Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats

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Wyoming Game and Fish Department
Cheyenne, Wyoming

PURPOSE AND USE OF THIS DOCUMENT

Management practices recommended in this document were developed in response to the greatly accelerated pace of fluid minerals leasing, permitting, and development in Wyoming, particularly on BLM-administered lands and minerals, to address the adverse effects we anticipate these activities will have on wildlife resources. These recommendations are also applicable to other land and mineral ownerships, and to other similar developments.

A working group of senior wildlife biologists who have several decades of experience working with energy-related issues, was tasked with developing the initial management recommendations in early 2004. The current version is a compilation of the original document and several changes made to address comments and concerns expressed by the oil and gas industry, the agricultural community, and conservation organizations. We recognize some of our recommendations are currently reflected in standard practices used by several companies and the BLM. We included existing, standard practices to reinforce their importance and effectiveness, to provide greater specificity where appropriate, and for reference by companies or agency offices that may not currently be using them.

The resource protection and mitigation recommendations were also derived predominantly from literature. Many of the concepts were adapted from a BLM publication entitled: "Best Management Practices for Oil and Gas Development on the Public Lands" available at: http//www.blm.gov/bmp/. We added specific criteria, based on available literature and interpretation of literature, to better define the circumstances and extent to which these practices should be applied to protect wildlife resources and maintain habitat functions.

In order to accommodate the current planning and implementation schedule for oil and gas development, the Wyoming Game and Fish Department drafted these management recommendations as a programmatic basis for integrating wildlife protection and mitigation criteria into the Bureau of Land Management's (BLM's) resource management planning and implementation processes. We emphasize the Wyoming Game and Fish Commission has a single-purpose mandate: "… to provide an adequate and flexible system for control, propagation, management, protection and regulation of all Wyoming wildlife" [W.S. 23-1-103]. We believe our consultation and commenting role in federal agency actions subject to NEPA review is fully consistent with the Commission's mission and purpose. Further, it is within the Department's authority, and indeed its obligation to make recommendations on any aspect of a federally conducted activity that potentially affects wildlife, whether positively or negatively.

The recommendations in this document are a planning tool that provides advanced disclosure of potential wildlife-related concerns, and suggests mitigation and management options companies and resource agencies can incorporate into project designs and operations to benefit wildlife. The general recommendations should be considered within areas of crucial and important wildlife habitats, in which intensive energy developments are planned. Maps of crucial big game winter ranges, sage grouse habitat, and other important habitats are available from the Wyoming Game and Fish Department. Recommendations may be site-specifically adjusted to deal with unique issues and circumstances, on a case-by-case basis. Ultimately, the authority to make land management decisions rests with the surface management agency.

The management practices were developed to avoid, minimize, and mitigate actual and anticipated impacts to habitat functions resulting from large-scale oil and gas development. The working group reviewed pertinent literature to identify and describe these impacts (refer to Appendix G – Annotated Bibliography). In some cases, studies of effects directly attributed to oil and gas operations were available, for example on displacement of elk from a crucial winter range. However, not all aspects of oil and gas operations have been specifically studied, so the group also interpreted information from studies of activities comparable to those associated with oil and gas fields. For example, we consulted studies of wildlife responses to humans on foot, equipment disturbance, roads, noise levels, etc., to describe disturbance thresholds for similar activities associated with oil and gas field developments. We believe this approach is reasonable and the results applicable for recommending programmatic management practices.

The working group did not have the opportunity to consult all available literature within the timeframe recommended practices were needed. Efforts to identify and incorporate additional literature, monitoring procedures and more effective mitigation are continuing. The technologies of oil and gas development, as well as wildlife mitigation, are continually evolving. Accordingly, this is a working document and the recommendations will be updated and revised as relevant new information becomes available. We encourage input that may improve future iterations of the document. Please direct that input to the working group chairman, Steve Tessmann, Wyoming Game and Fish Department, 5400 Bishop Boulevard, Cheyenne, WY 82006.

This version includes Wyoming Game and Fish Department's recommendations for protecting and mitigating wildlife resources affected by oil and gas development.

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INTRODUCTION

Several of the most intact, native ecosystems that remain in the Intermountain West are found within Wyoming. Sagebrush and grasslands throughout the western U.S. continue to gain importance for several reasons. Sagebrush provides diverse habitats to approximately 87 species of mammals, 297 species of birds (Braun et al. 1976) and 63 species of fish, reptiles and amphibians (Wyoming Game and Fish Department Vertebrate Species List, 1992). Sagebrush ecosystems in Wyoming contain crucial habitat for some of the largest, migratory populations of ungulates in North America and offer the best chance for survival of healthy populations of sage grouse and other obligate species. Grassland habitats of the north-central prairie states sustain 138 species of land mammals, including 16 considered narrowly endemic to grasslands (Appendix F) (Samson and Knopf 1996). Nine avian species (excluding wetland and sagebrush associates) are narrowly endemic to grasslands (Appendix F). Twenty additional species are more widespread but have strong affinities to the northern Great Plains region.

Beetle and Johnson (1982) estimated sagebrush-steppe communities comprised nearly 58,000 square miles (37 million acres) of Wyoming. The current estimate of sagebrush is about 29 million acres based on recent information compiled by U.S. Dept. Interior, Bureau of Land Management (2001). More than 21,000 acres of sagebrush have been converted to annual grasslands. The BLM study also documented approximately 381,000 acres of conifer/juniper encroachments, and approximately 684,000 acres dominated by perennial grasses with sagebrush cover loss.

Grassland ecosystems comprise approximately 20 percent (19,600 square miles) of Wyoming, predominantly in the eastern half of the State (USGS Biological Resources Division 1996). Shortgrass prairie is located mainly in the southeast corner of the state and extends southward into Colorado (Knight 1994). Mixed-grass prairie is common across much of eastern Wyoming.

Throughout the West, Sagebrush and grassland communities are in a diminished state of health and continue to be impacted by various agents including drought, incompatible usages of fire and fire suppression, excessive herbivory, agricultural conversions, energy developments, rural subdivisions, and other factors. As anthropogenic activities continue to impact ecosystems throughout the western U.S., Wyoming’s rangelands are becoming increasingly important in efforts to conserve functional, native ecosystems and their assemblages of dependant wildlife.

Much of the sagebrush in Wyoming is in late successional stages dominated by older plants (>50 years old) of relatively even age classes (sagebrush monocultures). These stands are characterized by reduced vigor, productivity, diversity, and nutritional quality (WY Interagency Vegetation Committee 2002). Grasslands have been extensively altered by agriculture and other land uses in Wyoming. Fragmentation and declining quality of these ecosystems are the principal reasons why populations and distributions of dependent wildlife are declining. Nationally, grassland and shrubland birds have declined more consistently over the past 30 years than any other ecological association of birds (WY Game and Fish Dept. and WY BLM 2002).

Many of the issues affecting sagebrush and grasslands are also impacting other ecosystems. Mixed mountain shrubs, aspen, riparian corridors, streams and wetlands provide extremely important habitat for a diversity of wildlife, but exhibit symptoms of declining health including advanced succession and overall loss of quality. To address these concerns, the Wyoming Game & Fish Department developed a Strategic Habitat Plan that sets forth the following goals (WY Game & Fish Dept. 2001): 1) manage, preserve and restore habitat for long-term sustainable management of wildlife populations; 2) increase wildlife based recreation through habitat enhancements that increase productivity of wildlife; and 3) increase or maintain wildlife habitat and associated recreation on Commission lands. To implement the Strategic Habitat Plan, priority terrestrial and aquatic (watershed) habitats were identified (Appendices D and E, respectively). These generalized priority areas should not be confused with specific habitat types identified under the Commission's Mitigation Policy, to which these oil and gas recommendations apply. Vital habitats such as crucial winter ranges and sage grouse breeding habitat are more limited and may be within or outside priority habitat areas.

Sagebrush-dependant wildlife are a fundamental part of the West's culture and heritage, a renewable resource, and a principal source of outdoor recreation. Wildlife-related expenditures are the second highest source of income to the economy of Wyoming, totaling nearly $0.5 billion annually in Wyoming (WY Game and Fish Dept. 2003). Development of expansive coal, oil and natural gas deposits that underlie crucial and important wildlife habitats, combined with other intensive uses of the land, constitutes one of the greatest, contemporary challenges to conservation of western wildlife. The impending, large-scale development of these domestic energy reserves could place sagebrush communities and wildlife at risk on lands overlying BLM-administered minerals.

The Department believes wildlife resources can be sustained on federal lands, at levels acceptable to the public, provided the agencies manage wildlife habitats, energy development and other land uses in a manner that is fully consistent and compatible with principles of multiple use and sustained yield set forth by the Federal Land Policy and Management Act of 1976 (FLPMA). These principles include "… a combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources … and harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources and not necessarily to the combination of uses that will give the greatest economic return or the greatest unit output."

SCOPE AND PURPOSE

The 3 major purposes of this document are:

1) Identify thresholds of oil and gas development and related activities that impair the functions of important wildlife habitats;
2) Prescribe management, mitigation, and monitoring practices to sustain important wildlife habitats as oil and gas developments reach identified thresholds; and
3) Prescribe mitigation practices to offset or compensate unavoidable, adverse effects of oil and gas development.

DEFINITIONS

As used in this document, "important wildlife habitats" include habitats defined by the Wyoming Game and Fish Commission's Mitigation Policy as "irreplaceable," "vital," or "high value" (WY Game & Fish Commission 1998). "Irreplaceable habitats" must be formally designated by the Commission and include habitats that cannot be replaced or mitigated (e.g., designated critical habitats of species listed under the federal Endangered Species Act). "Vital habitats" directly limit a community, population, or subpopulation, and restoration or replacement may not be possible. Such habitats include, but are not limited to: big game crucial winter ranges, sage grouse nesting and brood-rearing habitats, habitats of Status 1 and 2 native species, and Class 1 Streams. The Department is directed by the Commission to recommend no loss of habitat function. Some modification of habitat characteristics may occur, provided habitat function is maintained (i.e., the location, essential features, and species supported are unchanged). "High value habitats" sustain a community, population or subpopulation, but can be reconstructed or enhanced where avoidance is not possible. These habitats include, but are not limited to: parturition habitats and winter-yearlong ranges of big game species, riparian habitats, habitats of Status 3 native species, and Class 2 Streams. The Department is directed by the Commission to recommend no net loss of habitat function within the biological community that encompasses the project site. If impacts are likely, the Department will recommend replacement of the affected habitats, or enhancement of similar habitats.

The majority of habitats addressed by this document are classified as "vital" or "high value" by the Commission's mitigation policy. The approach to resource protection and maintenance in this document follows that of the Commission Mitigation Policy, which sets forth the following priority of actions: 1) avoid the impact; 2) minimize the impact through appropriate planning and management actions; 3) mitigate the impact by providing replacement or substitute resources; and 4) provide financial compensation only when no reasonable alternative is available to avoid, minimize or mitigate the impact.

Additional terms used in this document are defined below:

"Activity Plan Working Group or APWG" means an operational group of Cooperating Agencies, who would be available to assist the BLM in the preparation of environmental analyses for activity level actions or modifications to current plans. The BLM or

Potential Cooperating Agencies may identify and recommend the need for activity planning and the associated formation of an APWG, as well as the need for public involvement associated with working group activities. APWGs may be set up to address specific resource management issues such as where crucial habitats overlap areas with high potential for surface disturbance or where 2 or more resources of interest to Cooperating Agencies are in conflict. The major purposes of the APWG concept are to: minimize analysis and decision making controversy by being proactive rather than reactive to public land use and resource conflicts; provide effective and cost efficient mitigation of resource conflicts; improve resource conditions by recommending practices and mitigation measures appropriate to special situations; and streamline public land authorizations, increase implementation flexibility, and notify public land users of required practices. The APWG will make implementation recommendations to the BLM Field Office Manager, to achieve the purpose and intent of the recommendations in this document. The group's recommendations shall not be construed as policy. Although the group will strive to achieve consensus recommendations, all recommendations of individual group members will be forwarded to the Field Office Manager for his/her consideration.

"habitat function" means the arrangement of habitat features, and the capability of those features, to sustain species, populations, and diversity of wildlife over time (WY Game and Fish Commission 1998);

"habitat effectiveness" means the degree to which habitat features fulfill specific habitat functions; the degree to which a species or population is able to continuing using a habitat for a specific function;

" habitat value" means the relative importance of various habitat types and conditions in sustaining socially or ecologically significant wildlife populations and biological diversity; and

" to the extent reasonable" or "reasonable" means effective technologies and practices can be applied to avoid, minimize, or mitigate an impact. "Reasonable" is used here in the same context as 43 CFR 3162.5-1(a). We presume the basis for this determination includes technological feasibility, applicability, and economic considerations.

" threshold (or "impact threshold") means the level of development or disturbance that can impair key habitat functions by directly eliminating habitat, by disrupting access to or use of habitat, or by causing avoidance and stress.

OIL AND GAS IMPACTS

Sources and Significance of Impacts

Oil and gas developments may cause a range of adverse effects (consult Appendices A and G), and in limited circumstances, some positive effects. All disturbances constitute an impact at some level. Disturbances created by excavations, roads, facilities, equipment, human activity, and noise physically eliminate some habitat, impair the effectiveness of a larger area of otherwise suitable habitat, and may introduce or attract abnormally high numbers of competitive or predatory organisms. The significance of the impact to wildlife depends on the amount and intensity of the disturbance, the specific locations and arrangements of the disturbance, and the ecological importance of the habitats affected. Small, isolated disturbances within non-limiting habitats may be of minor consequence within most ecosystems. However, larger-scale developments within habitats that limit the abundance and productivity of wildlife are a significant concern to managers because such impacts cannot be relieved or absorbed by surrounding, unaltered habitats. Prudent risk management dictates each increment of disturbance should be planned, managed and mitigated to avoid cumulatively significant effects. Impacts to limiting habitat components and functions will be the focus of this document.

Examples of some positive effects might include: water sources, wetlands or irrigated vegetation created using produced water in appropriate ecological situations; and successful reclamation, monitoring and mitigation programs. An integrated, mitigation program can consider and incorporate beneficial aspects of oil and gas development, where they accrue.

