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 coal, has been steady in the Powder River 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 Powder River 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 RMP.

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

Coalbed Methane

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

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

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

Chemical	OSWER NAWQC/FCV	OSWER Tier II	Region IV Acute Screening	Region 4 Chronic Screen.
Aluminum			750	87
Antimony			1300 (2s)	160 (2s)
Arsenic III	190		360	190
Arsenic V		8.1		
Barium		3.9		
Beryllium		5.1	16 (6s)	053 (1s)
Boron			--	750
Cadmium	1.0 h		1.79 h	0.66 h
Chromium III	180 h		984.32 h	117.32 h
Chromium VI	10		16	11
Cobalt		3.0		
Copper	11 h		9.22 h	6.54 h
Iron	1000		--	1000
Lead	2.5 h		33.78	1.32
Manganese		80		
Mercury			2.40	0.0123
Molybdenum		240		
Nickel	160 h		789.00 h	87.71 h.
Selenium	5.0		20.0	5.0
Silver			1.23 h	0.012 (1s)
Thallium			140.0 (3s)	4.00 (2s)
Vanadium		19		
Zinc	100 h		65.04 h	58.91 h.

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

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

In addition, aquifers in different geologic strata are not watertight units, and often there is significant water leakage between aquifers (Phillips et al. 1989, Walvoord et al. 1999). Thus,

coalbed methane development may not only dewater the target seam of coal, but may also result in the contamination of neighboring aquifers above or below with natural gas or other pollutants.

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, **either municipal use or wastewater reinjection should 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 Powder River 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.

Coal Mining

Strip mining for coal is a major industry in the Powder River Basin, and 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 where oil and gas development should be 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). 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 wheatgrass[*Agropyron cristatum*]) will probably result in declining sage grouse populations because of reduced nesting success" (p. 524). Rosentreter (1997) recommended against the conversion of native habitats to non-native seedings such as crested wheatgrass in order to encourage the persistence of vagrant lichens. Thus, the use of crested wheatgrass in seedings and reclamation should be prohibited.

Retention of topsoil for reclamation purposes is important, because availability of mycorrhizal propagules in soil used for reclamation can influence the success of sagebrush reestablishment (Lyford 1995). Topsoil should be reserved during every surface-disturbing activity, so that it can be replaced during the reclamation process.

POWERLINES AND UTILITY CORRIDORS

Powerlines have a number of unique impacts. In addition to focussing raptor predation on nearby prey populations, Brum et al. (1983) observed that powerline ROWs can become access ways for ORV use, serving as a means of gaining access to previously undisturbed areas. Brum et al. also found that effects of disturbance in the Mojave Desert were still apparent 33 years after construction, including depressed mycorrhizal activity, high seedling mortality, and poor shrub recruitment (Ibid.). 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 Powder River Basin to satisfy the needs of motorized recreations, the establishment of user-created routes through illegal off-road

driving can be a problem in some areas. This is particularly an issue in parts of the Powder River 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. Motorized use should occur only on designated routes throughout the planning area.

VEGETATION MANIPULATION PROJECTS

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

Biodiversity Conservation Alliance has commissioned a study by Wyoming Wildlife Consultants to determine the effects of past sagebrush manipulation projects on sage grouse populations in the Bighorn Basin. This study should be completed in January of 2009 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 Powder River Basin: Plants like cheatgrass, kosha, knapweed, leafy spurge, and spotted knapweed have the potential for major outbreaks. Each of these weeds, if allowed to invade across broad areas, would degrade wildlife habitats and impair the function of native ecosystems. Weed seeds carried by vehicles are several orders of magnitude more abundant when traveling on unsurfaced roads versus paved roads (Hodkinson and Thompson 1997). Livestock grazing can facilitate the invasion of noxious weeds (Green and Kaufman 1995). And rest from grazing may not solve the problem. Robertson (1971) found that even after 30 years rest from grazing, cheatgrass had actually increased. The new RMP should include measures to minimize the risk of weed invasion. The BLM must take a preventative approach to the noxious weed issue, rather than its past approach of remedial measures once weeds have already become established. This approach includes minimizing the extent of new road construction or reconstruction, reducing stocking levels when overgrazing is implicated in noxious weed invasion, and requiring that fill material is weed-seed free.

LIVESTOCK GRAZING

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

Grazing Effects on Vegetation Communities

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

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

Effects of Grazing on 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 Powder River 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.

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 RMP, a thorough analysis of the cumulative impacts of oil and gas development in the Powder River 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 Powder River 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 RMP must thoroughly analyze the cumulative effects of oil and gas development in the Buffalo Field Office 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 RMP.

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 Powder River 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).

