2002). Prescribed burn projects should be conducted in a manner that does not threaten the viability of sagebrush obligate passerines.

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) and in Wyoming in recent years. 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 have continued over the past 8 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). Recent data indicate a relatively stable population trend in the Bighorn Basin, but this is the only part of Wyoming where this is the case. A recent study reported that the overall cumulative population trend for sage grouse in this area was upward, but that this conclusion was clouded by the fact that monitoring effort had increased over the same period, and the number of sage grouse males at leks actually decreasedc slightly over the study period (EDAW, in prep.). It is crucially important that the new Bighorn Basin plans 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.

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 and 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.l 13). 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 Bighorn Basin, 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 (Artemesia) suitable for nesting and brood rearing" (p. 563).

Biodiversity Conservation Alliance has commissioned a study by Wyoming Wildlife Consultants to determine the effects of past habitat treatment types in the Bighorn Basin on sage grouse populations. This study is scheduled to be completed by December 2008, and we will provide the results of this study to the BLM for its consideration in designing standards and guidelines for habitat treatment projects.

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 Bighorn Basin, 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). In the Bighorn Basin, bentonite mining provides a potentially much greater threat to sage grouse habitat than coal mining. Most of the best sage grouse habitat that rings the outer edge of the Bighorn Basin corresponds with the

outcrops of the best bentonite deposits, with a strong likelihood that a major expansion of this type of mining with threaten the viability of sage grouse populations. Reclamation is difficult: According to EDAW (in prep.), "Efforts to reclaim bentonite mined areas in the northeastern Bighorn Basin have resulted mainly in establishment of grasses, saltbush and/or bare ground and halogeton." A little over a third of all sage grouse leks in the Bighorn Basin are currently winthin 2 miles of a bentonite mining operations (EDAW, in prep.). 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.

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 (and hence lower reproduction), 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 (2005), the world's 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. See Attachment 1. Thus, areas within 3 miles of a sage grouse lek should be put under year-round "No Surface Occupancy" stipulations.

Sage grouse mitigation measures have been demonstrated to be ineffective at maintaining this species at pre-development levels in the face of oil and gas development by Holloran (2005) and Walker et al. (2006). In both of these studies, comparable levels of development led to significant declines in sage grouse populations. Holloran found that, for the Pinedale Anticline and Jonah Fields of western Wyoming, current population trends predicted extirpation of sage grouse in developed areas within 19 years of the date of the study. Walker et al. found an 85% decline of sage grouse populations in the Powder River Basin of northeastern Wyoming since the onset of coalbed methane development there, - under well densities and mitigation measures approved under the Atlantic Rim project. Under both studies, the BLM had implemented and required mitigation measures identical to those that commonly apply in the Bighorn Basin today. Walker et al. (2006) concluded:

> Seasonal restrictions on drilling and construction do not address impacts caused by loss of sagebrush and incursion of infrastructure that can affect populations over long periods of time. Regulatory agencies may need to increase spatial restrictions on development, industry may need to rapidly implement more effective mitigation measures, or both, to reduce impacts of CBNG development on sage-grouse populations in the PRB.

Attachment 2 at 2. There is no scientifically valid reason to expect the results to be any different in the Bighorn Basin. Furthermore,

> Strong support for models with negative effects of CBNG at both the 0.8-km and 3.2-km scales indicate that the current restriction on surface infrastructure within 0.4 km is insufficient to protect breeding populations.

Id. at 18. In the end,

> Our analysis indicates that maintaining extensive stands of sagebrush habitat over large areas (6.4 km or more) around leks is required for sage-grouse breeding populations to persist. This recommendation matches those of all major reviews of sage-grouse habitat requirements (Schroeder et al. 1999, Connelly et al. 2000&, Connelly et al. 2004, Crawford et al. 2004, Rowland 2004). Our findings also refute the idea that prohibiting surface infrastructure within 0.4 km of the lek is sufficient to protect breeding populations and indicate that increasing the size of no-development zones around leks would increase the probability of lek persistence.... Timing restrictions on construction and drilling during the breeding season do not prevent impacts of infrastructure (e.g., avoidance, collisions, raptor predation) at other times of the year, during the production phase (which may last a decade or more), or in other seasonal habitats that may be crucial for population persistence (e.g., winter).

Id. at 21.

For sage grouse, Holloran (2005) demonstrated that wells sited within 1.9 miles (during the post-drilling, post-construction production phase) caused negative impacts on sage grouse. Walker et al. (2006) demonstrated negative effects on sage grouse lek populations when wells were sited between 0.5 and 2 miles of the lek. Attachment 2 at 2. Under current BLM statewide policy for sage grouse, wells could be sited as near as 0.25 mile from a lek site. *See* FEIS at Table 2-6. In the context of the Atlantic Rim CBM project, the U.S. Fish and Wildlife Service also voiced its disapproval for these mitigation measures:

> The Service is very concerned that authorization of this project, as proposed, will significantly affect the population of greater sage-grouse that occurs in this area of Wyoming. Adverse affects to sage-grouse may occur through the long-term loss of sagebrush habitat, fragmentation of habitat, and noise associated with project activities. The Service does not support a 0.25-mile protective buffer around sage-grouse leks as a mitigation measure, nor do we support a 2-mile buffer to protect nesting habitat.... Additionally, recent information from a doctoral dissertation on the impacts of oil and gas development to greater sage-grouse in the Pinedale Anticline found that as development increased, lek activity declined up to 100 percent (Holloran 2005)...Additionally, Holloran concluded that stipulations placed on oil and gas development in the Pinedale Anticline, which are identical to those proposed for the Atlantic Rim development, were insufficient to maintain sage-grouse breeding populations in natural gas fields.