Adverse effects of oil and gas development can be divided into 6 general categories: 1) direct loss of habitat; 2) physiological stress to wildlife; 3) disturbance and displacement of wildlife; 4) habitat fragmentation and isolation; 5) introduction of competitive and predatory organisms; and 6) secondary effects created by work force assimilation and growth of service industries. The direct loss or removal of habitat is always a concern, however oil and gas developments are typically configured as point and linear disturbances scattered throughout broader areas. Collectively, the amount of disturbance may encompass just 5-10% of the land. However, avoidance and stress responses by wildlife extend the influence of each well pad, road, and facility to surrounding habitats. Zones of negative response can reach a quarter mile radius for mule deer (Freddy et al. 1986) to more than a half mile for elk on open winter ranges (Brekke 1998, Hayden-Wing Associates 1990, Hiatt and Baker 1981, John and Lockman 1980) and up to several hundred meters for some raptors during egg laying and early incubation (Fyfe and Olendorff 1976, White Thurow 1985). Berger (pers. comm.) indicated preliminary results from an ongoing study also suggest migrating pronghorn avoid the more densely developed areas of the Jonah Field south of Pinedale.

As densities of wells, roads, and facilities increase, the effectiveness of adjacent habitats can decrease until most animals no longer use the habitat. Although vegetation and other natural features may remain unaltered within areas near oil and gas features, wildlife make proportionately less use of these areas than their availability. Animals attempting to forage inside the affected zones are also subjected to increased physiological stress. The avoidance/stress effect impairs function by reducing the capability of wildlife to use the habitat effectively. In addition, physical or psychological (i.e., disturbance-related) barriers lead to fragmentation of habitats and further reduce the availability of effective habitat. These impacts can be especially problematic when they occur within limiting habitat components such as crucial winter ranges and reproductive habitats.

Sawyer et al. (*in press*) state, "… reduction in effective winter range size, as potentially brought about by extensive natural gas development … may increase deer density on remaining winter ranges, reducing forage quality, fawn survival, and over-winter carrying capacity. Over-winter fawn survival decreases as densities approach carrying capacity (White et al. 1987, Bartmann et al. 1992), and low over-winter fawn survival may be interpreted as density-dependent population regulation (Bartmann et al. 1992). A reduction in winter carrying capacity also increases the probability of deer moving onto poorer quality ranges, where adult survival is further decreased. Additionally, any reduction in the ability of mule deer or pronghorn to move about freely on winter ranges reduces their options for coping with a variety of environmental conditions [snow depth, wind, etc.] and human disturbances. Flexibility in movement across ranges is ultimately reflected in the survival and productivity of the deer population and likely enhances their ability to recover from population declines. Brown (1992) suggested that winter movement flexibility also reduced mule deer density and competition for available resources."

Oil and gas developments can also affect aquatic ecosystems. The overall health of aquatic habitats is a direct result of the condition of the entire watershed including the uplands, riparian corridor and the stream channel. Impacts to the upland plant community and environment can have very direct and immediate impacts to the health of aquatic habitats. The condition and health of vegetation throughout a watershed is the major factor determining the quantity and quality of the associated flow regime. In essence the runoff is naturally regulated by healthy, diverse vegetation. Vegetation in good condition provides greater ground cover, which reduces runoff and increases infiltration rates. Furthermore, diverse plant communities contain various microsites that enable snow to melt at differing rates, thereby extending the runoff period. Collectively, these factors produce more stable base flows, essential for good fish and riparian habitats. Reduced sedimentation is another major benefit to aquatic organisms. Healthy vegetation naturally produces a healthy water cycle.

Some Important Misconceptions about Wildlife Responses to Oil and Gas Disturbances-

1) Wildlife relocate to adjacent, unaffected habitats, so there really is no impact (i.e., "they just move out of the way").

   This presumption contradicts the fundamental axiom of population ecology and wildlife management that has been known and reconfirmed since the time of Aldo Leopold – populations of organisms increase to fill vacant, suitable habitat and are then regulated by the essential component of their habitat that is in least supply (Leopold 1933, Edwards and Fowle 1955, Smith 1966:355, Odum 1971:183). Amounts and quality of crucial winter ranges at lower elevations generally limit productivity, recruitment and abundance of migratory big game populations in mountainous environments. Numbers of complexes of suitable breeding and brood-rearing habitats are thought to limit populations of sage grouse. Other habitat components limit populations of other species. Wildlife populations occupy whatever vacant, suitable habitat exists. Conversely, the areas not used are not suitable for one reason or another. When activities associated with energy development displace animals from otherwise suitable habitats, the animals are either forced into marginal habitats or they compete with animals that already occupy the unaffected habitats. Consequences of such displacement and competition are lower survival, lower reproductive success, lower recruitment, and ultimately lower carrying capacity and reduced populations.

2) Deer and pronghorn are frequently seen foraging near oil and gas facilities, and even use habitats in the middle of oil fields. This indicates they become accustomed to, and are not affected by such activities.

Individuals within any population exhibit varying tolerance to disturbances. Some animals, especially resident or non-migratory individuals, can become very acclimated to repetitious, non-threatening activity such as traffic. However, other individuals of the same species remain sensitive to disturbance. The health of the overall herd depends on the ability of all population segments to effectively utilize limiting resources. Migratory ungulates that occupy high-elevation summer habitats in remote areas are not routinely exposed to repetitive disturbances. When migratory segments arrive on winter ranges, they are more likely to react stressfully to oil and gas development by displacing from disturbance. However, the displacement is not necessarily evident if some animals remain visible near the disturbance because they appear acclimated to it. And, the presence of animals on disturbed sites near human activity does not mean they are not being negatively affected. Studies have documented increased physiological stress within several species exposed to varying degrees of human activity. Responses to activity may also be less apparent as the animal reaches a state of diminished health.

Migratory behavior is an important adaptation that enables a population to benefit from seasonal abundance of forage and cover at higher elevations and milder winters at lower elevations. Migratory animals attain better physiological condition by accessing high quality forage within transitional and summer ranges, then move to winter ranges typified by a milder climate, less snow accumulation and available browse. However, the sensitivity of migratory segments to disturbance can reduce the effectiveness of winter ranges on which oil and gas developments are located, thereby canceling the advantages of migratory behavior. Resident animals may tolerate disturbances, but typically exist at lower densities and are less productive because they do not utilize higher quality forage and parturition cover that exist on seasonal ranges at mid and high elevations. Avoidance and stress responses to disturbance are thoroughly documented in the literature (Refer to Appendices A and G).

3) Existing seasonal use stipulations, standard operating procedures, and reclamation practices are adequate consideration for wildlife resources affected by oil and gas development.

Although seasonal restrictions are intended to protect specific habitats (e.g., winter and reproductive habitats) and species (e.g., pronghorn, mule deer, elk, sage grouse) at critical times of year, they generally have been most effective during the exploration and drilling phases of oil field development. However, oil and gas operations also disturb and displace wildlife throughout the production phase (up to 40 years and longer). A variety of management and mitigation tools are available to minimize effects of oil field development (Appendix B) and offset unavoidable impacts by providing replacement resources.

In accordance with 43 CFR 3162.5-1(a) and Section 6 of the standard federal oil and gas lease terms (Form 3100-11), "Lessee shall conduct operations in a manner that minimizes adverse impacts to the land, air, and water, and to cultural, biological, visual, and other resources, and other land uses or users. Lessee shall take reasonable measures deemed necessary by lessor to accomplish the intent of this section." This provision gives the BLM authority to stipulate reasonable protective measures necessary to reduce or mitigate impacts to wildlife habitat. The current interpretation and application of standard lease terms, timing limitations, and reclamation are important mitigation during the initial and final phases of oil and gas development. It is equally important that mitigation measures be applied during the production phase, as production results in substantial, long-term loss of habitat function. Mitigation during the production phase has generally not been required, as noted in past NEPA documents (USDI Bureau of Land Management 1985, 1986a, 1986b, 1987, 1988a, 1988b, 1992, 1996a, 1996b, 1997, 1998, 1999, 2000, 2003a, 2004a).

Long-term displacement of wildlife from preferred habitats and disruption of migration routes could, in the extreme case, eliminate "migration memory" that required several thousand years to evolve. Each successive cohort of young ungulates learns the locations of suitable winter habitats and migration routes from older, experienced females that lead them (e.g., Baker 1978, Mackie et al. 1998:44). Extended disruptions of migration or habitat use can result in loss of learned behavior from entire cohorts of young animals, breaking the tradition of migration to the most suitable winter habitats.

IMPACT CONCEPTS

Impact Thresholds

As adopted in this document, "impact thresholds" are levels of development or disturbance that can impair key habitat functions by directly eliminating habitat, by disrupting access to, or use of habitat, or by causing avoidance and stress. Appropriate thresholds, management, and mitigation practices vary for different species and habitat functions. Our most pressing need is to address species and habitat functions affected by impending, large-scale developments in sagebrush/steppe ecosystems. In the future, this document may be expanded to consider additional species, ecosystems and habitat functions.

Participating biologists from the Wyoming Game and Fish Department (WGFD) identified appropriate impact thresholds, based on the best science available (Appendices A and G) and their collective field experience. Applicable studies have documented varying degrees of avoidance and/or stress response to sources of noise and activity. Any level of oil field development potentially causes an impact. It is legitimate to apply management practices and mitigation to reduce or offset the effects of even a single well in crucial habitat. The challenge of the Mitigation Working Group was to identify ranges of oil and gas field development that constitute “moderate,” “high,” and “extreme” impacts, for the purpose of applying management and mitigation prescriptions.

We based the thresholds on 2 quantitative measures – density of well locations and cumulative acres of disturbance per section. (“Section”, as used in this document refers to a legal section of 640 acres or an area equivalent to 640 acres). The density of well locations has bearing on the intensity of disturbances associated with oil and gas field operations. The cumulative area of disturbance measures direct loss of habitat. In addition to well pads, a typical oil and gas field includes many other facilities and activities that can affect wildlife – roads, tanks, equipment staging areas, compressor stations, shops, pipelines, power supplies, traffic, human activity, etc. The density of well pads is a general index to well field development and activities. The Working Group adopted this approach because it would be exceedingly difficult, based on the available literature, to factor every aspect of well field development into a set of disturbance criteria. Thresholds based on well pad densities and cumulative acreages may under-represent the actual level of disturbance. Cumulative effects of well field features and activities can be reduced through the conscientious application of standard management practices described in Appendix B.

<u>Threshold Classifications</u>

Priority wildlife and habitat functions addressed by the current version of these mitigation recommendations are:

Mule Deer ………………	crucial winter range
Pronghorn ………………	crucial winter range
Sage Grouse …………….	leks, nesting and brood-rearing complexes, winter habitat
Elk ………………………	crucial winter range, parturition (calving) areas
Big Game ……………….	migration corridors
Moose …………………..	crucial winter range
Bighorn Sheep ………….	crucial winter range, parturition (lambing) areas
Status 1-3 Native Species	occupied habitats (Oakleaf et al. 1996)
Aquatic Resources ………	categories 1-3
Overlapping Vital & High Value Habitats	

We identified impact thresholds based on well densities and acres of disturbance that correspond to “moderate,” “high,” and “extreme” impacts to habitat effectiveness. The mitigation policy of the Wyoming Game and Fish Commission (WY Game and Fish Commission 1998) establishes programmatic direction to avoid or rectify impacts to important wildlife habitats. Big game crucial winter ranges, sage grouse habitats, raptor nest sites, and habitats of status 1 and 2 native species are classified as “vital” under Commission policy. No loss of habitat function is recommended, although some modification of habitat characteristics can take place. Big game parturition areas, riparian habitats, and habitats of status 3 native nongame are classified as “high value” under

Commission policy. No loss of habitat function is recommended within the biological community that encompasses the project site. Impacts can be mitigated within the same biological community.

Priority terrestrial and aquatic habitats are broadly identified on the maps in Appendices D and E. More specific definition of these areas can be obtained from publications, maps, databases, and GIS layers maintained by the WGFD. The information available from these sources includes locations of crucial winter ranges, parturition areas, migration corridors, sage grouse leks and other habitats, raptor nests, priority non-game species and habitats, native species status (NSS), wetlands and priority streams. Specific maps and data sets include the big game seasonal range maps, herd unit reports, the wildlife observation system database, priority terrestrial and aquatic habitat maps, National Wetland Inventory maps, stream/lake database, and fish link database. Rationale for priority rankings of NSS species is explained in the Nongame Bird and Mammal Plan (Oakleaf et al. 1996). The Current NSS list can be obtained from the Department. The list will be published on the Department's web site and in the next revision of the Nongame Bird and Mammal Plan. Explanations and maps of priority watersheds and terrestrial habitats are currently available on the Department's public web site [wgf@state.wy.us] by selecting "wildlife" and "habitat home." Specific requests for other maps, inventories and data queries can be directed to (307)-777-4588 (terrestrial resources and wetland maps) and (307)-777-4559 (aquatic resources). The Department plans to include more of this information on its web site.

IMPACT THRESHOLDS, MANAGEMENT PRACTICES, AND MITIGATION PRESCRIPTIONS – TERRESTRIAL RESOURCES

All 3 levels of impact, moderate, high, and extreme, cause loss of habitat function. To the extent reasonable, management procedures in Appendix B should be applied at all levels of development to avoid and minimize impacts. Additional prescriptions, habitat treatments, and optional monetary assessments should be applied to mitigate impacts resulting from moderate and high thresholds of well field development. The following matrix is a general key to impact thresholds, management practices and mitigation prescriptions for each species/habitat category. Detailed discussions of these items are provided in subsequent sections.

The development and impact thresholds outlined in this section were identified by the WGFD to classify various levels of impact to wildlife, and are not based on classification systems used by the Wyoming Oil and Gas Conservation Commission (WOGCC) or any other entity.

