Elk

Mule deer and elk are important game species in the Great Divide planning area. These game animals contribute importantly to the Wyoming economy, both from hunting and wildlife viewing visitors. The Great Divide planning area contains virtually all of the winter range for the Baggs elk and deer herds, significant amounts of winter range for herds that summer on other units of the Medicine Bow National Forest, and yearlong elk and deer habitats in the Ferris Mountains, the Seminoe Mountains, the Shirley Mountains, and the juniper woodlands of the Powder Rim. Thus, protections to maintain the viability of elk and mule deer are needed on the Great Divide, an these protections sould be focussed on crucial winter ranges, crucial winter yearlong ranges, severe winter relief ranges, and calving areas identified by the Wyoming Game and Fish Department.

Effects of Livestock Grazing

Loft et al. (1991) found that moderate to heavy cattle grazing pushed deer out of riparian habitats and into upland shrub communities that deer avoid when cattle are absent. These researchers noted that these habitat shifts could substantially impact deer populations, concluding that "high quality forage may be limiting on Sierra Nevada summer ranges grazed by cattle, thus contributing to suboptimal nutrition for female deer and their offspring" (p. 24). Elk avoid areas where livestock stocking rates are high (Knowles and Campbell 1982), so standards and guidelines should be authored such that livestock are not present in calving areas during the calving season or crucial winter ranges between November 15 and April 15. But in some cases, overgrazing by cattle and horses may improve winter range for mule deer (Hubbard and Hansen 1976, Reiner and Urness 1982) and elk (Reiner and Urness 1982) through stimulating shrub productivity. In the final analysis, livestock grazing should be managed in a way that does not reduce or impair the viability of elk and mule deer populations.

Winter Ranges

These areas will address specific habitat needs of plant and wildlife species, particularly crucial winter, migration, and birthing areas used by elk, deer, and bighorn sheep. Prescribed burning has been shown to improve browse quality on winter ranges (Bunting et al. 1984, Gruell et al. 1984, Cook 1990), and thus management objectives will be attained preferentially through prescribed burning. Thomas et al. (1988) asserted that hiding and thermal cover are critical components of elk winter range, and that patches of cover greater than 200m wide are more effective than smaller blocks. With this in mind, extensive security areas comprised of forested habitat must be retained on winter ranges.

Wintering elk, deer, and bighorn sheep are sensitive to disturbances of all kinds. Both snowmobiles and cross-country skiers are known to cause wintering ungulates to flee (Richens and Lavigne 1978, Eckstein et al. 1979, Aune 1981, Freddy et al. 1986). Because flight response may be particularly costly to wintering ungulates (Parker et al. 1984), disturbance on winter ranges should be avoided at all costs. As a result, winter ranges will be closed to both motorized and nonmotorized entry from November through April under the Ecosystem Management Alternative. Furthermore, Thomas et al. (1988) asserted that winter logging on elk winter range is disruptive to elk, and thus a moratorium will be placed on winter logging on winter ranges under this alternative.

In general, natural processes should prevail on winter ranges, and natural disturbances should be allowed to proceed unhindered by management. Limited extractive activities may be allowed in these areas if they are consistent with maximizing the habitat capabilities of terrestrial and aquatic wildlife.

There may be some habitat partitioning between elk and mule deer on winter ranges. According to Oedekoven and Lindzey (1987), wintering mule deer in southwestern Wyoming favored draws, flats, and ridgelines, while wintering elk selected ridges, hilltops, and steep topography. In this study, mule deer used lower elevation sagebrush grasslands preferentially, while elk preferred to remain at high elevations until deep snows pushed them down.

Elk

The BLM lands of the Great Divide planning area contain significant amounts of elk summer and yearlong range, particularly in the Ferris, Seminoe, and Shirley Mountains and along Powder Rim. Elk are grazers, and their summer range requirements center around forest opening and edge habitats (Marcot et al. 1994). Compton (1974) found that elk in the Sierra Madre concentrated their summer use in subalpine parks, and found heavy autumn use in aspen cover types. Strickland (1975) noted that subalpine and mid-elevation parks formed the primary summer range of elk. Davis (1977) found that elk on the Medicine Bow N.F. used natural parks and burns preferentially over clearcuts, and that burns contained cover that was critical to elk use, which is unavailable in clearcuts. Large clearcuts tend to be of little use to elk, because elk tend not to venture farther than 600 feet from cover (Reynolds 1966, Hershey and Leege 1976). Because parks and burns are more important than clearcuts as summer range, the let-burn approach of the Western Heritage

Alternative will do more to maintain and enhance elk summer range than a continuing reliance on clearcutting to provide openings in forested habitats.

Several studies have shown that closed-canopy forests are required by elk for thermal cover during summer (Patterson 1996, Millspaugh et al. 1998, Cooper and Millspaugh 1999). Hiding cover may be an important or even limiting factor in predominantly open habitats; Patterson (1996) found that in a study area where woodlands made up only 8% of the landscape cover, wooded habitat was the most important variable determining elk distribution. According to this study, the average size of woodland patches used by elk was 9 times greater than average patch size, and elk preferred thermal cover of trees during summer. For this reason, the BLM should restrict the logging or other reduction of wooded patches in the primarily open areas in the Great Divide planning area that are elk habitat.

A number of studies have shown that elk avoid open roads (Grover and Thompson 1986, Rowland et al. 2000). Edge and Marcum (1991) found that elk use was reduced within 1.5 km of roads, except where there was topographic cover. (It is important to note that much of the Great Divide planning area has very little topographic variation, and thus provides little topographic cover). Gratson and Whitman (2000) found that hunter success was higher in roadless areas than in heavily roaded areas, and that closing roads increased hunter success rates. On the Black Hills, elk chose their day bedding sites to avoid tertiary roads and even horse trails (Cooper and Millspaugh 1999). Cole et al. (1997) found that reducing open road densities led to smaller elk home ranges, fewer movements, and higher survival rates. The reduction of road densities on the winter ranges as a whole and the maintenance of low road densities in important habitat areas would aid in maintaining healthy elk populations.

Crucial elk winter ranges in the Great Divide planning area occur along the lower-elevation fringes of the mountains, in areas dominated by ponderosa pine, limber pine, and Douglas fir savannas as well as basin shrub communities. In the Laramie Range, elk on winter ranges preferred the ponderosa pine savanna type (Butler 1972). Grasses are preferred winter forage, but shrubs are used when snow conditions render grasses unavailable (Butler 1972). Elk concentrations on winter ranges may have significant effects on the growth and density of preferred shrubs. Elk foraging on winter ranges has been shown to depress growth and prevent reproduction of aspen in Rocky Mountain National Park (Baker et al. 1997, Suzuki et al. 1999). Elk fidelity to winter ranges is not constant, and use of winter range may shift from year to year (Van Dyke et al. 1998). With this in mind, both existing critical winter range and potential winter range should be managed to enhance its value to elk.

On winter ranges, elk are highly susceptible to disturbance. They are so sensitive to human disturbance that even cross-country skiers can cause significant stress to wintering animals (Cassirer et al. 1992). Ferguson and Keith (1982) found that while cross-country skiers did not influence overall elk distribution on the landscape, elk avoided heavily-used ski trails. Disturbance during this time of year can be particularly costly, since the metabolic costs of locomotion are up to five times as great when snows are deep (Parker et al. 1984). The regular vehicle traffic associated with oil and gas fields constitutes a significantly higher threshold of disturbance, and thus would cause even greter stress to the animals. Thus, all human activities should be prohibited on elk winter ranges between November 15 and April 30.

Several studies have shown that elk abandon calving and winter ranges in response to oilfield development. In mountainous habitats, the construction of a small number of oil or gas wells has caused elk to abandon substantial portions of their traditional winter range (Johnson and Wollrab 1987, Van Dyke and Klein 1996). Drilling in the mountains of western Wyoming displaced elk from their traditional calving range (Johnson and Lockman 1979, Johnson and Wollrab 1987). Powell and Lindzey (2001) found that elk avoid lands within 1.5 kilometers of oilfield roads and well sites in sagebrush habitats of the Red Desert. Migration corridors may in some cases be equally important to large mammals and are susceptible to impacts from oil and gas development (Sawyer et al., in press). Thus, winter range areas should be withdrawn from the surface disturbances associated with oil and gas development, and leased only under "No Surface Occupancy" stipulations.

Mule Deer

Mule deer are an important game animal in the Great Divide planning area. They use forest habitats, but are primarily associated with openings, edge areas, and montane shrub communities. Mule deer are primarily browsers in this region, with a diet dominated by shrubs (Compton 1974, Strickland 1975). Mule deer typically summer in montane forests and woodlands and use foothills areas for spring and fall transitional ranges, but typically winter in the low basins on BLM lands.

Riparian areas are the primary summer range of mule deer in this region (Compton 1974). Strickland (1975) found that riparian areas and clearcuts were important summer ranges on the Medicine Bow N.F., and that coniferous forest was utilized primarily for cover. Davis (1977) found that mule deer on the Medicine Bow used clearcuts and natural parks about equally, and used burns more heavily than clearcuts. Wallmo et al. (1972) found that clearcuts and roadsides could be temporarily important foraging habitats for mule deer, but pointed out that forage available in clearcuts declines after 10 years post-cut, as saplings begin to crowd out understory plants. Mule deer avoid parts of clearcuts that are farther than 300 feet from cover, and thus large clearcuts have limited use as mule deer summer range (Strickland 1975). Compton (1974) found that mule deer on the western slope of the Sierra Madres summered on desert shrub, mountain shrub, and aspen communities. The BLM should manage summer ranges for the benefit of mule deer populations.

Compton (1974) postulated that mule deer populations on the Medicine Bow N.F. are limited by the availability of winter range, much of which is BLM land managed by the Rawlins Field Office. For the Medicine Bow, many critical mule deer winter ranges are in surrounding basins outside the boundary of Forest Service lands (Strickland 1975). Ponderosa pine savanna is a favored winter range where it is available, such as in the Laramie Range (Butler 1972). Welch (1968) found that on yearlong ranges, south and southeast exposures were most important to mule deer, and bitterbrush was a key browse species. The most important winter forages for Wyoming mule deer are bitterbrush, big sagebrush, and rabbitbrush (Butler 1972, Strickland 1975). Welch (1968) found that cattle grazing decreases the abundance and productivity of bitterbrush. Bunting et al. (1984) found that periodic burning may be necessary to maintain the presence of bitterbrush in ponderosa pine savannas. The presence of cattle has been found to decrease deer use on yearlong ranges (Welch 1968). A study by Loft et al. (1991) found that at moderate to high levels of grazing intensity, female mule deer and the fawns were displaced from preferred riparian habitats and onto suboptimal upland habitats. This study also found that female mule deer have a high degree of home range fidelity, and will not move to other areas even when their core habitats are heavily impacted.

The ability of mule deer to forage effectively on winter ranges in a stress-free environment is the key to maintaining viable populations in this region. Winter mortality has claimed up to 80% of the adult mule deer population of southeastern Wyoming, and also depresses fawn production during the following spring (Strickland 1975). On winter ranges, mule deer are easily disturbed by snowmobile traffic and even nonmotorized visitors (Freddy et al. 1996). This can be a critical factor, because metabolic costs of locomotion in snow can be five times as great as normal locomotion costs for mule deer (Parker et al. 1984). Thus, due to the sensitivity of mule deer to disturbance on winter ranges and the crucial nature of winter range performance to maintaining healthy deer populations, mule deer winter ranges must be with drawn from all road construction and development, particularly oil and gas development, which would increase the level of human disturbance on these winter ranges.

Pronghorns

Pronghorns are a unique species, which evolved on the plains and steppes of North America. This species is so unique that it has been given its own Order, Antilocapridae, distinct from the cervids and the bovids that comprise the remainder of native ungulate species in North America. It evolved in wide-open habitats; it possesses great speed and endurance, but is a very poor jumper. Wyoming is the last stronghold of this species, once commonplace throughout the desert and plains environments throughout North America. It is a favorite with hunters and wildlife viewers alike. The wide-open spaces of the Great Divide are a haven for major concentrations of pronghorn, which must be granted adequate protection to assure the continued survival and vigor of the native herds, and to assure that the natural patterns of their migrations are not further altered.

Diet

In a Red Desert study, Taylor (1972) found that forb use made up 29% of the diet in spring and summer versus 62 and 69% for browse, respectively; browse use in fall and winter rose to 97% of the antelope's diet. In this study, grass use peaked at 9% in spring and otherwise hovered around 2%. Taylor concluded that competition with cattle for grass is therefore low. Another Red Desert study showed that sagebrush made up 95% of antelope winter diets, but only 77% of the summer diet (Olsen and Hansen 1977). Yoakum (1986) reported that rabbitbrush was also a highly preferred forage. Taylor (1972) reported that sagebrush and rabbitbrush were the most important antelope forages in both summer and winter in the Red Desert. In addition to the importance of shrubs in the pronghorn diet, shrubs provide cover important for the survival of newborn fawns (Yoakum 1986). But Kindschy et al. (1982) reported that pronghorns avoid areas where sagebrush is tall.

Another Red Desert study showed that pronghorns consumed only 1.2-1.5% of the net annual primary productivity, but ingested 8.7-10.9% of the net annual primary productivity in concentration areas (Maxell 1973). Kreuger (1986) found that pronghorns foraged more efficiently on prairie dog towns, and that forage quality was higher in nutrients on prairie dog sites.

Competition with Domestic Livestock and Wild Horses

Schwartz et al. (1977) observed that pronghorns are more selective and take in higher quality diets than either cattle or bison, allowing them to coexist. These researchers concluded:

> "[The] botanical and chemical dietary divergence between bison and pronghorn may indicate evolutionary interspecific niche separation and dietary selection strategies between small and large ruminants. It can partially explain the coexistence of large herds of bison and pronghorn...on the pristine prairies of North America. It also suggests, as does empirical experience, that antelope can coexist on rangelands more successfully with cattle than with sheep" (p. 167).

A study from New Mexico showed that pronghorns have an annual diet dominated by forbs (51-99%), while cattle diets are dominated by grass (48-97%) and domestic sheep diets were roughly equally weighted toward grass and forbs (40-50%, Beasom et al. 1982). Dietary overlap between pronghorns and domestic livestock is greatest in winter (58% overlap for sheep and 29% overlap for cattle, *ibid*.). McNay and O'Gara (1982) found only a 2.3-2.9% overlap between the diets of pronghorns and cattle on spring ranges. The presence of cattle can drive off parturient pronghorns and their fawns from fawning areas (McNay and O'Gara 1982). Wild horses have a lower degree of dietary overlap with pronghorn, approximately 13%, with horses concentrating heavily on grasses while pronghorns used shrubs and forbs (Meeker 1982). Olsen and Hansen (1977) found that in the Red Desert, antelope did not show meaningful competition with other grazers. But Taylor (1975) reported that during severe winters, cattle will forage on browse, increasing competition with antelope.

Potential competition between pronghorns and domestic sheep is a much more important consideration. Clary and Beale (1983) found that pronghorns avoided areas grazed by sheep, and noted that winter sheep grazing severely depletes pronghorn forage until spring greenup. Even moderate winter grazing by domestic sheep can have deleterious effects on pronghorn winter ranges (Clary and Holmgren 1982). Taylor (1975), made the following recommendations regarding grazing on pronghorn winter ranges: "Winter sheep use, especially, should be avoided; however, moderate grazing by cattle during summer months would not materially reduce winter carrying capacity for pronghorns" (p.48).

While competition for forage between pronghorns and cattle or wild horses is rarely an issue, access to water may be a focal point for conflict between these species. Taylor (1972) reported that antelope are quite wary and easily disturbed when watering. In the Red Desert, pronghorns avoid water sources when they were crowded with domestic cattle or wild horses (Miller 1980). Water developments that minimize crowding may be beneficial for pronghorns.

Predator-Prey Relationships

Barrett (1984) reported that in Alberta, coyotes and bobcats caused a 50% mortality rate annually on pronghorn fawns over a 10-year period, but the population grew dramatically over this period despite this high predation rate. Beale and Smith (1973) reported a similar fawn mortality rate of 42% as a result of predation in Utah. Bobcats were also the most important fawn predator in this study, followed by coyotes and golden eagles. Beale and Smith noted that predator control efforts directed at coyotes may cause increases in the numbers of bobcats, which are more effective predators on fawns. There is little evidence to support the idea that the predators of the Great Divide area are driving pronghorn population dynamics.

Pronghorn Winter Range

Winter range is critically important to pronghorn populations, as its availability and quality is likely the strongest determinant of population dynamics. Barrett (1982) reported that during a severe winter in Alberta, overall pronghorn mortality was 48.5%, with fawns and adult males taking particularly heavy losses. This same study documented that pregnant female pronghorns resorbed their fetuses when conditions were poor. Deep winter snows also decrease the survival rate of fawns born the following spring (Cook 1984). Emergency supplemental feeding in ineffective in promoting pronghorn survival during severe winter weather (e.g., Julian 1973, Barrett 1982). Thus, it is critically important to be sure that the winter ranges are maintained in the best possible condition.

Ryder (1983) studied pronghorn winter range along Separation Creek, and found that pronghorns selected winter range at a landscape scale, rather than on a microsite basis. This study found that pronghorns used both sagebrush and greasewood habitat types in winter, and that most of the pronghorn winter use was on greasewood flats and along Separation Creek, with windblown ridges receiving increasing use during deeper snow years (Ibid.). In the Bighorn Basin, Cook (1984) reported that winter range areas were characterized by greater shrub cover (specifically Wyoming big sagebrush), greater topographic diversity, but lower shrub height. Ryder (1983) concluded that optimal winter range would possess varied topography to allow shelter from wind and offer areas with wind-blown vegetation.

Vagrant lichens may be important pronghorn winter forage on windblown benches during severe winters (Thomas and Rosentreter 1992), and these lichens are significantly reduced through trampling by cattle and eliminated by domestic sheep grazing. The relationship between pronghorns and vagrant lichens may be commensal, as pronghorns may also assist in the dispersal of vagrant lichens (Rosentreter 1997).

Although vagrant lichens have apparently been studied little in Wyoming, they are widespread in other cold-desert shrubsteppes in the Great Basin province. In Wyoming, occurrences have been recorded for *Aspicilia fruticulosa* in Uinta County (Rosentreter 1993), for *Dermatocarpon reticulatum* in Yellowstone National Park and the Bighorn Basin (Rosentreter and McCune 1992). Dermatocarpon species have been found in sagebrush steppe habitats associated with pools of standing water in winter and spring for the interior Columbia River Basin (Rosentreter and McCune 1992). Surveys should be undertaken to identify the occurrence and distribution of vagrant lichens of the taxa *Aspicilia*, *Dermatocarpon*, *Masonhalea*, and *Xanthoparmelia* , occurring in cold deserts in the western U.S. (Rosentreter 1993) within the lands managed by the Rawlins Field Office, particularly in cold desert shrubsteppe habitats and on windblown ridges. Rosentreter (1997) proposed a number of management recommendations for conserving vagrant lichen populations, and we endorse these recommendations. Further study of the distribution and abundance of vagrant lichens on pronghorn winter ranges in the Great Divide is needed.

Antelope migration routes become critically important during severe winters that occur periodically in the Great Divide area. During the severe winter of 1971-72, snows were so deep that no brush remained exposed, and antelope in the Washakie Basin migrated to winter ranges across the Colorado state line (Julian 1973). North of Interstate 80 during the same winter, a major storm concentrated both domestic sheep and antelope in the Shamrock Hills, aggravating competition between these two species (Taylor 1975). Deep and crusty snows cause antelope to flounder, and increase predation by coyotes, which can run along atop the snow crust (Julian 1973). During such severe winters, the crucial winter relief habitats rise to paramount importance for herd survival.

Thomas and Rosentreter (1992) recommended limiting livestock grazing to low levels in crucial pronghorn winter range. Cook (1984) noted that densities of pronghorns on winter ranges were lowest in areas of “severe” oil and gas development. This result indicates that oil and gas development tends to drive pronghorns away from winter range areas.

Fences

Barbed-wire fences are known to be a major impediment to pronghorn migration and dispersal. Taylor (1975) reported, “Fences were an important factor preventing optimum range use by antelope” in the Red Desert (p. 1). He added that “[u]npublished department data indicate that the wintering areas have been reduced by roughly one half because of fences” (p.2). Bruns (1977) found that fences are major impediments to winter travel, as are roadways with high traffic volume. During the severe winter of 1971-72, fences impeded antelope movements to crucial winter relief ranges: Some 1500-2,000 antelope were trapped by the highway fence beside what is now U.S. 191 near Farson before the fence was cut, allowing them to proceed; hundreds of antelope were trapped in fenced pastures outside Evanston, and open gates apparently were insufficient to allow them to escape (many died despite supplemental feeding); and 66 antelope were found dead beside the railroad right-of-way fence outside Granger (Julian 1973). Julian concluded, "The lack of fences, mainly high net wire fences in Southwestern Wyoming, probably prevented antelope losses from being higher" (p. 10). Fences also aid coyotes in catching pronghorns (e.g., McNay and O'Gara 1982), potentially inflating predation losses.

Taylor (1975) recommended that "Fences which cross migration routes should be removed or at least modified to allow ready passage by pronghorns under adverse weather conditions..." (p. 47). Bruns (1977) recommend a minimum clearance of 46 cm and a barbless lower strand for fences. Rosentreter (1997) recommended that fences which could affect pronghorn dispersal be modified so that the bottom wire is smooth (not barbed) and is kept more than 60 cm (24 inches) above the ground. Under this alternative, there should be no new fence construction, illegal fences should be removed, and all remaining fences should at least conform to antelope passage requirements set forth by WGFD.

Wild Horses

While ancestral wild horses may have been present in the Great Divide area during Pleistocene times, these animals are not native to the sagebrush steppe ecosystems of North America. There is concern that wild horses may compete with or degrade the habitat of native species, and livestock permittees often voice concerns over competition between wild horses and domestic livestock for forage or water. At the same time, wild horses are broadly admired by the general public and seeing them is often perceived as a desirable part of the overall Red Desert visitor experience. The controversial nature of wild horses and their nebulous ecological role in the ecosystems of the Great Divide make them a thorny issue demanding a cautious approach.

The diet of wild horses is dominated by grasses and sedges (Crane 1994). In Colorado's Piceance Basin, Hubbard and Hansen (1976) found that dietary overlap between horses and cattle was 59-75%, versus less than 11% overlap between either grazer and mule deer. In the Red Desert, Olsen and Hansen (1977) found that wild horse diets showed 40% similarity with elk, 45% similarity with cattle, 27% similarity with sheep, and 4% similarity with antelope. Taylor (1975) reported that competition between pronghorns and wild horses during the severe winter of 1971-72 was minimal. An experimental study conducted in small pastures in the Red Desert found that dietary overlap between horses and cattle was 72% in summer and 84% in winter (Cresol et al. 1984). Horses can afford to be less selective that cattle because food retention time in the gut is half as great (Olsen and Hansen 1977). In the Red Desert, wild horses undertake traditional migrations through the seasons which are consistent from year to year, amounting to a natural form of rest rotation (Miller 1983a).

In his study in the Lander Field Office of the BLM, Crane (1994) found that wild horses selected streamside, bog meadow, and mountain sagebrush types while avoiding lowland sagebrush types; lowland sagebrush communities were used in winter when snows were deep at higher elevations. In the Red Desert, Miller (1980) found that cattle and wild horses selected different vegetation types in summer and winter but similar types in spring and fall; he also noted that wild horses used the saltbush-winterfat community type in late spring, which was not used appreciably by cattle at any time. Miller (1983b) reported that competition between horses and cattle was greatest for forage in fall and severe winters, and for water during summer. But in the final analysis, he concluded, "Because of the dissimilarity of diet in the spring, dissimilarity of vegetation types used in summer and dissimilarity in both diet and vegetation types used in winter, I believe direct competition for forage between cattle and feral horses is less likely in those seasons" (p.198).