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 Powder River 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 are a number of areas where Wilderness Study Areas could (and should) be expanded to encompass adjacent lands with wilderness characteristics. These include Fortification Creek and Gardner Mountain. BLM should undertake a complete analysis of public lands to determine unprotected lands that possess full wilderness characteristics (size > 5,000 acres or adjacent to WSA or wilderness, naturalness, and either solitude or outstanding opportunities for primitive and unconfined recreation) and ensure that new new RMP protects these wilderness qualities.

Proposed ACECs and SMAs
All currently existing ACECs and SMAs should be retained, and additional ACECs should be added to include important prairie dog complexes and mountain plover nesting concentration areas. The Fortification Creek ACEC should be created and expanded to include all crucial habitats of the Fortification Creek elk herd. These areas should be withdrawn from surface disturbing activities, and leased only under No Surface Occupancy (NSO) restrictions. In addition to the special areas enumerated in the sections that follow, all crucial winter, crucial winter relief, and elk calving areas identified by WGFD should be granted ACEC status and withdrawn from new mineral leasing and entry.

Additional Recommendations
We recommend a balanced approach to management of the public lands and resources in the Buffalo Field Office. The final RMP for these lands should promote the best use of the lands and resources in the Area, with the overarching goal that all permitted activities will be compatible with maintaining healthy ecosystems. It must also prevent any undue or unnecessary degradation of public land values. In keeping with these goals, the recommendations below provide that some areas with high wildlife, scenic, or recreational values are preserved and managed to support these fragile resources. Even so, the vast majority of these federal lands should remain available for energy development, logging, livestock grazing, and other uses.

Wildlife Habitat and Fisheries Management

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

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

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

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

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

Fire/Fuels Management

1. Natural fires shall be allowed to burn unless and until they directly threaten human lives and property.
2. Fuels reduction projects designed to reduce fire hazard shall be limited to areas within ¼ mile of existing buildings.
3. Prescribed fire will be the principal tool of fuels reduction, not mechanical treatments.

Areas of Critical Environmental Concern

1. Existing Areas of Critical Environmental Concern will be retained in the new Plan.
2. Areas where there is overlap between three or more types of big game crucial habitats as delineated by WGFD will be designated ACECs and leased only under No Surface Occupancy stipulations.
3. All ACECs will be withdrawn from locatable mineral entry and be classified as "unsuitable" for coal leasing.
4. Fluid minerals in all ACECs may be leased only under No Surface Occupancy stipulations.

Wilderness

1. All lands encompassed by citizens' wilderness inventories are granted Wilderness Study Area status and managed to protect their wilderness qualities.
2. Citizens' proposed wilderness areas will be withdrawn from mineral leasing, coal leasing, and locatable mineral entry.

Land Ownership Adjustments

1. BLM should identify and acquire non-BLM lands and consolidate ownership to enhance its ability to manage important recreation opportunities and wildlife habitats such as migration corridors, crucial big game habitats as defined by WGFD, riparian areas, and wetlands.
2. All land swaps will be conducted with adequate public notice and involvement.
3. The RMP should determine which lands are currently legally accessible by motor vehicle, horse, or foot for public recreation, and which lands are rendered unavailable for public recreation due to private lands which hold no access easements. The RMP should address the problem of inaccessibility of public lands for public recreation, including acquisition of easements and appropriate land exchanges.

Oil and Gas Leasing and Development

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

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

   - Existing and citizens' proposed Wilderness Study Areas;
   - Existing and Proposed ACECs; and
   - Lands in Visual Resource Management Classes I and II.

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

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

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

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

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

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

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

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

   a. Lands within 5 miles of historic trails, Native American Trails, or a site eligible for the National Register of Historic Places.

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

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

   - Lands where there is overlap between three or more types of wildlife crucial winter ranges, crucial winter relief areas, and elk calving areas as defined by WGFD,
   - Other Areas of Critical Environmental Concern as outlined in the Western Heritage Alternative,
   - areas within 1 mile of active raptor nests,
   - areas within 3 miles of active sage grouse or 1 mile of sharp-tailed grouse leks,
   - large prairie dog colonies and complexes, or those associated with BLM Sensitive Species such as the black-footed ferret, burrowing owl, mountain plover, or swift fox, plus a ½-mile buffer zone around these colonies,
   - critical habitats of Endangered and Threatened species, and
   - areas within the 100-year floodplain of permanent or intermittent streams or within 500 feet of natural water sources or riparian vegetation.

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

12. Oilfield exploration standards.

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

   b. Shot-hole seismic exploration will be the preferred method for seismic exploration where sensitive archaeological resources are not threatened, but shall be limited to hand-laying

of geophone lines and helicopter transport of drilling rigs in sensitive landscapes outlined in Section 2.