	Category of Impact		
Species and Habitat Function	**Moderate** impacts can be minimized or avoided through effective management practices & habitat treatments	**High** impacts are increasingly difficult to mitigate and may not be completely offset by management and habitat treatments	**Extreme** habitat function is substantially impaired and cannot generally be recovered through management or habitat treatments
Mule Deer and Pronghorn Crucial Winter Ranges	1-4 well locations* and ≤ 20 acres disturbance per section – seasonal use restrictions – standard management practices (Appendix B) – habitat treatments necessary to maintain habitat function on site	5-16 well locations* and 20-80 acres disturbance per section – seasonal use restrictions – standard management practices (Appendix B) – additional prescriptions – habitat treatments on or adjacent to the impacted site, to maintain habitat function for the affected herd or population. Habitat treatments can be off lease, if not feasible on the lease.	> 16 well locations* or > 80 acres disturbance per section <u>Avoid to the extent reasonable</u> – seasonal use restrictions – standard management practices (Appendix B) – additional prescriptions – compensatory mitigation to offset unavoidable impacts. Mitigation projects can be off-lease, as necessary.
Sage Grouse Nesting and Early Brood-Rearing Habitats	Thresholds and mitigation apply to development within 2 miles of a lek, or within identified nesting/brood-rearing habitats > 2 miles		
	1-4 well locations* and ≤ 20 acres disturbance per section Same mitigation concepts identified for mule deer & pronghorn	5-16 well locations* and 20-80 acres disturbance per section Same mitigation concepts identified for mule deer & pronghorn	>16 well locations* or > 80 acres disturbance per section <u>Avoid to the extent reasonable</u> Same mitigation concepts identified for mule deer & pronghorn
Sage Grouse Winter Habitats	No wells, roads, or other facilities constructed within 200 m of identified winter habitat		
Elk Crucial Winter Ranges and Parturition Areas	N/A	1-4 well locations* and up to 60 acres of disturbance per section <u>Avoid to the extent reasonable</u> Same mitigation concepts	> 4 well locations* or > 60 acres of disturbance per section <u>Avoid to the extent reasonable</u> Same mitigation concepts

		identified for mule deer & pronghorn	identified for mule deer & pronghorn
Bighorn Sheep Crucial Winter Ranges and Lambing Areas	No disturbance within 1 mile of crucial winter ranges or lambing areas		
Big Game Migration Corridors	No disturbance within narrow migration corridors or bottlenecks (<0.5 mi wide), avoid further constrictions of broader corridors		
Status 1, 2, and 3 Native Species (Terrestrial)	1-4 well locations* and ≤ 20 acres of disturbance per section – standard management practices (Appendix B)	5-16 well locations* and 20-80 acres of disturbance per section – standard management practices (Appendix B) – evaluate status 1-3 native species and habitats that are present – consult WGFD Non-game Section for additional management prescriptions and habitat treatments	> 16 well locations* or > 80 acres of disturbance per section <u>Avoid to the extent reasonable</u> – standard management practices (Appendix B) – evaluate status 1-3 native species and habitats that are present – consult WGFD Non-game Section for additional management prescriptions and habitat treatments
Nongame Birds, Bats	– standard management practices (Appendix B) – additional mitigation prescriptions (Page 24)		
T&E Species	Protective measures are identified through Section 7 Consultation with the USFWS		
Overlapping Vital or High Value Habitats	– Apply impact thresholds and management/mitigation practices identified for each species. – As necessary, habitat treatments and assessments are additive. – Inconsistent practices and prescriptions are resolved in favor of the more restrictive		
Aquatic Resources	See Aquatic Section (Page 24)		

* Based on a relatively even geographic distribution of well locations in a section. Appropriate allowances will be made for clustered configurations, on a case-by-case basis.

<u>Mule Deer</u> – crucial winter range
<u>Pronghorn</u> – crucial winter range

The purpose of these recommendations is to maintain habitat functions by minimizing the intensity of development and associated disturbances by providing effective mitigation for unavoidable impacts. Similar impact thresholds, standard management practices and mitigation prescriptions should apply to crucial winter ranges of either species. In overlapping crucial winter ranges, the habitat treatments or assessments may become additive in order to fully mitigate the effect upon each species.

<u>moderate impact</u>: 1-4 well locations, and up to 20 acres of well pad disturbance per section. Habitat effectiveness is reduced within a zone surrounding each well, facility, and road corridor, persons afoot, vehicular and equipment activity. Appropriate management practices and habitat treatments can be applied to mitigate impacts. The WGFD recommends well field developments not exceed 4 well locations per section within crucial winter ranges, because it is unlikely habitat effectiveness can be maintained at higher densities. The following mitigation measures should be required for well field developments in the range of 1-4 well locations, and up to 20 acres of disturbance per section:

- Apply seasonal use restrictions for big game (standard drilling stipulations). No drilling on crucial winter ranges from 15 November through 30 April. To the extent reasonable, limit disturbances and activities within operating well fields during the same timeframe.
- Apply standard mitigation practices described in Appendix B, as reasonable.
- Design and implement habitat treatments sufficient to maintain habitat function on-site or off-site. Habitat treatments should consider options from Appendix C, selected through consultation with the WY Game & Fish Department and the Activity Plan Working Group (APWG). Mule deer exhibit a stress response to disturbances associated with noise and activity up to 0.29 mi from the source (Freddy 1996). Therefore, habitat effectiveness can be reduced throughout an area of at least 170 acres surrounding each well pad. Humans on foot cause a flight response at least 0.12 mi from the source. Therefore, habitat effectiveness can be substantially reduced throughout an area of at least 29 acres surrounding each well pad. Avoidance distances reported for pronghorn range from 0.25 mi (Autenrieth 1983) to 0.6 mi (Easterly et al. 1991) from sources of disturbance. Accordingly, we presume disturbance thresholds for pronghorn are comparable to those identified for mule deer. Habitat treatments should be designed to offset the reduction of habitat effectiveness throughout the areas covered by these zones of impact. Management practices identified in Appendix B may reduce the size of the area affected by each well, and accordingly, the extent of habitat treatments needed to offset or mitigate the effect.
- Mitigation Trust Account Option. This voluntary option should be considered only when impacts cannot be avoided, minimized, or effectively mitigated through other means. If recommended by the APWG and approved by the BLM, the operator may contribute funding to maintain habitat function based on the estimated cost of habitat treatments and other mitigation needed to maintain the functions of impacted habitats. The preferred approach is for the operator to fund and arrange the implementation of successful habitat treatments after consultation with BLM and WGFD, and under the BLM's direction and oversight. The acreage basis for mitigation will be determined from the amount of surface that is directly disturbed, plus the additional area on which habitat functions are impaired by noise, activities and other disturbance effects. As habitat treatments are implemented and their effectiveness monitored, the mitigation may be refined and possibly standardized. Seasonal stipulations, standard management

practices and additional prescriptions should still apply and will be considered when determining how many acres of habitat are functionally impaired within a well field.

The amount of land treated to offset an impact will depend on the types of treatments applied, the expected improvement to the functional capacity of the lands after treatment and the effectiveness of disturbance abatement practices being implemented. An appropriate mitigation ratio is calculated based on these considerations. There is no set or standard ratio. If 100% of the habitat function is lost on an acre of land, then enough land needs to be treated such that the sum of the improvement increments on each treated acre equates to the amount of habitat function that is lost.

For example, if browse production can be increased 20% by fertilization of crucial winter ranges, the functional improvement on each treated acre is equivalent to an additional 0.2 acres of untreated browse (i.e., 0.2 acres of browse from the disturbed area). Accordingly, 5 acres would need to be treated for every acre that is disturbed or functionally impaired, to replace the browse that was lost. This treatment would be repeated as necessary to offset the loss of forage throughout the life of the disturbance.

high impact: 5-16 well locations per section and 20-80 acres of well pad disturbance per section. At this range of development, impact zones surrounding each well pad, facility and road corridor begin to overlap, thereby reducing habitat effectiveness over a much larger, contiguous area. Human, equipment and vehicular activity, noise and dust are also more frequent and intensive. This amount of development will impair the ability of animals to use crucial winter ranges and the impacts will be much more difficult to mitigate. It may not be possible to fully mitigate the impacts caused by higher well densities, particularly by applying habitat treatments on site. Management practices described in Appendix B can reduce impacts somewhat and a few opportunities may exist to develop habitat treatments within the well field. However habitat treatments will generally be located in areas near, rather than within well fields to maintain the function and effectiveness of crucial winter ranges. The WGFD discourages this level of well field development within crucial winter ranges. If densities exceeding 4 well locations per section cannot be avoided, the following management practices and additional prescriptions should be required:

– Apply seasonal use restrictions for big game (standard drilling stipulations). No drilling on crucial winter ranges from 15 November through 30 April. To the extent reasonable, limit all disturbances and activities within operating well fields during the same timeframe.
– Apply standard management practices described in Appendix B, as reasonable.
– Additional prescriptions:
    - directional drilling. To the extent reasonable, develop multiple wells from single pads by employing directional or horizontal drilling. Reducing densities of well locations and roads, and minimizing associated activities, are the highest priorities within crucial winter ranges. Directional drilling is an extremely important tool to accomplish this goal when operating within such environments. Feasibility of directional drilling will depend on several factors, including geology, technology, economics, and operational constraints.

- clustered development. To the extent technologically reasonable, locate well pads, facilities and roads in clustered configurations within the least sensitive habitats. The WGFD and APWG will identify the least sensitive locations for positioning facilities in clusters. Clustered configurations are a geographical and not necessarily a temporal consideration.
- condensate removal. If substantial condensate is produced, disturbance to wildlife can be greatly reduced by piping rather than trucking condensate off site, or by installing larger storage capacity to minimize truck trips and eliminate truck trips during sensitive times of year such as winter and breeding seasons. This recommendation generally applies to crucial winter ranges on which more than 1 truck trip per month is necessary to remove condensate. If the potential for condensate production is unknown, but exceeds 1 truck trip per month after production begins, consideration should be given to retrofitting the field with pipelines or larger tanks as needed. Each truck trip and activity associated with pumping has the potential to displace animals from suitable portions of winter ranges for several days. To be effective at maintaining habitat function, the Department permits no entry or activity on it's Wildlife Habitat Management Area winter range units throughout the winter period. The Department believes 1 disturbance event per month, while having some level of impact, is not likely an excessive amount of disturbance to wintering animals. If subsequent monitoring establishes animals are tolerant to this type of disturbance, more frequent trips may be permissible.
- remote monitoring. To the extent technologically reasonable, install remote monitoring instrumentation to reduce or eliminate travel by persons and vehicles for the purpose of manually inspecting and reading instruments.
- travel plan. Develop a travel plan that minimizes frequency of trips on well field roads.
- As appropriate, gate and close all newly constructed roads to public travel (preexisting BLM roads should remain open). Where possible, public use of oilfield roads should be eliminated or restricted during sensitive times of year. The purpose of these roads is to facilitate access to well sites and not to provide public access. In addition, BLM road construction Best Management Practices (BMPs) no longer require that roads be constructed to meet public traffic safety standards, further supporting the closure to public access.
- environmental monitoring. Implement an adequate monitoring program to detect and evaluate ongoing wildlife effects, including avoidance responses, distribution shifts, habituation, evidence of migration barriers, mortalities, and depressed productivity (e.g., low fawn ratios), and to determine effectiveness of mitigation. Monitor vegetation utilization within the well field. A wildlife monitoring report should be submitted by the company annually for review by the APWG, WGFD, and BLM. Companies may agree to conduct or fund monitoring and environmental studies as part of an integrated mitigation program, but BLM should also include adequate budget and personnel to conduct the necessary monitoring.

– Design and implement habitat treatments sufficient to maintain habitat functions within or immediately adjacent to the well field. Habitat treatments should include options from Appendix C as outlined for "moderate impact," recommended by the APWG and approved by the surface management agency. Management practices in Appendix B may reduce the zone of impact surrounding each well, and the extent of habitat treatments needed to accomplish mitigation. Effectiveness of management practices will be evaluated by the APWG after considering analysis and recommendations from the WGFD.

– Off-Site and Off-Lease Mitigation. If it is not possible to maintain habitat functions within or immediately adjacent to the well field, off-site and off-lease mitigation is a voluntary option that may be considered on a case-by-case basis. The primary emphasis of off-site or off-lease mitigation is to maintain habitat functions for the affected population or herd, as close to the impact site as possible. Off-site and off-lease mitigation should only be considered when no feasible options are available to mitigate within and immediately adjacent to the impacted site, or when the off-site or off-lease location would provide more effective mitigation than can be achieved on-site. Such determinations will be made by the APWG after considering analysis and recommendations from the WGFD.
– Mitigation Trust Account Option. This voluntary option should be considered only when impacts cannot be avoided, minimized, or effectively mitigated through other means. If recommended by the APWG and approved by the BLM, the operator may contribute funding to maintain habitat function based on the estimated cost of habitat treatments or other mitigation needed to maintain the functions of impacted habitats (refer to previous discussion). As the densities of wells and roads increase, activity levels also increase and zones of impact surrounding oil field facilities begin to overlap. Accordingly, the acreage basis for mitigation or trust account funding will be greater. Standard management practices in Appendix B, "additional" prescriptions, and seasonal use stipulations should still apply to the extent reasonable:

extreme impact: >16 well locations or > 80 acres of disturbance per section. Commission Mitigation Policy does not provide a viable alternative to address this level of development within vital habitats. The function and effectiveness of crucial winter habitat would be severely compromised. The long-term consequences are continued fragmentation and disintegration of the winter range complex, leading to decreased survival, productivity and ultimately, loss of carrying capacity for the herd. This will result in a loss of ecological functions, recreation opportunity, and income to the State's economy. An additional consequence may include the permanent loss of migration memory from large segments of unique, migratory big game herds in Wyoming. If densities exceeding 16 well locations per section absolutely cannot be avoided, the following mitigation practices, in addition to all management practices and mitigation prescriptions applicable to "high impact," are recommended to retain as much effective habitat as reasonable.

– Developing a well field in smaller incremental phases could potentially minimize the overall impact of a high-density field. However, the Department acknowledges complex geological, technical, regulatory, and legal issues would preclude this strategy from being used in most if not all cases.
– Opportunities may exist to partially offset the loss of crucial winter range by implementing habitat treatments in appropriate locations outside the well field. This type of mitigation is exceedingly difficult and expensive to accomplish effectively, and should not be looked upon as a prescriptive solution to authorize high-density well

fields in crucial winter range. The most effective strategy is to avoid high-density developments. If avoidance is not reasonable, plan effective habitat treatments in locations that minimize the loss of habitat function for the herd or population affected by the field development.

- All seasonal use restrictions, standard management practices, additional prescriptions, and optional mitigation funding listed for "high impact" should apply. Habitat effectiveness is essentially eliminated from high-density well fields, so the area of the well field will generally serve as the acreage basis for mitigation.

Sage Grouse

The purpose of these recommendations is to maintain habitat function by minimizing the intensity of development and associated disturbances, and by providing effective mitigation for unavoidable impacts.