Miller (1983a) found that wild horse migrations were keyed on water sources and ridges. Both cattle and horses in the Red Desert showed strong seasonal use of areas within 4.8 km of water sources, especially during summer (Miller 1983b). Thus, competition between these grazers near watering areas is likely. During severe winters, there may be direct competition between horses, cattle, and pronghorns in the Red Desert, all of which concentrate on windblown ridges and in sheltered areas with softer snow (Miller 1980). Wild horses are more winter hardy than domestic cattle; Miller (1983b) reported that during one severe winter in the Red Desert, hundreds of cattle dies, but only 10 wild horse deaths were recorded. It appears that competition between wild horses and livestock or wildlife has been overstated in some cases. Nonetheless, under this alternative, wild horse numbers should be kept at levels that do not threaten the viability of native wildlife or degrade rangelands.

Reptiles and Amphibians

A number of rare and sensitive reptile species are likely to occur within the Great Divide planning area. Germano and Lawhead (1986) found that lizards increased in abundance with increasing patch complexity, indicating that spatial aspects of land management are important to maintaining reptile diversity. Our own field work has turned up eastern short-horned lizards. The smooth green snake has been recorded along Savery Creek (WGFD 1984). According to data from the Wyoming Natural Diversity Database, the pale milk snake and red-lipped prairie lizard are known from lands around the Laramie Range. Tiger salamanders and Wyoming toads are known from the Laramie Plains. The northern many-lined skink has been found on the High Plains within the Great Divide planning area. And the Great Basin spadefoot has been found near Adobe Town and in the vicinity of Lost Creek in the Great Divide Basin.

Native fishes

While the Great Divide Basin is devoid of native fishes, the Little Snake River watershed is home to several sensitive endemic species, and these waters contribute in important ways to the waters of the upper Colorado Basin, home to 5 species of Endangered fishes. According to Langner and Flather (1994), 34% of the native fishes in the upper Colorado Basin are threatened, endangered, or extinct. A Section 7 consultation with the U.S. Fish and Wildlife Service will be needed for this plan. In addition, the hornyhead chub is found in the Laramie River above Duck Creek, and these waters must also be protected from impacts. Thus, special conservation efforts are needed to protect resident fishes as well as downstream waters.

Wyoming Sensitive Species

Roundtail chubs, flannelmouth suckers, and bluehead suckers can be found in the Little Snake watershed. These species reside in large, slow-moving rivers and also in smaller tributary streams (Bezzerides and Betsgen 2002). According to Wheeler (1997), these species "have experienced dramatic reductions in their range in western Wyoming since 1965, and may need immediate conservation attention" (p. 54). In the Upper Colorado Basin, the roundtail chub has been extirpated from 45% of its historical range, bluehead suckers occupy about 45% of their historical range, and the flannelmouth sucker occupies about 50% of its historic range (Bezzerides and

Bestgen 2002). All three of these species are on the BLM Sensitive Species list, and merit special conservation attention.

All three of these Sensitive Species occur throughout the Little Snake watershed and in downstream rivers as well. Roundtail chubs have been documented for the Little Snake River and Muddy Creek (Wheeler 1997). Flannelmouth and bluehead suckers have been documented in Savery Creek, and known occurrences of bluehead sucker have been recorded for Little Savery Creek, the North Fork of Savery Creek, Muddy Creek, Littlefield Creek, Big Sandstone Creek, and the Little Snake River (WGFD 1984). Oberholtzer and Johnson (1987) reported that flannelmouth suckers were "widely distributed" in Little Snake, roundtail chubs were widely distributed in lower reaches, above 6,500 feet. Oberholtzer (1987) reported that although roundtail chubs and flannelmouth suckers were collected from the lower reaches of Littlefield Creek in 1980, mountain suckers were the only non-game fish collected in 1986. Roundtail chubs and flannelmouth suckers were found during 1999 and 2000 surveys of lower Muddy Creek, and flannelmouth suckers were also found in Wild Cow Creek and upper Muddy Creek (Bower 2000). The Yampa River also holds important roundtail chub populations; Karp and Tyus (1990) reported that roundtail chub were three times more abundant in the Yampa than in the Green River.

Muddy Creek is a waterway of particular concern for conserving Sensitive native fishes. The presence of the rare bluehead sucker and roundtail chub led Knight et al. (1976) to propose Muddy Creek as a potential National Natural Landmark. But Oberholtzer (1987) reported that headcutting along Muddy Creek has lowered the water table in many areas of the stream. Muddy Creek historically had a perennial flow at its confluence with the Little Snake River, but in recent years, the lower reaches of this stream are intermittent, possibly impeding the dispersal and spawning runs of the flannelmouth sucker, bluehead sucker, and bluehead sucker in the stream (Bower 2000). According to Oberholtzer (1987), "Downstream of Wyoming Highway 789, irrigation withdrawals cause reduced flows, and the stream is often dry for several miles in this area" (p.13). Biodiversity Conservation Alliance's own reconnaissance of the lower Muddy Creek watershed revealed an enormous number of reservoirs built as "range improvements" by BLM and/or livestock permittees along tributary draws. These reservoirs rob water from the lower reaches of Muddy Creek and doubtless play a major role in the drying up of Muddy Creek during the summer and fall. Furthermore, several dams have been built across Muddy Creek itself in the vicinity of Mexican Flats, forming barriers to native fish migration and dispersal. In order to conserve native fishes in this watershed, barriers to fish passage and wastewater inputs into Muddy Creek must not be allowed.

Roundtail Chub

Comparatively little has been published regarding the habitat requirements of the roundtail chub. They are found in eddies, pools, runs, and riffles (Karp and Tyus 1990). In Arizona, Barrett and Maughan (1995) found that most adults were found at depths around 2.1 m and sufficient instream cover (undercut banks, rocks, and large woody debris) (Bestgen and Propst 1989, Sigler and Sigler 1996). Juveniles are usually are found near the shore or in backwaters (Sigler and Sigler 1996) and select a narrower range of both velocity (0-0.61 m/sec. vs. 0-0.96 m/sec.) and depth (0.9-1.5 m vs. 0.9-3.1m) than adults (Barrett and Maughan 1995). Adults and juveniles occupy areas with a variety of substrates, ranging from fine sand to boulders, but are more common over sand-gravel (Bestgen 1985). Larvae also use low velocity backwaters (Haines and Tyus 1990). Roundtail chub in laboratory experiments showed a preference for water temperatures between 20 and 24°C (Schumann 1977), but in the wild are known to occur in water temperatures ranging from 0 to 32°C (Bestgen 1985, Bestgen and Propst 1989).

Roundtail chub feeds on aquatic and terrestrial insects, crustaceans, and filamentous algae (Baxter and Simon 1970, Sigler and Sigler 1996) and may move seasonally to different habitats (Bezzerides and Bestgen 2002). This species matures between ages 3-5 at lengths of 5.9 to 11.8 in (150 to 300 mm) (Bestgen 1985, Sigler and Sigler 1996) and may reach lengths of 17 in (432mm) and a weight of 1.4 lb (0.64kg) (Sigler and Sigler 1996). Average life span is 8-10 years in larger systems but fewer in smaller tributaries (Bestgen 1985, Sigler and Sigler 1996).

Although spawning movements have been noted, long distance migration to specific sites has not been observed (Bezzerides and Bestgen 2002). Spawning occurs in June to early July (Sigler and Sigler 1996) when temperatures reach approximately 18 to 20°C (Bezzerides and Bestgen 2002). One female is usually accompanied by three to five males (Sigler and Sigler 1996). The eggs are broadcast over gravel in deep pools and runs (Bezzerides and Bestgen 2002) and stick to rocks and other substrate or fall into crevices (Baxter and Simon 1970, Kaeding et al. 1990, Sigler and Sigler 1996).

Flannelmouth Suckers

Flannelmouth suckers are generally found in large rivers and sometimes small streams, and even occasionally in lakes (Baxter and Stone 1995). They can sometimes become abundant in impoundments, but have not been found to persist there (Minckley 1973).

Flannelmouth suckers are found in a variety of habitat types, but typically inhabit deeper runs and pools (Bezzerides and Bestgen 2002). They also utilize a variety of substrates, from mud and silt to cobble and gravel (McAda et al. 1980). Juveniles use lower velocity habitats and are likely to be found in shallow riffles, eddies, side channels, and backwaters (Bezzerides and Bestgen 2002). Larvae prefer backwater and shoreline habitats (Haines and Tyus 1990) and congregate along the edges of shallow pools (Minckley 1973).

Although information on temperature preferences is scarce, Sublette et al. reported that flannelmouth suckers in the Virgin River, Utah were most common at 26ºC and preferred temperatures between 10 to 27ºC (1990).

Flannelmouth suckers display a definite affinity for a well-defined home range (Chart and Bergerson 1992). Flannelmouth suckers can be tolerant of cold tailwaters, but long-distance migrations are impeded by dams (McKinney et al. 1999). On Colorado's White River, Chart and Bergerson (1992) observed that flannelmouth movements were random rather than directed migrations, but noted that dam construction blocked movements to preferred areas. Chart and Bergerson (1992) found that a dam on the White River lowered downstream temperatures only a few degrees, but flannelmouth populations decreased markedly, possibly due to a loss of turbidity which can lead to sunburn in catostomids. Douglas and Marsh (1998) observed that flannelmouth suckers tend to congregate at and enter tributaries, and confirmed movements into tributary streams.

Flannelmouth suckers may not breed until they reach their fourth year (McAda and Wydoski 1985). In the Colorado River, flannelmouths spawned in tributary streams, and returned to the main stem following spawning (Weiss et al. 1998). This population spawned over gravel and cobble substrates (16-32 mm preferred size class), at water depths ranging from 5 to 41 cm, and at temperatures from 9-18°C (Ibid.). Juvenile flannelmouth suckers use wetlands during spring peak flows, and flooded bottomlands may be important nursery areas (Modde 1996).

Bluehead Suckers
The bluehead sucker is usually found in large streams with cooler waters of 20°C or less but may flourish in small, warm creeks where they can tolerate temperatures as warm as 29°C (Sigler and Sigler 1987, 1996). They are rarely found in lakes (Sigler and Miller 1963). Large adults prefer deep (2-3 m), pools, coves, or undercut banks (Bezzerides and Bestgen 2002). In addition, adults are commonly found in moderate to fast currents over areas with rocky substrates. Juveniles and larvae utilize low velocity, shallower backwater and shoreline areas (Sigler and Miller 1963, Haines and Tyus 1990).

In Arizona, Maddux and Kepner (1988) found that bluehead sucker spawning activity occurred at water temperatures between 18 and 25°C, at water depths of 9 to 29 centimeters, and over a substrate of gravel averaging 6.6 +/- 6.2 mm in diameter. Spawning activity ceased during periods of direct solar illumination (Ibid.). Very little is known about movement of bluehead suckers (Bezzerides and Bestgen 2002).

Management Concerns
Dams and the interaction of their effects (temperature and flow changes and blockage of migration routes) are believed to be the primary cause for decline of all three species. The bluehead sucker is an obligate riverine species, and although roundtail chub and flannelmouth sucker can exist in impoundments, they cannot persist there and, in most cases, have declined or disappeared from riverine habitat above and below dams after construction (Bezzerides and Bestgen 2002).

Hybridization with non-native white suckers also threatens populations of both bluehead sucker and flannelmouth sucker. White suckers have been documented for Savery Creek, Little Savery Creek, and Big Sandstone Creek (WGFD 1984). The flannelmouth sucker has been known to hybridize with white suckers, and such hybrids were documented by Holden and Stalnaker (1975a) and Bower (2000). Bluehead suckers also hybridize with white suckers (Holden and Stalnaker 1975a). White suckers are uncommon in the mainstem of the Little Snake River, and this fish fauna in this waterway is still dominated by native species, unlike most rivers in the upper Colorado River system (Hawkins et al. 2001a). BLM management should seek to minimize populations of white sucker in order to reduce hybridization risks.

Colorado River Endangered Fishes
The Little Snake River is home to populations of Endangered humpback chub and Colorado pikeminnow, with spawning habitat for humpback chub as well as roundtail chub and bluehead and flannelmouth sucker in the Little Snake (Hawkins et al. 2001a). Marsh (1991) captured an adult Colorado pikeminnow in the Little Snake 18 km west of Baggs, and noted, “suitable habitat at least for adult big-river fishes remains available in the Little Snake River in Wyoming, and our capture of Colorado squawfish there is positive evidence for that species” (p. 1092). In the Little Snake River, specific spawning sites for razorback sucker and Colorado pikeminnow have been identified, and humpback chub have been monitored in this river for protracted periods of time during the spawning season, but spawning has not yet been confirmed (Hawkins et al. 2001a). According to Marsh (1991), the Little Snake should be considered among potential recovery sites for Colorado pikeminnow.

During baseflow periods in late summer and autumn, pools along the lower Little Snake River serve as refugia for native fishes, and are isolated by river reaches that are shallow, sandy, an impassable barriers to dispersal (Hawkins et al. 2001a). The Little Snake’s unusually high peak flow to baseflow ratio, large sediment load, and extremely low base flow have been cited as principal reasons that the Little Snake still harbors a largely native fish fauna, including humpback chub and Colorado pikeminnow (Hawkins et al. 2001a). BLM actions must maintain this natural disparity between peakflow and baseflow.

The Yampa River watershed, which includes the Little Snake basin, is critically important for the survival of the Colorado River Endangered fishes. According to Holden and Stalnaker (1975b), "The Yampa River is very important to the preservation of rare and endangered fishes in the Colorado basin primarily because all these rare forms are at least present in small numbers and some are apparently reproducing" (p. 411). Karp and Tyus (1990) proclaimed:

> "Existing flows of the Yampa River may be singularly responsible for enabling the persistence of chubs in the Yampa and Green Rivers. Alteration of Yampa River flows could reduce the availability or character of chub spawning habitat and presumably adversely affect their reproduction, aid in further proliferation of introduced competitors and predators, and reduce the quality and quantity of usable habitats. Dinosaur National Monument should be considered a refugium for native fishes, and efforts should be made to protect flows of the Yampa River" (p. 263).

According to the USFWS (2000), "The Yampa River, a tributary to the Green River, is essential for the maintenance and recovery of the Green River basin. The relatively unaltered flows of the Yampa River are responsible for providing a natural shape to the hydrograph of the Green River." The Little Snake River provides 28% of the Yampa River's flow (USFWS 2000), and 77% of the Yampa's sediment load (Hawkins and O'Brien 2001). The flow and sediment contribution of the Little Snake are important in maintaining nursery habitats for Colorado River Endangered fishes in the alluvial reaches of the Green River (Hawkins and O'Brien 2001). According to Hawkins and O'Brien (2001), "One of the most important resources of the Little Snake River to the habitat and recovery of endangered fish is the highly variable water discharge and sediment supply to the Green River system" (p. 9).

Scientists have also recommended protective measures for the Little Snake itself. Hawkins et al. (2001a) recommended, "Identify and maintain the discharge and physio-chemical conditions in the Little Snake River that support Colorado pikeminnow, humpback chub, and a mostly native fish community. These conditions might include the timing, magnitude, and pattern of runoff and baseflow and associated physico-chemical conditions such as turbidity, diel temperature fluctuations, or sediment load" (p. viii). Baseline hydrograph, chemical composition, and turbidity data for the lower Little Snake River are provided by Hawkins et al. (2001a). The BLM must maintain hydrograph and sediment load levels at these baseline levels through their management activities.

Actions which alter the sediment load or water quantity in the Little Snake jeopardize the survival of the Colorado River Endangered fishes. According to the US Fish and Wildlife Service (1999b), "it is assumed that these endemic fishes [Colorado River Endangered Species] evolved under natural conditions of high turbidity; therefore, the retention of these highly turbid conditions is probably an important factor in maintaining the ability of these fish to compete with non-natives that may not have evolved under similar conditions" (p.7). The U.S. Fish and Wildlife Service (1999b) found that flow depletion inherent to the proposed High Savery Dam "is likely to jeopardize the continued existence of the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail, and is likely to destroy or adversely modify designated critical habitat" in the

Yampa and Green Rivers (p. 34). Actions which reduce the turbidity of the Little Snake must be prohibited.

Colorado Pikeminnow
Formerly known as the Colorado squawfish, the Colorado pikeminnow is native to the upper Green River watershed, including the Little Snake River basin. As of 1998, the adult population of Colorado pikeminnows in the entire Green River watershed was estimated at only 250 individuals (Osmundson and Burnham 1998). Specimens of the Endangered Colorado pikeminnow (*Ptychocheilus lucius*) have been captured along the Little Snake River as far upstream as Baggs (USFWS 2000). Coupled with the presence of mature Colorado pikeminnows in the Little Snake, these behavioral observations suggest that the Little Snake harbors either a resident population of Colorado pikeminnows or spawning areas for this species. Holden and Stalnaker (1975b) reported spawning activity on the Yampa River, and concluded, “The Yampa system appeared important to the reproduction and preservation of Colorado squawfish” (p. 403).

Backwater areas formed by tributary streams and other features are used by Colorado pikeminnows during periods of high water, while backwaters associated with islands are important year-round (Wick et al. 1983). Spawning occurs in large, deep pools, eddies, and submerged bars of sand, gravel, or cobble associated with the main channel (Tyus 1990a). High flows during spring runoff may cleanse fine silt from spawning gravels, stimulating recruitment success (Osmundson and Burnham 1998).

Reproductive success may be the key to the maintenance and recovery of Colorado pikeminnow populations. According to Osmudnson and Burnham (1998), “Low adult numbers and sporadic pulses of recruitment may make this population vulnerable to extirpation. Though adult survival rate is probably fairly constant, recruitment is highly variable and may represent the most important demographic factor to population persistence” (p.957). Based on radiotelemetry and mark-recapture data, Wick et al. (1983) found that Colorado pikeminnows exhibited strong fidelity to the Yampa River, and that fish that established residency in a given reach remained there except during spawning periods.

Colorado pikeminnows engage in annual spawning migrations which are necessary to ensure the perpetuation of the species. The timing of migration and spawning for the Colorado pikeminnow is linked to water temperature and flow rates, with warming body temperatures triggering the onset of spawning (Wick et al. 1983). According to Tyus (1990a), “Sexually mature Colorado squawfish spawned in declining flows and increasing water temperatures following spring runoff” (p. 1045). When the appropriate combination of temperature, flow rate, and photoperiod are not present, gonadal maturation and subsequent migration and spawning do not occur (Wick et al. 1983). In a study by Tyus (1990), migrations were associated with water temperatures rising above 9°C, and averaged 140 km in distance. In the Green River Basin, spawning typically occurs on or near the summer solstice each year (Tyus 1990a). The BLM must maintain the natural regime of flow change and temperature so that pikeminnow migration and spawning activities are not disrupted.

In addition, Colorado pikeminnows may imprint on the chemical signature or scent of a waterway as a means of navigating to traditional spawning areas, much like Pacific salmon (Muth et al. 2001). Tyus (1990) also implicated olfactory orientation as the likely method of navigation, noting that “the presence of springs and other water inputs in the two spawning reaches may have provided olfactory cues” to pikeminnows (p. 1044). Wastewater discharge that enters the Little

Snake system directly or via groundwater would alter the chemical signature of the water; this must not be allowed.

Osmundson et al. (1997) found the following pattern of spatial distribution for adult and juvenile pikeminnows: Larval pikeminnows move downriver, with smaller individuals and few adults found in the lower reaches, and larger individuals progressively moving to upstream reaches, where forage fish are more abundant.

Pikeminnows are sensitive to alterations in water temperature regime. Kaeding and Osmundson (1988) found that 13°C is the minimum temperature threshold for growth, while 20°C is the temperature threshold for spawning. Colder, suboptimal temperature regimes in the upper Colorado Basin, where the fish survives today, result in slow growth and high juvenile mortality (Ibid.). A variable range of high water temperatures (64.4-86ºF [18-30ºC]) are necessary for embryos and larval fishes because they reflect the historically variable environments in which the species evolved (Bestgen and Williams 1994). Actions which might lower water temperatures are likely to jeopardize the survival and reproduction of pikeminnows.

According to Muth et al. (2001), water temperatures in excess of 15°C increase the potential for Colorado pikeminnow and humpback chub reproduction, and cold water temperatures can result in thermal shock and death for larval fishes. Bestgen and Williams (1994) found that the optimum egg hatching temperature was 18°C, while the optimum temperature for larval survival was 26°C; this disparity may explain the fact that pikeminnow larvae drift downstream into warmer habitats after hatching. Fluctuating water temperatures actually increased larval survival over constant water temperatures, even when these were optimal, suggesting that diurnal water temperature fluctuations are beneficial to larval pikeminnows (Ibid.). Water inputs that depress water temperatures or alter natural temperature fluctuations must not be allowed.

Humpback Chub (*Gila cypha*)
The humpback chub is adapted for life in fast, turbulent, and muddy waters (Sigler and Sigler 1996). General habitat requirements are rocky substrates and swift waters (Kaeding and Zimmerman 1983, USFWS 1990, Valdez et al. 1992). Humpback chub most often utilize eddies, shorelines and backwaters. They use the interface between eddies and adjacent runs for feeding and spawn on cobble/ gravel riffles and along rocky shorelines (Sigler and Sigler 1996). Young prefer shallow backwaters with silt substrate (Maddux et al. 1987, Valdez et al. 1982). When preferred habitats are limiting, they may use talus shorelines (Valdez et al. 1992). Subadults prefer shorelines with cover, and as one study shows will become more abundant as cover becomes more dense (Converse et al. 1998).

Humpback chub are native to the Little Snake basin, and have been captured in the lowermost 10 miles of the Little Snake (USFWS 2000). Humpback chubs show a high degree of site fidelity, and may remain in a single eddy for at least a month (Hawkins et al. 2001a). Converse et al. (1998) found that cover along shorelines was the key factor determining distribution and abundance of juvenile humpback chub, and noted that elevated base flows may reduce subadult humpback chub habitat quality by reducing available shoreline cover.

Tyus and Karp (1992) documented spawning by humpback chub in ephemeral shoreline eddies in the Yampa River, and reported that humpback chub showed strong fidelity to specific breeding sites from year to year. According to Vanicek and Kramer (1969), “Time of spawning of [Colorado pikeminnows, bonytails, and humpback chubs] varied and was related to water temperature and receding water level" (p. 193). Cold water temperatures resulted in humpback chub recruitment failure in the Colorado River below Glen Canyon Dam (Kaeding and Zimmerman 1983). Karp and Tyus (1990) captured ripe humpback chubs at water temperatures ranging from 14.5° to 23°C, and reported that humpbacks spawned only during the 5-6 weeks after peak spring flow.

Dropping temperatures can also prevent humpback chub reproductive success. Hamman (1982) found that found when temperatures dropped to 12-13°C, humpback chubs experienced 88% egg mortality and 85% fry mortality. Marsh (1985) found that survival and hatch of humpback chub eggs was greatest at 20°C, while temperatures of 5°, 10°, and 30°C caused total egg mortality. Thus, actions which cause a drop in water temperatures or a shift in seasonal temperature regimes must not be allowed.

In addition, the huge increase of nonnative fishes, particularly channel catfish and common carp has had great impact to the species (Karp and Tyus 1990, Tyus 1998b). A high number of channel catfish and common carp utilize the habitats of humpback chub food overlap suggests a potential for negative interactions. Additionally, carp and catfish may prey on chub eggs. Channel catfish and rainbow trout (*Oncorhynchus mykiss*) eat substantial amounts of juvenile humpback chub, and chubs up to 250 mm were found in stomachs, suggesting that predation not only affects recruitment but may also increase adult mortality (Marsh and Douglas 1997).

Razorback Sucker (*Xyrauchen texanus*)
Razorback suckers also are found in the Yampa River watershed, to which the Little Snake is a major contributor. In 1989, Lanigan and Tyus estimated the total Green River population of razorback suckers at 948 fish. Based on 1998 and 1999 data, razorback suckers still persist in the middle and lower Green and Yampa Rivers, but the population in the middle Green is down to about 100 individuals (Bestgen et al. 2002). The largest remaining riverine population of razorback suckers occurs in the Green and Yampa Rivers, near Vernal, Utah (Tyus 1998b). Some 4.7% of the greater Green River population spawns in the lower reaches of the Yampa (Modde and Irving 1998). The section of the Yampa from Cross Mountain Canyon to the confluence with the Green River is designated as critical habitat for this fish (Tyus 1998). Razorback suckers have been recorded at the confluence of the Little Snake River and the Yampa (USFWS 2000).