Attachment 3 at 3. Holloran (2005) also found that well densities exceeding 1 well per 699 acres had a negative impact on grouse. State agencies recommend that well densities not exceed one site per square mile in cases where sensitive habitats cannot be avoided altogether. Thus, in the absence of mitigation measures capping well density at this figure, oil and gas development would be expected to have

deleterious effects on nesting sage grouse despite the standard mitigation measures for sage grouse. Stronger mitigation measures are clearly necessary.

For the Cow Butte/Wild Cow Wildlife Habitat Management Area under the BLM's proposed Rawlins RMP, BLM conceded that stipulations for sage grouse are inadequate to maintain viable populations:

> The development of oil and gas wells surrounding the V^-mile buffer around grouse leks would reduce the amount of habitat available for nest site selection. The birds would be required to either nest in less optimal locations or space their nests more closely. Increased noise resulting from CBNG [coalbed methanej-related traffic would possibly affect the ability of female grouse (both greater-sage and Columbian sharp-tailed) to locate leks, potentially reducing the reproductive viability of the species. CBNG development within the Cow Butte/Wild Cow area would reduce the number of male grouse inhabiting leks within or adjacent to coalbed natural gas development. It would also increase fragmentation of plant communities used by grouse, degrading both nesting and brood-rearing habitat. The ability of these birds to move to adjacent, less disturbed habitat is extremely limited because of oil and gas development to the west and increasing elevation and snowpack to the east. Thus probable development would threaten sustained use of the area by sage grouse.

Rawlins RMP FEIS at 4-332. The same principles apply in the Bighorn Basin.

The adequacy of the current small NSO buffers for sage grouse leks has been repeatedly refuted in the scientific literature. Beck (2006:4) stated, "Results suggest that no surface occupancy within 0.4 km is not adequate to avoid lek abandonment or other negative influences on prairie grouse populations, and also indicates that surface occupancy may need to be at least 1.6 km from leks to avoid declines or abandonment" (internal ref. omitted). Attachment 5.

A west-wide panel of state fish and wildlife agency personnel examined the state of the science on sage grouse conservation, and had this to say about the current suite of oil and gas lease stipulations:

> Much of the greater sage-grouse habitat in MZ-1 and 2 has already been leased for oil and gas development. These leases carry stipulations **that have been shown to be inadequate** for protecting breeding and wintering sage-grouse populations during full field development. New leases continue to be issued utilizing these same stipulations.

Attachment 6 at 2, emphasis added, internal citations omitted. BLM must not continue to apply mitigation measures that have been uniformly rejected as inadequate by the scientific community and wildlife management agencies.

A Blueprint for Sage Grouse Conservation and Recovery by Dr. Clait Braun, arguably the world's leading expert on sage grouse conservation provides recommendations for sage grouse conservation, was submitted to the BLM during the planning process but was ignored by BLM. *See* Attachment 1. Dr. Braun's recommendations constituted a reasonable alternative based on the best available science that would place a moratorium on the constructions of well, roads, and other infrastructure for the important nesting habitat that occurs within 3 miles of a sage grouse lek. BLM should consider the implementation of these recommendations in at least one of the agency's alternatives, and adopt these recommendations as standards in the new RMPs.

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 Bighorn Basin 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 (2005) 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.

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).

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 Bighorn Basin 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). In particular, we wish to ensure that any nesting plover populations in the Polecat Bench area receive adequate conservation attention.

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 in south-central Wyoming "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). It was formerly believed that mountain plover nesting occurrences in close proximity to oil and gas wells in northeastern Utah constituted evidence that oil and gas development is compatible with the needs of nesting plovers. As the

Utah population of plovers is now extirpated, this interpretation of the data no longer is considered to hold any water.

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). Mountain plover nesting concentration areas should be managed as Areas of Critical Environmental Concern with No Surface Occupancy stipulations required.

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. Bald eagle roost sites are also a conservation concern in the Bighorn Basin. 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 Bighorn Basin; 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.

Power line 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 reduce 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.

Wind Power Development

We have attached the report, *Wind Power in Wyoming: Doing it Smart from the Start* for your review and incorporation in the revised RMPs. Attachment 6. This report includes a comprehensive review of the scientific and technical literature as well as outlining which lands should be excluded from wind power development, which lands should be available for development once certain Best Practices are put in place, and which lands have no identified resource conflicts and would be most favorable for wind energy development. We incorporate this report by reference into the comments, and this report constitutes

BCA's comments and recommendations for the Bighorn Basin plan revisions. Please respond to the issues raised in this report through the NEPA process.