Special Considerations: In severely fragmented habitats, habitat treatments may not be effective mitigation to offset impacts of oil and gas developments. Attempts to develop treatments such as prescribed fire or herbicide applications could further reduce and fragment suitable habitat for 15 years or longer. If 40% of nesting, early brood-rearing, or winter habitat within the range of a population has been lost or severely degraded, the management emphasis is to protect remaining sagebrush that is at least somewhat suitable for these functions (Connelly et al. 2000). Oil and gas developments within such fragmented sage grouse habitats should avoid impacts to remaining habitats. On the other hand, within comparatively intact sagebrush ecosystems, treating up to 20% of degraded nesting and early brood-rearing habitats, and 20% of the winter habitat may be acceptable to improve habitat conditions (e.g., restore herbaceous understory, create open patches of herbaceous vegetation, thin dense sagebrush canopies exceeding 30% cover, create openings within dense sagebrush, regenerate the shrub component by setting back succession, or enhance herbaceous understory by reducing herbivory). The existing condition of sagebrush, and the current and anticipated impact of all land uses should be considered when planning habitat treatments. At some point, vegetation treatments are not effective mitigation because the interim loss of habitat caused by the treatment, combined with the habitat loss that is being mitigated, creates an unacceptable level of impact to sage grouse. The same considerations could also apply to big game crucial winter ranges. Habitat management guidelines are currently being developed for sage grouse, and have not yet been incorporated into this document. The guidelines should be consulted when planning habitat treatments for any species within occupied sage grouse habitats.

Occupied Sage Grouse Habitats:

- Standard management practices described in Appendix B should apply to all well fields in occupied sage grouse habitats.
- Facilities. Provide tanks and other facilities with structures such that they do not provide perches or nest substrates for raptors, crows and ravens.
- Power lines. Where feasible, bury new power lines and retrofit existing power lines by burying them or installing perch guards to prevent their use as raptor perches.

Occupied Leks:

– Avoid surface disturbing activities within 0.25 mi of the perimeter of occupied sage grouse leks. An occupied lek is a lek that has been active at least 1 breeding season within the most recent 10-year period. This requirement should be applied as a "No Surface Occupancy" (NSO) or "Controlled Surface Use" (CSU) stipulation.
– Avoid human and vehicular activity between 8:00 p.m. and 8:00 a.m., from 1 March through 15 May, within 0.25 mi. of the perimeter of occupied sage grouse leks.
– To avoid disrupting auditory displays, from 1 March through 15 May, anthropogenic sources of continuous or frequently intermittent noise should not exceed 10 dBA above natural, ambient noise measured at the perimeter of any occupied sage grouse lek. In addition, between 1 hour before sunrise and 2 hours after sunrise, anthropogenic sources of continuous or frequently intermittent noise should not be detectable at the perimeter of any occupied lek. To the extent reasonable, only natural, ambient levels of noise are permissible. Lyon and Anderson (2003) determined nominal disturbances near leks and nesting habitat (1-12 vehicle trips per day) were sufficient to suppress reproduction of sage grouse. Considering their findings, we defined frequently intermittent noises to include anthropogenic noises that exceed 1 event per hour. Continuous noises are anthropogenic noises, such as from traffic on an interstate highway or from an operating oilrig or compressor, which can be heard most of the time or for extended periods during frequent intervals. Auditory disturbances from continuous or frequent traffic noises have eliminated all or most leks within 2 miles of the source, and reduced the number of active leks as far as 4-5 miles from the source [Connelly et al. (2004:Chapt 13, Pages 13-16); Christiansen (unpubl. data)].
– One-time disturbances of a short-term and temporary nature, for example a pipeline being laid through the 2-mile perimeter surrounding a lek, may be exempted from the noise recommendation if the APWG determines the noise and activity will cause minimal harm. Exempted disturbances will generally last no more than a few days. The operator may be requested to employ additional protective measures such as suspending activities during the display period from 1 hour before sunrise until 2 hours after sunrise, and/or using devices or practices that minimize the amount of noise and activity.
– The noise standard may be adjusted based upon site-specific considerations such as topographic or vegetation features that attenuate sound, as determined by APWG. Such considerations will generally require quantitative measurement of resulting noise levels within the areas being protected. Oil and gas operators may submit data for consideration by the APWG in evaluating a noise standard.

Nesting & Early Brood Rearing Habitats:

– To the extent reasonable, from 15 March through 15 July anthropogenic sources of continuous or frequently intermittent noise should not exceed 10 dBA above natural ambient or background noises measured in any suitable nesting and brood-rearing habitat within 2 miles of an occupied lek, or within identified nesting and brood-rearing habitats outside the 2-mile perimeter. This requirement should be stipulated as a seasonal restriction. Temporary disturbances may be exempted, and adjustments made, as described above.

– Avoid surface disturbing activities and geophysical surveys in suitable nesting and early brood-rearing habitat within 2 mi. of an occupied sage grouse lek, and within identified sage grouse nesting and early brood-rearing habitat outside the 2-mile buffer, from 15 March through 15 July. This requirement should be stipulated as a seasonal restriction.
– Select sites for construction that will not disturb suitable nest cover or brood-rearing habitats within 2 mi. of an occupied lek, or within identified nesting and brood-rearing habitats outside the 2-mile perimeter. A qualified person should visit each site to identify and map suitable nest cover and brood-rearing habitat. This information should be provided for review by the appropriate regional biologist within the WGFD. Connelly et al. (2000) recommend locating all energy related facilities at least 2 miles from active leks whenever possible.

Winter Habitats:

– Avoid placement of well pads, roads and other well field facilities on mapped winter habitats, or within a 200 m buffer surrounding each habitat. Avoid human and equipment activity on and within 200 m of winter habitats from 15 November through 14 March .

Impact Thresholds:

moderate impact: 1-4 well locations per section, and up to 20 acres of well pad disturbance per section within 2 miles of an occupied lek, or within identified nesting and brood-rearing habitat outside the 2 mile perimeter. At this level of development, habitat effectiveness is reduced within a zone surrounding each well, facility, and road corridor, and disturbances created by persons afoot and vehicular and equipment activity. The impacts can be controlled and mitigated by applying appropriate management practices and habitat treatments. The WGFD recommends that well field developments should not exceed 4 well locations per section within sage grouse nesting and early brood rearing habitats, because it is unlikely habitat effectiveness can be maintained. For well field developments in the range of 1-4 well locations per section, and up to 20 acres of disturbance, the following mitigation measures should be required:

– apply seasonal use restrictions described in the previous sections. To the extent reasonable, limit disturbances and activities within operating well fields during the same timeframes.
– apply standard management practices described in Appendix B, as reasonable.
– implement habitat treatments sufficient to maintain habitat functions within or immediately adjacent to the well field. Habitat treatments should include appropriate options selected from Appendix C after consultation with the WY Game & Fish Department. Habitat treatments should be designed to offset the loss of habitat function in disturbed areas and surrounding zones of impact. Standard management practices from Appendix B may reduce the size of the area affected by well field facilities, and accordingly the extent of habitat treatments needed to mitigate the effect, as determined through consultation with the BLM, WGFD and the APWG.
– Mitigation Trust Account Option. This voluntary option should be considered only when impacts cannot be avoided, minimized, or effectively mitigated through other

means. If recommended by the APWG and approved by the BLM, the operator may contribute funding to maintain habitat function based on the estimated cost of habitat treatments or other mitigation needed to maintain the functions of impacted habitats. The preferred approach is for the operator to fund and arrange the implementation of successful habitat treatments after consultation with the WGFD, the APWG, and under the BLM's direction and oversight. Refer to the corresponding discussion for mule deer and pronghorn crucial winter ranges.

high impact: 5-16 well locations per section and 20-80 acres of well pad disturbance per section within 2 miles of an occupied lek, or within identified nesting and early brood rearing habitat outside the 2 mile perimeter. At this range of development, impact zones surrounding each well pad, facility and road corridor begin to overlap, thereby reducing habitat effectiveness over a much larger, contiguous area. Human, equipment and vehicular activity and noise impacts are also more frequent and intensive. Management practices described in Appendix B can reduce impacts somewhat and a few opportunities may exist to develop habitat treatments within the well field. However habitat treatments will generally be located in areas near, rather than within well fields to maintain the function and effectiveness of nesting and early brood rearing habitats. Regardless, this level of development will reduce the effectiveness of nesting and early brood-rearing habitats and will be much more difficult to mitigate. At the higher well densities, mitigation may not be possible. The WGFD discourages this level of well field development within 2 miles of a sage grouse lek or within identified nesting and early brood rearing habitat. If densities exceeding 4 well locations per section cannot be avoided, the following management practices and additional prescriptions should be required:

– Apply seasonal use restrictions described in the preceding paragraphs. To the extent reasonable, limit disturbances and activities within operating well fields during the same timeframe (1 March through 15 July).
– Apply standard management practices described in Appendix B, as reasonable.
– Additional prescriptions:
  - directional drilling. To the extent reasonable, develop multiple wells from single pads by employing directional or horizontal drilling. Reducing densities of well locations and roads, and minimizing associated activities, are the highest priorities within sage grouse nesting and brood rearing habitats. Directional drilling is an extremely important tool to accomplish this goal when operating within such environments. Feasibility of directional drilling will depend on several factors, including geology, technology, economics, and operational constraints.
  - clustered development. To the extent reasonable, locate well pads, facilities and roads in clustered configurations within the least sensitive habitats. The WGFD will identify the least sensitive locations for positioning clusters of well field facilities.
  - condensate removal. If substantial condensate is produced, disturbances to wildlife can be greatly reduced by piping rather than trucking condensate off site, or by installing larger storage tanks to minimize truck trips. If the potential for condensate production is unknown, but requires multiple truck trips per week after production begins, consideration should be given to retrofitting the field with

pipelines or larger tanks as needed. Truck traffic should be scheduled such that it does not coincide with the display period each morning (1 hour before sunrise until 2 hours after), and cumulatively should not exceed 1 event per hour in combination with other kinds of traffic throughout the strutting and brood-rearing period.

- remote monitoring. To the extent technologically reasonable install remote monitoring instrumentation to reduce or eliminate travel by persons and vehicles for the purpose of manually inspecting and reading instruments.
- travel plan. Develop a travel plan that minimizes frequency of trips on well field roads.
- As appropriate, gate and close all newly constructed roads to public travel (preexisting BLM roads should remain open). Where possible, public use of oilfield roads should be eliminated or restricted during sensitive times of year. The purpose of these roads is to facilitate access to well sites and not to provide public access. In addition, BLM road construction Best Management Practices (BMPs) no longer require that roads be constructed to meet public traffic safety standards, further supporting the closure to public access.
- environmental monitoring. Implement an adequate monitoring program to detect and evaluate ongoing wildlife effects, including avoidance responses, distribution shifts, habituation, evidence of migration barriers, mortalities, and depressed productivity (e.g., declining lek attendance), and to determine effectiveness of mitigation. Monitor vegetation utilization within the well field. A wildlife monitoring report should be submitted by the company annually for review by the APWG, WGFD, and BLM. Companies may agree to conduct or fund monitoring and environmental studies as part of an integrated mitigation program, but BLM should also include adequate budget and personnel to conduct the necessary monitoring.

– Design and implement habitat treatments sufficient to maintain habitat functions within or immediately adjacent to the well field. Habitat treatments should include options from Appendix C as outlined for “moderate impact,” recommended by the APWG and approved by the surface management agency. Management practices in Appendix B may reduce the zone of impact surrounding each well, and the extent of habitat treatments needed to mitigate the residual effect. The effectiveness of management practices will be evaluated by the APWG after considering analysis and recommendations from the WGFD.

– Off-Site and Off-Lease Mitigation. If it is not possible to maintain habitat functions within or immediately adjacent to the well field, off-site and off-lease mitigation is an option that may be considered on a case-by-case basis. The primary emphasis of off-site or off-lease mitigation is to maintain habitat functions for the affected sage grouse population, as close to the impact site as possible. Off-site and off-lease mitigation should only be considered when no feasible options are available to mitigate within and immediately adjacent to the impacted site, or when the off-site or off-lease location would provide more effective mitigation of the impact than can be achieved on-site. Such determinations will be made by APWG after considering analysis and recommendations from the WGFD.

– Mitigation Trust Account Option. This voluntary option should be considered only when impacts cannot be avoided, minimized, or effectively mitigated through other means. If recommended by the APWG and approved by the BLM, the operator may contribute funding to maintain habitat function based on the estimated cost of habitat treatments or other mitigation needed to maintain the functions of impacted habitats (refer to corresponding discussion for mule deer and pronghorn crucial winter ranges). As the densities of wells and roads increase, activity levels also increase and zones of impact surrounding oil field facilities begin to overlap. Accordingly, the acreage basis for mitigation or trust account funding will be greater. Standard management practices in Appendix B, "additional" prescriptions, and seasonal use stipulations should still apply to the extent reasonable

extreme impact: >16 well locations or > 80 acres of disturbance per section. Commission Mitigation Policy does not provide a viable alternative to address this level of development within vital habitats. The function and effectiveness of sage grouse nesting and brood rearing habitat would be severely compromised. The long-term consequences are continued loss and fragmentation of sage grouse habitat, contributing to further population declines and the possibility this species will eventually be listed under the federal Endangered Species Act. If densities exceeding 16 well locations per section absolutely cannot be avoided, the following mitigation practices in addition to all management practices and mitigation prescriptions applicable to "high impact," are recommended to retain as much effective habitat as reasonable:

– Developing a well field in smaller incremental phases could potentially minimize the overall impact of a high-density field. However, the Department acknowledges complex geological, technical, regulatory, and legal issues would preclude this strategy from being used in most if not all cases.
– Opportunities may exist to partially offset the loss of nesting and brood-rearing habitat by implementing habitat treatments in appropriate locations outside the well field. This type of mitigation is exceedingly difficult and expensive to accomplish effectively, and should not be looked upon as a prescriptive solution to authorize high-density well fields in important sage grouse habitat. The most effective strategy is to avoid high-density developments. Only if this is not reasonable, plan effective habitat treatments in locations that minimize the loss of habitat function for the grouse population affected by the field development.
– All seasonal use restrictions, standard management practices, additional prescriptions, and optional funding listed for "high impact" should apply. Habitat effectiveness is essentially eliminated from high-density well fields, so the area of the well field will generally serve as the acreage basis for mitigation.

Elk – crucial winter range
Elk – parturition (calving) habitat

Refer to sections on mule deer and pronghorn crucial winter ranges for applicable seasonal use restrictions, standard management practices, additional prescriptions, habitat treatments, and optional mitigation assessments. The same criteria and concepts apply to elk crucial winter ranges and parturition habitats. However, the impact thresholds are lower due to the much greater sensitivity of elk to disturbances. The following disturbance thresholds are identified for elk crucial winter ranges and parturition habitats:

moderate impact: Elk are sufficiently sensitive that any level of development within crucial winter ranges or parturition habitats constitutes more than a moderate impact. Therefore, we do not define a "moderate" level of disturbance.

high impact: 1-4 well locations and up to 60 acres of disturbance per section.

extreme impact: > 4 well locations or >60 acres of disturbance per section.