The maintenance of natural temperature regimes is critical to maintaining the viability of razorback sucker populations. Barrett and Maughan (1995) found that razorback suckers occurred primarily over silty substrates where water velocities were less than 0.3 meters per second. Bulkley and Pimintel (1983) found that preferred temperature range for razorback suckers was between 22.9 and 24.8°C, with avoidance of temperatures colder than 8.0-14.7 C and higher than 27.4-31.6 C. These researchers recommended maintaining temperature range between 22° and 25° C for optimal razorback sucker viability. For razorback suckers, movement of adults to spawning sites is triggered by temperature and flow patterns rather than photoperiod (Modde and Irving 1998). Spawning occurs at traditional sites year after year (Modde and Irving 1998). Marsh (1985) found that survival and hatch of razorback sucker eggs was greatest at 20°C, while temperatures of 5°, 10°, and 30°C caused total egg mortality. Modde (1996) found that juvenile razorback suckers use wetlands during spring peak flows, and flooded bottomlands may be important nursery areas. Thus, activities that change temperature regimes are likely to adversely affect razorback sucker viability.

Habitat alteration and loss have negatively affected this species in many ways. Parasite and pathogenic bacteria attacks have increased, (Sigler and Sigler 1996), nursery habitats have effectively been eliminated, and migration corridors have been blocked. In addition, predation on eggs and larvae by other fish (mainly non-natives) may be the major underlying cause for lack of recruitment (USFWS 1998). The upshot is that the razorback sucker populations suffer from “genetic isolation, lack of recruitment, and an adult population nearing its life expectancy” (USFWS 1993).

Bonytail
Goldberg (1986) confirmed presence of bonytail in upper Colorado River system, and attributed the decline of this species to dewatering of streams and rivers and the conversion to cold waters below dam sites. Scarcity of extant populations and absence of young fish translate to a paucity of information regarding bonytail habitat requirements. Indeed, areas important for the conservation of the species are not fully known (USFWS 1993). While we know that bonytail are adapted to main channel rivers and typically occupy eddies and pools rather than higher velocity waters (USFWS 1993), spawning of riverine bonytail has never been observed in nature. As a result, important spawning habitat cannot be identified. However, bonytail are able to survive in ponds and reservoirs such as Lakes Mohave and Havasu (Sigler and Sigler 1996, USFWS 1993), occupying an active limnetic niche (Minckley 1973). In lacustrine environments, bonytail are most likely to be found in areas over clean, sandy bottom with reverse eddy current (USFWS 1993) and have been known to produce large numbers of young in some locations (USFWS 1990).

Marsh (1985) found that survival and hatch of bonytail eggs was greatest at 15° and 20°C, while temperatures of 5°, 10°, and 30°C caused total egg mortality. Like other Colorado River Endangereds, the maintenance of bonytail viability hinges at least in part on maintaining natural temperature levels and fluctuations.

The loss or degradation of habitat due to dams and water diversions is the primary source for bonytail decline (Sigler and Sigler 1996, Ono et al. 1983). Poor habitat causes stress, which may make the species less competitive, more susceptible to diseases and parasites, and more likely to hybridize (Sigler and Sigler 1996).

Threats
Sensitive and Endangered species in the Little Snake watershed and downstream have faced many impacts over the past century: impacts of grazing to streams and riparian areas, water depletions due to irrigation, dams both large and small, invasion of nonnative fishes, and nonpoint-source pollution from agricultural runoff. According to Johnson (1991), “Western springs and their spring runs are also disappearing due to ground water pumping, water diversion to agricultural croplands, and almost universal establishment of non-native fishes” (p. 162). All of these impacts have contributed to past declines of these species.

<u>Changes in Thermal Regime</u>
The thermal regime of rivers and streams, and its seasonal temperature fluctuations, are very consistent and predictable from year to year (Vannote and Sweeney 1980). Conversion of warmwater stream habitat to cold tailwaters has been a major factor in the extirpation of native fishes in many parts of the Colorado River system, and the proliferation of non-native competitor species (Tyus 1991). Water temperature has a controlling influence on the timing and development of aquatic insect life stages, as well as determining the structure of aquatic insect communities

(Vannote and Sweeney 1980). Flow regime is also a determining factor in stream periphyton (i.e., plant life) dynamics, which form the base of the food chain in stream systems (Biggs and Close 1989). Thus, natural temperature regimes must be maintained at all costs.

Alterations in temperature regime are likely to result in extirpation of Sensitive and Endangered fishes in waters where they occur, and to prevent the recovery of these species in potential habitats. According to Vanicek and Kramer (1969), low water temperatures prevented reproduction of Colorado squawfish, bonytail, and roundtail chubs in the Green above the Yampa River in 1964 and 1966 due to high summer discharges from Flaming Gorge Dam. This caused the disappearance of these species from the Green River above its confluence with the Yampa (Ibid.). Bulkley and Pimintel (1983) found no razorback suckers between Flaming Gorge Dam and the mouth of the Yampa River, where temperatures never rose above avoidance levels. Lanigan and Tyus (1989) attributed partial responsibility for the decline of the razorback sucker in the Green River to the construction of Flaming Gorge Dam. Razorback suckers are found below the confluence with the Yampa, where temperatures are above avoidance thresholds (Ibid.).

For the Colorado pikeminnow in particular, authorities have recommended no changes to natural thermal regimes. To maintain the viability of Colorado pikeminnow populations, Kaeding and Osmundson (1988) stated: “Water development programs that reduce available temperatures should of course be avoided” (p. 296). These researchers recommended the following: “Management efforts that might help this endangered species to recover include water management to enhance temperatures for growth...” (Ibid., p.287).

Recovery of these rare species requires the maintenance of natural flow regimes. Bestgen and Williams (1994) added, “Water temperatures that more closely reflect historic regimes are necessary to restore self-sustaining populations of Colorado squawfish in those areas” (p. 574). For the Yampa River, the Fish and Wildlife Service’s Recovery Action Plan for the Colorado River Endangered fishes is focused around maintaining and legally protecting the flow regime of the Yampa (USFWS 2000), which obviously implies protection for the flow regime of its tributary streams.

Non-Native Species

According to Holden and Stalnaker (1975a), introduction of non-native species to the Green River system was considered a primary reason for the decline of Endangered fishes, and non-natives outnumbered natives almost 2 to 1 at that time. Lanigan and Tyus (1989) blamed the decline of razorback suckers in the Green River system in part on predation from non-native fishes on juvenile razorbacks. Karp and Tyus (1990) reached the same conclusion for roundtail and humpback chubs. Ingestion of non-native channel catfish by pikeminnows, and problems with catfish spines catching in their throats, may be a significant cause of mortality (Vanicek and Kramer 1969, Osmundson et al. 1996). The BLM must maintain the natural habitat conditions found in the Little Snake, namely low baseflows and large disparity between baseflow levels and peakflow levels, that favors rare native fishes and discourages the invasion of nonnatives.

Changes in Water Flow Regimes

As discussed above, the maintenance of natural flow regimes is critical to the life history events of rare native fishes, and discourages invasion of exotic species. According to Tyus (1991),“Viable populations of Colorado fishes must be maintained to allow testing of various management scenarios. This can only be accomplished by providing suitable habitat. Of first consideration is provision and maintenance of instream flows of the proper quality, timing, duration, and magnitude" (Ibid., p. 177). All activities that would alter natural flow regimes must be prohibited.

Dams and Water Diversions

Dams and water diversions can also have major effects on stream and river flows, through interrupting natural flow patterns and causing water depletions through evaporation from reservoir surfaces. According to Hawkins and O'Brien (2001), "Disruption of the dynamic equilibrium by a dam or water diversion can result in dramatic channel morphology and aquatic habitat changes which are then followed by a long period of adjustment to a new equilibrium condition" (p. 23). Dams cause fluctuating flows which can interfere with Endangered fishes. Valdez (1990) found that Colorado pikeminnows and razorback suckers changed microhabitats more frequently during fluctuating flows, and reached the following conclusion: "Hourly fluctuations in water flows of the Green River appear to affect adult Colorado squawfish and razorback sucker as far as 120 miles downstream" (p.9).

Hawkins and O'Brien (2001) summarized current and projected water depletions from the Little Snake system, including 16,500 acre-feet from trans-mountain diversions (principally the Cheyenne Stage 2 Project), 23,300 acre-feet for irrigation, 100 acre-feet for municipal use, and 10,836 acre-feet for the High Savery Reservoir. This represents approximately 12% of the river's annual flow. Once the High Savery Dam is built, salt loads in the Little Snake are expected increase 25% during base flow periods (Burns and McDonnell 1999).

Chemical Contaminants

Chemical contaminants can directly poison native fishes or, as mentioned above, change the chemical signature of waterways, interfering with migrations. According to Tyus (1990b), "Water degraded in temperature or chemical composition can displace, or limit growth in fish populations" p. 19. Agricultural and urban contaminants may interfere with reproductive behavior, reduce egg viability, or reduce larval survival for Colorado pikeminnows (Osmundson and Burnham 1998). Activities that contaminate waters, whether point sources such as coalbed methane discharge points or nonpoint sources such as agricultural runoff, must be avoided.

Total dissolved solids are one measure of chemical contaminants which may impact native fishes. Pimintel and Bulkley (1983) performed a study of the effects of Total Dissolved Solids (TDS) on the Endangered fishes of the Colorado River system in anticipation of oil shale development in western Colorado. This research revealed that for juveniles, Colorado pikeminnows preferred a TDS of 560-1150 mg/l and avoided levels greater than 4,400 mg/l; humpback chub preferred a TDS of 1000-2500 mg/l and avoided levels higher than 5100 mg/l; bonytail preferred TDS levels of 4100-4700 mg/l and avoided levels lower than 560mg/l and higher than 6600 mg/l. Tests were performed at 12°C for this study; TDS tolerances may have been higher if tested at a warmer temperature. These researchers concluded, "Nevertheless, problems could arise for fish in localized situations where saline oil-shale-processing waters enter tributaries of the main river system. Fox et al ...found that TDS concentrations of oil-shale-process waters ranged from 1,750 to 24,500 mg/liter and averaged 6,800 mg/liter. Tributaries polluted with such high TDS concentrations may be avoided by these species resulting in a loss of habitat" (p.599).

Coalbed Methane Wastewater Discharge

But existing threats are dwarfed by the specter of coalbed methane development of the type proposed in the Atlantic Rim project, through wastewater discharged at the surface which could eventually make its way into waterways. Coalbed methane wastewater is typically saline and full of trace elements toxic to fishes. These pollutants can not only kill fishes directly but also can fundamentally change the chemical signature of the water, impairing the homing ability of fishes and preventing them from successfully completing spawning migrations. The sediment load of the Little Snake is critically important to the viability of Sensitive and Endangered fishes; the addition of sediment-free groundwaters would dilute the natural turbidity of the system, with potentially disruptive effects. Temperature regimes also are critical to survival of these fishes; the pumping of millions of gallons of cold groundwater into the Muddy Creek system could have disastrous effects that cascade downstream into the Little Snake and Yampa Rivers. Finally, the low flows and wide disparity between spring flows and base flows are what keeps the Little Snake free of non-native fishes that threaten the survival of Sensitive and Endangered species, and an increase and steadying in flow amounts could lead to the invasion of this last bastion of native fishes by non-native competitors and predators. Thus, the surface discharge of coalbed methane wastewater must be strictly prohibited in the Little Snake watershed.

Colorado River Cutthroat Trout

The Colorado River cutthroat trout is native to the Little Snake watershed. In Big Sandstone Creek, Oberholtzer (1987) reported that upper Colorado River cutthroat populations were genetically pure, but lower reaches showed interbreeding with rainbows. Reaches of Big Sandstone below the Deep Creek road were degraded by overgrazing, and Colorado River cutthroats were absent (Ibid.). Conservation populations, which are genetically pure and isolated by a barrier, can be found in the upper Roaring Fork of the Little Snake and in the headwaters of the North Fork of the Little Snake (Young et al. 1996). For the Little Snake watershed, Oberholtzer (1987) reported, “Preservation of existing populations and habitat of the Colorado River cutthroat trout has a high priority within this drainage” (p.3). Because much of the western slope of the Sierra Madres has seen only relatively light development thus far, many habitat parameters for this species are in good shape. It is important to note, however, that development projects could threaten Colorado River cutthroat populations in the future.

Roads are another important factor that threatens the survival and recovery of the Colorado River cutthroat trout. A number of studies point out that roads are one of the most important causes of trout habitat degradation, and that habitat damage a water quality degradation are unavoidable consequences of road construction (Rhodes et al. 1994, Henjum et al. 1994, NMFS 1995, USFS and USBLM 1997a,b). This damage persists over the long term and is difficult to reverse (Furniss et al. 1991, Rhodes et al. 1994, NMFS 1995, Espinosa et al. 1997). Habitat damage resulting from road construction also has the indirect effect of granting competitive advantages to introduced species at the expense of native trout (Behnke 1992, Duff 1996). Road construction effects can also increase water temperatures (Meehan 1991), which can help brook trout to permanently displace native cutthroats (Behnke 1992). As a result of these factors, a number of scientists agree that reductions in the extent of road networks are essential to protecting and restoring trout habitats (Henjum et al. 1994, Rhodes et al. 1994, USFS and USBLM 1997a). This is a perticularly important consideration when evaluating potential oil and gas projects in watersheds that contain populations of Colorado River cutthroat trout.

Dams and Diversions

Many federal projects have potentially disastrous effects on aquatic ecosystems when cumulative impacts are examined. Frissell and Bayles (1996, p.231) summed up the current state of affairs as follows: “For aquatic systems in the west, the management crisis arises from the cumulative and persistent effects of thousands of miles of roads, thousands of dams, and a century of logging, grazing, mining, cropland farming, channelization, and irrigation diversion.” In Colorado, Ryan

(1994) noted that water diversion led to downstream dewatering during low-flow years, which may lead to inadequate depths or excessive temperatures that threaten the survival of populations of aquatic species. Wesche (1987, p. 14) assessed the effects of the Rob Roy dam on the stream channel dynamics of Douglas Creek in the Medicine Bow Mountains, and stated that “it can be estimated that natural processes will require upwards of 50 years to bring the channel back into equilibrium with the flow regime.” Moratoriums on new water diversion projects and the maintenance of minimum flows in streams affected by existing diversions will ensure that existing populations of this trout will have sufficient water to survive.

Dams and diversions have had a significant impact on Colorado River cutthroats in the Little Snake drainage. Oberholtzer (1987) studied the Little Snake watershed, and noted, "Diversions of water for irrigation of native hay crops, in many instances, deplete stream flows during late summer, thus diminishing carrying capacity for game fish” (p.3). The dams and diversion works associated with the Cheyenne Stage I and Stage II water diversion projects on Forest Service lands have had heavy impacts on aquatic ecosystems in several parts of the Forest. Construction of the Stage I project resulted in heavy sediment inputs to the North Fork of the Little Snake River, which in turn resulted in long-term declines in aquatic insects (Lockwood and DeBrey 1988). In the years that followed, stocks of the rare and indigenous Colorado River cutthroat trout declined dramatically (Jesperson 1981). Jesperson noted, “Water diversion accelerates the natural drop in streamflow following spawning and increases egg and fry mortality due to redd exposure and habitat loss” (Ibid., p. 74). In light of the potentially damaging effects of these projects, special provisions must be made to safeguard the health of aquatic ecosystems.

In addition, rigorous standards are needed for all existing water developments in order to sustain adequate habitat for viable populations of aquatic species downstream. Spring flushes of water are needed to remove silt deposited during artificially reduced summer flows; flushing flows at appropriate levels should occur during spring runoff in order to scour spawning gravels and prevent silt buildup that is harmful to both invertebrate and fishes (Lockwood and DeBrey 1988). Small tributary streams are the preferred habitat of Colorado River cutthroat fry, and dewatering these stretches during summer threatens fry survival (Rahel and Bozek 1989). These researchers also pointed out that low winter flows on the mainstem of the North Fork threaten the winter survival of fingerlings. Collection of water from small tributary streams should be prohibited between June and October, and all water collection should be prohibited between December and March, in order to meet the needs of juvenile trout. Jesperson (1981, p.78) concluded that, “It is imperative that adequate instream flows be required in all streams proposed for water diversion in the future.” Thus, minimum bypass flow levels must be guaranteed for all trout-bearing streams to maintain the habitat effectiveness at 80% throughout the year to meet the need of adult fish.

PROTECTING HISTORIC AND CULTURAL RESOURCES

Historical and cultural features should be thoroughly evaluated in accordance with BLM Information Bulletin 2002-101, with special attention given to historical and cultural sites that deserve long-term conservation (such as historic trails and ruins) or those features that may be important for traditional use, particularly by Native American groups. The settings for historic trails and sites must be diligently protected through 5-mile buffers in which oil and gas could be leased only under No Surface Occupancy stipulations. Waivers of this protective measure should be allowed only in cases where all impacts of oil and gas development (including wells and associated roads) are rendered completely invisible through intervening topographic features such as hills or draws. Native American trails, as well as important historic or cultural sites identified by the tribes, should be given similar protective measures.

MINING AND ENERGY DEVELOPMENT

While strip mining has been steady for a number of years, the level of oil and gas development has been increasing at breakneck speed in recent years. Not only are the traditional oil and natural gas plays being expanded, but new and unique threats to resource values are emerging from incipient coalbed methane drilling. Mining and energy development has been listed as a factor that has historically limited or may currently jeopardize populations of ferruginous hawks, black-footed ferrets, prairie dogs, mountain plovers, and burrowing owls (Finch 1992). The official policy of the Wyoming Game Commission states, "The Commission believes it is better to protect wildlife resources than attempt to compensate for adverse impacts" (WGFD 1998, p.3). In light of the major impacts that mining and energy development have on other multiple use resources, including wildlife, recreation, watersheds, and wilderness, the new RMP must determine which areas are appropriate for this type of heavy industry, and for these areas, the new RMP must regulate mining and energy development in such a way that it becomes compatible with other resource values.

While oil and gas development is often viewed as a benefit to local economies, the fact of the matter is that major increases in production create a "boom and bust" cycle that provides a brief period of prosperity accompanied by major stresses to local infrastructure and governments, followed by economic depression. The coalbed methane boom in the Powder River Basin between 1999 and 2000 brought with it major impacts on the community and its infrastructure: a 12-15% increase in truck traffic, a 26% increase in traffic violations, a 40% increase in emergency calls, coupled with a depletion in county workers who left for higher-paying jobs in the coalbed methane fields (Morton et al. 2002). A bust always follows the boom, leaving local governments holding the bag for major capital investments put in during the height of activity, with major declines in revenues, jobs, and real estate values.

Habitat Fragmentation

Habitat fragmentation occurs whenever there is a change in the spatial continuity of the habitat that affects occupancy, survival or reproduction in a particular species, whether or not a net loss of habitat accompanies the spatial change (Franklin et al. 2002). Oil and gas development, with its sprawl of drilling pads, access roads, and pipelines, is the primary cause of habitat fragmentation in the sagebrush steppes of the Great Divide area.

Although the portion of the landscape physically disturbed by roads, wellpads, and pipelines is often a relatively small percentage of the overall landscape, GIS analysis of full-field oil and gas development incorporating quarter-mile buffers to account for habitat degradation due to edge effects indicates that almost 100% of lands within a fully developed gas field are degraded (Weller et al. 2002). In this way, the development of an oil and gas field results in widespread habitat destruction that extends well beyond the acreage of roads and wellpads that are bulldozed in.

Fragmentation of shrubsteppe habitats has a particularly strong negative impact on birds. Knick and Rotenberry (1995) and found that sage sparrows and sage thrashers decreased with decreasing patch size and percent sagebrush cover, and reached the following conclusion:

> "Our results demonstrate that fragmentation of shrubsteppe significantly influenced the presence of shrub-obligate species. Because of restoration difficulties, the disturbance of semiarid shrubsteppe may cause irreversible loss of habitat and significant long-term consequences for the conservation of shrub-obligate birds" (p. 1059).

Ingelfinger (2001) found significant declines in nesting songbirds within 100m of gas field roads, and also found that sage sparrows declined near pipelines. Kerley (1994) found that 67% of songbird species selected for the tallest available sagebrush stands, and nest success was associated with 41% shrub cover, while the two nests in 15% shrub cover were both unsuccessful.

Ingelfinger (2001) conducted a study of sagebrush birds in a western Wyoming gas field and found that as gravel roads increased, densities of sagebrush obligate birds, Brewer's sparrows, and sage sparrows declined, while horned larks (a grassland species) increased. According to his findings, "roads associated with natural gas development negatively impact sagebrush obligate passerines. Impacts are greatest along access roads where traffic volume is high" (p. 69), but "bird densities are reduced along roadways regardless of traffic volume" (p.71). Kerley (1994) found that small patches had fewer shrub-nesting species than large patches, and the green-tailed towhee, an interior sagebrush species, was entirely absent from small patches. Remnant patches smaller than 1 ha will not support sagebrush shrub-nesting birds (Kerley 1994).

Predation is believed to be the major factor in the decline of burrowing owl populations in Canada, and habitat fragmentation serves to increase predation risk in burrowing owls (James et al. 1997, Hjertaas 1997).

Vagrant lichens that disperse via wind require continuous habitats; they are negatively affected by habitat fragmentation, particularly roadside ditches that collect these lichens in areas unsuitable for growth and survival (Rosentreter 1997). In several instances vagrant lichen habitats have become so fragmented that some taxa are threatened with extinction (Ibid.).

Oil and Gas

Connelly et al. (2000) provide a review of the many short- and long-term effects of energy development on sage grouse. Aldridge (1998) noted that oil and gas development has contributed to the serious decline of Canadian sage grouse populations, stating,

> "the removal of vegetation for well sites, access roads, and associated facilities can fragment and reduce the availability of suitable habitat. Furthermore, human and mechanical disturbance at wells may disrupt breeding activities, and traffic on access roads could cause some fatalities of birds…. Even if sites are reclaimed at a later date, birds may fail to return to previously used habitats."

Currently, only 7 of 31 historic lek complexes remain active in Canada (Braun et al., in press). For this Canadian population, these researchers have stated, "The future plans for oil and gas developments within the range of sage-grouse are unknown, but expansion is expected. The cumulative impacts of further activities could result in reduction of the Alberta sage-grouse population to non-viable levels."

Coalbed methane development has even greater impacts on sage grouse. According to Braun et al. (in press), "Impacts to sage grouse from CBM development include direct loss of habitats from all production activities along with indirect effects from new powerlines and significantly higher amounts of human activity, both during initial development and during production." For leks within 0.25 mile of coalbed methane facilities, significant reductions in males/lek and rate of growth, presence of overhead power lines within 0.25 mile of a lek also depressed sage grouse population growth, and compressor stations within 1 mile of a lek significantly reduced sage grouse numbers (Ibid.).

Oil and gas development also has potentially significant effects on raptors and other avian predators. Oil and gas development results in habitat fragmentation and increased levels of human disturbance, impacting raptor species; nesting and foraging habitat loss can be substantial in the case of full-field development (Postovit and Postovit 1989). Oil and gas development also creates nesting structures for ravens, which are an important nest predator on sagebrush bird species (Ingelfinger 2001).

Road sprawl associated with oil and gas development can also have major effects on watersheds. Eaglin and Hubert (1993) used culvert crossings of streams as an index of road density, and found that this measure was positively correlated with increased stream siltation.

Doing it Right

Whenever oil and gas development is pursued under the new RMP, it should employ available technologies in a way that minimizes damage to the environment. Attached to this Alternative you will find the report, *Drilling Smarter: Using Directional Drilling to Reduce Oil and Gas Impacts in the Intermountain West*. We incorporate this report and all of the studies referenced therein into this Alternative by reference. In areas where surface disturbance from drilling is appropriate (i.e., outside areas recommended for NSO stipulations or withdrawal from leasing), directional drilling and other technologies should be employed in every case where they reduce the environmental impacts over conventional methods. Because clustering wells on a few isolated pads for full-field development or drilling horizontally from existing wellpads in infill situations results in a radical decrease in road, wellpad, and pipeline construction, directional drilling is likely to become the standard drilling procedure under this Alternative.