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 RMPs.

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 in 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 Murphy 1978). 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. In southern Wyoming, 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).

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. 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.

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 ¼ 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. 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).

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 Cody and Worland Field Offices is habitat for the white-tailed prairie dog. 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 Bighorn Basin, prairie dog colonies are 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 (1977:213) 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." 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 white-tailed 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 quantity 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.

Sy I vatic 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. The Bighorn Basin may have advantages; 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 Bighorn Basin may already be stressed by endemic or epidemic levels of sylvatic plague, stronger conservation measures are needed to prevent impacts from activities such as prairie dog poisoning and shooting 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 Bighorn Basin. 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. We recommend that poisoning of prairie dogs not be permitted on public lands. We further recommend that shooting be prohibited on BLM lands, not only to reduce impacts on prairie dogs but also to reduce the potential for lead poisoning of hawks and eagles and other species which prey on or scavenge prairie dogs (see Pauli and Buskirk 2007).

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 Bighorn Basin, and indeed the last wild ferret population in the world was found near Meeteetsee. Today, Wyoming's only reintroduced population resides in the Shirley Basin, far to the south. 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 Reproduction

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 Bighorn Basin, particularly the Polecat Bench prairie dog complex, and such sites would be of primary conservation concern. The BLM should manage all prairie dog complexes of sufficient size to support ferret reintroduction specifically to enhance the reintroduction capability of these complexes.

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).

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: 17), "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." Kilgore (1969:525) 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." 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). Parker et al. (1985) highlighted Muddy Creek in southern Wyoming 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 encourage the BLM to reintroduce beaver to streams where it once occurred.

Deer and Elk

Mule deer and elk are important game species in the Bighorn Basin. These game animals contribute importantly to the Wyoming economy, both from hunting and wildlife viewing visitors. The Bighorn Basin includes important winter range for deer and elk populations that summer in the surrounding mountains, as well as resident populations. BLM (2007) provided a credible review of the impacts of oil and gas development on elk; we encourage the BLM to consider this literature review in drafting the EIS for the Bighorn Basin plans. Protections to maintain the viability of elk and mule deer are needed in the Bighorn Basin, an these protections should be focused on crucial winter ranges, migration corridors, 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 should be closed to both motorized and nonmotorized entry from November through April. 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 (and only 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

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 southern Wyoming 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 in coniferous habitats 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 Bighorn Basin 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. BLM should ensure that road densities never exceed one mile per square mile in important big game habitats.

Crucial elk winter ranges in the Bighorn Basin 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. 2006). 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 Bighorn Basin. 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 montane habitats (Compton 1974). Strickland (1975) found that riparian areas and clearcuts were important summer ranges on the Medicine BowN.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. For the Medicine Bow, many critical mule deer winter ranges are in surrounding basins outside the boundary of Forest Service lands (Strickland 1975). This is likely to be the case in the Bighorn Basin as well. 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.

For mule deer on the Pinedale Anticline winter ranges, subject to the same stipulation, displacement from crucial winter ranges has been total during most years. Researchers funded by BLM and industry recorded a 46% drop in mule deer populations wintering on the Pinedale Anticline winter ranges ***while seasonal stipulations were in full force and effect,*** with no corresponding decline for nearby populations unaffected by gas development; populations have not rebounded to date (Sawyer et al. 2006). It appears that during especially severe winters, snow conditions force mule deer to use traditional winter ranges even if they have been subjected to heavy oil and gas development, and population losses are the result. *Id.* These researchers concluded,

> In gas fields like the PAPA [Pinedale Anticline] where well pad densities may reach 16 or more per section (2.58 km^2), the number of producing well pads and associated human activity may negate the potential effectiveness of timing restrictions on drilling activities as a means to reduce disturbance to wintering deer. Mitigation measures designed to minimize disturbance to wintering mule deer in natural gas fields should consider all human activity across the entire project area and not be restricted to developing wells.

(Sawyer et al. 2006, p. 4-20). In the Bighorn Basin, we request that BLM develop stipulations for crucial winter range that result in no net loss of habitat function pursuant to the WGFD Mitigation Policy.

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 Bighorn Basin 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 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. Proghorn crucial winter ranges and migration corridors will need to be protected from conversion to industrial landscapes.

Vagrant lichens can be an important forage for pronghorns.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.).

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.

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 Cody and Worland Field Offices, 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 Bighorn Basin is needed.

Antelope migration routes become critically important during severe winters that occur periodically in the Bighorn basin. 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 "[ujnpublished 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. 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 Bighorn Basin 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 Bighorn Basin visitor experience.

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.

BLM should manage wild horse herds at levels that assure that their genetic viability is maintained. Horses are harem breeders, and many adult males do not participate in breeding each year lowering the effective number of breeding horses in a given herd. In general, the lowest effective number of breeding animals needed to maintain genetic variability is 50, and this assumes an equal number of breeders from each sex. BLM should study the minimum viable population needed to maintain genetic variability for its wild horse herds and ensure that populations are maintained comfortably above this minimum.