Moose – crucial winter range

Refer to sections on mule deer and pronghorn crucial winter ranges for applicable impact thresholds, seasonal use restrictions, standard management practices, additional prescriptions, habitat treatments, and optional mitigation assessments. The same criteria and concepts apply to moose crucial winter ranges. In addition, deeper snow typically found on moose crucial winter ranges warrants special consideration. For example, plowing roads to access well sites creates high embankments that can greatly influence the mobility of moose. The following additional prescriptions should apply:

- Place gaps in high snow embankments every quarter mile along plowed well field roads, enabling moose to move across and off roads.
- The management prescription for riparian habitats within moose crucial winter ranges should be no surface occupancy within the riparian zone and a 500-ft buffer extending from the outer edge of the riparian zone.

Bighorn Sheep – crucial winter range
Bighorn Sheep – parturition (lambing) areas

Bighorn sheep are much more susceptible to stress caused by disturbances than most other ungulates (MacArthur et al. 1982). Elevated stress levels in sheep have been linked to depressed immune response, loss of condition, reduced lamb survival, and elevated mortality rates. In addition, distributions of sheep crucial winter ranges and lambing habitats are very restricted in Wyoming and generally do not coincide with locations having high potential for oil and gas development. For these reasons, the management prescription should be "no surface occupancy" on bighorn sheep crucial winter ranges and lambing areas plus a 1-mile buffer.

Big Game Migration Corridors

- Within narrow migration corridors or "bottlenecks" of less than 0.5 mi width (Sawyer et al. *in press*), the management prescription for oil and gas development should be "no surface occupancy" (NSO).
- Within broader migration corridors exceeding 0.5 mi width, the recommended management prescription is to maintain options for animal movement along the corridor and to avoid further constricting the corridor such that a bottleneck is created. Well field density should

not exceed 4 well locations per section. Fences, expansive developments, and other potential impediments to migration should not be constructed.

Status 1, 2, and 3 Native Species (Terrestrial)

Status 1-3 native species vary considerably in their biology, ecology, and tolerance to disturbance. As a general rule, standard management practices listed in Appendix B will satisfactorily address oil and gas disturbances to native, nongame species in well fields of up to 4 well locations per section. If developments exceeding 4 well locations per section are planned, the operator should evaluate native nongame species and habitats that are present. Consult the WGFD Nongame Section to determine if important habitat functions will be affected, and whether additional mitigation prescriptions may be needed. Oakleaf et al. (1996) list Status 1, 2, and 3 native nongame species within Wyoming and identify management concerns. The following, general considerations are recommended for operations within habitats of status 1-3 non-game birds and bats:

NSS 1-3 songbird breeding and migration habitat:

– From 1 April through 30 June, reduce noise levels to 49 dBA or less within Status 1-3 songbird breeding habitat to minimize the effects of continuous noise on species that rely on aural cues for successful breeding (Inglefinger 2001).
– Cover or net all ponds that contain oily wastes to exclude their use as a water source by songbirds.

raptor nesting habitat:

– Reduce noise levels to 49 dBA or less at Status 1-3 raptor nest sites to minimize the effects of continuous noise on raptors that are sensitive to human disturbance during the breeding season.
– Apply buffers and timing restrictions to reduce the impacts of construction, operations, noise, and human presence on raptor nest sites (these vary slightly for different species – consult state or federal wildlife agencies for advice regarding appropriate buffers and timing).

NSS 1-3 waterbird loafing, staging, and migration habitats and NSS 1-3 bat foraging habitats:

– Cover or net ponds that contain oily wastes to exclude use by waterbirds and bats.

Federally-listed, Threatened or Endangered Species

The U.S. Fish and Wildlife Service (USFWS) has jurisdiction over federally listed, threatened and endangered species. Consultation with the USFWS, Ecological Services Section is required to identify threatened, endangered, or candidate species that may be present, and to determine what additional protection and mitigation measures may be needed.

AQUATIC RESOURCES

Point-source discharges and deposition of fill materials into "navigable" waters are regulated under the Clean Water Act of 1972 through state and federal primacy programs. However, several aspects of watershed management are not rigorously regulated including: non-point source runoff, overland sediment transport, structures in "non-navigable" waters, watershed vegetation, activities in watersheds generally, and associated effects on hydrology. Sections 401, 403 and 404 of the Clean Water Act set forth performance criteria to control point source discharges and fill deposition, but these performance-based programs do not prescribe specific management practices to achieve those criteria, nor do they prescribe habitat management practices. This section provides management recommendations for aquatic resources and watersheds. Recommendations can be modified or adjusted based on specific characteristics (topography, soils, vegetation, drainage) encountered in the area proposed for development, as recommended by the APWG and approved by the surface management agency.

Important aquatic habitats include a variety of riparian/stream ecosystems inhabited by native and introduced aquatic species. Depending on the location, these ecosystems may be typical cold-water streams sustaining species like boreal toads and Colorado River cutthroat trout, or they may be less familiar prairie streams that support a variety of native fish such as bluehead sucker and herpetofauna such as soft-shell turtles. Alteration of these streams and the surrounding environments by anthropogenic activities (e.g., water development projects, irrigation practices, livestock grazing and energy development), have impacted native fish communities throughout the Great Plains (Fausch and Bestgen 1997; Nesler et al. 1997; Rabeni 1996). Patton et al. (1998) determined the distributions of more than 50% of the native fish species have declined over a 30-year period within in prairie streams of the Missouri River Drainage (MRD) in Wyoming.

Impacts to aquatic systems are most often a response to the general condition of the watershed. Watershed health depends upon a combination of factors including vegetation cover and condition, grazing management, land disturbance and direct impacts to riparian and stream habitats. Advanced succession caused by fire suppression and improper grazing practices has accelerated a decline in quality and function of watersheds throughout much of Wyoming. In addition, loss of aspen and mountain shrub communities has reduced the diversity, quantity and quality of habitats necessary for life stage needs of several native species. In many cases, succession of sagebrush-grasslands has advanced to old aged stands lacking productive understories and wildlife habitat diversity. Within such areas, precipitation infiltrates less effectively into the soil due to the reduced ground cover. Thus, upland plant communities no longer function properly to recharge seep and spring flows, and most precipitation is lost quickly through overland flow. The reduction of aspen and willow communities has restricted beaver habitat to relict sites, negatively affecting the ecological stability of many stream systems in the State. Environmental consequences include entrenched streams, lowered water tables, reduced and undependable base flows, and increased sediment loads, all of which are impacting native fish, amphibians, and other wildlife. Heavy sediment and phosphorus loading of tributary streams also lead to downstream eutrophication. Road projects, culvert installations, and other crossings have caused long-term, adverse impacts. Large-scale oil and gas developments will exacerbate these impacts by further reducing vegetation cover in the watershed, increasing runoff and sediment transport, and potentially introducing pollutants through discharges, chemical spills, and surface runoff.

<u>Resource Categories and Impact Thresholds</u>:

Impact thresholds for aquatic resources are similar to those identified for mule deer and pronghorn (moderate impact = 1-4 well locations per section; high = 5-16; extreme = more than 16). Based on these thresholds, standard management practices and additional mitigation prescriptions are applied to three categories of aquatic resources defined by the Commission Mitigation Policy and the Department's Strategic Habitat Plan. Category 1 includes resources defined by the Commission Mitigation Policy as low or moderate importance. Category 2 resources include Priority Corridors and other habitats considered to be high and vital resources. Finally, Category 3 resources include Priority Watersheds identified by our Strategic Habitat Plan (Appendix E).

The following matrix lists mitigation thresholds and management recommendations for categories of aquatic resources. Standard management practices and additional mitigation prescriptions applicable to aquatic resources are described on succeeding pages.

	1 – 4 Well Locations* per Section	**5 – 16 Well Locations* per Section**	**>16 Well Locations* per Section**
<u>Category 1</u> **Low & Moderate Resources**	• Standard Management Practices	• Standard Management Practices	• Standard Management Practices • Additional Mitigation Prescriptions • Habitat Treatments or • Voluntary Mitigation funds
<u>Category 2</u> **Priority Corridors, High & Other Vital Resources**	• Standard Management Practices	• Standard Management Practices • Additional Mitigation Prescriptions	• <u>Avoid to the extent reasonable</u> • Standard/Additional Mitigation and Habitat Treatments or Voluntary Mitigation funds
<u>Category 3</u> **Priority Watersheds** **(Appendix E)**	• Standard Management Practices • Habitat Treatments or • Voluntary Mitigation funds	• Standard Management Practices • Additional Mitigation Prescriptions • Habitat Treatments or • Voluntary Mitigation funds	• <u>Avoid to the extent reasonable</u> • Standard/Additional Mitigation and Habitat Treatments or Voluntary Mitigation funds
<u>Category 4</u> **Threatened or Endangered spp**	Protective measures are identified through Section 7 Consultation with the USFWS		

* Based on a relatively even distribution of well locations in a section. Appropriate allowances will be made for clustered configurations, on a case-by-case basis.

<u>Standard Management Practices</u>: Refer to Appendix B.

<u>Additional Mitigation Prescriptions</u>:

– If suggested by the grazing permittee, temporarily remove livestock or reduce AUMs along stream/riparian corridors or within watersheds.
– Acquire water rights within the watershed and utilize them to benefit aquatic resources.

OVERLAPPING VITAL AND HIGH VALUE HABITATS

Overlapping, vital and high value habitats such as crucial winter ranges and sage grouse nesting habitats are exceptionally important wildlife areas. If oil and gas fields are planned within overlapping "vital" or "high value" habitats, seasonal use restrictions, standard management practices, additional prescriptions, habitat treatments and optional mitigation funding should apply as defined for each of the affected species and habitats. Where practices or prescriptions for 2 or more species are inconsistent, the more restrictive should control in most cases. To the extent reasonable, integrated habitat treatments should be planned to sustain important habitat functions without adversely affecting one species to benefit another. Optional mitigation funding for each species should be additive to the extent necessary to mitigate the impact. For example, if wells are developed within an area of overlapping mule deer and pronghorn crucial winter ranges and sage grouse nesting habitat, sufficient habitat treatments should be developed to offset impacts to each species without adversely affecting the other species. If the mitigation funding option is selected, the funding should be based on treatments needed to maintain habitat functions for all 3 species.

<u>APPENDIX A</u> – REFERENCES

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APPENDIX B

STANDARD MANAGEMENT PRACTICES TO REDUCE WILDLIFE IMPACTS ASSOCIATED WITH OIL AND GAS DEVELOPMENT

The following management practices are recommendations that can be considered to control or reduce wildlife impacts within all oil and gas fields:

Pre-planning

- Consult the appropriate state and federal wildlife agencies early in the process, during pre-planning exercises if possible.
- Design configurations of oil and gas development to avoid or reduce unnecessary disturbances, wildlife conflicts, and habitat impacts. Where possible, coordinate planning among companies operating in the same oil and gas field.
- Identify important, sensitive, or unique habitats and wildlife in the area. To the extent feasible, incorporate mitigation practices that minimize impacts to these habitats and resources.
- If geologically and technically feasible, plan the pattern and rate of development to avoid the most important habitats and generally reduce the extent and severity of impacts.
- Cluster drill pads, roads and facilities in specific, “low-impact” areas, if geologically feasible.

Roads

- Use existing roads & two-tracks if they are sufficient and not within environmentally sensitive areas.
- Construct the minimum number and length of roads necessary.
- Use common roads to the extent reasonable.
- Coordinate road construction and use among companies operating in the same oil and gas field.
- Design roads to an appropriate standard no higher than necessary to accommodate their intended purpose.
- Design roads with adequate structures or features to prohibit or discourage vehicles from leaving the roads.
- Salvage topsoil from all road construction and re-apply during interim and final reclamation.
- Locate all roads below ridgelines or behind topographic features (knolls, rises) to minimize the zone of visual and auditory effect.
- Locate roads away from bottoms of drainages, which often provide the most important sources of cover and forage for wildlife.
- Construct road crossings at right angles to all riparian corridors and streams to minimize the area of disturbance. In situations where this is not possible, never straighten or otherwise channelize a stream in order to create a right-angle crossing.
- Design road crossings of streams to allow fish passage at all flows. Types of crossing structures that minimize aquatic impacts, in descending order of effectiveness, are: a) bridge spans with abutments on banks; b) bridge spans with center support; c) open

bottomed box culverts; and d) round culverts with the bottom placed no less than one foot below the existing stream grade. Perched culverts block fish passage and are unacceptable in any stream that supports a fishery.

– Locate and construct all structures crossing intermittent and perennial streams such that they do not decrease channel stability or increase water velocity.
– Use a variety of native grasses and forbs to establish effective, interim reclamation on road shoulders and borrow areas.

Wells

– If geologically and technically feasible, drill multiple wells from the same pad using directional (horizontal) drilling technologies (up to 16 wells per pad, as technologically feasible).
– Disturb the minimum area (footprint) necessary to efficiently drill and operate a well.
– Salvage topsoil from all well pad excavations and re-apply during interim and final reclamation.
– If geologically and technically feasible, locate well pads in the least environmentally sensitive areas, well away from riparian habitats, streams or drainages, below ridge lines, away from important sources of forage, cover, reproductive habitats, winter habitats, parturition areas, brood-rearing habitats, etc.
– Use a variety of native grasses and forbs to establish effective, interim reclamation on all well pads and associated disturbances.

Ancillary Facilities

– Locate facilities including tanks, transfer stations, shops, equipment shelters, utility towers, etc. in the least environmentally sensitive areas, well away from riparian habitats, streams or drainages, below ridge lines, away from important sources of forage, cover, reproductive habitats, winter habitats, parturition areas, brood-rearing habitats, etc.
– Salvage topsoil from all facilities construction and re-apply during interim and final reclamation.
– Design all facilities such that they will not be used as perching or nesting substrates by raptors, crows, and ravens in open prairie or shrub-steppe environments.
– Modify new and existing power poles to prevent raptor electrocutions and perching.
– Use existing utilities, road and pipeline corridors to the extent feasible.
– Bury power lines in or adjacent to roads where possible.
– Establish effective, interim reclamation on all surface disturbances associated with ancillary facilities, including equipment staging areas. Interim reclamation should be achieved using a variety of native grasses and forbs.