In addition, pitless drilling permits smaller well pads and eliminating toxic reserve pits filled with toxic chemicals. In cases where this and other state-of-the-art technology reduces the overall environmental impacts, it should be required under the RMP.

Finally, for areas where surface disturbance is permissible, drilling activities should occur in a staged manner, allowing landscapes impacted by wellfields to heal at the same rate as new landscapes are gobbled up. While staged development would at first appear to be a difficult program to implement, we have devised a simple method to facilitate this process. The BLM should first identify all parcels of 3,000 acres or more that free of “roads” as defined under BLM Handbook H-6310-1, regardless of the presence or absence of wilderness qualities. This alternative would require a “No Net Loss” policy to be instituted for these qualified roadless areas, so that new roadless areas could not be entered for the purpose of roadbuilding and oil and gas development until a similar acreage already impacted was restored to “roadless” status.

Coalbed Methane

Coalbed methane production is associated with lowering of water tables, wells and springs drying up, and increases in methane gas seeps, which kills vegetation and is a hazard to humans and wildlife (BLM, n.d.). Corning (2001) provided a useful overview of the problems associated with coalbed methane wastewater disposal: Major components of coalbed methane wastewater include salts, carbonates, and sulfates of Sodium, Calcium, Magnesium, and Potassium. Important toxins that may be present can include Selenium, Arsenic, and Cyanide. Total dissolved solids (TDS), Sodium Adsorption Ratio (SAR), and Conductivity may all be used as indices of the impurities suspended in solution in coalbed methane wastewater. Clearwater et al. (2002) found that the discharge of coalbed methane wastewater tended to increase sodium and bicarbonate (HCO_3^-) concentrations in the Powder River while decreasing chloride and sulfate SO_4^{2-}) concentrations as well as water hardness. Thus, coalbed methane production entails a suite of major impacts to soils and waters over and above the impacts of habitat fragmentation and degradation due to the heightened activity, noise, and surface damage caused by the construction and operation of conventional oil and gas fields.

Corning (2001) noted that surface disposal of coalbed methane wastewater onto soils causes major problems for both plants and the soils themselves: Salt accumulations in soils immobilizes soil water, reducing water availability to plants and inducing drought stress and death. Water conductivity levels higher than 1920 umhos/cm is likely to present severe water availability problems in agricultural crops. When high levels of sodium are deposited on soils, soil structure is also disrupted as clays become deflocculated (achieving finer particle size and fewer interstices), reducing soil porosity and permeability to water infiltration; this problem becomes “severe” when water SARs rise above 16 (Corning 2001). Highly sodic soils (with high pH readings) immobilize mineral nutrients needed by plants, further stressing plants. Ion toxicity in plants occurs at a water SAR higher than 9. Balba (1995) noted that high-pH, nonsaline sodic soils are less permeable to water, while saline soils contribute to plant water stress by causing transpiration to increase, cause ion toxicity due to an increase in salts in plant tissue, and have a reduced nutrient availability and thus soil fertility.

Woodward et al. (1985) examined the toxicity to fish for wastewaters high in Potassium, Lithium, Magnesium, Molybdenum, Sodium, SO_4, and NO_3. Toxic levels were reached at conductivity of 2,750 umhos/cm and TDS of 2610 mg/l. By comparison, Clearwater et al. (2002) found that conductivity of produced water in the Powder River Basin ranged from 470-5300 umhos/cm and TDS ranged from 270-2390 mg/l. Produced water in the Rawlins Field office may have significantly higher concentrations of dissolved solids. For fathead minnows in the Woodward et al. study, $MgSO_4$ was the most toxic salt, followed by NaCl, $NaNO_3$, and Na_2SO_4.Suter and Tsao (1996) reported threshold values for metals concentrations to prevent toxicity to aquatic life. These are summarized in the table below (all values micrograms per liter). Because CBM wastewater discharge is most commonly a constant and continuous input into aquatic systems, the chronic threshold levels are the most appropriate benchmark. For the Powder River Basin, Clearwater et al. (2002) reported that coalbed methane wastewater discharge could cause exceedences of these thresholds if large volumes of produced water were released. Trace mineral concentrations must never be allowed to rise above these levels.

Chemical	OSWER NAWQC/FCV	OSWER Tier II	Region IV Acute Screening	Region 4 Chronic Screen.
Aluminum			750	87
Antimony			1300 (2s)	160 (2s)
Arsenic III	190		360	190
Arsenic V		8.1		
Barium		3.9		
Beryllium		5.1	16 (6s)	053 (1s)
Boron			--	750
Cadmium	1.0 h		1.79 h	0.66 h
Chromium III	180 h		984.32 h	117.32 h
Chromium VI	10		16	11
Cobalt		3.0		
Copper	11 h		9.22 h	6.54 h

Iron	1000		--	1000
Lead	2.5 h		33.78	1.32
Manganese		80		
Mercury			2.40	0.0123
Molybdenum		240		
Nickel	160 h		789.00 h	87.71 h.
Selenium	5.0		20.0	5.0
Silver			1.23 h	0.012 (1s)
Thallium			140.0 (3s)	4.00 (2s)
Vanadium		19		
Zinc	100 h		65.04 h	58.91 h.

According to Corning (2001), discharge of coalbed methane wastewater into stream channels will lead to radical flow increases, with attendant acceleration of erosion and channel widening and straightening, or “channelization.” These outcomes increase the likelihood of future flash flooding. The increase in sodium concentration leads to clay deflocculation in banks and streambed, accelerating physical erosion (Ibid.).

One method of surface disposal for coalbed methane wastewater is to discharge it into unlined reservoirs, either along drainage channels or away from them. Such reservoirs are designed to leak the wastewater gradually into the soil, where it joins groundwater in its down-gradient flow to the nearest surface stream. In earthen dams with high clay content, “piping” of water through the clay of the dam is a likely outcome of storage of highly saline waters, resulting in leakage of stored water into the channel below and ultimately failure of the dam.

In addition, aquifers in different geologic strata are not watertight units, and often there is significant water leakage between aquifers (Phillips et al. 1989, Walvoord et al. 1999). Thus, coalbed methane development may not only dewater the target seam of coal, but may also result in the contamination of neighboring aquifers above or below with natural gas or other pollutants.

Under this alternative, wastewater would have to be reinjected into aquifers of similar qualities or treated to match surface water qualities. In addition, in cases where changes of temperature, flow pattern, or water properties might cause impacts to rare native fishes or otherwise threaten the viability of native species, wastewater reinjection would be mandatory.

Seismic Exploration

Seismic oil and gas exploration can also have serious environmental impacts. There are two main methods: vibroseis, which relies on heavy equipment to send vibrations through the Earth, and shot-hole method, which required setting off underground explosive charges. The resulting shock waves are recorded by geophones to produce an underground map of oil and gas deposits.

Seismic exploration has many environmental impacts. Desert soils, particularly those with biological soil crusts, are acutely susceptible to compaction and destruction when subjected to off-road vehicle driving of the type that accompanies heavy-impact types of seismic exploration; these soils and crusts can take 50-200 years to recover (Belnap 1995). According to Postovit and Postovit (1989), “it is very likely that seismic crews inadvertently, but regularly, pass near active raptor nests and occasionally destroy ferruginous hawk ground nests” (p. 168). Menkens and

Anderson (1985) reported that prairie dog colonies subjected to vibroseis-method exploration showed population declines while neighboring colonies experienced population increases. Seismic exploration projects can also have impacts on big game, particularly in sensitive habitats. Both shot-hole and vibroseis methods have been shown to disturb and displace elk on winter ranges (Ward 1986). Seismic exploration can also cause elk to abandon preferred calving habitats (Gillin 1989). Shot-hole seismic projects, while less damaging to the land, may also have negative impacts on wildlife. Explosions from shot-hole seismic testing may injure or kill fish when the shots are placed too close to aquatic habitats (Yukon Fish and Wildlife Management Board 2002). When performed in the winter, seismic shots can disturb and cause stress to hibernating bears (Reynolds et al. 1983). For these reasons, seismic exploration projects also deserve special planning to minimize their impacts on lands and wildlife.

The most prevalent method, 3-D seismic exploration, can be accomplished through two distinct techniques. In both types of seismic work, strings of receivers called “geophones” are strung out along set patterns across the landscape to pick up vibration signals from artificial sources. “Vibroseis” techniques employ 56,000-pound trucks that lower a 6,000-pound vibrating pad to create the vibration. “Shot-hole” methods employ drilling shallow holes and setting off explosive charges to set up the vibration signals. When properly conducted, this method can be a lower-impact alternative to vibroseis.

The vibroseis truck method is very heavy handed, requiring extensive off-road driving by massive machinery, which crushes vegetation and destroys fragile soils. According to the U.S. Bureau of Land Management, “Thumper trucks are obsolete technology that generate a greater shock wave through the ground and have the potential for greater impact to undiscovered cultural sites (due to the fact that they operated by dropping a 6,000 pound weight)” (BLM 2002b). Nonetheless, vibroseis trucks continue to be widely used throughout the American West.

The shot-hole method is much lighter on the land, particularly if it is performed without off-road vehicle travel. For environmentally sensitive areas, geophone cables can be laid by hand, and heliportable drills can be airlifted in to shot-hole sites (BLM 2001). This eliminates the need for damaging off-road truck and buggy traffic. Advances in shot-hole technology now allow 3-D seismic exploration to be conducted even in cities (Hansen 1993). Hansen later pointed out that exploration companies have a high degree of flexibility in locating shot points, increasing their ability to reduce impacts with this method (Hansen 1996). As in the case of drilling, some lands are so sensitive to disturbance that they are inappropriate for any type of seismic exploration. Under the new Great Divide plan, shot-hole seismic will be the method of choice unless specific concerns about archaeological or paleontological resources preclude the use of the shot-hole method. In addition, heliportable drills and hand-laying of geophone lines should be mandated for sensitive lands.

Coal Mining

Strip mining for coal is currently underway at several locations within the Great Divide area. Smith et al. (1981) had this to say of the coal deposits managed by the Rawlins Field Office: “These sites have vast underlying reserves of coal, a resource currently subjected to intensive and extensive development.” Strip mining destroys the land, and current reclamation technologies are unable to restore it to pre-mining conditions. As a result, all sensitive lands outlined in this alternative where oil and gas development is restricted to No Surface Occupancy stipulations or recommended for withdrawal from leasing should also be withdrawn from suitability for coal extraction under

SMCRA. In addition, where coal mining is permitted, underground mines should be the first option and strip mines should not be permitted in cases where underground extraction is possible.

Some raptors, notably golden eagles and ferruginous hawks, preferentially nest on “highwalls” created in open-pit mine sites, causing nests to be destroyed or relocated (sometimes resulting in nest abandonment) as coal and/or overburden is removed (Parrish et al. 1994). Thus, strip mining should not be allowed within one mile of raptor nests.

Reclamation

Mine reclamation has so far failed to achieve the goal of returning arid lands to their native condition. Baker et al. (1976) stated, “Effects of mining will be apparent long after extraction has been completed as current reclamation attempts leave considerable doubt that disturbed lands can be restored to any semblance of their original condition” (p.168). Nonetheless, no effort should be spared to return mined, roaded, and drilled landscapes to their original condition once development activities have ceased.

According to the Wyoming Game and Fish Department (1995), “Revegetation should include native plant species, preferably a mix of species which occur on site. Seed mixtures should be tailored to soil and topography – one seed mixture may not suffice throughout a large site” (p. 14). For the benefit of sage grouse, Connelly et al. (2000) recommended reseeding with native species, and adding sagebrush to the seed mixture. Zemetra et al. (1983) recommended Indian ricegrass, a species native to the Great Divide area, for mine reclamation due to its tolerance to grazing and infertile soils. Under this alternative, only native species would be allowed for reseeding.

The reclamation of shrubs is also important; reseeding a disturbed area to colonizer grasses will not re-create the original vegetation community. Availability of adequate moisture is crucial to sagebrush reestablishment until a deep tap root becomes established (Lyford 1995). In the same study, Lyford found that active seeding of sagebrush was most successful in northeastern Wyoming, while invasion from local seed sources was most prevalent in western Wyoming. Reclamation should take into account the vegetation community extant on the site prior to development, and re-create that mixture and distribution pattern of plants when reclamation occurs.

In Idaho, large-scale crested wheatgrass plantings were implemented in an effort to increase forage for domestic livestock. In the Red Desert, this non-native species has often been used to reseed reclaimed roads and well pads. But crested wheatgrass plantings create poor habitat. Reynolds and Trost (1980) found that crested wheatgrass plantings supported significantly fewer species of nesting birds than did sagebrush. Crested wheatgrass monoculture also produces a depauperate prey fauna for raptors (Kochert 1989), and has been implicated in reductions to ferruginous hawk nest success (Woffinden and Murphy 1989, *sensu* Howard and Wolfe 1976). Call and Maser (1985) reported that crested wheatgrass plantings are of little use to sage grouse. According to Connelly et al. (1991), “conversion of large tracts of sagebrush habitat to other vegetation (e.g., crested wheatgrass[*Agropyron cristatum*]) will probably result in declining sage grouse populations because of reduced nesting success” (p. 524). Rosentreter (1997) recommended against the conversion of native habitats to non-native seedings such as crested wheatgrass in order to encourage the persistence of vagrant lichens. Thus, the use of crested wheatgrass in seedings and reclamation should be prohibited.

Retention of topsoil for reclamation purposes is important, because availability of mycorrhizal propagules in soil used for reclamation can influence the success of sagebrush reestablishment

(Lyford 1995). Topsoil should be reserved during every surface-disturbing activity, so that it can be replaced during the reclamation process.

POWERLINES AND UTILITY CORRIDORS

Powerlines have a number of unique impacts. In addition to focussing raptor predation on nearby prey populations, Brum et al. (1983) observed that powerline ROWs can become access ways for ORV use, serving as a means of gaining access to previously undisturbed areas. Brum et al. also found that effects of disturbance in the Mojave Desert were still apparent 33 years after construction, including depressed mycorrhizal activity, high seedling mortality, and poor shrub recruitment (Ibid.). Under this alternative, utility corridors would follow existing heavy-impact rights-of-way (such as county roads and highways) and be excluded from sensitive areas.

OFF-ROAD VEHICLE MANAGEMENT

While there are plenty of established vehicle routes in the Great Divide area to satisfy the needs of motorized recreations, the establishment of user-created routes through illegal off-road driving is a problem in some areas. In 1997, for example, the proliferation of user-created roads was recognized as a “top priority issue” in the Shirley Mountains (BLM 1997). Associated problems were listed: fragmentation of big game hiding cover, loss of big game security areas during hunting seasons, decrease in the quality of hunting opportunities, erosion of soils into waterways, loss of forage plants (Ibid.). Wilshire (1983) reported that “[o]ff-road vehicles destroy smaller plants at very low levels of use, and even the larger, more resilient, deep rooted plants…succumb to repeated vehicular impacts” (p.32). In a fragile desert environment, there is a strong need to keep motor vehicles on established roads and trails.

Sand dunes are particularly fragile and are easily impacted by even light motorized use. According to Allen and Jackson (1992), “Damage by recreational vehicles has become an issue on some public lands, and sand dunes especially are subject to desertification because of public pressure for vehicular recreation areas” (p. 58). Bury and Luckenbach (1983) concluded, “It is obvious that ORVs have had a major detrimental effect on dune plant communities.” Thus, areas of the Killpecker Dunes, both active and stabilized, merit special protection from illegal off-road traffic.

Off-road vehicle travel destroys the biological soil crusts that are crucial to preventing erosion in arid lands. Wilshire (1983) noted, “One pass of a vehicle inducing mainly compression across well-developed lichen crusts crushes the lichen and makes it much finer textured but apparently does not kill it. In general, however, all of the soil-stabilizing functions of the microfloral crusts are quickly eliminated in areas of ORV use” (p.40). This is yet another reason to keep motor vehicles on established roads.

Compaction has many negative effects on soil characteristics and plant productivity (discussed in the *Soils* section). Webb (1983) noted that loamy sands or coarse, gravelly soils are most susceptible to compaction by off-road vehicles, and that reduced soil porosity from compaction leads to increased water runoff and erosion. Paradoxically, off-road vehicles cause the greatest compaction at a shallow depth, rather than at the soil surface (Ibid.).

Off-road traffic also results in increased erosion. Hinckley et al. (1983) found that ORV use destroys the microtopographic roughness of soil surfaces, resulting in simpler, more direct drainage patterns and faster runoff velocity. Soils disturbed by ORVs may become subject to wind erosion where they were resistant before disturbance, particularly desert flats, bajadas, and playas (Gillette and Adams 1983). In order to protect soils, vehicles should be limited to existing roads and trails.

The noise of motorized vehicles also has impacts on wildlife. Loud off-road vehicles, such as motorbikes, cause deafness in lizards and kangaroo rats, impairing their abilities to escape from predators (Brattstrom and Bondello 1983a, 1983c). Bury and Luckenback (1983) documented decreases in fringe-toed lizards and kangaroo rat populations as a result of ORV activity. Motorbikes also can cause spadefoot toads to emerge prematurely during dry times of year, as the loud noise of engines mimics the sound of thunder used as a cue by spadefoots to emerge from aestivation (Brattstrom and Bondello 1983b). Thus, areas without roads serve as refugia for these sound-sensitive species, and the proliferation of user-created roads into pristine areas may threaten the viability of these species.

The BLM's current policy restricting motor vehicles to existing roads and trails is a bit ambiguous: "Existing" is in the eye of the beholder; a wild horse or game trail might be viewed by some as an "existing" trail open to motorized use. Furthermore, a track created through illegal use becomes "existing" and thus open to subsequent users, which further increase the wear and entrenchment of the route. Thus, restricting motorized use to "existing" roads and trails has been a recipe for the proliferation of user-created routes, precisely the opposite outcome to what was intended by the regulation. Under this alternative, motorized use would occur only on designated routes throughout the planning area.

VEGETATION MANIPULATION PROJECTS

There is a prevailing belief among range managers that vegetation treatments that reduce or eliminate sagebrush stimulate a compensatory growth of forage grasses. For instance, Wamboldt and Payne (1986) found that the burning of sagebrush reduced sagebrush and increased forage. There is currently a move afoot to engage in a program of widespread sagebrush "control" through prescribed fire in order to increase edge, boost forage production for livestock, and create a patchier landscape. Proponents of this program argue that there is a need to return the landscape to its pre-settlement mosaic, which was driven by natural wildfire. However, there are absolutely **no reliable data** available for the Rawlins Field Office on pre-settlement fire frequency or the landscape pattern of fire-driven habitat mosaics (see *Fire in Sagebrush Steppe*) . Thus, proponents of this policy have no scientific backing for a campaign of widespread sagebrush eradication that would recapitulate the ecologically disastrous efforts west-wide in the 1960s and 70s. Such a campaign could cause habitat fragmentation on a massive scale and drive the sage grouse and other sagebrush obligate wildlife toward extinction.

Ironically, numerous studies have demonstrated that sagebrush treatments actually increase sagebrush density over the long term. In the Big Horn Mountains, Thilenius and Brown (1974) found that after sagebrush spraying, total herbage production was actually less on two of three treated sites after spraying, and remained the same on the third site. Along the Beaver Rim, Johnson (1969) found that within 5 years, grass production on unsprayed plots exceeded treated areas. Similarly, Harniss and Murray (1973) found that overall grass production increased at the 12-year mark following prescribed burning before declining below original levels at the 30-year mark, and forbs showed a small short-term increase followed by a long-term decline. Wamboldt and Payne (1986) found that plowing increased sagebrush canopy cover 15 years post-treatment.

Johnson (1969) studies sagebrush spraying along the Beaver Rim, and found that there were more sagebrush on treated sites than adjoining unsprayed areas within 14 years after spraying. According to Watts and Wamboldt (1996), prescribed burning reduced sagebrush density for a period of 30 years, after which densities returned to pre-treatment levels; plowing and seeding, rotocutting, and 2,4-D chemical treatments returned to pre-treatment sagebrush densities within 5-10 years, and over the long term significantly increased the density of sagebrush on the treatment site. Their findings: "Equilibrium level for plowing and seeding was 1.41, which means the canopy cover of Wyoming big sagebrush in that treatment was 41% greater than in the untreated controls...In rotocutting, spraying and plowing and seeding, the estimated equilibrium resulted in more sagebrush canopy cover than the control...burning resulted in less sagebrush, but also produced less herbaceous growth than other treatments" pp.100-101. Thilenius and Brown (1974) did find that sagebrush failed to return to original densities following spraying, but attributed this failure to marginal sagebrush growing conditions in the montane zone of the Big Horn Mountains. Harniss and Murray (1973) found that after prescribed burning, rabbitbrush increased markedly at the 12-year level before ultimately falling off to below original levels, and sagebrush were reduced initially, but returned to near original levels after 30 years.

Sagebrush may not compete for the same resources as graminoids, explaining the lack of compensatory forage growth when sagebrush is eliminated. Harniss and Murray (1973) concluded that sagebrush must use nutrients unavailable to other steppe plants, because maximum vegetation yields are found when sagebrush is present. This lack of competition between shrubs and grasses explains why sagebrush treatments typically fail to achieve long-term enhancements of forage or wildlife habitat.

Sagebrush is a very important habitat component for wildlife species. Call (1974) asserted, "In spite of past recommendations and opinions of administrators of various governmental agencies regarding sagebrush, the plant is still considered by many wildlife biologists to be the most valuable food and cover plant for wildlife on ranges of the Intermountain Region" (p.8). Call added, "Any land use practice which has as its objective the permanent elimination of sagebrush and establishment of grasses in the Mountain West will ultimately reduce the collective carrying capacity of that range for livestock (especially sheep), elk, mule deer, antelope, sage grouse, and many smaller species of wildlife" (p. 8). In another example, Kerley (1994) found that 67% of songbird species selected for the tallest available sagebrush stands, and nest success was associated with 41% shrub cover, while the two nests in 15% shrub cover were both unsuccessful. Thus, sagebrush should be maintained as a valuable asset to wildlife, rather than eliminated like a weed.

Because sagebrush "treatments" typically have negative impacts on sage grouse, such activities should be banned within 3 miles of leks and on wintering habitats. For Wyoming big sagebrush habitats, Connelly et al. (2000) stated that vegetation treatments (whether chemical, mechanical, or prescribed fire) should never exceed 20% of sage grouse breeding habitat in any 30-year period. Vegetation treatments in tall sagebrush stands on south-facing slopes may destroy sage grouse wintering habitat (Kerley 1994). Heath et al. (1997) cautioned against vegetation treatments in sage grouse nesting and wintering habitats: "Winter ranges were comprised almost exclusively of Wyoming big sagebrush and land managers should refrain from removing sagebrush from these important habitats. Because of the long time period required to re-establish Wyoming big sagebrush any treatment could severely affect sage grouse winter habitat. Furthermore, most of the winter range is located in potential sage grouse nesting habitat. Typically, treatments occur in areas where canopy cover is >20% in order to open canopies and increase grass production for herbivores and because fire carries easily in dense sagebrush canopies. These burns will then have a negative impact on sage grouse nesting and winter habitat" (pp. 52-53).

Sagebrush "control" also can have deleterious effects on nongame wildlife. Vegetation treatments such as prescribed burning and 2,4-D herbicide application had negative effects on Brewer's blackbirds (burning only), Brewer's sparrows, and sage thrashers, while green-tailed towhees and white-crowned sparrows were entirely excluded by such treatments (Kerley 1994). Due to negative impacts on sagebrush obligate passerines, sagebrush treatments should be closely scrutinized in order to minimize their ecological impacts.

A decrease in grazing pressure may be more effective at reducing sagebrush density than costly and high-impact eradication programs. Overgrazing may increase sagebrush density, and in areas where this is occurring, a rest from grazing pressure can reduce sagebrush density. Wamboldt and Murray (1986) found that rest from grazing alone resulted in a 29% decrease in sagebrush canopy cover. In areas where sagebrush is perceived to be decadent, rest from grazing should be evaluated as an alternative to more heavy-handed methods.