Native 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 native 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). Jesperson (1981) 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. BLM should avoid the permitting of additional water diversions in order to maintain viable 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) or other industrial intrusions are rendered completely invisible through intervening topographic features such as hills or draws. Native American trails, as well as important histric or cultural sites identified by the tribes, should be given similar protective measures.]

MINING AND ENERGY DEVELOPMENT

Strip mining, particularly for bentonite, has been steady in the Bighorn Basin for a number of years, while the level of oil and gas development shows signs of a major increase in coming 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 tight shale drilling. Mining and energy development has been listed as a factor that has historically limited or may currently jeopardize populations of sensitive wildlife such as ferruginous hawks, 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 can 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 a primary cause of habitat fragmentation in certain parts of the Bighorn Basin.

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).

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. 2004). 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. (2004), "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 you will find the report, *Drilling Smarter: Using Directional Drilling to Reduce Oil and Gas Impacts in the Intermountain West.* Attachment 7. 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 should become the standard drilling procedure.

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 RMPs.

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, SO4, and NO3. Toxic levels were reached at conductivity of 2,750 umhos/cm and TDS of 2610 mg/1. 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/1. 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		

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Beryllium		5.1	16 (6s)	053 (Is)
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	1 1 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 (Is)
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.

Wastewater should have to be reinjected into aquifers of similar qualities or treated to match surface water qualities for immediate agricultural or municipal use (not wasted by dumping it into local waterways). 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 Bighorn Basin plans, shot-hole seismic should be the method of choice unless specific concerns about archaeological or paleontological resources or water table concerns preclude the use of the shot-hole method. In addition, heliportable drills and hand-laying of geophone lines should be mandated for sensitive lands.

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Coal Mining

Strip mining for coal is possible in the Bighorn Basin, abnd coal mines have operated here in the past. 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 in most cases 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). This is particularly true in the Bighorn Basin, where restoration of sagebrush after bentonite mine reclamation has largely failed (EDAW 2008). 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 Wyoming, 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 *w\\Qatgrass[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.). Utility corridors should 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 Bighorn Basin to satisfy the needs of motorized recreations, the establishment of user-created routes through illegal off-road driving is a problem in some areas. This is particularly an issue in parts of the Bighorn Basin with low rainfall and thin or salty soils, where a single off-road pass can leave long-lasting scars. 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.

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 and nonmotorized areas should be established to provide quiet backcountry recreation opportunities.

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 <u>designated</u> 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 Cody and Worland Field Offices 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.

Biodiversity Conservation Alliance has commissioned a study by Wyoming Wildlife Consultants to determine the effects of past sagebrush manipulation projects on sage grouse populations. This study should be completed in December of 2008 and we will share it with BLM as soon as the results become available.

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 Bighorn Basin: Plants like cheatgrass, kosha, halogeton, 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 RMPs 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). 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 Bighorn Basin 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 Bighorn Basin plans 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 Bighorn Basin, 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 pastures (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.

Economics of Grazing

There is an inherent conflict between short-term profitability and long-term economic 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 and ultimately benefits livestock permittees as well.

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 appear to 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 required 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, BLM should manage grazing on crucial winter ranges to ensure that adequate forage remains after the cessation of livestock grazing to provide ample forage for wildlife.

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 on BLM lands in the Bighorn Basin have historically been small from an economic standpoint. 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.l 14) 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 et al. (2005) 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 "[njatural 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, this study found that the soil scarification (e.g., tractor walking, rollerchopping) that often 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 (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 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 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 BLM lands of the Bighorn Basin. The new RMPs should specifically place 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. 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). 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 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 failed to manage timber harvest in a responsible, sustainable, and ecologically sound manner. It is therefore necessary for the revised Bighorn Basin RMPs 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 between entries.

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 2001). 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 Huff et al. (1995), "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 Wildland-Urban Interface areas, defined as within V^* 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

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 Wyoming tend to be 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. Timber harvest rotations should be 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 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, serai 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, Wyoming's forested ranges 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." The modern pattern of isolated tracts of mature forest in a sea of roads and clearcuts in managed forest landscapes 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 Wyoming, and yet Environmental Impact Statements have heretofore ignored the cumulative effects of the massive roading, habitat fragmentation, construction, and increased activity on 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 RMPs, a thorough analysis of the cumulative impacts of oil and gas development in the Bighorn Basin 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 National Forest lands in southern Wyoming 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. We would expect a similar relationship to occur in the Bighorn Basin and adjacent National Forest lands.

The effects on Class I (Pristine) airsheds must be examined. Also, impairment to the air quality and visibility in other wilderness areas as well as BLM WSAs, not granted special protection under the Clean Air Act, must be analyzed and minimized. The new RMPs must thoroughly analyze the cumulative effects of oil and gas development in the Worland and Cody Field Offices together with all other projects in the basin as a whole, including development in other parts of the region that share the same airshed.