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

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

14. Oil and gas infill development.

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

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

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

15. Full-field development of new fields.

    a. Production wells shall be drilled from cluster pads immediately adjacent to existing improved gravel roads and subject to the limitations above; these cluster pads will be spaced at the widest possible spacing to minimize surface disturbance.

    b. The construction of new roads shall not be permitted unless the maximum interspersion cannot be met under the provisions of Section 4(b), subject to the limitations of Section 1. If new roads are constructed, the siting of cluster pads away from existing improved gravel roads will be achieved by minimizing the length of new road construction, using existing unimproved roadways wherever they are available.

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

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

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

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

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

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

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

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

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

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

Noxious Weeds

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

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

- Reduce the road construction associated with oil and gas development and other surface disturbance to the minimum practicable footprint.
- Reduce grazing pressures where overuse is promoting the spread of invasive species.
- Require that any fill material used on the Resource Area be free of non-native seeds or other noxious weed material.

Coal and Locatable Minerals

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

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

2. Sensitive areas that will be withdrawn from locatable minerals entry on a year-round basis, with ***no waiver available***:
   - wildlife crucial winter ranges, crucial winter relief areas, and birthing areas,
   - Other Areas of Critical Environmental Concern as outlined in the Western Heritage Alternative,
   - areas within 1 mile of active raptor nests,
   - areas within 3 miles of active sage grouse or 1 mile of sharp-tailed grouse leks,
   - large prairie dog colonies and complexes, or those inhabited by BLM Sensitive Species such as black-footed ferret, burrowing owl, mountain plover, or swift fox,
   - critical habitats of Endangered and Threatened species, and
   - areas within the 100-year floodplain of permanent or intermittent streams or within 500 feet of natural water sources or riparian vegetation.

Off-Road Vehicle Management

1. All motor vehicles should be limited to designated roads and trails throughout the planning area.
2. Designated routes will be limited to those which minimize damage to soil, harassment of wildlife, and conflicts with other recreational users in accordance with Executive Orders # 11644 (1972) and 11989 (1977), and 43 C.F.R. § 8340 et seq.

Sensitive Plants Management

1. All current special management areas should be maintained.

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

Soil, Water, and Air Management

Soils

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

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

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

Water Quantity

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

Water Quality

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

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

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

Air Quality

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

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

Visual Resource Management

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

Wild and Scenic Rivers

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

Adaptive Management Strategy

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

Monitoring

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

Vegetation Treatments

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

Forest Management

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

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

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

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

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

Historical and Cultural Resources

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

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

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

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

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

ROW Corridors

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

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

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

- Other Areas of Critical Environmental Concern as outlined in the Western Heritage Alternative,
- areas within 1 mile of active raptor nests,
- areas within 3 miles of active sage grouse or 1 mile of sharp-tailed grouse leks,
- large prairie dog colonies and complexes, or those inhabited by BLM Sensitive Species such as black-footed ferret, burrowing owl, mountain plover, or swift fox, and
- critical habitats of Endangered and Threatened species.

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

4. Communications sites and antenna structures will not be built in or adjacent to:

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

Livestock Grazing Management

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

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

2. The RMP should include a three-year schedule for reviewing the condition of all allotments and riparian areas and swift rehabilitation of those that are not in compliance with these requirements. The RMP should adopt a similar schedule for ensuring the timely completion

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of evaluations required under the National Environmental Policy Act and the Endangered Species Act for grazing activities on the Resource Area.

3. The BLM should manage all allotments toward "good" to "excellent" range condition.
4. Sufficient forage should remain following livestock grazing to support native wildlife.
5. The new RMP should impose measures to minimize the transmission of diseases from livestock to native wildlife.
6. All fences shall meet WGFD standards with regard to construction standards.
7. Illegal fences should be brought into compliance or removed.
8. The construction of new fences that might potentially interfere with the migration or dispersal of wildlife should be avoided.
9. The "Standards and Guidelines for General Application to All Components of the Rangeland Ecosystem," as well as "Standards and Guidelines for Unhealthy Ecosystems," currently in force on BLM lands, shall be formally adopted in full into the new RMP.
10. The BLM must ensure that grazing complies with the Fundamentals of Rangeland Health and other statewide requirements, and all riparian areas must be managed to comply with current "Properly Functioning Condition" requirements.

Conclusions

We applaud BLM for revising its Resource Management Plan in the Powder River Basin in the face of clear evidence that current activities are ecologically unsustainable and hope that this will lead to a more complete analysis of the direct and cumulative impacts to the ecosystems found here. Please consider these comments in crafting your range of alternative land-use plans, and please copy us will all future communications regarding the NEPA process for these plans. We will look forward to seeing your range of alternative plans in the forthcoming Draft EIS.

Sincerely yours,

Erik Molvar

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