NOXIOUS WEEDS

Invasive weeds are a potentially major problem in the Great Divide area: Plants like cheatgrass, kosha, leafy spurge, and spotted knapweed have the potential for major outbreaks. Each of these weeds, if allowed to invade across broad areas, would degrade wildlife habitats and impair the function of native ecosystems. Weed seeds carried by vehicles are several orders of magnitude more abundant when traveling on unsurfaced roads versus paved roads (Hodkinson and Thompson 1997). Livestock grazing can facilitate the invasion of noxious weeds (Green and Kaufman 1995). And rest from grazing may not solve the problem. Robertson (1971) found that even after 30 years rest from grazing, cheatgrass had actually increased. The new RMP should include measures to minimize the risk of weed invasion. The BLM must take a preventative approach to the noxious weed issue, rather than its past approach of remedial measures once weeds have already become established. This approach includes minimizing the extent of new road construction or reconstruction, reducing stocking levels when overgrazing is implicated in noxious weed invasion, and requiring that fill material is weed-seed free.

LIVESTOCK GRAZING

It is important to maintain the range in good to excellent condition, not only to provide a sustained yield of forage for livestock but also to provide for a diverse and healthy assemblage of native wildlife. In 1986, 59% of BLM Rangelands were in poor or fair condition nationwide, and only 15% were classified as improving; the 1988 report listed 43% as poor or fair, with 20% as improving (GAO 1988b). Holechek (1993) reported that 35-40% of federal rangelands were "grazed heavier than ideal for wildlife, long-term ecological sustainability, and maximum economic return," and 15-25% were "undergoing serious degradation" (p.168).

Overgrazing also has impacted the ecosystems of the Great Divide. For example, the U.S. Army Corps of Engineers (1998) had this to say about range conditions the High Savery Dam site:

> "Many of these communities are in poor condition because of heavy ungulate (livestock and big game) grazing, which disturbs and lowers the percent of plant cover. Regeneration of the cottonwoods and other woody species in the riparian community has been severely reduced, because of the heavy grazing of seedlings and hydrologic modification that has forced the formerly meandering stream channel into a more rigid alignment or bed" (p. 3-20).

We urge the BLM to manage range resources to improve range conditions into the "good" to "excellent" categories.

Bock et al. (1993a) recommended that 20% of each grazing allotment be set aside as a reserve, to provide baseline data to monitor the effects of grazing and preserve biodiversity. We do not recommend anything so ambitious. But small exclosures should be erected in representative habitat types of each allotment to serve as a baseline for measuring for monitoring departure from ungrazed condition as a result of the cumulative effects of wildlife and livestock grazing.

The BLM's Rangeland Reform program presents a set of “Standards and Guidelines for General Application to All Components of the Rangeland Ecosystem,” as well as “Standards and Guidelines for Unhealthy Ecosystems,” detailing Properly Functioning Condition measures (BLM 1993). On the national level, the Rangeland Reform measures are vulnerable to weakening to achieve the political goals of the current administration. We support the Rangeland Reform measures as a solid baseline upon which to organize the Great Divide grazing program, and feel that these provisions are a minimum that should be pursued in southeast and southcentral Wyoming. Thus, we ask the BLM to formally adopt these measures as Standards and Guidelines in the revised Great Divide plan regardless of whether they duplicate existing federal mandates at the time.

Grazing Effects on Vegetation Communities

The “herbivore optimization” hypothesis states that grazing pressure can improve forage conditions for herbivores by accelerating rates of nutrient cycling and improving forage quality (see, e.g., Molvar et al. 1993). But the effects of grazing on the fitness of plants is universally negative, and grazing can only benefit ungrazed plants through removal of competitors (Belsky 1986, 1987). And certainly grazing pressure can cause shifts in the distribution and abundance of plant species, as discussed below.

Obvious, grazing influences the amount and type of forage plants, primarily grasses and forbs. Brotherson and Brotherson (1981) found that the main effect of grazing on their central Utah study site was the loss of native perennial grasses and an increase in introduced annuals. Western bunchgrasses are poorly equipped to withstand grazing as their meristems occur in higher and more vulnerable positions, and most are non-rhizometous (Mack and Thompson 1982). Heavy livestock trampling retards the emergence of both grasses and forbs, and favors the emergence of sagebrush and weedy annuals (Eckert et al. 1986). Weins (1973) found that grazing produced a directional change toward plant species typical of drier environments. A quantitative review of grazing studies by Jones (2000) revealed that cryptogamic crust cover declines significantly with increasing cattle grazing, as do shrub and grass cover, vegetation biomass, shrub seedling survival, litter cover. In Nevada, Clary and Medin (1990) found that overgrazing prevented aspen recruitment, and that willows were replaced by currants, snowberry, and wild rose on the grazed plot as water tables dropped. On the Colorado Plateau, Orodho et al. (1990) found that long-term heavy grazing increased soil compaction and decreased desirable shrubs, but did not affect grass productivity. In a New Mexico study, Holechek and Stephenson (1983) found that 200 years of sheep grazing had virtually eliminated all forbs from the area. Thus, the negative impacts of overgrazing on desert ecosystems are well-known, and overgrazing must be prevented in order to retain productivity of vegetation communities and wildlife.

Effects of Grazing on Biological Soil Crusts

Anderson et al. (1982a) found that both total cover and diversity of cryptogams decreased under grazing pressure, and that grazed areas had 22% of the cover and 25% of the species of lichens and mosses. Brotherson et al. (1983) noted that total soil crust cover and number of species declined in response to grazing; lichens and mosses were most heavily affected by grazing in this study, while algae were more tolerant of grazing disturbance. Anderson et al (1982b) found that on Utah winter ranges, grazed areas supported one tenth as much moss, one-third as much lichen and one-half as much algal cover as exclosures. Rosentreter (1997) recommended that domestic sheep and goats should be excluded from areas with vagrant lichen populations, and that new water developments be prohibited in these areas. We recommend using biological soil crusts as indicators of rangeland health to trigger adaptive management changes when range conditions deteriorate.

Effects of Grazing on Small Mammal Populations

Grazing can cause population decreases and species shifts within rodent assemblages. Bock et al. (1984) found that rodents were more abundant inside grazing exclosures than outside. In a Nevada study, Medin and Clary (1989) found that although grazing was not sufficiently heavy to alter plant community structure, small mammal populations were 1/3 higher in ungrazed versus grazed plots, and species richness and diversity were also greater within the exclosure. Several studies in the Great Basin have shown that heavy grazing causes fundamental shifts in rodent abundance and species composition (Reynolds 1980, Hanley and Page 1982, Jones and Longland 1999). Reynolds and Trost (1980) found that sheep grazing significantly reduced density and diversity of small mammals in a sagebrush-crested wheatgrass community. A quantitative analysis of grazing studies by Jones (2000) revealed that rodent species richness and diversity decline significantly with increasing cattle grazing.

Similarly, lagomorph species, an important prey for raptors in the Great Divide, are affected by grazing patterns. On the High Plains, Flinders and Hansen (1975) found that lagomorphs were most populous at moderate levels of both summer and winter grazing; heavy summer grazing produced lower populations of lagomorphs, but not always significantly so.

Effects of Grazing on Birds

Grazing can have negative impacts on bird communities in both High Plains sites and sagebrush deserts. Heavy grazing also is likely to hinder sage grouse nest success (Braun 1987). In a study on the High Plains, Tewksbury et al. (2002) found that open-cup nesters were more heavily affected by grazing than cavity nesters. But on their Missouri River site, not only were low and high open-cup nesting birds less abundant with increasing grazing, but primary cavity nesters also were less abundant as grazing increased (Ibid.). Among passerine birds, negative effects from grazing have been shown for the green-tailed towhee (Tewksbury et al. 2002). In Arizona, Bock et al. (1984) found that during summer, birds were significantly more abundant inside grazing exclosures than outside.

On allotments where impacts are occurring to passerine species, a change in the grazing season may serve to mitigate these impacts. Knopf et al. (1988) noted that winter grazing has much less effect on hardwood shrubs than summer grazing, and found that willow flycatchers, white-crowned sparrows, and Lincoln’s sparrows were present on winter-grazed pastures (with widespread but smaller willows) but absent on summer-grazed pastured (with few, decadent willows). Sedgwick and Knopf (1987) found that late-fall grazing had no measurable effect on breeding bird populations on their High Plains site.

Various grazing systems have been advanced as panaceas for ecological damage due to grazing. Bock et al. (1993b) noted that rotational or uniform grazing pressure leads to uniform habitat types rather than a mosaic of successional stages, a result of the slow recovery of ecological succession compared to the typically rapid frequency of grazing rotation. But while optimization for livestock weight gain may maximize livestock production while maintaining net primary productivity, it may also shift the community away from late-successional dominants (which have high value as forage) to mid- to early-successional annuals, including introduced weed species (Briske 1993). Thus, there appear to be no “silver bullets” for grazing impacts that avoid the need to make tough choices between livestock output and ecological health.

Indicator species may be a good way to monitor impacts of grazing on bird communities. For instance, on the Great Plains, common yellowthroats and yellow-breasted chats are most sensitive to grazing effects, and are good indicators of ground-shrub quality (Sedgwick and Knopf 1987). Thus, these species would be good indicators of overgrazing for the High Plains portions of the Rawlins Field Office.

Economics of Grazing

There is an inherent conflict between short-term profitability and long-term sustainability with regard to livestock grazing. According to Thurow and Taylor (1999), increases in unpalatable shrubs and decreases in water infiltration capacity lead to long-term losses of livestock carrying capacity, even under moderate stocking levels. Based on their results, Hart et al. (1988) concluded that the most profitable stocking rate was actually above that which could be sustained over the long term with regard to forage production (Ibid.). Furthermore, moderate continuous stocking produces a gradual decline in range condition, while heavy stocking produces a rapid decline (Bryant et al. 1989). Overgrazing results in lower economic returns for the permittee because livestock consume forage of lower-nutrition, eat more poisonous plants, and must expend more energy to get the same quantity of forage (Holechek 1993). Quigley et al. (1984) found that while heavy stocking rates are most profitable for one year, light to moderate stocking rates offer optimum economic return over the long-term. We urge the BLM to manage for long-term sustainability rather than short-term profitability, because long-term management renders livestock grazing more compatible with ecosystems and wildlife.

Grazing systems appear to have no economic advantages over simple regimes. In a comparative study of grazing systems near Cheyenne, Wyoming, Hart et al. (1988) found, “Steer average daily gain decreased as grazing pressure increased (r^2=0.66); systems had no significant effect” (p.28). Bryant et al. (1989) concluded that livestock weight gain and range condition are sensitive to stocking rate, but not grazing system type. These researchers observed that the heavier range is stocked, the greater the weight gain per acre, but the lighter the range is stocked, the greater the gain per animal (Ibid.). Rotational grazing at high stocking levels adversely affects livestock performance and financial returns the same as under heavy continuous grazing; it is reduced stocking rates, not rotational systems, that most strongly affects range quality and livestock productivity (Holechek 1993). Quigley et al. (1984) actually found that season-long grazing was more profitable than deferred rotation. In the final analysis, grazing systems offer no economic advantages over traditional methods.

When considering the economics of grazing, the BLM often focuses solely on the economic outputs of the livestock industry, and often ignores the economic value of recreation and hunting outputs that are often traded off against livestock grazing. Loomis et al. (1991) analyzed a reduced-grazing program to increase the hunter harvest of mule deer by 200 animals, and found that the projected economic output of the reduced-grazing program would be an added $2.3 million, versus $71,153 in lost AUMs.

Grazing Systems

Various grazing management schemes have been advanced as methods to maintain or increase livestock production while reducing environmental impacts. Abdel-Magid et al. (1987a) found that short-duration grazing caused less detachment of vegetation through trampling than season-long grazing. But Taylor (1989) found that bunchgrasses are significantly reduced in cover by short-duration grazing, and soil loss results in a permanent reduction in site potential. According to Pieper and Heitschmidt (1988),

> "Most of the literature clearly shows that that vegetation growth response in a short-duration grazing system is quite similar to that in any other grazing system, regardless of number of paddocks," and added, "So far as the effects of short-duration grazing on forage growth dynamics are concerned, we find no studies to support the hypothesis that proper implementation of a short-duration grazing system will substantially enhance forage production on arid or semiarid rangeland" (p. 135).

Quigley et al. (1984) showed that deferred rotation grazing would not allow increases in stocking rates over season-long grazing.

In their review of literature, Hart et al (1993a) concluded, "Stocking rates have much greater potential than grazing systems for altering frequency and intensity of defoliation and subsequent changes in botanical composition of range plant communities" (p. 122). Bartolome (1993) echoed this conclusion, stating that although compensatory growth had been shown on high productivity, intensively managed sites, it had not been shown for semi-arid rangelands. Hart et al. (1993b) asserted that creating smaller pastures through fencing and creating additional water sources could more evenly distribute the effects of livestock across a given area. But this outcome may also have disadvantages. Mattise et al. (1982) found that the more even cropping of vegetation in a rest-rotation system produced inferior sharp-tailed grouse nesting habitat to season-long grazing. Thus, it appears that grazing systems offer no particular ecological advantages.

Grazing in Riparian Areas

Belsky et al. (1990) pointed out that domestic cattle evolved in the wet meadows of northern Europe, and observed that in arid and semi-arid rangelands, suitable "habitats" are often restricted to riparian areas. Because livestock concentrate in riparian areas, which in arid lands harbor the highest biodiversity, their effects on biodiversity can be particularly heavy (Fleischner 1994). Autenreith et al. (1982) recommended withdrawing seeps, springs, and streams from heavy or continual livestock use in order to protect sage grouse habitat. Further discussion of the effects of overgrazing in riparian areas is found under the *Riparian Areas* section.

With the removal of disturbance agents, riparian communities can recover quickly following disturbance. According to Kochert (1989), "Mitigation for riparian habitats consists of either livestock exclusion or regulation of grazing intensity and use patterns" (p.199). Kaufman et al. (1997) asserted, "the first and most critical step in ecological restoration is passive restoration, the cessation of those anthropogenic activities that are causing degradation or preventing recovery. Given the capacity of riparian ecosystems to naturally recover, often this is all that is needed to achieve successful restoration" (p. 12). These researchers emphasized that passive restoration is the most effective tool for riparian areas, stating, "While some have suggested that livestock can be used as a 'tool' in riparian enhancement, there is no ecological basis to indicate that livestock grazing, under any management strategy, can accelerate riparian recovery more rapidly than total exclusion" (p. 20). Pieper and Heitschmidt (1988) added, "destocking is the quickest, surest, and most viable way to reduce current deterioration trends wherever they are occurring" (p.136).

To allow for optimal revegetation, Benson et al. (1991) recommended curtailing grazing for 2-3 years following fire. This recommendation should be heeded in the planning for all prescribed fire projects.

Grazing and Winter Ranges

Fall grazing on winter ranges can have beneficial effects on forage quality for mule deer on winter ranges (McLean and Williams 1982). As noted in the *Pronghorns* section, sheep grazing on pronghorn winter ranges degrades these ranges. Competition between mule deer and cattle on winter range is considerably less when the range is in good condition (Vavra et al. 1982). Dietary overlap between elk and cattle is higher than between mule deer and cattle, but in some cases elk and deer select higher and steeper country (e.g., Berg and Hudson 1982). In the Bighorn Mountains, Long and Irwin (1982) found that both elk and cattle selected similar diets in wet and dry meadows, indicating a high potential for competition for forage. In general, adequate forage should remain after the cessation of livestock grazing to provide ample forage for wildlife on their crucial winter ranges.

Springs and Water Developments

Lange (1969) introduced the concept of a *piosphere*, or area of heavy grazing that typically develops around a water source. This heavy grazing degrades habitats for native species around water sources. For this reason, the management of springs and other water sources, so important in desert environments, is crucially important.

Several researchers have made concrete recommendations regarding the management of springs and water sources. A study of small mammals in the Great Divide Basin found that montane voles are restricted to spring areas and water drainages with taller, denser vegetation (Maxell 1973). Thus, the current strategy of fencing off the springs themselves from livestock and providing for livestock watering outside the fence is an ecologically sound strategy. Furthermore, Connelly et al. (2000) recommended against developing springs for livestock water, which serves to dry out riparian and wet meadow habitats that are key to successful sage grouse brood rearing, and pointed out the need to modify existing water developments to restore natural free-flowing water and wet meadows. Miller (1983b) recommended against constructing new water sources near ridges in the Red Desert, because doing so could heighten competition between domestic cattle, wild horses, and pronghorns.

FOREST MANAGEMENT

Timber management on Wyoming's public lands has historically emphasized maximizing board-foot production and providing cheap and easy timber harvest methods, rather than providing for a broad spectrum of multiple uses other than timber and harvesting timber at sustainable rates, as set forth in federal law. BLM timber operations in the Great Divide area have been small from an economic standpoint, and yet some clearcutting has been done on BLM lands around the fringes of the Medicine Bow National Forest and in other forested parts of the Field Office. Timber management can usefully be classified in to even-aged methods (e.g., clearcutting, seed-tree cutting, and shelterwood harvest) and uneven-aged methods (single-tree and group selection harvests). This section will discuss the relative merits of timber harvest options, and outline ecologically acceptable methods.

Fire, insect outbreaks, and blowdown events are the natural arbiters of forest structure on a landscape scale, and they create a shifting mosaic of stand ages and compositions that determines the availability of habitat for plants and wildlife in undisturbed forest ecosystems (Knight and Reiners 2000). Timber harvest in Wyoming has been based heavily on clearcutting during the past 50 years (see, e.g., Baker 1994, von Ahlefeldt and Speas 1996). This practice has been espoused as a substitute for natural fire despite the fact that it is the least acceptable harvest method to the public. Although the Forest Service has long contended that silvicultural practices can take the place of natural disturbance, science contends that logging is not a substitute for natural disturbance patterns and processes (DellaSala et al. 1995, Aplet 2000), and even that logging creates long-term obstacles to restoring natural patterns. Noss (1983, p.704) summed up the difficulty posed by forest fragmentation: "The complication in restoring a semblance of the old-growth system in a fragmented landscape is that the natural pattern of disturbance and recovery has been so terribly disrupted that the shifting mosaic has virtually nowhere to shift."

Even-Aged Management

Clearcutting has been the dominant timber harvesting practice in Wyoming for the past 50 years. Clearcutting has heretofore been considered the preferred silvicultural treatment because it is the cheapest and least labor-intensive method of timber harvest (Alexander 1986). In lodgepole pine forests, clearcutting can maximize board-foot production of timber (Alexander and Edminster 1981). But legal mandates clearly require the BLM to manage for multiple uses and sustainable yields; there is no legal mandate for maximizing timber volume or minimizing extraction costs. Indeed, the Multiple Use Sustained Yield Act states that management will occur "with consideration being given to the relative values of the various resources, [but] not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output." 16 USC 531 § 4(a).

Fifty years of intensive forest management have led to an inevitable conclusion: Clearcut logging is a poor substitute for natural disturbance regimes. Superficially, clearcutting would appear to mimic wildfire inasmuch as it creates a mosaic of stand ages (Dillon and Baker, in prep.). However, the fact that clearcutting does not recreate natural landscape patterns has been amply demonstrated in the Pacific Northwest (Wallin et al. 1996), Wisconsin (Mladenoff et al. 1993), and Colorado (Lowsky and Knight 2000). On the Medicine Bow, modern patterns of clearcutting (Figure 1) clearly do not mimic natural patterns of forest openings extant before the advent of clearcutting (Figure 2). Huff et al. (1995, p. 36) pointed out that "[b]ecause ecosystems change and fire events are essentially random, rigid maintenance of historical patterns poorly reflect the stochastic nature of ecosystem patterns and processes." Franklin et al. (1997, p.114) stated that "[i]t is very doubtful that a forest ecosystem can be re-created by silvicultural treatments that is compositionally, functionally, and structurally complete, even over long rotations." According to Hessburg and Smith (1999), "At the landscape level, we lack almost any knowledge of the combination of mosaics and patterns best suited to specific populations, and we have little understanding of how to maintain the total landscape for regional biodiversity." Dillon and Knight (in prep.) concluded that the mosaic created by past clearcutting on the Medicine Bow National Forest does not resemble the natural fire and disturbance mosaic of presettlement times.

On a stand scale, clearcutting does not mimic the ecological benefits of fire. Clearcutting removes much more coarse woody debris and stem biomass than does fire, which means fewer long-term nutrient inputs into the soil than would occur following fire (Wei et al. 1997). Tinker (1999, p.88) found that "[n]atural fires may create up to four times more CWD during a 100-year period than current post-harvest slash treatments in the MBNF in Wyoming...regardless of fire-return interval." at p. 88. In addition, the soil scarification (e.g., tractor walking, rollerchopping) that takes place in post-clearcut site preparation has disastrous effects on rhizometous plants and soil biota that has no counterpart in wildfire disturbance.

Moreover, clearcutting has a number of serious ecological consequences that render it incompatible with the maintenance of healthy, functioning ecosystems. For instance, clearcutting increases the likelihood of insect irruptions by weakening trees along the edges and creating single-aged monocultures of insect-intolerant early successional tree species (Berryman 1986). The Irland Group (1988, p. 80) evaluated clearcutting as a timber management tool for the Maine Department of Conservation and offered the following caution: “Shoddy, exploitive clearcutting is clearly one of the more destructive forest management practices...It is not forestry and it is certainly not land stewardship...Clearcutting in these cases is simply cheap logging and not a planned silvicultural practice.”

First of all, clearcutting has significant long-term effects on soil communities that lead to loss of forest productivity. Clearcuts increase the outflow of nutrients from forest soils (Knight et al. 1985). When compared to openings left by wildfire, nutrients left behind by clearcutting do not persist as long as post-fire nutrients (Wei et al. 1997), leading to a long-term nutrient drain on forest soils. Harvey et al. (1994) noted that heavy losses of organic matter due to clearcutting can affect water holding capacity, aeration, drainage, and cation exchange in soils, and may affect long-term productivity. These researchers further noted that clearcutting causes greater loss of soil organic matter than other harvesting systems. Harvey et al. (1980) found that all soil mycorrhizae in clearcut areas were dead by the summer following harvest, except in areas within 5m of a living tree. These declines in soil mycorrhizae can have serious consequences for future forest productivity. Mosses and lichens also disappear following clearcutting (von Ahlefeldt and Speas 1996). Erosion from clearcuts is known to increase nutrient inputs to streams and impact water quality (Harr and Fredricksen 1998), and has been shown to increase in-stream siltation on the MBNF (Eaglin and Hubert 1993).

Second, clearcutting creates forest edges of a type that have harmful ecological effects. The forest edge created by clearcutting bears little resemblance to the edges of natural forest openings, which are typified by gradual transitions and high levels of available cover (Rosenburg and Raphael 1986). Researchers have found that the hard edges left behind by clearcuts make nesting birds more susceptible to predators than more gradual natural edges (Ratti and Reese 1988, Rufenacht and Knight 2000). These high-contrast edges interfere with the migrations and dispersal of some salamanders (deMaynardier and Hunter 1998). In addition, 22% of bird species in the study by Ruefenacht and Knight (2000) on lodgepole pine forests in northern Colorado used only edge habitats surrounding natural openings, and were not found along clearcut openings. The “hard” edges created by clearcutting also allow light and wind to penetrate into the adjacent forest, causing changes in forest microclimate in terms of sunlight, temperature, wind, and humidity (Chen et al. 1993, Vaillancourt 1995). Clearcut edges also increase windthrow in adjacent, uncut stands (Alexander 1967).

Third, clearcutting creates favorable environments for the invasion of nonnative plant species, which prefer open, disturbed habitats. Selmants (2000) found that 87% of clearcuts studied on the neighboring Medicine Bow National Forest contained exotic species of plants, while Dion (1998) found that exotic plants constituted a significant percentage of overall plant cover on clearcuts on the Medicine Bow. Nonnative species can have disruptive effects on native ecosystems, and their invasions should be actively discouraged through forest management.