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 5° C 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 RMPs.

LANDS REQUIRING SPECIAL ADMINISTRATIVE PROTECTIONS

In the nation's inventory of protected lands, there is a substantial lack in representation of the species and ecosystems found in the Bighorn Basin. 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).

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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.

Heart of the West Conservation Plan

We recommend that BLM adopt the Heart of the West Conservation Plan as a framework for managing a system of core habitats and connecting linkages so that viable populations of wildlife will be maintained throughout the Bighorn Basin. See Attachment 8. This plan was developed using the SITES modeling process, by inputting the habitat requirements of key indicator species, rare biological elements, and other known correlates of habitat quality and ran the model exhaustively to identify the areas of greatest ecological importance. Areas not selected by the model, identified as Compatible Use Areas, would be appropriate for industrial development as long as it is done in a way that minimizes impacts. We recommend that at least one alternative adopt the recommendations of this framework, which we incorporate by reference into our comments.

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 that are underway, conducted by Biodiversity Conservation Alliance, was more intensive and covered a few of the wilderness-quality lands thus far including the McCullough Peaks and (in preparation) Bobcaty Draw. The Bobcat Draw inventory has identified the Paradise Alley road as not conforming to wilderness qualities, but there is a unit greater than 5,000 acres and possessing wilderness character to the south of the Paradise Alley road which meets wilderness criteria. We await a response on the McCullough Peaks inventory, but incorporate this inventory by reference into our comments. Additional wilderness-quality lands are known to exist along the northern boundary of the Red Butte WSA, across Elk Creek (which once had a road following it that now is completely gone) as far as the top of the bluffs to the north of the streamcourse. We call for the BLM to grant Wilderness Study Area status to ALL citizens' proposed wilderness in the planning areas, granting it the same protections that the current WSAs now enjoy.

Cedar Mountain

Summary

Citizens' Proposal: 26,975 acres
Intensive Inventory: 39,300 acres
Wilderness Study Area: 21,560 acres
BLM Recommendation: 10,223 acres

Highlights

Cedar Mountain is an imposing juniper-studded rock escarpment towering over the Bighorn Basin. Steep drainages, slick rock, and hoodoos and goblins of stone make this a big exciting area to explore. On the western boundary, grotto covered-bluffs drop sharply to the Bighorn River. The

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sagebrush and grass slopes are interspersed with cottonwoods lining the streambeds, and junipers which grow in belts and pockets along the hillsides.

This wilderness area is a rare example of a dry "cold" desert badland which borders a large river.

Location and Access

Cedar Mountain is just 8 miles southwest of Worland in Washakie County situated on the east side of the Bighorn River. A good access is from County Road 172 to County Road 23 (Cowboy Springs Road) to enter the southwestern boundary area.

Wilderness Qualities

This high desert site offers a variety of outstanding recreation opportunities, including hunting and trapping, horseback riding, rockhounding, fishing and canoeing from the river front. BLM's Bighorn River Special Recreation Management Area encompasses the western half of Cedar Mountain, while the BLM has recommended the southern half of the area for wilderness designation.

Two to three hundred mule deer use crucial winter range and yearlong habitat here (WG&F, 1992). The Wyoming Game and Fish supported the area for wilderness designation because of its natural condition and its importance as year round deer and pronghorn antelope habitat.

Bald eagles (listed endangered/threatened under the Endangered Species Act) forage along the western edge of the area, and are observed nesting and incubating in riparian areas there (BLM 1990; WNDD, 1993). Merlin falcons and Richardson's merlin falcon, both rare and unique species as determined by the State, have been observed in the area (WNDD, 1993). Golden eagles, prairie falcons, and several hawk species nest throughout the area, while great blue herons have a riverside rookery just outside the boundary. Sage grouse strut and nest in the eastern portion.

Cedar Mountain provides habitat for many other species such as bobcats, chukar and gray partridge. Rock walls throughout the area provide habitat for Townsend's big-eared bats and for the pallid bat—two State priority species due to their rarity (WNDD, 1993).

The Bighorn River provides aquatic habitat for two unique and rare State Priority species of fish - the Western silvery minnow and the Mississippi silvery minnow (WNDD, 1993). This section of the Bighorn River is rated Class III (of Regional Importance) by the Wyoming Game and Fish. Some of the game fishery the river contains include stocked and wild rainbow, Yellowstone cutthroat, Snake River cutthroat, Bear River cutthroat, brown, walleye, sauger, and linge cod.

Because of Cedar Mountain's vantage point over the Bighorn River, it was undoubtedly much used by native people. The area also contains a wealth of reptile and mammal fossils ranging from 65 to 80 million years old, as well as petrified wood.