Noise

– Minimize noise generally. All compressors, vehicles, and other sources of noise should be equipped with effective mufflers or noise suppression systems (e.g., "hospital mufflers").
– NSS 1-3 Breeding birds (except sage grouse). To minimize the effects of continuous noise on bird populations, reduce noise levels to 49 dBA or less, particularly during the bird nesting season (1 April through 30 June). Constant noise generators should

be located far enough away from sensitive habitats or muffled such that noise reaching those habitats is less than 49 dBA.
– Sage grouse. Refer to noise specifications in the Sage Grouse Section.

Traffic

– Develop a travel plan that minimizes the amount of vehicular traffic needed to monitor and service wells and other facilities.
– Prohibit or substantially limit traffic during high wildlife use hours (within 3 hours of sunrise and sunset) to the extent possible.
– Use pipelines to transport condensates off site, or install larger capacity storage tanks when frequent truck trips would impact habitat effectiveness.
– Transmit instrumentation readings from remote monitoring stations to reduce maintenance traffic.
– Post speed limits on all access and maintenance roads to reduce wildlife collisions and limit dust: 30-40 mph is adequate in most cases.

Human Activity & Secondary Effects

– All employees should receive environmental awareness training during orientation. BLM should fund development of an environmental awareness video for use by all companies. The video should provide information about native wildlife, sensitivity to various kinds of impacts, effects and consequences of poaching, information about Wyoming wildlife laws, licensing and residency requirements, and outdoor recreation opportunities.
– Employees should be instructed to avoid walking away from vehicles or facilities into view of wildlife, especially during winter months and reproductive (courtship, nesting) seasons.
– Employees should not be allowed to carry firearms while on the job or riding in company vehicles.

Pollutants, Toxic Substances, Fugitive Dust, Erosion and Sedimentation

– Avoid exposing or spilling hydrocarbon products on the surface. Oil pits should not be used, but if absolutely necessary, they should be enclosed in small-mesh netting and fence to prevent entrapment of birds and mammals. All netting and fence should be maintained and kept in serviceable condition.
– Limit the permitted discharge of produced water to those areas where it can be beneficially used by wildlife, provided water quality standards for wildlife and livestock are met. Produced water use should be carefully considered, on a case-by-case basis, as seemingly beneficial uses may actually be detrimental (e.g., additional water on big game crucial winter ranges may encourage additional summer use by big game or livestock, thus decreasing forage availability for the more crucial winter period). Produced water of suitable quality may be used for supplemental irrigation to improve reclamation success.
– Employ erosion control practices and sediment retention structures to prevent sediment transport off site during precipitation events and runoff.
– Sour gas (hydrogen sulfide) should not be released into the environment.

– Use dust abatement procedures including reduced speed limits, and application of [environmentally compatible] chemical suppressants or suitable quality water.

Monitoring and Environmental Response

– Monitor conditions or events that may indicate environmental problems. Such conditions or events can include any significant chemical spill or leak, detection of multiple wildlife mortalities, sections of roads with frequent and recurrent wildlife collisions (especially big game or sage grouse), poaching and harassment incidents, severe erosion into tributary drainages, raptor electrocutions, structures associated with frequent bird or bat collisions, migration impediments (e.g., pronghorn concentrating along a fence), wildlife entrapment, sick or injured wildlife, or other unusual observations.
– Promptly report observations of potential wildlife problems to the regional office of the WY Game and Fish Dept. and, as applicable, the U.S. Fish and Wildlife Service.
– The application of GIS technologies to monitor the annual extent of disturbance, document the progression and footprint of disturbances, and depict projected development would be a very useful management and planning tool for the BLM, WGFD, and the APWG. Compilations of this information should be released to state and federal resource agencies at least annually.

Research and Special Studies

– Where questions or uncertainties exist about the degree of impact to specific resources, or the effectiveness of mitigation, companies should consider funding or cost-sharing special studies to collect data for evaluation and documentation.

Noxious Weeds

– Control noxious and invasive plants that become established along roads, on well pads, or adjacent to other facilities.
– Clean and sanitize all equipment brought in from other regions. Seeds and propagules of noxious plants are commonly imported by equipment and mud clinging to equipment.
– Request employees to clean mud from boots/work shoes before traveling to the work site, to prevent importation of noxious weeds.

Interim Reclamation

– Establish effective, interim reclamation on all surfaces disturbed throughout the operational phase of the well field. A variety of native grasses and forbs should be used. Non-native vegetation is unacceptable for any purpose, including surface stabilization. Continue to monitor and treat reclaimed surfaces until satisfactory plant cover is established.

Final Reclamation

– Salvage topsoil during decommissioning operations and reapply to reclaimed surfaces.
– Replant a mixture of forbs, grasses, and shrubs that are native to the area and suitable for the specific ecological site.

- Restore vegetation to achieve numeric standards of cover, composition, and diversity that are commensurate with the ecological site.
- Continue to monitor and treat reclaimed areas until plant cover, composition, and diversity standards have been met.
- The BLM should reevaluate its existing system of bonding and reclamation enforcement. Bonds should be set at a level that is adequate to cover the company's liability for final reclamation of the entire well field. Compliance with reclamation standards should be enforced and companies should be required to correct reclamation that does not meet established standards.

Stream habitats and Riparian Corridors

- No drilling activity or disturbance should be permitted within 500 feet of a riparian area, wetland or stream channel. Apply a standard NSO stipulation to all riparian zones and a 500-ft corridor extending from the outermost limit of the riparian habitat.
- Drilling should not be permitted on slopes exceeding 25%.
- Line reserve pits with a suitable, impermeable barrier to eliminate possible contamination of soil and groundwater.
- Design drill pad sites to drain excess storm water and other fluids into a properly sized reserve pit. The pit should have adequate capacity to intercept and hold excess precipitation.
- Discharges from other than reserve pits should meet NPDES standards or otherwise assure the discharged water is of suitable quality.
- All pipeline crossings of a watercourse should be protected against surface disturbances and damage to the pipeline, which could result in a spill event.
- Any stream crossing of a pipeline should be protected by installation of automatic shutoff valves.
- Any pipeline crossing of a perennial stream should be done by boring underneath the stream rather than trenching
- Pipeline crossings can be installed through ephemeral streams by trenching. Use appropriate size riprap to stabilize stream banks. Place riprap from the channel bottom to the top of the normal high water line on the bank at all stream crossings. We recommend double-ditching techniques to separate the top one foot of stream bottom substrate from deeper soil layers. Reconstruct the original layers by replacing deeper substrate first.
- Design road crossings of streams to allow fish passage at all flows. Types of crossing structures that minimize aquatic impacts, in descending order of effectiveness, are: a) bridge spans with abutments on banks; b) bridge spans with center support; c) open bottomed box culverts; and d) round culverts with the bottom placed no less than one foot below the existing stream grade. Perched culverts block fish passage and are unacceptable in any stream that supports a fishery.
- Locate and construct all structures crossing intermittent and perennial streams such that they do not decrease channel stability or increase water velocity.
- Avoid stripping riparian canopy or stream bank vegetation if possible. It is preferable to crush or shear streamside woody vegetation rather than completely remove it. Any locations from which vegetation is stripped during installation of stream crossings, should be revegetated immediately after the crossing is completed.

– Staging, refueling, and storage areas should not be located in riparian zones or on flood plains. Keep all chemicals, solvents and fuels at least 500 feet away from streams and riparian areas.
– Hydrostatic test waters released during pipeline construction could cause alterations of stream channels, increased sediment loads and introduction of potentially toxic chemicals or invasive species into drainages. Avoid discharging hydrostatic test waters directly to streams. Release these waters first into a temporary, sediment retention basin if the concentration of total suspended solids is significantly higher than in the receiving water. Dewater temporary sedimentation basins in a manner that prevents erosion.
– Locate pipelines that parallel drainages, outside the 100-year floodplain. Construct pipeline crossings at right angles to all riparian corridors and streams to minimize the area of disturbance.
– Use the minimum practical width for rights-of-way where pipelines cross riparian areas and streams.
– Instream activity restrictions may be necessary to protect fish spawning habitat in certain streams. These restrictions will be identified in Section 404 permits issued by the U.S. Army Corps of Engineers (COE). In such cases, the COE will consult regional fisheries or statewide fisheries personnel at the Department's local or Cheyenne offices, respectively. We encourage companies to consult the Department's fisheries personnel for advice regarding appropriate practices and design considerations when planning instream activities.

APPENDIX C

WILDLIFE HABITAT MITIGATION OPTION LIST

prepared by:
Wyoming Game & Fish Department

The habitat enhancements suggested in this appendix are options for companies and resource agencies to consider in designing an integrated mitigation plan to sustain habitat functions potentially affected by oil and gas developments. The list is not exhaustive – many additional options and practices could be effective mitigation. Regional biologists may be able to provide alternative suggestions to address specific circumstances.

Conservation Easements – This concept includes numerous options/practices for mitigating impacts to the most crucial habitats. These options/practices include maintaining open space, excluding subdivisions and keeping an agricultural base of operations compatible with wildlife, excluding fencing or other development restrictive to wildlife migration and movement, grazing management systems, etc. Depending upon the amount of property rights acquired costs could range from 35% to 95% of fee title acquisition. The mitigation would be in effect as long as the easement is held and monitored by the assignee. The intent is to maintain the easements at least throughout the length of project disruption to habitat functions, including the time required for reclamation to mature.

Grazing/AUM Management Program – This practice could include many options, if suggested by the permittee, that improve habitat quality for wildlife. Some options might include: (1) paying for private grazing AUMs to provide rest and/or treatments on public lands; (2) paying for a portion of the AUMs within an allotment; (3) providing for rest/treatments and once completed, turning the land back to grazing use; or (4) purchase of AUMs to reduce grazing use on important habitats. Other grazing management options may also be utilized such as electric fencing to provide pasture systems, herding, water developments, etc. These could all be utilized to better manage/control grazing animals to improve range/habitat conditions.

Habitat Improvements – These options may be considered as standard procedures for managing habitat, or for offsite mitigation where important habitats could potentially be improved to restore habitat functions impacted in other areas. The costs are subject to site-specific adjustments based on the true cost of implementation. If monetary assessments are made, the amounts should be calculated based on the true or fair cost of implementation, or inflation-adjusted amounts listed in this section if so agreed by the parties to negotiation. The amounts in this section are 2004 dollars.

Long Term (>15 years)

1. Water Developments

    a. Springs/Seeps - $2500 and $250/yr for maintenance. Longevity of approx. 20 years.
    b. Wetland Development – Average of $4000/acre and ranging from $1000 to $10,000 to develop and $75/ac yearly maintenance – Longevity of 25+ years.
    c. Ponds/Reservoirs – approx. $20,000 per reservoir. Longevity of 25 years.
    d. Guzzlers - $3000 average with a range of $2000 to $6000 each (medium to large size). Annual maintenance of $150 each.
    e. Wells/Windmills - $20,000 each.
2. Prescribed Burning
    a. Average of $25 to $50 per acre in shrublands, $50 to $100 per acre in juniper, and $100 to $500 per acre in mixed conifer. Longevity – 15 years in herbaceous vegetation types. Treated areas require proper pre- and post-burn grazing control and management (two growing seasons of rest). Within shrub ecosystems, burned areas generally will not recover to a functional seral stage for 10-20 years and this process can take much longer in some ecosystems (e.g., xeric *Artemisia tridentata wyomingensis*). The beneficial effect may last an additional 20-30 years.
3. Herbicide Treatments
    a. Use to change vegetative composition and/or set back seral stage of succession to benefit wildlife. Average of $20/acre with range of $10 to $35 per acre. Longevity – 15 years in herbaceous vegetation types. Within shrub ecosystems, burned areas generally will not recover to a functional seral stage for 10-20 years and this process can take much longer in some ecosystems (e.g., xeric *Artemisia tridentata wyomingensis*). The beneficial effect may last an additional 20-30 years.
4. Cutting/Chopping Regeneration
    a. Aspen - $120/acre with range of $80 to $180/acre. Longevity of 50 years.
    b. Conifer – Thinning - $120 to $180 per acre taking 1700 trees/acre and with a range of $100 to $300/acre. Longevity – 20-40 years. Clear cutting - $200/acres
    c. Sagebrush/Mountain shrub - $55/acre ranging from $30 to $150 per acre. Longevity – 15+ years.
    d. Willow - $120/acre ranging from $60 to $180 per acre. Longevity – 25+ years.
5. Seeding – grass, legumes, forbs into permanent cover - $120/acre ranging from $60 to $250 per acre. Longevity – 25+ years
6. Planting shrubs and trees (shelterbelts and thickets) – Installation - $22,000 per tree row mile including site preparation, weed barrier, cost of trees, shrubs, fencing and labor. Maintenance costs = $3500 per year for 3 years. Longevity – 25+ years.