Science has demonstrated that clearcutting is absolutely incompatible with the habitat needs of many forest species, and may lead to local extinctions. Niemela et al. (1993) noted that two species of beetle never successfully recolonized second growth stands following clearcutting, and suggested that clearcutting reduces the abundance and diversity of generalist beetles. Interior forest species found in this region that are adversely affected by clearcutting include cavity-nesting birds (Scott and Oldemeyer 1983), bole- and canopy-feeding birds (Franzreb and Ohmart 1978), red-breasted nuthatch and brown creeper (Chambers et al. 1999), American martens (Thompson 1994, Potvin and Breton 1997, Hargis and Bissonette 1997), mountain lions (Van Dyke et al. 1986), and northern goshawks (Crocker-Bedford 1990). Koehler (1990) suggested that clearcutting interferes with lynx dispersal. Keller and Anderson (1992) found that brown creeper, red-breasted nuthatch, and hermit thrush declined in response to clearcutting on the nearby Medicine Bow National Forest; Mannan and Meslow (1984) found that these species and the golden-crowned kinglet were significantly more abundant in old-growth than in managed forests. Selmants (2000) demonstrated that the loss of grouse whortleberry from clearcut areas can last at least 30-50 years following clearcutting.

The decline of interior forest species leads directly to a forestwide decrease in species diversity. Although clearcuts may initially show small-scale increases in species diversity, clearcutting has been shown to cause significant reductions in old-growth obligates such as red-backed voles (Sullivan et al. 1999). A similar relationship has been shown for birds (Rosenburg and Raphael 1986) and insects (Niemela et al. 1993). Hejl et al. (1995) reviewed the scientific literature and found that 11 species of forest birds were always less abundant in clearcut-logged forests. Thus, although on-site diversity may increase as edge-adapted and open-country species invade the forest, overall species diversity declines as interior forest species disappear altogether.

Clearcutting may meet the objectives and requirements of the timber industry, but it constitutes irresponsible land management and results in long-term damage to forest ecosystems, as outlined above. Due to the devastating effects of clearcutting on ecosystem health, we conclude that that a moratorium on clearcutting is needed for the Great Divide planning area. The Western Heritage Alternative specifically places a moratorium on clearcutting throughout the area, and even-aged harvest methods that create clearcuts over the long term, such as seed-tree cuts and two-stage selection cuts, will also be prohibited. Three-stage shelterwood cuts may in some cases be compatible with the ecological requirements of forest species, and will remain as the sole even-aged timber harvest option under the Western Heritage Alternative. Crompton (1994) found that shelterwood cuts had negative effects on interior forest birds and increased numbers of nest-parasite cowbirds, but had little effect on assemblages of small mammals. The use of three-stage shelterwood harvest should be implemented where their use is compatible with other multiple uses.

Partial Cutting

There are a number of uneven-aged harvesting strategies can be applied to coniferous forests. Foresters contend that individual-tree and group selection cuts are appropriate for spruce and fir (Alexander et al. 1984, Alexander 1986). While some agencies have contended that single-tree selection is inappropriate for lodgepole pine forests (e.g., MBNF 1985), some 1,145 million board-feet of timber, mostly lodgepole pine, were selectively harvested on the Medicine Bow between 1868 and 1950 (Baker 1994). Studies show that partial cutting in lodgepole pine stands does not result in significant mortality from windthrow or other factors when the trees removed represent less than 45% of the stand basal area (Alexander 1966, Alexander 1975). Thus, uneven-aged harvesting, both group selection (defined as cuts no larger than 2 tree heights in diameter, Franklin et al. 1997) and individual-tree selection, are appropriate for use throughout the MBNF from a silvicultural standpoint, although there certainly are areas that should be excluded from logging for other reasons.

Uneven-aged harvesting is less harmful to forest ecosystems when compared with clearcutting. Uneven-aged timber harvest results in a more homogeneous landscape (Aplet 2000), which over the short term can mitigate the effects of forest fragmentation. Single-tree selection, as a form of late thinning, is compatible with the habitat needs of lynx (Koehler and Brittell 1990). Group selection cuts were found to be less destructive to forest bird communities than either clearcutting or selective harvest that removes most of the forest overstory (Chambers et al. 1999). It is important to note, however, that single-tree selection and thinning does not create forest communities that sufficiently mimic old-growth characteristics to maintain old-growth wildlife assemblages such as small mammals (Wilson and Carey 2000).

It is important to recognize that uneven-aged timber harvest can also cause serious ecological problems when abused. For example, the benefits of single-tree selection in maintaining a forest overstory are dependent on maintaining an adequate period of time between harvest entries. Chambers et al. (1999) found that selective harvest which removed 75% of the overstory caused bird diversity and abundance to decline almost as much as in clearcuts. If half of the trees in a harvest unit were selectively removed, and then a second entry was made five years later to remove the remaining large trees, then the selection cut would have effectively been transformed into a clearcut, with all of the attendant ecological ramifications. Foresters are encouraged to use aggregate retention techniques, which leave behind intact soil and moisture regimes and contribute to a variety of structural classes (Franklin et al. 1997).

In the past, federal agencies have acted in bad faith regarding its responsibility to manage timber harvest on the MBNF in a responsible, sustainable, and ecologically sound manner. It is therefore necessary for the revised Rawlins RMP to include ironclad standards to ensure that partial cuts are conducted in a manner that minimizes their ecological impacts. With this in mind, a maximum of 40% of the forest canopy may be removed in any timber harvest entry, and a minimum period of 60 years between entries shall be enforced for shelterwood and group selection cuts, and single-tree selection entries shall be separated by a minimum period of 80 years. Note also that timber harvest schedules shall be made to conform to additional limitations presented through standards written into the forestwide direction and individual MAPs.

Salvage Logging and Thinning Treatments

Too often, fires and insect outbreaks have been used as an excuse to approve large-scale timber grabs in the western United States. With new directives to reduce susceptibility of forests to fire comes additional pressure for accelerated thinning on a broad scale. But both thinning and salvage logging have serious ecological drawbacks. Frissell and Bayles (1996, p. 231) concluded that "many of the proposed cures (e.g., salvage logging and massive thinning programs, continuing existing livestock policies) pose far greater threats to fish populations and aquatic ecosystem integrity than do fires and other natural events..." Hutto (1995, p.1053) evaluated the effects of post-fire salvage logging , and reached the following conclusion: "If some bird species require burned forests for the maintenance of viable populations (which is strongly suggested by this study), then post-fire salvage cutting may be conducted too frequently to be justified on the basis of sound ecosystem management." In addition, woody debris left behind by forest fires plays an important role in protecting regenerating aspens from ungulate browsing (Ripple and Larsen, in press). Thus, the snags and woody debris created by forest fires play an important role in maintaining the forest ecosystem. Like other forms of logging, salvage cuts and thinning must be limited to cases where they are consistent with maintaining ecosystem health and function. Thus, "sanitation sales" that log off trees that are population centers for beetle or mistletoe would be prohibited because they interfere with the natural function of the ecosystem. Under this Alternative, salvage logging would not be permitted because it destroys the architecture of post-disturbance landscapes.

The effectiveness of thinning to prevent or reduce wildfires is dubious and unproven. According to the Huff et al. (1995) study, "In general, rate of spread and flame length were positively correlated with the proportion of area logged...***All harvest techniques*** were associated with increasing rate of spread and flame length..." (emphasis added). In a study on fire severity following thinning and prescribed burning on the Wenatchee National Forest, high tree mortality was found on 43% of the area that experienced fuels reduction, compared with only 37% for the untreated area (USDA 1995). In northern California, Weatherspoon and Skinner (1995) higher levels of crown scorch in thinned stands than in adjacent unthinned stands, with the lowest levels of crown scorch in unmanaged stands. Prescribed fire is a more favorable fuels reduction treatment, resulting in lower fire intensity (Stephens 1998). Because the result of fuels treatment thinning to reduce fire are at best unproven and counterproductive at worst, prescribed fire will be the preferred method of fuels reduction under this alternative. No fuels treatment of any sort will be allowed outside Residential-Forest Interface areas, defined under this Alternative as within ¼ mile of currently existing structures.

Snag Retention

Snag retention is an important means to maintain structural diversity in managed areas and to provide habitat for snag-dependent wildlife. Several studies have documented the value of retaining snags in maintaining populations of cavity-nesting birds (e.g., Scott and Oldemeyer 1983, Cunningham et al. 1980). Other wildlife associated with snags include boreal owls (Herren et al. 1996), American marten (Ruggiero et al. 1998), and woodpeckers (Loose and Anderson 1985). Some studies indicate that snag retention can be effective at creating habitat for cavity-nesting birds even in clearcuts (Scott and Oldemeyer 1983). Cavity-nesting birds prefer larger snags (Cunningham et al. 1980, Bull 1983, Scott and Oldemeyer 1983, Winternitz and Cahn 1983) and snags with broken tops (Bull 1983). Retaining snags only in riparian buffer zones does not sufficiently address the needs of cavity nesters (Cline and Phillips 1983). High-cut stumps are inadequate for providing appropriate habitat for cavity nesters (Morrison et al. 1983).

Timber Removal and Post-Harvest Treatments

Under this alternative, methods of timber removal should be closely examined, and minimum-impact timber removal practice will be used. Swank et al. (1989) noted that "road building, skidding and stacking logs, and some site preparation activities can produce major soil surface disturbance that greatly increases the erosion on a site." Romme et al. (2000) suggested using large-wheeled vehicles or winter horse logging to minimize the impacts of roadbuilding within harvest units. The creation of winter, packed-snow roads is far less damaging than summer skidding. Helicopter and high-line logging techniques also reduce road proliferation and minimize soil disturbance and should be employed in managed forest settings wherever possible. Post-harvest treatments such as scarification increase rates of soil nutrient loss, resulting in long-term losses in forest productivity (Harvey et al. 1994). Scarification of soils and reductions in soil organic layers as a result of site preparation hinder the survival of mycorrhizae (Harvey et al. 1981). Post-harvest treatments such as rollerchopping and tractor-walking also hinder the survival of grouse whortleberry (Dion 1998, Selmants 2000), a principal understory species in lodgepole pine stands in this region. In the future, post-harvest treatments should minimize soil disturbance.

Sustainable Timber Harvest Rotations

Timber harvest on BLM lands must be sustainable, both in terms of sustaining avaiability of timber and sustaining natural ecosystems. Timber harvest rotations in current use in southeastern Wyoming are unsustainable over the long term, accelerate forest fragmentation, interfere with forest succession, and prevent the establishment of a natural pattern of patch dynamics (see *below*). Long rotations offer the advantages of reducing the cumulative effects of logging on forest ecosystems, allowing a reduction in road density, and increasing the quality of wood products (Franklin et al. 1997). Ceroski et al. (2001) recommended lengthening harvest rotations to improve habitat for brown creepers. In this alternative, timber harvest rotations are set to accurately mimic the intervals of natural forest disturbances.

To add to the ecological problems of past forestry practices, the harvest rotations historically used by federal agencies are completely incompatible with the natural cycle of stand replacement in southern Wyoming. In subalpine forests, natural return intervals for stand replacement fires have been established at 202 years in Colorado (Veblen et al. 1994), 300-400 years in Yellowstone National Park (Romme 1982), and 300 years on drier slopes and 600 years in valley bottoms for the Medicine Bow National Forest (Romme and Knight 1982). By contrast, harvest rotations have historically been set at 90-140 years for lodgepole pine and 100-180 years for spruce-fir (see, e.g., MBNF 1985). These harvest rotations are uniformly half as long as natural stand turnover periods, and transform the forest from mature forest to young, seral stages. As a result, stands 200 years old and older are much rarer today than they were before the advent of forest management (Veblen 2000). Clearly, stand turnover under the current regime of cutting does not reflect natural rates of turnover. Wallin et al. (1996) noted that longer harvest rotations were needed to return forests to their natural range of variability. The BLM needs to recognize that mistaken assumptions have been made about the recovery times of timber-producing stands, and lengthen harvest rotations to reflect the natural rates of stand turnover under which the forest ecosystem has evolved.

Experts agree that during presettlement times, the forested ramnges of southern Wyoming were characterized by broad, interconnected expanses of mature timber punctuated by isolated tracts of younger forest. According to research by Kipfmueller and Baker (2000), before 1869 on the Medicine Bow, "[t]he landscape contained a matrix of connected old forest, perforated by a few younger patches." Knight and Reiners (2000) add that "...the structural properties of interior forests would have been widespread prior to intensive timber harvesting, especially in areas with little relief, such as in the Medicine Bow Mountains of southern Wyoming." Characterizing the pre-settlement landscape of the Medicine Bow Range, Kipfmueller and Baker (2000) stated that "...large patches of connected forest would nearly always have dominated, because patterns of infrequent, large fires retain dominance in the landscape during a period when small fires occur." They concluded that, "[a] period of restoration (e.g., road closures), rather than continued harvest and road construction, is needed if the goal is to achieve a landscape within the range of variability of the pre-EuroAmerican landscape." Aerial photos taken circa 1953 clearly show that prior to the onset of clearcutting, the Medicine Bow and Sierra Madre Ranges were comprised of vast tracts of mature forest interrupted by a few, widely scattered natural openings. The modern pattern of isolated tracts of mature forest in a sea of roads and clearcuts bears no resemblance to the landscape in which this forest ecosystem evolved.

CUMULATIVE EFFECTS ANALYSIS

The scale at which cumulative effects analyses are performed determines the validity of such assessments. According to WGFD (1995), "Analysis units for cumulative impacts assessments should be biologically meaningful divisions such as breeding or wintering subpopulations, herd units, watersheds, areas bounded by geographic barriers, ecological communities, or broad eco-regions" (p. 1). With this in mind, several aspects of past cumulative effects analysis become obvious: (1) Using a project area boundary for cumulative effects analysis has no biological or geophysical basis and should not be done; and (2) Field Office boundaries, which are based on land ownership and political considerations are also inappropriate units upon which to base cumulative effects analyses. WGFD (1995) recommended the appropriate scope for cumulative effects analysis on various wildlife and habitats, and we urge the BLM to set the scope of the agency's cumulative effects analyses according to these recommendations. Valid cumulative effects analyses must therefore encompass whole populations or subpopulations in terms of wildlife, entire watersheds in terms of aquatic resources, and entire airsheds for air quality assessments.

Oil and gas development is occurring at a breakneck pace all across the Red Desert, and yet environmental Impact Statements have heretofore ignored the cumulative effects of the massive roading, habitat fragmentation, construction, and increased activity on the Red Desert's native wildlife. According to Ingelfinger's (2001) study of sagebrush birds in Wyoming,

> "the cumulative impact of state wide patterns of [oil and gas] development in sagebrush communities could cause substantial habitat fragmentation that impacts the sagebrush avian community negatively" (p.34), and "While the population consequences of development of one natural gas field may not be important, the development of multiple gas fields simultaneously, accompanied by historic sagebrush management practices, could have important long-term population ramifications. Given the inability of sagebrush obligate passerines to expand their populations quickly…it may take decades for sagebrush obligates to recover following reclamation" (p. 72).

Similar cumulative effects are being felt by mountain plovers, prairie dogs, elk, pronghorns, sage grouse, and burrowing owls, all of which are sensitive to disturbance. Postovit and Postovit (1989) stated, "Although individual energy projects will seldom severely affect raptors over large geographic areas, such developments are often clustered and could thereby affect regional populations" (p. 171). Parrish et al. (1994) echoed these concerns regarding raptors, noting that "even less radical habitat alterations may have a significant impact over a large area – e.g., numerous small/medium alterations in close proximity, such as gas fields" (p. 53). In the new RMP, a thorough analysis of the cumulative impacts of oil and gas development, not just in the Great Divide planning area but across the Red Desert and other neighboring ecosystems as a whole, is needed.

Oil and gas development also has major effects on air quality, which operate on an airshed or basinwide basis, and have no respect for Field Office boundaries. The USDA (2003) summarized the impacts of oil and gas development on air quality on the Medicine Bow National Forest as follows:

> "Air quality is affected by oil and gas development activities that include road and drill pad construction, development-related vehicle traffic, well drilling, well testing, and gas compression. Air pollutants of concern include particulate matter from dust during well site construction and from vehicle traffic on unpaved roads, carbon monoxide and nitrogen oxides from gasoline and diesel engines (including both vehicle and stationary engines such as generators), and hydrocarbons released during natural gas extraction" (p.3-11).

The agency concluded, “Long-term air quality impacts to the forest will likely come from upwind regional sources...”(p.3-9), significantly including those from BLM lands immediately to the west of the national forest, which are managed by the Rawlins Field Office.

The effects on Class I (Pristine) airsheds, such as the Mount Zirkel and Savage Run wildernesses, must be examined. Also, impairment to the air quality and visibility in other wilderness areas such as the Huston Park and Platte River wildernesses as well as BLM WSAs, not granted special protection under the Clean Air Act, must be analyzed and minimized. The new RMP must thoroughly analyze the cumulative effects of oil and gas development in the Rawlins Field Office together with all other projects in the basin as a whole, including development in other parts of the Red Desert, in the Upper Green River Valley, in the Kemmerer Fields Office, in northeastern Utah oil and gas fields, and in northern Colorado fields in the Powder Wash region.

The cumulative effects of global warming are beginning to be felt in Wyoming. According to Naftz et al. (in press) average temperatures at the Upper Fremont Glacier in Wyoming’s Wind River Range rose 5ºC between the mid-1800s and the early 1990s. The BLM must analyze the cumulative effects from emissions of greenhouse gases that result from permitted activities managed under the RMP.

LANDS REQUIRING SPECIAL ADMINISTRATIVE PROTECTIONS

In the nation’s inventory of p[rotected lands, there is a substantial lack in representation of the species and communities found in the Great Divide area. The USGS (1996) stated, “Outside the GYE, most status 1 and 2 lands [areas with some form of permanent protection] in Wyoming are relatively small, isolated tracts that are subject to outside influences. In themselves, these areas probably will not be sufficient for maintaining biodiversity in the long-term, but they will need to become part of a state-wide network of management areas.” In Wyoming, intermountain shrub steppe and Great Plains plants have 22-28% of their species that are not represented at all on protected lands (Fertig and Thurston 2001). The Wyoming natural heritage program recognizes 522 plant taxa of “special concern” (Fertig and Beauvais 1999), and of these rare species, 196 (or 37.55%) do not occur at all within at least minimally protected lands (Fertig and Thurston 2001).

Several researchers have weighed in on prioritizing areas for conservation protection. Fertig and Thurston (2001) concluded that Great Plains and intermountain shrubsteppe plant communities are underrepresented in the federal system of protected landscapes. According to the USGS (1996), “The highest priority should be given to protecting vegetated dunes, active sand dunes, forest-dominated riparian, shrub-dominated riparian and grass-dominated wetlands and riparian areas because their current protection is minimal and because they are potentially the most vulnerable to ongoing land management practices.” These researchers examined lands protection from an ecological standpoint, but it is also important to protect treasured wildlands from a social and recreational standpoint, to save these outstanding landscapes for future generations.

Wilderness Study Area Expansions

There have been two distinct sets of citizens’ wilderness inventory results that have been submitted to the BLM over the years. The first was the 1994 citizens’ inventory, titled *Wilderness at Risk*, which was submitted in 1994 and to which the BLM has never responded. The second series of inventories, conducted by Biodiversity Conservation Alliance, was more intensive and covered a subset of the wilderness-quality lands including Adobe Town, the Kinney Rim North and South units, Wild Cow Creek, and the Ferris Mountains. So far, the BLM has responded only to the

Adobe Town inventory, agreeing with BCA that 40,000 acres of land adjoining the current Adobe Town WSA does in fact possess wilderness qualities. We expect the BLM to respond to the remaining inventories in its Great Divide/Rawlins RMP documents. The Western Heritage Alternative further calls for the BLM to grant Wilderness Study Area status to ALL citizens' proposed wilderness in the planning area, granting it the same protections that the current Adobe Town WSA now enjoys.

Adobe Town (95,200 acres of expansions)
Adobe Town is proposed by the conservation community for wilderness designation. The area proposed for wilderness includes all of the Adobe Town Wilderness Study Area, plus additional lands of wilderness quality in The Haystacks, along Willow Creek and the Willow Creek Rim, and south of the WSA to the Powder Rim and just beyond it. All of these areas possess the full complement of required characteristics for wilderness in abundance: outstanding opportunities for both solitude *and* primitive and unconfined recreation, wilderness-quality naturalness, size (at over 180,000 acres, the citizens proposed Adobe Town wilderness is well above the 5,000-acre minimum), and in addition has outstanding supplemental values such as abundant wildlife, wild horse herds, unique geology, and abundant archaeological and paleontological resources. The Adobe Town area has long attracted attention for its mesmerizing landscapes of badlands and high rims. In 1869, General A.A. Humphreys led a Geological Exploration of the Fortieth Parallel. In his report, General Humphreys describes the Adobe Town area as follows:

> "This escarpment is the most remarkable example of the so-called bad-land erosion within the limits of the Fortieth Parallel Exploration...Along the walls of these ravines the same picturesque architectural forms occur, so that a view of the whole front of the escarpment, with its salient and reentrant angles, reminds one of the ruins of a fortified city. Enormous masses project from the main wall, the stratification-lines of creamy, gray, and green sands and marls are traced across their nearly vertical fronts like courses of immense masonry, and every face is scored by innumerable narrow, sharp cuts, which are worn into the soft material from top to bottom of the cliff, offering narrow galleries which give access for a considerable distance into this labyrinth of natural fortresses. At a little distance, these sharp incisions seem like the spaces between series of pillars, and the whole aspect of the region is that of a line of Egyptian structures. Among the most interesting bodies are those of the detached outliers, points of spurs, or isolated hills, which are mere relics of the beds that formerly covered the whole valley. These blocks, often reaching 100 feet in height, rise out of the smooth surface of a level plain of clay, and are sculptured into the most remarkable forms, surmounted by domes and ornamented by many buttresses and jutting pinnacles. But perhaps the most astonishing single monument here is the isolated column shown in the frontispiece of this volume. It stands upon a plain of gray earth, which supports a scant growth of desert sage, and rises to a height of fully sixty feet. It could hardly be a more perfect specimen of an isolated monumental form if sculptured by the hand of man." Report of the Geological Exploration of the Fortieth Parallel, 1869, p.397-398.

The BLM recognized the unique and significant natural qualities present in the Adobe Town Area when it designated the area as an "Interim Critical Management Area" under the Management Framework Plans drafted prior to 1973. It has also been managed as the Adobe Town Wild Horse Management Area. In its URA Step III (Present Situation) document (hereinafter referred to as URA), BLM concluded: "Quality, we feel, is a function of the combination of interrlated (sic) values that the area exhibits and the uniqueness of that combination. In that sense the area is very high quality." URA at p.15.

In their *Inventory of Significant Geologic Areas in the Wyoming Basin Natural Region*, compiled under contract with the National Park Service in 1973, the authors noted that "The greatest natural value of this area is that it is still a 'howling wilderness.'" (at p. 187). The authors of this report gave the Washakie Basin the highest rating for priority in evaluation for National Natural Landmark designation. A later study tiled *Potential Natural Landmarks in the Wyoming Basin*, released in 1976, rated the area as having the highest rating for ecological and geological values, a rating that reflects "high degree of national significance, recommended without reservation." at pp. 216-218. In 1979, the National Park Service and the Heritage Conservation and Recreation Service identified the resources of the Washakie Basin as possessing nationally significant and threatened natural-ecological-geological features and listed the basin as a possibility for new study and potential inclusion as a national park, underscoring the outstanding natural attributes of the area.

The outstanding natural qualities of this area echo through BLM's own documents from its Wilderness Intensive Inventory of the area. In the early 1970s, BLM recognized that "[t]hese highly significant wildlife values, coupled with open space and a sparse human population, figure prominently in the way of life enjoyed by the residents" (Wyoming Land Use Decisions, Overland Area, at p.4). BLM officials played up the unique and outstanding natural values of the area as follows. "Many of the spires take on strange life-like forms - stone sentinals (sic) frozen in time standing guard over their silent desert domain. Walking amidst groups of these strange spires gives one the eerie feeling of being watched - by beings who have witnessed the evolution of Adobe Town for millennia." (URA at p.4). The document went on to state, "Contrast between colors, sunlight and shadows, and landforms is increased creating enormous vistas..." (URA at p.5). "Although similar landforms are found elsewhere in southern Wyoming, these are perhaps the most outstanding example, a factor which contributes to the uniqueness of the area." (URA at p.9). Adobe Town has also received recent accolades in the popular literature. In the recently released book *Wild Wyoming*, author Erik Molvar describes Adobe Town as "a fantastic landscape of spires, balanced rocks, keyoles, and cliffs" (at p. 321) and "a landscape worthy of National Park status" (at p.323). This book goes on to assert that "[w]hen the BLM developed its wilderness recommendations, natural gas potential was given priority over public recreation and environmental quality" (at p. 325). BLM has the responsibility to rectify the tainted nature of its original Wilderness Intensive Inventory by setting aside ***all*** lands in the Adobe Town area that possess wilderness characteristics until the U.S. Congress can act on them.