Resource Analysis

Cedar Mountain is not likely to have oil and gas reserves. USGS has determined that Cedar Mountain only has low to moderate potential for the occurrence of oil and gas. The WSA contains three dry holes, and of about 20 wells drilled within 3 miles of the WSA boundary, only three have produced—one is now plugged, and two are shut-in for economic reasons. The closest producing oil well is 3 miles east of the WSA at the western edge of a field. The southern area of the wilderness proposal has oil and gas leases extended to the year 2001, but there is no production in the area. Coal beds under the area are very deep and of such marginal quality that they will never be mined. The Cedar Mountain wilderness proposal has low potential for locatable and salable minerals, with no current or historic mining claims.

Should Cedar Mountain not be protected by wilderness designation the following could occur: Although no producing wells are expected, exploration would increase roading and sediment loads in the Bighorn River and stress to wildlife (BLM 1990). Nesting success of eagles, falcons, and other raptors would be reduced by an unknown amount due to increased human disturbance. Other activities, such as a

recent proposal to dam the Bighorn River and develop a resort in place of Kirby, could destroy special values on most of the study area. According to BLM (1990), development over the long term would result in a total loss of all wilderness values.

Boundary Rationale and Management Recommendations

BLM management decisions: The WSA has 21,560 acres - the BLM recommended only 10,223.

This area is bordered by private lands and a vehicle way on the northwest and southwest, roads or ways on the south and east. The Citizens' Proposal excludes part of the WSA in which BLM allowed plowing and construction of a powerline.

2. Buffalo Creek (010-220)

Summary

Citizens'Proposal:	27,081 acres
Intensive Inventory:	27,300 acres
Wilderness Study Area:	0 acres
BLM Recommendation:	0 acres

Highlights

The undulating plains and deep draws of the Buffalo Creek Area with awe inspiring views of the Bighorn Mountains truly represent the open range that is so unique to Wyoming. The proposed wilderness includes portions of Buffalo Creek, Buffalo Springs Creek, and Blue Bank Draw, which drain to the Nowood River. As the name suggests, bison once roamed in vast herds over the wide open spaces here.

Location and Access

The Buffalo Creek area is located just southeast of the Honeycombs and 8 miles south of Tensleep in Washakie County. Access is from the southern Nowood River road from Tensleep (State Road #434).

Wilderness Qualities

Visitors to Buffalo Creek discover remote open spaces, and wide vistas of the Nowood River country and Bighorn Mountains. Large white cliffs of the Chalk Cliff area are surrounded by badland plains. Wildflowers are abundant in the spring.

Buffalo Creek provides crucial and year-round mule deer and pronghorn antelope winter range (Berry and Goldbach 1991; WGFD Completion Report 1991). Small mammals also inhabit the area, and all provide a prey base for large numbers of golden eagles. While reviewing this study area, volunteers saw a group of seven eagles circling together, and another eagle nesting.

Survey work for rare plants or animals has not been done for the Buffalo Creek area (WNDD, 1993).

Resource Analysis

The Buffalo Creek Wilderness Proposal area is mostly leased for oil and gas for the next two to six years, however there are no producing wells in the area. There are no active mineral claims within the proposal boundary. The BLM has limited vehicle travel in the area to designated roads and trails due to the highly sensitive and erodible soils. Thus conflicts with off-road vehicles have been minimized.

With the extensive oil and gas leasing in the area, exploration would ruin Buffalo Creek as habitat for elk, eagles, and other unique species should the area not be protected as wilderness.

Thirty-two outfitters have permits for hunting in the general area.

Boundary Rationale and Management Recommendations
BLM management decisions: This area was not recommended for wilderness.

This study area is bounded by bladed roads and private land on the west and south, and by vehicle ways on the north and east.

3. Honeycombs (010-221)

Summary

Citizens' Proposal:	52,764 acres
Intensive Inventory:	68,400 acres
Wilderness Study Area:	21,000 acres
BLM Recommendation:	0 acres

Highlights

The stunning badlands of the Honeycombs is one of the most spectacular areas in Wyoming. The area mesmerizes its visitors with a kaleidoscope of pastel orange hills, tan rock mushrooms, and red-, white-, and purple-striped cliffs. Situated to the west of Castle Gardens, the area exemplifies the biblical notion of wilderness as an area for contemplation and spiritual renewal, even to the non-devout. Sagebrush and grasslands are interspersed through the array of unusual pinnacles, spires, and buttes, while greasewood and rabbitbrush grow along the winding canyonlands. With only 7-10 inches of rainfall per year, this area is a pristine high desert badlands landscape at its best.

Location and Access

Located just six miles southwest of Tensleep in Washakie County, the Honeycombs is accessed from State Highway 16 on the Blue Bank Road.

Wilderness Qualities

Opportunities for solitude and primitive recreation are truly outstanding. Visitors may lose themselves in a maze of vivid badlands or watch the full moon rise over a place that looks much like a moonscape.

The Honeycombs provide year-round and crucial winter range for 100 mule deer, and 200 to 300 pronghorn antelope, as well as nesting areas and crucial winter habitat for sage grouse. Golden eagles, great-horned owls, and other raptors also nest in the area and forage there year-round (Ritter 1991). Bobcats and coyotes roam the Honeycombs, as well. The black-footed ferret, a federally listed endangered species, was found in the area in 1974 (WNDD, 1993). The Wyoming Game and Fish Department has found the area to possess outstanding natural qualities and superb wildlife habitat and has recommended it for wilderness designation.