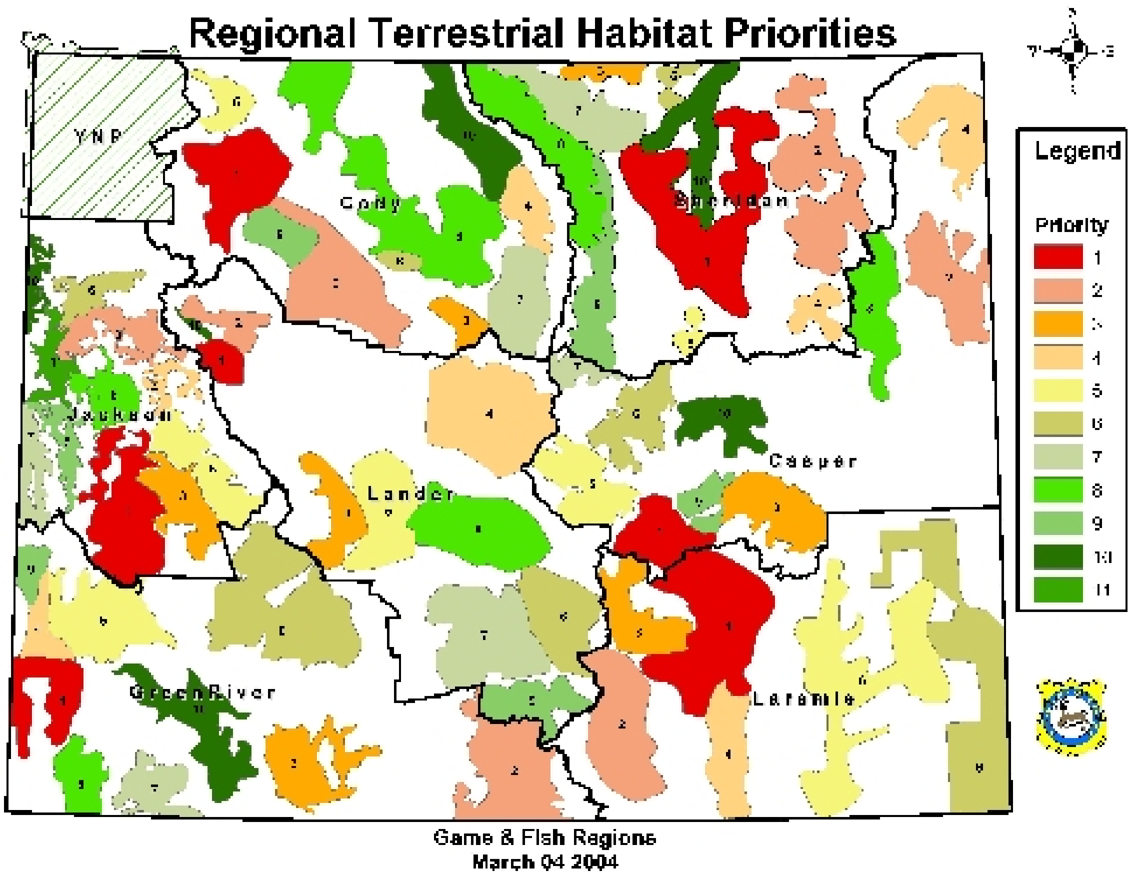
7. Sagebrush seeding – Transplanting containerized stems of Wyoming big sagebrush at $2/stem and 809 stems per acre = $1620 per acre. Seeding costs are much less than transplanting but at a much greater risk of establishment failure. 1999 data for contracted seeding prices for Wyoming big sagebrush approached $500 per acre.
8. Fencing - $6000/mile ranging from $3000 to $20,000 per mile. Longevity – 25 years.
9. Stream bank protection and In-stream structures – Bank stabilization, log and rock revetments and over-pours, boulders, sheet pilings for small streams averages - $6.50 to $7.50 per foot and for large streams averages $23 to $33 per foot. Range – Extremely variable. Annual maintenance - $4.75 to $5.25 per foot. Longevity is variable but should last more than 15 years.
10. Beaver transplanting – designed to raise water table and improve riparian systems - $2500 per colony establishment. Ranging from $1000 to $4500 per colony depending upon remoteness of area and beaver habitat available in the area.

Short Term (<15 years)

1. Fertilization – Average $50 per acre with a range of $20 to $150 per acre. Longevity – 3 years.
2. Food Plots – Average $50 per acre with a range of $40 to $80 per acre. Longevity – 1 to 3 years.
3. Range pitting – to scarify mat-forming forbs and increase moisture collection and penetration - $65 per acre ranging from $40 to $100 per acre. Longevity – 10 years.
4. In-stream structures – i.e. structures to improve small streams or intermittent water draws. Average - $500 per structure ranging from $150 to $800. Longevity – 8 years.
5. Inter-seeding – Average of $50 per acre – ranging from $30 to $80 per acre. Longevity – 10-15 years.
6. Herding/Moving Livestock, if suggested by the permittee – to improve riparian or range conditions - $2000/month average – ranging from $1000 to $3000 per month. Longevity – 1 year but the effects could be up to 2 to 5 years.
7. Fencing (temporary) – such as electrical fencing – Average - $2500 per mile ranging from $1000 to $4000 per mile.
8. Pothole Blasting – Average of $1000 per pothole ranging from $600 to $2000 per pothole.

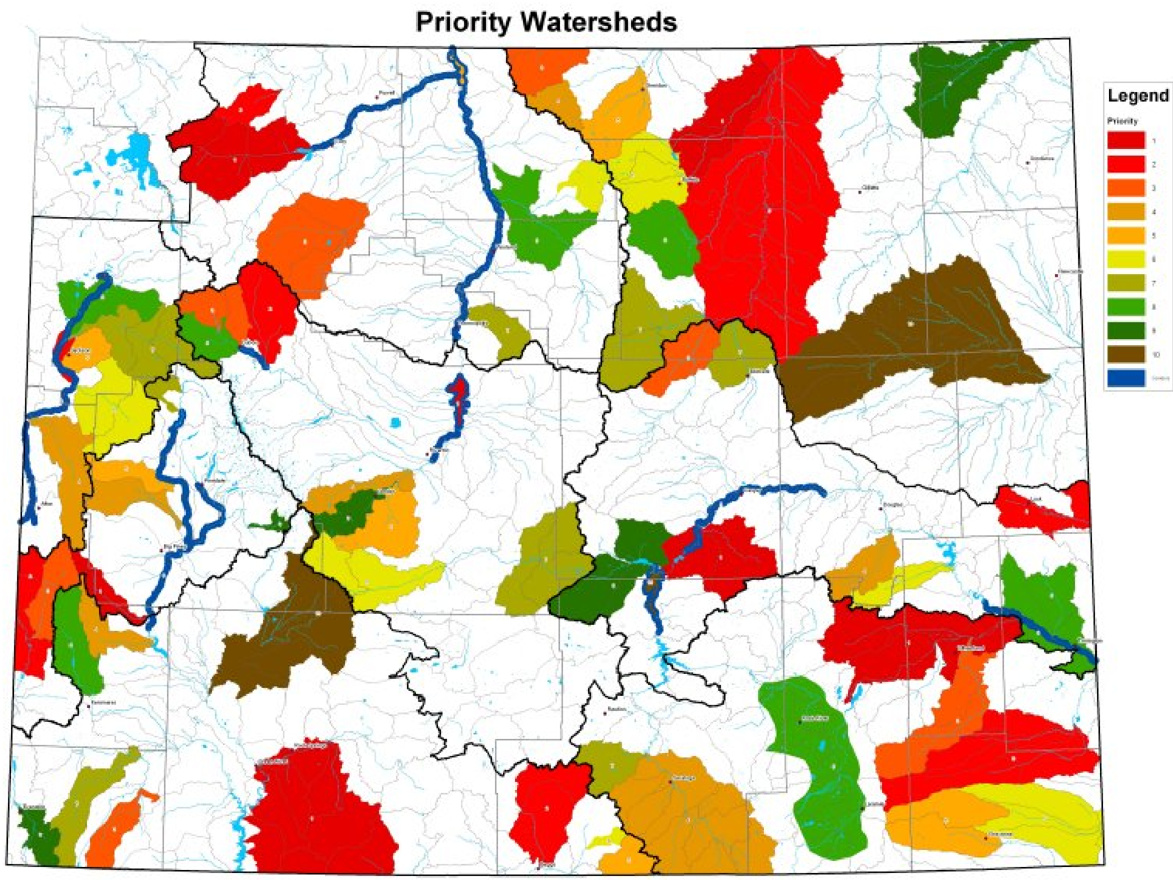
<u>**APPENDIX D**</u>

PRIORITY HABITAT AREAS IN WYOMING



APPENDIX E

PRIORITY WATERSHEDS IN WYOMING



APPENDIX F

BIRD AND MAMMAL SPECIES ENDEMIC TO THE NORTHERN GREAT PLAINS REGION

Avian species endemic to the grasslands of the Great Plains (Samson and Knopf 1996).

Species	Habitat Affinity
Ferruginous hawk	Shortgrass prairie
Mountain plover	Shortgrass prairie
Long-billed curlew	Shortgrass prairie
Sprague’s pipit	Mixed-tallgrass prairie
Cassin’s sparrow	Shortgrass prairie
Baird’s sparrow	Widespread
Lark bunting	Short-mixed-grass prairie
McCown’s longspur	Shortgrass prairie
Chestnut-collared longspur	Short-mixed-grass prairie

Mammalian species endemic to the grasslands of the Great Plains (Samson and Knopf 1996).

Species	Habitat Affinity
White-tailed jack rabbit	Short-mixed-grass prairie
Franklin’s ground squirrel	Tallgrass prairie
Richardson’s ground squirrel	Short-mixed-grass prairie
Thirteen-lined ground squirrel	Widespread
Black-tailed prairie dog	Short-mixed-grass prairie
Plains pocket gopher	Widespread
Olive-backed pocket mouse	Short-mixed-grass prairie
Plains pocket mouse	Short-mixed-grass prairie
Hispid pocket mouse	Short-mixed-grass prairie
Plains harvest mouse	Short-mixed-grass prairie

Northern grasshopper mouse	Short-mixed-grass prairie
Prairie vole	Tallgrass prairie
Swift fox	Short-mixed-grass prairie
Black-footed ferret	Short-mixed-grass prairie
Spotted skunk	Widespread
Pronghorn	Short-mixed-grass prairie

APPENDIX G

ANNOTATED BIBLIOGRAPHY
Wildlife Disturbance Literature
Relevant to the Effects of Oil and Gas Development

SAGE GROUSE

Aldridge, C.L. 1998. Status of the sage grouse (*Centrocercus urophasianus*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, and Alberta Conservation Association, Wildlife Status Report No. 13, Edmonton, AB.

The status of sage grouse in Alberta, Canada was evaluated. Spring lek surveys indicated the sage grouse population in Alberta had declined 80% over the past few decades. Disturbances contributing to loss of sage grouse habitat include "agricultural developments, oil and gas exploration, and vehicular traffic." Livestock grazing can reduce habitat suitability, oil and gas development can fragment and reduce suitable habitat, and roadways contribute to fragmentation as well as direct mortality. The effects of disturbances may be compounded during drought conditions.

sort criteria: sage grouse, oil & gas, roads, agriculture, sagebrush, quantitative, research-based, Canada

Aldridge, C.L., and R.M. Brigham. 2002. Sage-grouse nesting and brood habitat use in southern Canada. Journal of Wildlife Management 66:433-444.

Greater sage grouse nest and brood habitat use in Alberta, Canada were examined. Although sagebrush habitat is less available in Alberta, nest success (46.2%) in this study was comparable to other areas (normally 30-60%). "Overall cover of sagebrush is considerably lower in Canada (5-11%) compared with sagebrush (*Artemisia* spp.) cover in other areas throughout the range of greater sage-grouse (15-25%)." Nest selection seemed to be based on habitat structure, with taller shrubs available within a 15 m radius but no less that 7.5 m in radius, and taller grass within 15 m of the nest site. Management strategies included protecting and maintaining available sagebrush habitat and enhancing mesic sites to increase forb growth for brood rearing.

sort criteria: sage grouse, grazing, sagebrush, quantitative, research-based, Canada

Aldridge, C.L., and R.M. Brigham. 2003. Distribution, abundance, and status of greater sage-grouse, *Centrocercus urophasianus*, in Canada. Canadian Field Naturalist 117:25-34.

Distribution, abundance, and status of sage grouse in Canada were evaluated. An estimated 66 to 92% population decline, in the past 30 years, was based on currently occupied habitat. Low chick survival (18% survived to 50 days of age) was the most probable factor contributing to the decline. Human activity near leks could result in site abandonment, which may reduce breeding success. Oil and gas development, and associated activities led to removal of vegetation, fragmentation of suitable habitat, increased predation, and mortality due to vehicular traffic. Agricultural and livestock operations can also negatively affect sage grouse populations and habitat. "These threats may be magnified by climate change."

sort criteria: sage grouse, oil & gas, human activity, roads, sagebrush, quantitative, research-based, Canada

Aldridge, C.L., and M.S. Boyce. 2004. Modeling greater sage-grouse habitat in Alberta: a multi-scale approach. Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee. Wenatchee, Wa. Abstract only.

Local and landscape scale resource selection function models were presented. The models identify habitat requirements for nesting and brood rearing of sage grouse in Alberta. "Models include both habitat covariates (i.e. sagebrush, litter and forb biomass, range ecosite classification, elevation, slope, aspect, Landsat TM derived variables) and human-use covariates (i.e. road density, oil and gas well site density)." The models identify habitats that should be protected, and highlight habitat management needs for sage grouse recovery plans.

sort criteria: sage grouse, oil & gas, roads, sagebrush, quantitative, research-based, Canada

Applegate, R.D. 2000. In my opinion: Use and misuse of prairie chicken lek surveys. Wildlife Society Bulletin 28(2):457-463.

Methods and accuracy of lek surveys were evaluated. The author suggested surveys be referred to as indices (indicators of population trends) but not used to calculate absolute estimates of population size.

sort criteria: sage grouse, sharp-tailed grouse, wildlife, sagebrush, quantitative, prescriptive

Barrett, H., E. Campbell, S. Ellis, J. Hanf, R. Masinton, J. Pollet, T. Rich, J. Rose, J. Sadowski, F. Taylor, P. Teensma, J. Dillon, D. Zalunardo, B. Bales, W. Van Dyke, and N. Pustis. 2000. Greater sage-grouse and sagebrush-steppe ecosystems management guidelines (Oregon and Washington). Bureau of Land Management, U.S. Fish and Wildlife Service, U.S. Forest Service, Oregon Department of Fish and Wildlife, and Oregon Department of State Lands.

Management goals and objectives were presented to promote conservation of sage grouse and their habitats in Oregon and Washington. Conservation goals included: (1) "Protect existing leks and provide secure sage-grouse breeding habitat with minimal disturbance and harassment." (2) "Promote habitat that supports nesting and early brood-rearing success…." (3) "Promote habitat conditions that support growth and survival of young sage-grouse in late brood-rearing habitat." (4) "Maintain sagebrush that is accessible to sage-grouse for food and cover during the winter months." Management actions regarding energy and minerals for each conservation management goal include avoiding surface occupancy within 1 km of known or occupied sage grouse habitat.

<u>sort criteria</u>: sage grouse, agriculture, oil & gas, sagebrush, qualitative, prescriptive, Oregon, Washington

Beck, J.L., and D. L. Mitchell. 2000. Influence of livestock grazing on sage grouse habitat. Wildlife Society Bulletin 28:993-1002.

Positive and negative impacts of livestock grazing on sage grouse and sage grouse habitat were evaluated in the western U.S. Timing of use and stocking intensity could have the greatest impact on sagebrush habitat. Late spring grazing could reduce herbaceous cover necessary for concealing nests from predators. Management recommendations included: (1) No sagebrush eradication treatments. (2) Rehabilitation work should focus on reestablishment of mixed vegetation (e.g., native herbs and sagebrush). (3) Seedings should focus on establishment of forbs and subspecies of big sagebrush. (4) No insecticides should be applied to sage grouse summer habitat. (5) Regulate livestock use around riparian areas. (6) Manage livestock grazing to allow growth of forbs, grasses, and sagebrush.