Proposed Expansions

Our intensive inventory of routes and impacts within the greater Adobe Town area reveals that many of the vehicle routes that form the boundaries of Adobe Town (and hence the basis for excluding adjacent roadless lands) either were never "roads" that significantly impact the naturalness of the landscape or have become so reclaimed through the passage of time and the processes of natural degradation that they no longer qualify as roads or significant impacts. In these cases, we inventoried surrounding undeveloped lands for vehicle routes and human impacts to determine which (if any) areas met the wilderness criteria and warranted inclusion in an expanded Adobe Town WSA. We found a number of large areas which meet every criteria for wilderness designation and yet were excluded from Adobe Town WSA. As it now stands, many of the scenic overlooks within Adobe Town WSA have within their viewshed lands which are unprotected from industrial development. An expansion of the WSA to include undeveloped lands that possess wilderness quality would thus enhance and protect the wilderness quality of lands within the current WSA while addressing the problem of the exclusion of wilderness-quality lands nearby from interim protection. We formally request that BLM reinventory these areas, and extend WSA protection to those areas that qualify for wilderness as outlined in the BLM Wilderness Inventory Study Procedures.

The Haystacks

The Haystacks are a broad arc of deeply dissected badlands that extend northeast from the Adobe Town Rim. According to local tradition, it was in the Haystacks that Butch Cassidy and his gang hid their fresh horses, which helped them elude their pursuers following the Tipton train robbery. This lofty chain of ridges and badlands is home to a juniper woodland whose isolated nature within the surrounding sea of sagebrush lends it great ecological importance. In the Park Service's Inventory of Significant Geological Areas in the Wyoming Basin Natural Region (published in 1973), the authors describe The Haystacks as follows: "A dominant feature of the landscape in the northern part of the area is Haystack Mountain. It is arctuate in shape and 10 miles long. On the north end, badland slopes of variegated sediments rise precipitously 500 feet above the adjacent plains." at p.187-188. Today, visitors to the Haystacks can enjoy the same wild, remote, and pristine character that Cassidy found here in the 1800s. The unit is separated from Adobe Town WSA by the Manuel Gap "Road," a rugged jeep trail. During the Wilderness Intensive Inventory, BLM officials came to the rather amazing conclusion that it was constructed, maintained, and regularly used, qualifying as a "road" and fit for exclusion from wilderness. Our inventory provides voluminous evidence that much of the route was never constructed, those parts which received blading have since deteriorated, use is very light and sporadic (not regular), and maintenance has not been performed for such a long time that substantial portions of the route are no longer passable to vehicles of any kind. Hence, this route meets none of the characteristics of a "road" and must be considered a "way," and as such it does not present an intrusion of significant magnitude to warrant its exclusion from wilderness.

Of the 50,000 acres of wilderness-quality land in this area, BLM in its Wilderness Intensive Inventory considered only 8,090 acres of this unit, the portion outside the "Checkerboard" of public and private land ownership. In its analysis, BLM officials noted that the limited area inventoried "..contains enough acres to meet the size criterion but field investigations indicate that this portion of the unit fails to satisfy other basic wilderness criteria. Opportunities to experience solitude are not outstanding and the opportunity for a primitive and unconfined type of recreation is limited." Staff Specialist Synopsis, Unit No. WY-030-401, WY-040-408, 1/16/80, p.7. But when the entire unit is considered as a whole, ***both*** the opportunity for solitude ***and*** outstanding opportunities for primitive and unconfined recreation are available throughout this unit, particularly within the northeastern extension of the Adobe Town Rim and within the Haystacks themselves. BLM conceded that the subunit that it considered possessed the full measure of naturalness required for wilderness, noting, "[t]his portion is bisected by a way [Route AT-89B]..Its presence alone is insufficient to compromise apparent naturalness" (Ibid. at p.7). But the report recommends dropping the area from wilderness consideration because it "contained intrusions and otherwise did not meet wilderness criteria" (Id. at p.4). We found that in the unit as a whole, there were 8 plugged and abandoned wells with access routes that have been obliterated and re-seeded, one access road that had been abandoned but has yet to be obliterated as per BLM requirements, no stock reservoirs, and a handful of two-track "ways." These impacts, singly or when taken together, are similar in all particulars to those found within the existing Adobe Town WSA and do not significantly impair the naturalness of the area.

We request that BLM grant all public lands within The Haystacks unit as outlined in this report be granted WSA status and be immediately withdrawn from all mineral leasing, road or pipeline construction, and the construction of new range improvement structures until such time as Congress can reach a final decision to either grant it wilderness status or release it from wilderness consideration. In the interim, BLM should actively pursue a program of land swaps in order to free up the potential wilderness from private inholdings.

Willow Creek Rim

This unit encompasses a sloping table land between the WSA and the Willow Creek Rim, an area of 20,000 acres that BLM inventoried and then excluded from WSA protection in 1980. It also includes wilderness-quality lands in the badlands of Willow Creek itself, which lie immediately to the east of the rim. The Willow Creek Rim is a tall, vertical scarp that bisects the area from north to south, affording spectacular views of the surrounding country. At its foot lies a maze of badlands that invite exploration on foot or horseback. The spectacular scenery alone is sufficient to lend the area outstanding opportunities for primitive and unconfined recreation. In its inventory of the area, BLM excluded the tract including Willow Creek Rim, citing a lack of vegetative or topographic screening and land features that were "commonplace" (Staff Specialist Synopsis at p.8). The report noted that "[s]everal ways are also found in this portion of the unit...they receive no maintenance and most are deteriorated" (Ibid. at p.8). This report further noted a pipeline right-of-way that had been approved but not yet constructed and a bladed road along the Willow Creek Rim that received substantial use. The BLM concluded that the Willow Creek Rim unit "contained intrusions and otherwise did not meet wilderness criteria" (Id. at p.4) and excluded it from further wilderness consideration.

Today, there is no visible evidence that the pipeline was ever laid, and the bladed "road" has been **mechanically obliterated** and reseeded in the intervening years. A light amount of use still occurs on a two-track way that follows the revegetation strip of the old road, but this route was *created and maintained solely by the passage of vehicles* and thus must be considered a "way." An improved gravel road has been built atop one of the primitive "ways" to access a drilling site east of Willow Creek Rim. Like the roads found within Adobe Town WSA, this road is a "temporary intrusion" that will need to be fully reclaimed when the well site is abandoned. For the purposes of this report, this road has been excluded from the proposed wilderness via a "cherry-stem;" we expect that the road be obliterated upon abandonment of the well site, at which time the route will be suitable for inclusion within wilderness. There also are 3 stock water reservoirs in this area, both of which are sound and hold water, but have dams camouflaged by native vegetation and are no more of an impact on the area than the similar reservoirs within Adobe Town WSA.

Powder Rim

The Powder Rim is a broad swell of high country that rises at the south end of the Washakie Basin. It is robed in a mix of juniper woodland and sagebrush meadows, and provides nesting habitat for sage grouse. The northern side of the rim slopes down into the Skull Creek basin, where it is dissected into clay badlands. This area apparently escaped the Wilderness Intensive Inventory entirely, even though it possesses all of the required attributes. This area provides perhaps the finest opportunities for primitive and unconfined recreation in a juniper woodland setting available in Wyoming. It is separated from the Adobe Town WSA by an old jeep trail that received so little use that it has been completely obliterated by the forces of natural degradation over most of its length. Several jeep trails within this area have been improved by bulldozer blading, an impact that will heal over the course of time once these routes are abandoned. There is one reservoir within the area, which is breached and no longer functional.

East Fork Point

We recommend that all of the lands northeast of Pipeline AT-36 be incorporated into the Adobe Town WSA. This area is traversed by three vehicle routes: AT-9 (BLM Route "G"), which BLM has already classified as a "way," and route AT-8 which is essentially identical and visits a fully reclaimed drill site, and AT-37, a dead-end jeep trail that has fallen into disuse. The area includes three active reservoirs, comparable in every way with Blank, No Name, and Miserable Reservoirs which already are included within Adobe Town WSA. As it now stands, if Adobe Town were granted wilderness status, there would be no major rim summit that would not be vehicle accessible; the addition of this parcel would allow at least some of the rim tops to fall within a wilderness backcountry.

Wild Cow Creek (33,403 acres of new WSA)

Wild Cow Creek, encompassing the drainages of both Deep Gulch and Wild Cow Creek, is proposed by the conservation community to be designated as wilderness. This area has not previously been designated a wilderness study area, and was never inventoried by BLM for wilderness qualities during its Initial Review of Wilderness Inventory Units.

The area is dominated by two deep canyons incised into the sloping sagebrush steppes, Deep Gulch and the canyon of Wild Cow Creek. A sparse mantle of vegetation covers the canyon walls, through which reddish sedimentary strata protrude in the steeper areas. In the upper reaches of each watershed, the canyons branch out onto a maze of draws, basins, and ridges. Here, islands of aspen and serviceberry dot the sagebrush steppe, particularly on north-facing slopes. Wildflower displays in May and June are so outstanding that a neighboring drainage was named "Garden Gulch." Elevations within the proposed wilderness range from a low of 6,520 feet to a high of 7,929 feet atop Cow Creek Butte. Snowdrifts persist at the heads of north-facing draws into June even in dry years, recharging aquifers that feed numerous springs and permanently-flowing stretches of stream throughout the area.

Wildlife abound in the proposed wilderness, an astonishing diversity of mammals, birds, and fishes once common throughout Wyoming's sagebrush deserts but now largely absent from most landscapes. The area offers calving/fawning grounds for elk, mule deer, and pronghorn antelope, and most of the area is considered Crucial Winter Range by the Wyoming Game and Fish Department. The high ridges and draws form important migration corridors for game animals moving between parturition areas and winter ranges. Sage grouse are abundant on the uplands above the rims. Several active prairie dog colonies are found along the floodplains of both Deep Gulch and Wild Cow Creek. Permanent streams and springs provide habitat for native fish species that are growing increasingly scarce statewide. Raptors, including northern harriers, golden eagles, merlins, and ferruginous hawks, find ideal nesting opportunities along the canyon walls and atop the high rims. The eastern half of the unit falls within the Grizzly Habitat Management Unit, managed by the Wyoming Game and Fish Department for big game and sage grouse.

This area is the best remaining example of the transitional uplands that form the ecotone between the Red Desert ecosystem and the forest ecosystem of the Sierra Madre Range. As such, it fills an important gap in ecosystem representation within the National Wilderness System.

Ferris Mountains (6,738 acres of WSA expansion)

A roadless portion of the Ferris Mountains, adjacent to the current Ferris Mountains WSA and encompassing Black Canyon and the hogbacks to the west of it, is proposed by the conservation community to be designated as wilderness. This area has not previously been designated a wilderness study area, and based on the BLM's initial wilderness inventory, Wilderness Program in Wyoming, most of the lands within this proposed addition were never considered during the BLM's Initial Review of Wilderness Inventory Units.

The area is dominated by a series of low, sharp hogbacks trending northwest-southeast to the west of Black Canyon. The proposed addition lies almost entirely below the coniferous forest zone of the Ferris mountains, and is covered in sagebrush steppe and desert grassland. The southwestern quadrant of the proposed addition consists of low-lying desert flats dominated by a saltbush-greasewood plant community. Several permanent streams flow down from the Ferris Mountains to traverse the proposed addition, sustaining rich bottomland riparian communities with lush growths of vegetation and diverse assemblages of wildlife.

According to the Wyoming Game and Fish Department, the proposed WSA addition provides winter/yearlong and summer range for elk and pronghorn antelope, and also includes crucial winter/yearlong range for mule deer as well as important migration corridors for this species.

Pedro Mountains (13,000 acre new WSA)
The Pedro Mountains are an impressive and rugged chain of tall granite peaks that rise to the east of Pathfinder Reservoir. This area is remote and difficult to access, lending to its wilderness appeal. Granite domes and slickrock rise sharply over 1000 feet above the surrounding plains. Pockets of pine and aspen grow hidden in moist draws, while cactus and sagebrush spring up in sandy crevices. From Iron Springs, to The Chimneys, to Pyramid Peak, the Pedro Mountains harbor astounding scenery and a mystical feel of primeval land. The Pedro Mountains are an island of biodiversity and rocky, mountainous terrain amidst the surrounding plains. Visitors to the Pedro Mountains discover an unmistakable feeling of ancient secrets hidden deep within the rocks. Although the area has not been thoroughly inventoried for archaeological sites, evidence exists along the former North Platte River, on the area's western boundary, of human habitation as long as 10,000 years ago. And about 1934, a group of WPA workers found a tiny mummified adult human near the area.

These mountains are unusual in that they provide winter roosting areas for approximately 20 bald eagles. The Pedro Mountains also provide crucial winter and year-long habitat for about 800 elk. They also provide habitat for a wide variety of wildlife, including antelope, mule deer, and nesting poorwills, and golden eagles and other raptors. Nesting habitat for endangered peregrine falcons exists in the area. The Pedros border a BLM National Back Country Byway and Watchable Wildlife Route, and overlook the Pathfinder National Wildlife Refuge.

Bennett Mountain (4,216 acre WSA expansion)
At the eastern edge of the Seminoe Mountains, east of Miracle Mile, the landscape is equally primitive as the western side, where the current Bennett Mountain WSA was established. The Bennett Mountains lift abruptly from the prairie. Sheer layered cliffs of limestone, red beds and other sedimentary rock face south overlooking Seminoe Reservoir, while steep canyons and gulches cut the more gradually sloping north flank of this section of the Seminoe Mountains. The area ranges in elevation from 6600 to 8000 feet and features a variety of plant cover, from cushion plants and gnarled juniper, to sagebrush, to thick grassy meadows and draws of chokecherry, willow, and aspen.

This area offers visitors spectacular scenery and isolation. Views from the top feature the Pedro

Mountains, Ferris, Sand Dunes, Seminoe Reservoir, and mountain ranges of Wyoming and Colorado in the distance to the south. The Bennetts are also in clear view of BLM's National Back Country Byway.

Plant diversity in the area is unusually high, providing for outstanding botany studies. The area provides good summer habitat and crucial winter range for elk (WG&F Completion Report: 1991). Riparian zones in the area provide forage for deer. Pika, marmots, golden eagles, and other raptors, also call the area home. Historical verification of the endangered black-footed ferret were sighted in 1972 and 1979 in the area.
Although a thorough archaeological survey has not been completed, shelter rings and flint chips show that Native Americans came to these mountains. A pit house and other sites along the old river course west of the area indicate occupation dating to 10,000 years ago. We seek an expansion of the WSA to include the entire ridge east of Kortes Dam.

Prospect Mountain (4,351 acre WSA expansion)
Prospect Mountain encompasses a needed ecological addition to the Platte River Wilderness Area in the Medicine Bow National Forest. This area's steep canyon/mountain terrain, dense stands of lodgepole pine, and pockets of golden mountain aspen contrast sharply with the adjacent high, dry pastel desert. A large herd of bighorn sheep and about 200 elk are dependent on Prospect Mountain for their survival.

The area offers high quality mule deer and elk hunting along with exceptional scenic vistas. Adjacent nationally-renowned portions of the North Platte River are popular with anglers and river runners. Outstanding botanical attributes and interesting geological features make the area important from a scientific and educational standpoint.

Up to 200 head of elk from the Snowy Range elk herd use the Prospect Mountain WSA year round. The northern half of the WSA is part of a large crucial winter range that is considered essential for the survival of the herd. This area contains yearlong range for mule deer and riparian habitat for numerous species of wildlife. This distinctive area provides for a large, unique herd of approximately 50 bighorn sheep for crucial habitat throughout the year . Rock walls and grottoes within the area may provide habitat for Townsend's big-eared bat, a forest service sensitive species that is also on the Wyoming Game and Fish Department's Watch List.

The area is known for its concentration of raptors. Bald eagles and peregrine falcons, both listed under the Endangered Species Act, are found to be nesting in this area. The Northern goshawk and the boreal toad are also found here and are also quite rare. In addition, WYNDD records indicate that the wolverine and the black-crowned night heron are unique species found near the Prospect Mountain area.

Several unique or rare plant species are found in this area according to WYNDD. Listed by the State of Wyoming for protection are mountain muhly, Colorado tansy-aster, park milk-vetch, and Ward's goldenweed.

Proposed ACECs
Under the Western Heritage Alternative, all currently existing ACECs would be retained, and additional ACECs would be added as outlined below. We have attached GIS-generated maps for each of these areas. All of these areas should be withdrawn from surface disturbing activities, and leased only under No Surface Occupancy (NSO) restrictions. In addition to the special areas

enumerated in the sections that follow, all crucial winter, crucial winter relief, and elk calving areas identified by WGFD should be granted ACEC status and withdrawn from new mineral leasing and entry.

Shamrock Hills

The Shamrock Hills are currently managed as an ACEC under the original Medicine Bow – Divide RMP. A total of 284 raptor nest were surveyed in the Shamrock Hills in 2000, including 17 active ferruginous hawk nests, most of them on artificial nesting structures; nesting densities and successful nesting densities were significantly higher than in any other area surveyed within the Rawlins Field Office (Apple 2000). In addition, successful nesting was also reported for 5 pairs of golden eagles, one pair of prairie falcons, three pairs of American kestrels, two pairs of burrowing owls, one pair of northern harriers, and one pair of Swainson's hawks in the Shamrock Hills area.

Raptor concentration areas should also be granted special status as ACECs. A BLM report authored by Olendorff and Kochert (1992) recommended the following strategy for BLM lands nationwide: "Designate Key Raptor Areas as ACECs during the RMP process. Each state should review the status of ACEC plan implementation in Key Raptor Areas, identify likely candidates for designation during the next planning cycle, and program appropriate funding for inventory of these areas" (p. 25). With this in mind, the current Shamrock Hills ACEC should be retained, and other raptor concentration areas identified by the BLM should also be given ACEC status.

Plover ACECs

Four plover ACECs have been proposed, at Mexican Flats, Eagle Rock Springs, and two in the Shirley Basin. These ACECs are centered around known mountain plover nesting concentrations (Fritz Knopf, Regan Plumb pers. comm.). As noted in the section on Mountain Plovers, concentration areas which are developed would be expected to show reduced plover viability for a variety of reasons. Plover nesting concentrations like these that are found through subsequent research also should be protected by granting them ACEC status.

Bates Hole/Chalk Mountain

This area contains cushion plant communities on limestone and sandstone rims, as well as sagebrush grasslands. It has 5 species of rare plants, including *Spaeromeria simplex*, a BLM Sensitive Species that is rated G2 (Globally Imperiled) by the Wyoming Natural Diversity Database (WYNDD), as well as *Phisaria eburniflora*, rated G2/G3.

Shirley Mountains

Also referred to as Shirley Mtns./Basin West, this area contains cushion plant communities on limestone and sandstone rims, as well as sagebrush grasslands and greasewood communities on playas. It has four rare species of rare plants, including a large population of *Spaeromeria simplex,* a BLM Sensitive Species. The area contains important cave resources that are important from a recreational and scientific perspective. It also contains graminoid-dominated wetlands and shrub-dominated riparian communities, of "highest priority" under the Wyoming Gap study (USGS 1996).

Chain Lakes

The Chain Lakes are an important Red Desert wetland that is a stopover for migrating shorebirds. It also contains mud volcanoes that are interesting from a geological standpoint. The graminoid-dominated wetlands found here are rated "highest priority" for conservation under the Wyoming Gap study (USGS 1996). According to Knight et al. (1976), "The greasewood communities are as diverse in species composition as we've seen for this vegetation type, and the ponds provide a rare habitat in the area for avocets, ducks, killdeer, willets, and other waterfowl. Red-winged blackbirds were seen in the rushes, and gray-fish were observed in the water. This whole area is truly unique and should be studied as a possible representative of the alkaline depression – alkaline pond natural history theme. Circle Bar Lake and Battle Springs Flat to the west should also be studied" (p. 167).

Powder Rim

The Powder Rim is a large and important juniper scrub woodland, which also boasts its own desert elk herd and seven species of rare native plants. Among these are two populations of Gibben's beardtongue (*Penstemon gibbensii*), rated G1 (Globally Critically Imperiled) by WYNDD. It also includes cottonwood riparian communities rated "highest priority" under the Wyoming Gap study, as well as xeric upland shrub, and desert shrub communities that are also of high concern (USGS 1996).

Seig (1991) found higher bird densities and greater species richness in juniper woodlands than in neighboring grasslands in the Badlands of South Dakota, and pointed out the importance of juniper in providing thermal cover and forage. In the Great Divide planning area, juniper woodlands along the Powder Rim and elsewhere are likely to perform a similar ecological role. The importance of junipers as a nesting substrate for ferruginous hawks has been documented by a number of different researchers (e.g., Howard and Wolfe 1976, Powers 1976, Smith and Murphy 1978, Smith and Murphy 1982, Woffinden and Murphy 1983, Bechard et al. 1990). Although ferruginous hawk nesting in junipers has not yet been documented for the Powder Rim, this may be an indicator of little survey effort for this species along the Powder Rim rather than a lack of ferruginous hawk nesting activity in this habitat type.

Fitton and Scott (1984) listed 10 species virtually confined to Utah juniper communities in Wyoming: gray flycatcher, ash-throated flycatcher, western scrub jay, plain titmouse, bushtit, Bewick's wren, blue-gray gnatcatcher, gray vireo, black-throated gray warbler, and Scott's oriole. Fitton (1989) described these juniper obligates as follows. The ash-throated flycatcher is a secondary cavity nester that utilizes steeper slopes with old-growth juniper. The plain titmouse requires old growth juniper for cavity nesting and foraging. Gray vireos inhabit mature stands of juniper with moderate canopy closure and well-developed shrub understory or patches of shrubs in clearings. The Scott's oriole requires mature juniper with moderate to sparse canopy cover, often foraging on smaller junipers or deciduous shrubs. Fitton reported that the ash-throated flycatcher and scrub jay each declined 66-67% in its juniper range during the 1970s and 1980s. Bushtits and western scrub jays are particularly sensitive to human disturbance, and abandon their nests easily. Fitton recommended the ash-throated flycatcher, scrub jay, plain titmouse, bushtit, gray vireo, and Scott's oriole as "Species in need of special management in Wyoming." The ash-throated flycatcher, western scrub jay, and juniper titmouse have been granted Special Concern III status by the Wyoming Game and Fish Department (Pavlacky 2000).

Nine of Wyoming's ten juniper obligate birds (all except the gray vireo) have nest records along the Powder Rim, and several lesser sites farther east host a lesser number of these species (Fitton and Scott 1984). In the Great Divide area, Scott's orioles have been recorded from both Powder Rim and from the vicinity of Anthill Reservoir, and Wyoming's first nesting record for this species came from the latter site (Findholt and Fitton 1983). Findholt (1983) recorded blue-gray gnatcatcher nesting on the Powder Rim, and also noted that Wyoming's original nest record for the plain titmouse came from the Powder Rim as well.

Pavlacky (2000) noted that species typically classified as sagebrush obligates also are found in association with juniper woodlands: In this study, Brewer's sparrows were associated with small, early-succession juniper patches, and the green-tailed towhee showed an affinity for larger juniper patches, but preferred open, shrubby stands. Mourning dove, mountain bluebird, plumbeous vireo, and juniper titmouse also occupy dense, mature woodlands with little shrub cover, high grass cover, and little juniper regeneration (Pavlacky 2000). During the course of BCA field work, we also noted an abundance of mourning doves and raptors in the juniper woodlands along the Powder Rim.

Pavlacky (2000) recommended that natural processes be allowed to prevail in juniper woodlands: "Fire suppression and livestock grazing may decrease habitat suitability for woodland-dwelling species, such as the juniper titmouse and plumbeous vireo, that occupy mature woodland with low shrub cover and little juniper regeneration in the understory...Fire suppression and livestock grazing may have far-reaching consequences for the juniper woodland bird community, possibly affecting food availability and dispersal of native plants by birds" (p.184).