In addition to dramatic scenery and unique geologic features, this area is known for fossil deposits of large Tertiary mammals and reptiles. An archaeologic survey has not been conducted in the area, but scrapers, points, and other stone artifacts are commonly found.

Resource Analysis

The area has no salable minerals. There are no mineral leases within the boundary area (BLM, 1992). Coal reserves will probably never be leased due to their poor quality and high development costs (BLM 1990). The area has potential for occurrence of titanium and other metals, but these are mined more economically elsewhere. Although the area has been rated as having moderate potential for the

occurrence of oil and gas, it is considered to be on the nonproductive side of a facies change in the Phosphoria formation (Love 1991). According to BLM, one well was drilled in the boundary area and was abandoned in 1982. Oil and gas leasing occurring within the western and southern boundary area are due to expire in one to nine years (BLM 1992).

Periodic access for maintenance of water sources, fences, and use of a cow camp just inside the boundary could continue as in the past.

Should the Honeycombs not be protected as wilderness, mineral exploration, ORV use, and other surface-disturbing activities would result in a loss of most, if not all, wilderness values (BLM 1990). The terrain and its associated soils are not conducive to motor vehicle or bicycle use. Paleontology resources could be destroyed through incomplete mitigation. Sediment loading into the Bighorn River would increase slightly and wildlife would be displaced.

Boundary Rationale and Management Recommendations

BLM management decisions: The BLM did not recommend the Honeycombs for wilderness designation. The Wilderness Study Area contains 21,000 acres.

The citizens' proposed additions to the WSA are necessary to protect equally wild and scenic badlands topography. BLM should acquire state land within the study area for enhanced manageability. Boundaries for this area are roads, trails and private land on the north and east, and vehicle ways on the south and west.

4. Alkali Creek (010-241)

Summary

Citizens' Proposal:	17,117 acres
Intensive Inventory:	17,000 acres
Wilderness Study Area:	10,100 acres
BLM Recommendation:	8,187 acres

Highlights

Alkali Creek is an odd mix of high desert pastel plains sloping quickly downward into a tight cottonwood canyon surrounded by hoodoo sandstone pinnacles. It lies in a transition zone below the Bighorn Mountains, and offers spectacular views of the Bighorn Basin. Gradual slopes and rough canyons of red Chugwater soil contrast with pockets of blue-green juniper and light green sagebrush, while monoliths of Tensleep sandstone jut up above the grasslands. Lemonade berries and cottonwood grow around springs and along the drainages. Elevations range from 4850 to 7000 feet.

This area has many unchartered aboriginal sites and provides a haven for wintering elk migrating from the Bighorn Mountains.

' Location and Access

Alkali Creek is located in Big Horn County, 7 miles north of Hyattville. On the eastern boundary, the Red Gulch National Scenic Byway (along the west face of the Bighorn Mountains) easily accesses the area.

Wilderness Qualities

The Alkali Creek area holds a wealth of prehistory dating back at least 12,000 years. A cultural inventory of about one percent of the study area yielded ten sites, five of which were eligible for the National Register of Historic Places. Two other known sites are also eligible. This indicates that the area contains a very high number of important archaeologic sites (BLM 1990). Known features include pictographs, petroglyphs, rock shelters, tepee rings, chert collecting areas, and stone tools. These and other undiscovered cultural resources will probably lead to listing of the area as an Archeological District as more studies are completed.

A great variety of wildlife use the area. More than 300 elk and____many mule deer find crucial winter range. There are at least two sage grouse strutting grounds in the WSA and golden eagles nest here. Other desert creatures, such as pronghorn antelope, bobcats, chukar partridge, prairie falcons, and horned toads abound.

The area is unique in habitat that supports several plant species. Branched fleabane lives in the generally sparsely vegetated juniper and mountain mahogany communities is federally protected (rated 3c) as well as Cary beardtongue - a penstemon - (a candidate for federal listing). In the survey for rare plant communities, the Alkali Creeks supports two worthy of special protection - that of the "mountain big sagebrush/Idaho fescue community" and the "narrow-leaf cottonwood/chokecherry community" (WNDD, 1993).

Alkali Creek WSA is located within the West Slope Special Recreation Management Area and affords visitors access to remote, wide open spaces. It is also bordered on the east and north by the Red Gulch National Scenic Byway, and is described in BLM Byway publications as a place where one can "get away from it all" (BLM undated). The BLM has recommended most of the WSA for wilderness.

This site is also geologically important in that it contains unique outcrops of ancient eolian sandstones.

Resource Analysis

Low potential for oil or gas occurs in the area. The two oil and gas leases occur in the far eastern area and will expire in 1993 (BLM, 1992). The potential for tar sands is moderate. A low to moderate potential exists for minor silver sulfides and other metals, and potential for the occurrence of uranium is moderate—as is the case for most of the region. There are no mineral claims active in the boundary area. Gypsum beds in the area are too thin, discontinuous, and of too poor quality to be developed (BLM 1990). The BLM has designated lands in the region of Alkali Creek accessible to motorized vehicles only on designated roads and trails, making the conflicts with off road vehicles minimal.

Three outfitters have day-use permits for hunting in the area.

The entire Alkali Creek area would be open for mineral exploration and leasing, and these activities could destroy wilderness values on a substantial portion of the area (BLM 1990) should the area not be designated as wilderness. Crucial game wintering areas, eagle nesting use, special archaeologic resources, and other values could be inadvertently damaged or lost.

Boundary Rationale and Management Recommendations

BLM Management Decisions: 8,187 acres are recommended for wilderness, 1,913 are not.

5. Medicine Lodge (010-240)

Summary

Citizens'Proposal:	16,654 acres
Intensive Inventory:	10,800 acres
Wilderness Study Area:	7,740 acres
BLM Recommendation:	3,600 acres

Highlights

Medicine Lodge is one of the most spectacular canyons on the western slope of the Bighorn Mountains. Sheer cliffs of Madison limestone stair-step down over 1000 feet to a clear, cascading stream. A shallower canyon on Captain Jack Creek enters from the south, while orange Tensleep sandstone crops out on the shrubsteppe away from the canyon. The study area supports many types of vegetation: alder and chokecherry line the water courses, Douglas fir and other conifers blanket higher parts of the steep north-facing slopes, mountain mahogany and juniper grow on the southern aspects and shrubsteppe, and sagebrush grasslands cover the canyon rims. Wildflowers and berries abound.

Location and Access

1313

This wilderness study area is located in Big Horn County, 5 miles northeast of Hyattville along the western slope of the Bighorn Mountains. Medicine Lodge is easily accessed from the south utilizing the Cold Springs Road from Hyattville.

Wilderness Qualities

Visitors to Medicine Lodge make their way through wild, rugged terrain and thick vegetation to find excellent hunting and fishing. Superb nature and geology studies are provided by pristine ecological conditions and an abundance of fossils from the Lower Mississippian Age. Additionally, they can explore the passages of P-Bar Cave—which swallows up Medicine Lodge Creek every spring when the water is high.

Medicine Lodge is situated within the BLM's West Slope Special Recreation Management Area of the Bighorn Mountains, and is a scenic backdrop for the Red Gulch National Scenic Byway.

The BLM has included much of the Medicine Lodge Canyon in its Spanish Point Karst Area of Critical Environmental Concern and has recommended much of the area for wilderness designation. The ACEC was designated to protect important groundwater sources, while about half of the area is cooperatively managed as a Wyoming Game and Fish Department Habitat Management Area.

Nearly the entire area is crucial elk winter range—over a thousand may be present at one time—and a portion is crucial winter range for several hundred deer. Black bear, mountain lion, chukar and gray partridge, and nesting raptors, including American kestrel, prairie falcon, golden eagle, and red-tailed hawk (Ritter 1991), also call this area home. Harlequin duck and North American lynx, both candidates for Federal listing for endangered/threatened status, are found in the Medicine Lodge canyon area (WNDD, 1933). Sage and blue grouse strut and nest in the northern part of the area. In the winter, up to 20 bald eagles - federally listed as endangered - have been counted roosting in cottonwoods along the streams. Habitat occurs for spotted bats - federal threatened and endangered candidate species, and five state Priority Species of other bats - Townsend's big-eared bats, Yuma myotis, California myotis, Keen's myotis and fringed myotis - in the extensive cliffs within the area (Luce 1991). The long-legged myotis which has been observed in the Medicine Lodge Canyon area, is a rare State Priority species of bat (WNDD, 1993).

This lush deep canyon habitat in the transition zone on the very edge of the Bighorn Mountains is host to an array of rare plant species - blanched fleabane, Cary beardtongue, soft aster, and Hapeman's sullivantia have been identified in the area.

The multitudes of Medicine Lodge Canyon's diverse, rare plant communities listed demonstrate that this area's uniqueness is not only worthy of wilderness protection but a requirement for this area. The rare plant communities the area supports are: mountain big sagebrush/Idaho fescue community, bluebunch wheatgrass-Hood's phlox potential community, boxelder/bedstraw potential community, chokecherry/bedstraw potential community, Utah juniper/bluebunch wheatgrass community, curl-leaf mountain mahogany/bluebunch wheatgrass community, Douglas fir/heartleaf arnica community, Douglas fir/common juniper community, lodgepole pine/whortleberry community, prickly currant/bluebells potential community, narrowleaf cottonwood/chokecherry community, chokecherry/bedstraw potential community, mountain big sagebrush/Idaho fescue community, and limber pine/common juniper community.

Medicine Lodge Creek, which was named for a Native American ceremonial sweat lodge, flows by a wall of petroglyphs just outside the study area in Medicine Lodge State Park. Although an archaeologic survey has not been done for the study area, it is expected to contain a great diversity of sites, some of which would be eligible for the National Register of Historic Places.