According to Pavlacky (2000), "Since juniper woodlands make up a mere 2% of the land area in Wyoming, the juniper woodland bird community is unique and has substantial conservation value" (p.171). He added, "Because very few large woodland patches > 19 km^2 are present on the landscape, woodlands of this size have high conservation value" (p. 181).

Ferris Dunes

The sand dunes south of the Ferris Mountains are a spectacular and fragile ecological community boasting a diverse assemblage of unique plants and animals, including the Endangered blowout penstemon. The proposed ACEC also contains the ghost town of Ferris, an important historical resource that may be eligible for the National Register of Historic Places. For the Great Divide Basin, Maxell (1973) found that scurfpea and ricegrass communities in the sand dunes contained the greatest kangaroo rat concentrations, and drew the following conclusion: "Kangaroo rats were almost exclusively restricted to the sand dunes and adjacent areas in the Basin" (p. 86). The vegetated sand dunes, active sand dunes, and graminoid-dominated "vernal pond" wetlands in this area all are rated "highest priority" for conservation by the Wyoming Gap study (USGS 1996).

Bury and Luckenback (1983) observed that "[d]unes often lack adjacent or nearby colonization sources and much of the biota may be endemic" (p.218), and made the following recommendations for the conservation of sand dune communities:

> "A paradigm for the management of desert dune systems should follow the recommendations of Whitcomb et al. (1976), who urge that ecological preserves be kept as large as possible because (1) large areas have low extinction rates and high immigration rates; (2) some taxa require very large areas for survival; (3) preservation of entire ecological communities, with all trophic levels represented, requires large areas; (4) large preserves are a better buffer against human disturbance; (5) large areas are necessary to minimize the predation, parasitism, and competition exerted by species abundant in the disturbed area surrounding reserves; (6) the failures of small reserves have been adequately documented; and (7) because fragmentation is irreversible, a conservative preservation strategy needs to be adopted" (p.219).

Bury and Luckenback also documented that ORV use causes major destruction of dune plant communities, and reported decreases in fringe-toed lizard and desert kangaroo rat populations as a result of ORV activity. The sensitive nature of this landscape demands strong protections from both ORVs and oil and gas development.

Blowout Penstemon
Both known Wyoming populations of the Endangered blowout penstemon occur within the proposed Ferris Dunes ACEC. In Nebraska, Hardy et al. (1989) stated, “It is apparent after 11 years of study that numbers of individuals in a particular colony vary widely, with the tendency for catastrophic decline” (p. 227). The large degree of population fluctuation inherent to this species makes it imperative to employ a conservative approach in which potential threats that might contribute to population declines, or which might prevent population spreads, are prohibited in this area. In addition, Lawson et al. (1989) found that in Nebraska, pollinators of blowout penstemon appear to be limited to four species of solitary bees of the family Megachilidae (*Hoplitis pilosifrons*, *Osmia cyaneonitens*, *O. distincta*, and *O. integra*), which showed high fidelity to penstemons. *Osmia integra* would be expected to occur throughout Wyoming, while the other species are known from Colorado but Wyoming presence is unknown (Ibid.). Thus, the survival of the blowout penstemon may hinge not only on protecting the plant populations themselves but also on guaranteeing the persistence of its obligate pollinators to assure the penstemon’s ability to reproduce.

In the Sand Hills of Nebraska, Stubbendieck and Weedon (1989) noted that blowout penstemon are dependent on sites of active wind erosion. For this habitat, these researchers stated, “The number of blowouts has decreased with the control of fire and improved range management techniques” (p. 223). While this may be true in the Sand Hills of Nebraska, it is unclear that livestock grazing contributes to the maintenance of active dunefields in the Red Desert, which were active in the absence of large numbers of herbivores prior to the arrival of domestic livestock. Blowout penstemon is a poor competitor, and in the Nebraska is replaced through succession by lemon scurfpea (Hardy et al. 1989), a species also present in the Great Divide area.

Wild and Scenic Rivers – Encampment River
The BLM itself has recognized that the Encampment River as it flows through the Encampment Canyon WSA is eligible for Wild and Scenic status. This stretch of river has outstanding historical resources including the remnants of the old water diversion system for the Encampment smelter and numerous old mines and ruins, is of outstanding recreational importance both from a fishing and hiking/horseback riding perspective, and is important range for the Encampment River bighorn sheep herd. We urge the BLM to propose this river for inclusion in the national Wild and Scenic Rivers system.

PROVISIONS OF THE WESTERN HERITAGE ALTERNATIVE

The Western Heritage Alternative for the Rawlins Area Resource Management Plan (RMP) represents a balanced approach to management of the public lands and resources in the Rawlins Resource Area of Wyoming. The final RMP for these lands should promote the best use of the lands and resources in the Area, with the overarching goal that all permitted activities will be compatible with maintaining healthy ecosystems. It must also prevent any undue or unnecessary degradation of public land values. In keeping with these goals, this Western Heritage Alternative provides that some areas with high wildlife, scenic, or recreational values are preserved and managed to support these fragile resources. Even so, the vast majority of these federal lands would remain available for energy development, logging, livestock grazing, and other uses.

Wildlife Habitat and Fisheries Management

1. Broad stretches of undeveloped landscape should be maintained in a well-distributed pattern throughout the planning area.

2. All management activities shall be done in a manner compatible with maintaining thriving populations of BLM Sensitive Species and other plants or wildlife classified as rare or declining.

3. Wild horse numbers should be managed at sustainable levels, taking into consideration impacts to wildlife, habitats, and rangelands.

4. The BLM shall protect habitat so as to maintain the viability of all native species widely distributed throughout the planning area.

5. All management activities should prevent soil erosion and compaction, and maintain or restore biological soil crusts over the long term.

Fire/Fuels Management

1. Natural fires shall be allowed to burn unless and until they directly threaten human lives and property.

2. Fuels reduction projects designed to reduce fire hazard shall be limited to areas within ¼ mile of existing buildings.

3. Prescribed fire will be the principal tool of fuels reduction, not mechanical treatments.

Areas of Critical Environmental Concern

1. Existing Areas of Critical Environmental Concern will be retained in the new Plan.

2. The following areas will be designated as new Areas of Critical Environmental Concern, as delineated in the attached maps: Chain Lakes, Powder Rim, Ferris Dunes, Bates Hole/Chalk Mountain, West Shirley Basin, Mexican Flats Plover ACEC, Eagle Nest Spring Plover ACEC, and the two Shirley Basin Plover ACECs.

3. Areas where there is overlap between three or more types of big game crucial habitats as delineated by WGFD will be designated ACECs and leased only under No Surface Occupancy stipulations.

4. All ACECs will be withdrawn from locatable mineral entry and be classified as “unsuitable” for coal leasing.

4\. Fluid minerals in all ACECs may be leased only under No Surface Occupancy stipulations.

Wilderness

1. All lands encompassed by citizens' wilderness inventories are granted Wilderness Study Area status and managed to protect their wilderness qualities.

2. Citizens' proposed wilderness areas will be withdrawn from mineral leasing, coal leasing, and locatable mineral entry.

Land Ownership Adjustments

1. BLM should identify and acquire non-BLM lands and consolidate ownership to enhance its ability to manage important recreation opportunities and wildlife habitats such as migration corridors, crucial big game habitats as defined by WGFD, riparian areas, and wetlands.

2. All land swaps will be conducted with adequate public notice and involvement.

3. The RMP should determine which lands are currently legally accessible by motor vehicle, horse, or foot for public recreation, and which lands are rendered unavailable for public recreation due to private lands which hold no access easements. The RMP should address the problem of inaccessibility of public lands for public recreation, including acquisition of easements and appropriate land exchanges.

Oil and Gas Leasing and Development

Goal: Sensitive landscapes and habitats (defined below) must be spared from the impacts of oil and gas development. In lands that are not especially sensitive, major reforms are needed to prevent widespread degradation of the land, to minimize the overall impacts of the oil and gas industry, and to make oil and gas development as compatible as possible with other multiple-use resources, including fish and wildlife habitat, watershed values, recreation, and wilderness.

1. Pursuant to supplemental program guidance, the BLM shall determine which lands should be off-limits to oil and gas leasing, including at minimum:

    - Existing and citizens' proposed Wilderness Study Areas;

    - Existing and Proposed ACECs; and

    - Lands in Visual Resource Management Classes I and II under the original Medicine Bow – Divide RMP.

2. BLM shall institute a program to suspend and/or trade to nullify currently existing leases in the above three categories of land.

3. No new leasing shall occur on crucial winter ranges, crucial winter relief ranges, crucial winter yearlong habitats, of elk calving ranges as defined by WGFD until BLM thoroughly evaluates the effectiveness of seasonal timing and No Surface Occupancy stipulations and mitigation measures.

4. In the case of split-estate lands, the surface owner shall be given written notification prior to the offering of underlying subsurface mineral rights at a lease sale.

5. BLM shall prepare site-specific environmental analysis consistent with the requirements of NEPA § 102(2)(C) (i.e., an EIS) for leasing decisions on split-estate lands (e.g., federal minerals underlying private surface). Accordingly, under this approach, the RMP decision would defer leasing decisions on split-estate lands subject to subsequent site-specific analysis (which would be triggered by industry nomination to lease).

6. BLM shall provide the record surface owner 45 day advance written notice of proposed leasing decision and opportunity to comment, including recommending specific lease stipulations.

7. Staged development shall be instituted to achieve no net loss of crucial winter ranges, crucial winter yearlong ranges, severe winter relief ranges, and elk calving ranges as delineated by WGFD.

8. In cases where drilling is approved (subject to the limitations outlined below), directional drilling shall be the required to minimize environmental impacts, unless a less environmentally harmful alternative is available.

9. Areas may be leased only under a No Surface Occupancy Stipulation with appropriate buffers to guarantee protection of the special resources in question, and will be excluded from surface development. Waivers may be granted for surface disturbances and developments ***if*** they will be completely invisible by line-of-sight from the site in question. These include:

    a. Lands within 5 miles of the Overland and Cherokee historic trails, the Continental Divide National Scenic trail, Native American Trails, or a site eligible for the National Register of Historic Places.

    b. Lands within Native American religious or cultural sites as identified by the tribes.

10. Sensitive areas that will be leased under No Surface Occupancy stipulations and shall be withdrawn from surface disturbing activities on a year-round basis, with ***no waiver available***:

    · Lands where there is overlap between three or more types of wildlife crucial winter ranges, crucial winter relief areas, and elk calving areas as defined by WGFD,

    · Other Areas of Critical Environmental Concern as outlined in the Western Heritage Alternative,

    · areas within 1 mile of active raptor nests,

    · areas within 3 miles of active sage grouse or 1 mile of sharp-tailed grouse leks,

    · large prairie dog colonies and complexes, or those associated with BLM Sensitive Species such as the black-footed ferret, burrowing owl, mountain plover, or swift fox, plus a ½mile buffer zone around these colonies,

    · critical habitats of Endangered and Threatened species, and

    · areas within the 100-year floodplain of permanent or intermittent streams or within 500 feet of natural water sources or riparian vegetation.

11. Wilderness Study Areas, including new citizens' proposed wilderness additions, will be withdrawn from mineral leasing and other surface disturbing activities.

12. Oilfield exploration standards.

    a. Seismograph testing will take place without the construction of additional roads. Construction for the purposes of this policy shall include blading, grading, or the use of mechanical means such as hand tools.

    b. Shot-hole seismic exploration will be the preferred method for seismic exploration where sensitive archaeological resources are not threatened, but shall be limited to hand-laying of geophone lines and helicopter transport of drilling rigs in sensitive landscapes outlined in Section 2.

13. Exploration wells will be constructed within 100 feet of existing improved gravel roads, limited by the stipulations outlined above. If improved gravel roads are unavailable, previously constructed but unmaintained roadways may be upgraded, with the stipulation that the minimum length of roadway will be reconstructed and that these route shall be returned to their original condition upon termination of production.

    a. Off-road travel on steep or unstable soils or during wet weather is prohibited.

14. Oil and gas infill development.

    a. Wherever possible, infill production wells shall be sidetracked from existing wells or drilled from existing wellpads or from cluster pads immediately adjacent to improved gravel roads and subject to the limitations of Section 1

    b. Cluster pads shall be constructed at intervals that create the minimum practicable footprint.

    c. The construction of new roads will not be permitted for oilfield infill development unless exceptional difficulties are presented.

15. Full-field development of new fields.

    a. Production wells shall be drilled from cluster pads immediately adjacent to existing improved gravel roads and subject to the limitations above; these cluster pads will be spaced at the widest possible spacing to minimize surface disturbance.
    b. The construction of new roads shall not be permitted unless the maximum interspersion cannot be met under the provisions of Section 4(b), subject to the limitations of Section 1. If new roads are constructed, the siting of cluster pads away from existing improved gravel roads will be achieved by minimizing the length of new road construction, using existing unimproved roadways wherever they are available.

16. New oil and gas drilling activities shall be regulated under a Staged Development scenario:

a. There shall be no net loss of unroaded or undeveloped lands. Drilling will not be introduced into new unroaded or undeveloped areas until an equivalent acreage of formerly developed lands achieves undeveloped status.

17. State-of-the-art drilling technologies, including but not limited to pitless drilling techniques (using closed-loop circulation of drilling muds), shall be employed for all exploration and production wells unless there is a less environmentally harmful alternative.

18. Coalbed methane produced water may either be reinjected into aquifers of similar water quality or treated to remove pollutants prior to discharge. Produced water from coalbed methane wells shall not be discharged onto soil surfaces or into water bodies if it might affect sensitive wildlife species, water quality, or soil productivity.

19. The plan of operations shall include a reclamation plan which describes in detail the methods and practices that will be used to ensure complete and timely restoration of all lands affected by oil and gas activities to the condition that existed prior to surface disturbing activities. Unless otherwise provided in an approved surface use plan of operations, reclamation shall be conducted concurrently with other operations.

20. Disturbed lands should be returned to their natural condition immediately after the termination of development activities for oil and gas; bonds shall not be refunded until this requirement is met.

21. Revegetation activities should re-create the original distribution and species composition on plant on the site prior to disturbance.

22. The reseeding of disturbed sites shall use only native species of plants.

23. Topsoil shall be retained for all surface-disturbing activities, and shall be replaced during reclamation activities.

24. The obligation to complete reclamation will persist until the site is substantially returned to its natural condition.

Noxious Weeds

1. The BLM will work with other agencies to prevent the introduction of noxious weeds.

2. In order to retard the spread of noxious weeds, the following steps will be taken:

- Reduce the road construction associated with oil and gas development and other surface disturbance to the minimum practicable footprint.

- Reduce grazing pressures where overuse is promoting the spread of invasive species.

- Require that any fill material used on the Resource Area be free of non-native seeds or other noxious weed material.

Coal and Locatable Minerals

1. Sensitive areas that will be classified “unsuitable” for coal leasing under SMCRA on a year-round basis, with ***no waiver available***:

   - Areas where there is overlap between three or more wildlife crucial winter ranges, crucial winter relief areas, and birthing areas,
   - Other Areas of Critical Environmental Concern as outlined in the Western Heritage Alternative,
   - areas within 1 mile of active raptor nests,
   - areas within 3 miles of active sage grouse or 1 mile of sharp-tailed grouse leks,
   - large prairie dog colonies and complexes, or those inhabited by BLM Sensitive Species such as black-footed ferret, burrowing owl, mountain plover, or swift fox,
   - critical habitats of Endangered and Threatened species, and
   - areas within the 100-year floodplain of permanent or intermittent streams or within 500 feet of natural water sources or riparian vegetation.

2. Sensitive areas that will be withdrawn from locatable minerals entry on a year-round basis, with ***no waiver available***:

   - wildlife crucial winter ranges, crucial winter relief areas, and birthing areas,
   - Other Areas of Critical Environmental Concern as outlined in the Western Heritage Alternative,
   - areas within 1 mile of active raptor nests,
   - areas within 3 miles of active sage grouse or 1 mile of sharp-tailed grouse leks,
   - large prairie dog colonies and complexes, or those inhabited by BLM Sensitive Species such as black-footed ferret, burrowing owl, mountain plover, or swift fox,
   - critical habitats of Endangered and Threatened species, and
   - areas within the 100-year floodplain of permanent or intermittent streams or within 500 feet of natural water sources or riparian vegetation.

Off-Road Vehicle Management

1. All motor vehicles should be limited to designated roads and trails throughout the planning area.

2. Designated routes will be limited to those which minimize damage to soil, harassment of wildlife, and conflicts with other recreational users in accordance with Executive Orders # 11644 (1972) and 11989 (1977), and 43 C.F.R. § 8340 et seq.

Sensitive Plants Management

1. All current special management areas should be maintained.

2. The BLM should take measures to ensure preservation of the plant species of concern listed on the Wyoming Natural Diversity Database.

Soil, Water, and Air Management

Soils

1. The RMP should map the occurrence of Biological Soil Crusts throughout the planning area and evaluate current and future impacts to this important soil resource from livestock grazing, seismic exploration, and other types of development.

2. Develop and implement long-term monitoring protocols for the restoration of soil crust communities. Adapt and refine monitoring protocols, in particular the Biological Soil Crust Stability Index, for evaluation of existing BSC condition. When used in conjunction with corresponding measures of landscape stability, biotic integrity, and watershed function, the BSCSI can be used to help determine the relative health of grassland and sagebrush communities.

3. Identify, map and protect from human related disturbances any remaining areas (refugia) where BSC represent 50% or more of the total ground cover (These are unlikely to represent more than 0.1% of the GRDA).

Water Quantity

1. The RMP should provide that BLM will pursue whatever mechanisms are available to it under federal and state law to preserve minimum stream flows necessary for wildlife habitat, fisheries, and recreation. These mechanisms include conditions on the issuance of rights-of-way for water projects on BLM lands, reserved water rights, and state instream flow protections.

Water Quality

1. The RMP must ensure compliance with all federal and state water quality standards.

2. The RMP should detail the steps BLM intends to take to improve water quality in those stream segments that are not currently meeting state standards. Special attention is required for those stream segments on the state's 303(d) list. These steps should include, at a minimum, reducing the impact of livestock grazing on water quality by limiting livestock access to riparian areas; reducing the impact of timber operations on water quality by creating adequate buffer zones; restricting road construction and ORV use in riparian areas, and ensuring that produced water is either treated or re-injected.

In addition, the Resource Area contains several stream segments that have been designated as Class 1 or Outstanding Waters. For these stream segments, the RMP must ensure that there is no deterioration in water quality.

Air Quality

1. BLM must ensure that all activities on BLM lands are in compliance with federal and state air quality standards and take steps to improve air quality where such standards are not being met.

2. Air quality impacts associated with oil and gas development should be strictly limited which might degrade current Class I Areas (and on lands proposed for wilderness designation), and any areas of non-attainment of current air quality standards.

Visual Resource Management

1. Lands within the viewsheds of National Trails and lands proposed for wilderness designation must be managed as VRM Class I.

Wild and Scenic Rivers

1. Segments of the Encampment River located within the current WSA will be nominated for protection under the Wild and Scenic Rivers Act.

Adaptive Management Strategy

1. Recognizing that the costs of monitoring and mitigating for private uses on the public lands often outstrip the agency's resources, the RMP will contain a schedule for re-evaluating the ability of BLM to achieve the non-commodity resource goals contained in the RMP. If those goals are not or cannot be met, the RMP will outline how BLM will adapt its management of the Resource Area in order to ensure preservation of wildlife, scenic, and recreational values.

Monitoring

1. The BLM shall undertake a systematic program of periodic monitoring of resources and attributes, including but not limited to grazing levels, biological soil crusts, sage grouse populations, burrowing owl populations, extent and occupancy of prairie dog colonies, and population trend of Sensitive Species.

Vegetation Treatments

1. Sagebrush reduction treatments shall not occur within 3 miles of a sage grouse lek, within 1 mile of a sharp-tailed grouse lek, or on sage grouse or sharp-tailed grouse winter habitats.

Forest Management

1. The new RMP should outline standards and guidelines for timber harvest that require harvest to be sustainable over time and compatible with other multiple uses such as wildlife, recreation, and watershed values.

2. Timber harvest rotations should reflect natural stand turnover before the advent of widespread logging.

3. The RMP should ban clearcutting and seed-tree harvest in favor of group selection, individual tree selection, and three-stage shelterwood harvests to minimize additional forest fragmentation.

4. No new timber roads should be constructed in lands proposed for wilderness designation, lands where three or more wildlife migration corridors and crucial habitats coincide, and lands requiring NSO stipulations for leased minerals.

5. For timber sales, a minimum of 5 snags/acre of the largest diameter available will be retained to enhance wildlife habitat.

Historical and Cultural Resources

1. Cultural and paleontological resources should be preserved in place so that their full scientific and cultural values can be evaluated and maintained.

2. BLM should inventory the Resource Area in order to identify sites of cultural and paleontological resources.

3. BLM should engage the Native American community in identifying sites that should be given special protections, including ACEC designation.

4. Sites of known cultural or paleontological resources, such as the Morrison Formation, should be designated and protected as ACECs.

5. All permits, leases, contracts, rights-of-way or other agreements allowing private uses should require consultation and inventories prior to any surface disturbance to determine whether such resources are or may be present.

ROW Corridors

1. Utility corridors should be designated along existing rights-of-way or high-traffic gravel roads or highways.

2. The following areas shall be classified as “exclusion areas” for the purposes of siting ROW corridors:

   - wildlife crucial winter ranges, crucial winter relief areas, and birthing areas,

   - Other Areas of Critical Environmental Concern as outlined in the Western Heritage Alternative,

   - areas within 1 mile of active raptor nests,

   - areas within 3 miles of active sage grouse or 1 mile of sharp-tailed grouse leks,

- large prairie dog colonies and complexes, or those inhabited by BLM Sensitive Species such as black-footed ferret, burrowing owl, mountain plover, or swift fox, and
- critical habitats of Endangered and Threatened species.

3. Areas within the 100-year floodplain of permanent or intermittent streams or within 500 feet of natural water sources or riparian vegetation shall be classified as "avoidance areas" for the purposes of sighting ROW corridors.

4. Communications sites and antenna structures will not be built in or adjacent to:
   - wildlife crucial winter ranges, crucial winter relief areas, and birthing areas,
   - Other Areas of Critical Environmental Concern as outlined in the Western Heritage Alternative,
   - areas within 1 mile of active raptor nests,
   - areas within 3 miles of active sage grouse or 1 mile of sharp-tailed grouse leks,
   - large prairie dog colonies and complexes, or those inhabited by BLM Sensitive Species such as black-footed ferret, burrowing owl, mountain plover, or swift fox, and
   - critical habitats of Endangered and Threatened species.

Livestock Grazing Management

Overall, the BLM should manage allotments to avoid overgrazing and render livestock grazing compatible with other multiple-use values.

1. The RMP should include a reasoned determination as to which lands within the Resource Area should be grazed at all. The special values of lands in ACECs or other special management areas, lands that warrant the protection of NSO stipulations, lands with concentrations of biological soil crusts, or lands with plant or animal species of concern may dictate a determination that such lands are unsuitable for livestock grazing.

2. The RMP should include a three-year schedule for reviewing the condition of all allotments and riparian areas and swift rehabilitation of those that are not in compliance with these requirements. The RMP should adopt a similar schedule for ensuring the timely completion of evaluations required under the National Environmental Policy Act and the Endangered Species Act for grazing activities on the Resource Area.

3. The BLM should manage all allotments toward "good" to "excellent" range condition.

4. Sufficient forage should remain following livestock grazing to support native wildlife.

5. The new RMP should impose measures to minimize the transmission of diseases from livestock to native wildlife.

6. All fences shall meet WGFD standards with regard to construction standards.

7. Illegal fences should be brought into compliance or removed.

8. The construction of new fences that might potentially interfere with the migration or dispersal of wildlife should be avoided.

9. The "Standards and Guidelines for General Application to All Components of the Rangeland Ecosystem," as well as "Standards and Guidelines for Unhealthy Ecosystems," currently in force on BLM lands, shall be formally adopted in full into the new RMP.

10. The BLM must ensure that grazing complies with the Fundamentals of Rangeland Health and other statewide requirements, and all riparian areas must be managed to comply with current "Properly Functioning Condition" requirements.

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