<u>sort criteria</u>: sage grouse, agriculture, sagebrush, quantitative, research-based, western U.S.

Beck, J.L., D.L. Mitchell, and B.D. Maxfield. 2003. Changes in the distribution and status of sage-grouse in Utah. Western North American Naturalist 63:203-214.

Distribution and status of sage grouse in Utah were analyzed to evaluate trends in abundance and productivity. Historically greater sage grouse in Utah occupied approximately 72,995 km^2. Currently they inhabit 29,208 km^2 or an estimated 41.3% of their potential historical distribution. Potential habitat has declined 60% for greater sage grouse and 49% of known leks are no longer used. "Long-term trends (1971-2000) in Utah indicate marked declines in all breeding populations, particularly in Gunnison and smaller Greater Sage-Grouse populations."

sort criteria: sage grouse, agriculture, fragmentation, sagebrush, quantitative, research-based, Utah

BLM Sage-Grouse Habitat Conservation Strategy Team. 2003. Draft BLM sage-grouse habitat conservation strategy. Bureau of Land Management, Boise, ID.

A framework to support the development and implementation of BLM state-level sage grouse habitat strategies was presented. Public land uses, such as energy development and recreation, have intensified habitat loss, degradation, and fragmentation. "Over 47% of suitable habitat in the historical range of sage-grouse has been lost." Human activity, noise, surface disturbances (i.e., construction activities), and mineral extraction activities all contribute to fragmentation, degradation, and loss of habitat. The BLM's vision, goals, strategies, and actions were presented.

sort criteria: sage grouse, oil & gas, roads, fragmentation, sagebrush, qualitative, prescriptive, western U.S.

Braun, C.E. 1986. Changes in sage grouse lek counts with advent of surface coal mining. Pages 227-231 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder Co.

Changes in sage grouse lek counts in relation to surface coal mining were investigated from 1973 through 1983 in northern Colorado. Three mines were in some stage of operation throughout the 10-year period. Active leks "… increased from 1973 through 1979, decreased in 1980, and were stable through 1983." Number of males per lek within 2 km of mines was low from 1974-76, fluctuated from 1977-81, and decreased in 1982 and 1983. Beyond 2 km of mining activity the number of males per lek was stable from 1973-77, increased in 1978, and remained high through 1983. "Number of males counted on leks closest to the 3 active surface coal mines decreased markedly (average=60/lek in 1981; 25 in 1983) with increased mine preparation and mining activity."

sort criteria: sage grouse, mining, sagebrush, quantitative, research-based, Colorado

Braun, C.E. 1987. Current issues in sage grouse management. Proceedings of the Western Association of Fish and Wildlife Agencies 67:134-144.

Current data on impacts of energy exploration and development to sage grouse were evaluated. A decrease of males at strutting grounds near oil fields in Colorado was believed to be ". . . related to loss of habitat caused by site preparation and road development." Refineries, pumping stations, gasification plants, etc., also have negative effects on sage grouse populations. Grouse populations decreased in areas impacted by surface coal mines. "... sage grouse could be temporarily attracted to artificial display areas . . . " and ". . . once mines 'mature' or become inactive, numbers of males on leks adjacent to the mining area increase."

<u>sort criteria</u>: sage grouse, oil & gas, sagebrush, quantitative, research-based, western U.S., Canada

Braun, C.E. 1998. Sage grouse declines in western North America: What are the problems? Proceedings of the Western Association of State Fish and Wildlife Agencies 78:139-156.

An evaluation of the causes for the decline of sage grouse in western North America was based on review of available literature. Since European settlement an overall decrease of 50% was estimated, with a 45-80% decrease since the early 1950s. In spring 1998, 142,000 sage grouse were estimated to exist range-wide. Although a few studies indicate some recovery of grouse populations after initial energy development, there is no evidence that levels will reach their pre-development size. Up to 50% of sage grouse habitat is under subdivision development in some counties in Colorado.

<u>sort criteria</u>: sage grouse, mining, oil & gas, roads, rural subdivisions, quantitative, research-based, western U.S., Canada

Braun, C.E. 2002. A review of sage-grouse habitat needs and sage-grouse management issues for the revision of the BLM's Pinedale District Resource Management Plan, Wyoming.

Potential negative effects on sage grouse from energy development in western Wyoming were reviewed, evaluated, and analyzed. Recommendations for monitoring sage grouse winter use areas, leks, nesting habitat, and brood rearing areas included: (1) "… locating and mapping sage-grouse winter-use areas…" (2) "… surveys of all areas within the proposed project area should be conducted in April 2003 and continuing at 3-year intervals." (3) "Guidelines should be followed to offer some protection to habitats useful for nesting at distances up to 3 miles form active leks." (4) "Management that should be in place includes movement of livestock to avoid degradation of plant communities in moist sites and riparian areas…". Other mitigation measures and monitoring requirements were also presented.

<u>sort criteria</u>: sage grouse, oil & gas, sagebrush, qualitative, prescriptive, Wyoming, mitigation

Braun, C.E., M.F. Baker, R.L. Eng, J.W. Gaswiler, and M.H. Schroeder. 1976. Conservation committee report on the effects of alteration of sagebrush communities on the associated avifauna. Wilson Bulletin 88:165-171.

Relevant data were reviewed in the mid-1970s to assess the effects reducing sagebrush have on associated avifauna (notably sagebrush obligates). Based on estimates, at least 10% of sagebrush rangelands had been altered in the west at that time. "Development of energy resources, especially coal, will have major impacts on sagebrush communities and dependent avifauna for at least the next 40 years." Recommendations include, confining sagebrush alteration to small areas of 16 ha or less, and scheduling sagebrush control programs to avoid bird nesting seasons.

sort criteria: sage grouse, sagebrush obligates, non-game birds, sagebrush treatment, sagebrush, quantitative, prescriptive, western U.S.

Braun, C.E., T. Britt, and R.O. Wallestad. 1977. Guidelines for maintenance of sage grouse habitats. Wildlife Society Bulletin 5:99-106.

Guidelines were based upon a review of studies relating to the importance of sagebrush in maintaining population stability of sage grouse. Effects of sagebrush control were discussed. Guidelines for maintaining sage grouse habitats include, applying treatment measures in irregular patterns, no treatment in known wintering areas, no control of vegetation within 3 km of leks or on nesting/brood areas, and no treatment of areas with live sagebrush cover less than 20%.

sort criteria: sage grouse, sagebrush treatment, sagebrush, quantitative, prescriptive, western U.S.

Braun. C.E., O.O. Oedekoven, and C.L. Aldridge. 2002. Oil and gas development in western North America: effects on sagebrush steppe avifauna with particular emphasis on sage grouse. Transactions of the 67th North American Wildlife and Natural Resources Conference 67:337-349.

Effects of energy exploration and development on sagebrush dependent avian species (especially sage grouse) were examined through a review of available information. In Alberta, Canada the sage grouse population had declined at least 66% in the last 3 decades. Research in Colorado indicated grouse would continue to use areas near production facilities if suitable sagebrush habitat was available and disturbance was minimal. It was estimated that 5000 acres of sage grouse habitat had been lost due to (12,000) CBM (coal bed methane) wells in production in northeastern Wyoming. "CBM activity has affected an estimated 28 percent of the known sage-grouse habitats within the project area." Companies are required to avoid disturbing leks during breeding season, locate overhead power lines at least 0.5 mile from breeding or nesting grounds, and reduce compressor noise close to leks, however, all requirements can be waived by federal land management agencies.

sort criteria: sage grouse, oil & gas, sagebrush, quantitative, research-based, western U.S., Canada

Bureau of Land Management. 2000. Interim management guidelines for sage grouse and sagebrush ecosystems in Nevada.

Guidelines to promote conservation of sage grouse and sagebrush habitats in Nevada were presented. Specific guidelines were suggested for various threats including locatable, leasable, and salable energy and minerals. Some of these management guidelines were: (1) "Avoid permitting or leasing energy or mineral-associated facilities or activities in known sage grouse habitat, as practicable (e.g. modifying location, implementing time-of-year and/or time-of-day restrictions, etc.)." (2) "Consider the habitat needs of sage grouse when developing reclamation plans, as appropriate." (3) "Avoid permitting or leasing mineral and energy-related activities within 3.3 km (2 miles) or other appropriate distance based on site-specific conditions, of leks, or within 1 km (0.6 mi.) of known nesting, brood rearing and winter habitat."

sort criteria: sage grouse, oil & gas, mining, roads, human activity, agriculture, rural subdivision, sagebrush, qualitative, prescriptive, Nevada

Burkepile, N.A., K.P. Reese, and J.W. Connelly. 2004. Modeling greater sage-grouse chick survival in southeastern Idaho. Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee. Wenatchee, Wa. Abstract only.

Sage grouse nesting activity and chick survival were monitored and evaluated in southeastern Idaho. Nest success ranged from 41-51% and chick survival from 20-25%. Highest chick mortality occurred within 3 weeks of post-hatch. Drought conditions reduced chick survival—likely from reduced vegetative cover.

sort criteria: sage grouse, drought, sagebrush, quantitative, research-based, Idaho

Christiansen, T. 2000. Sage grouse in Wyoming: What happened to all the sage grouse? Wyoming Wildlife News 9(5). Wyoming Game and Fish Department, Cheyenne.

Reasons for the decline of sage grouse populations on western shrub lands were investigated. Oil and gas development, mining, agricultural activities, sagebrush manipulation (prescribed fire and herbicide treatment), and livestock grazing are just a few of the possible activities contributing to the decline of sage grouse. Seasonal periods critical to sage grouse survival are 1) nesting (May to early June), 2) early brood rearing (the first 2 weeks after hatching), and 3) fall hen survival.

<u>sort criteria</u>: sage grouse, agriculture, mining, oil & gas, grazing, roads, fences, powerlines, quantitative, research-based, Wyoming

Colenso-Postovit, B. 1981. Suggestions for sage grouse habitat reclamation on surface mines in northeastern Wyoming. M.S. Thesis, University of Wyoming, Laramie.

Characteristics of crucial sage grouse habitat and seasonal changes in habitat selection were investigated in northeastern Wyoming. Favored habitat consisted of sagebrush with a mean height of 27 cm, and provided 25% cover. Critical components of pre-disturbance habitat were big sagebrush, forbs, and patchiness. Negatively correlated habitat types included: clay slope, playa grassland, and herbicide sprayed sagebrush. The author advocates "… establishment of patchy shrub stands intermixed with grass/forb vegetation."

<u>sort criteria</u>: sage grouse, mining, sagebrush, quantitative, research-based, Wyoming

Commons-Kemner, M.L., and S. Sather-Blair. 2004. Working together to provide a broadscale habitat planning map for greater sage-grouse in Idaho. Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee. Wenatchee, Wa. Abstract only.

A broad scale habitat-planning map for sage grouse in Idaho was developed. The map was designed to help fire managers develop attack plans for fires occurring in sage grouse habitats, and aid in determining habitat restoration potential. "The maps are a useful visual tool to help biologists, fire managers, private land owners, ranchers, and others develop appropriate conservation measures for sage-grouse across Idaho."

<u>sort criteria</u>: sage grouse, sagebrush, quantitative, research-based, Idaho

Comstock, B.C., and J.S. Sedinger. 2004. Sage-grouse population dynamics and movement in central Nevada. Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee. Wenatchee, Wa. Abstract only.

Characteristics of demographic processes in greater sage grouse were investigated in Nevada. Nest success was monitored, and vegetative cover characteristics for nest sites were evaluated. "The long-term goal of this 10 year study is to determine if possible increases in avian predators due to transmission lines perch sites have an impact on sage-grouse leks and survival."

sort criteria: sage grouse, power lines, sagebrush, quantitative, research-based, Nevada

Connelly, J.W., W.J. Arthur, and O.D. Markham. 1981. Sage grouse leks on recently disturbed sites. Journal of Range Management 34(2):153-154.

Authors examined the use of recently disturbed sites for strutting by sage grouse near the Idaho National Engineering Laboratory Site (INEL) in southeastern Idaho. Three of 51 leks on or near the INEL were located on recently disturbed sites (1 burned area and 2 gravel pits) suggesting sage grouse will strut in man-made clearings if sufficient sagebrush is located nearby, and natural clearings are lacking.

sort criteria: sage grouse, roads, mining, sagebrush, quantitative, research-based, Idaho

Connelly, J.W., K.P. Reese, R.A. Fischer, and W.L. Wakkinen. 2000. Response of a sage grouse breeding population to fire in southeastern Idaho. Wildlife Society Bulletin 28(1):90-96.

Response of a sage grouse breeding population to prescribed fire was investigated from 1986 through 1994, in a desert shrub biome in southeastern Idaho. The decline in lek attendance by male sage grouse was greater following burning (90%) than within unburned areas (63%). Authors recommend against use of prescribed burning in low-precipitation sagebrush habitats where breeding sage grouse could be negatively affected.

sort criteria: sage grouse, sagebrush treatment, sagebrush, quantitative, research-based, Idaho

Connelly, J.W., M.A. Schroeder, A.R. Sands, and C.E. Braun. 2000. Guidelines to manage sage grouse populations and their habitats. Wildlife Society Bulletin 28(4):967-985.

Guidelines were based upon a summary of current knowledge of the ecology of sage grouse. Effects of human-caused and natural disturbances are discussed. Guidelines for population and habitat management include: "Avoid building powerlines and other tall structures that provide perch sites for raptors within 3 km of seasonal habitats . . ., manage breeding habitats to support 15-25% canopy cover of sagebrush . . ., for nonmigratory grouse occupying habitats that are distributed uniformly . . . protect (i.e., do not manipulate) sagebrush and herbaceous understory within 3.2 km of all occupied leks . . ., where sagebrush is not distributed uniformly . . . protect suitable habitats for ≤ 5 km from all occupied leks . . ., for migratory populations, identify and protect breeding habitats within 18 km of leks . . ., adjust timing of energy exploration, development, and construction activity to minimize disturbance . . ., facilities should be located > 3.2 km from active leks . . .."

sort criteria: sage grouse, oil & gas, mining, sagebrush treatment, quantitative, research-based, western U.S.

Connelly, J.W., K.P. Reese, and M.A. Schroeder. 2003. Monitoring of greater sage-grouse habitats and populations. Publication 979, College of Natural Resources Experiment Station, University of Idaho, Moscow.

Sagebrush habitat assessment and sage grouse population monitoring were examined to determine guidelines for management decisions. Techniques for assessing habitat, monitoring sage grouse populations, capturing and marking sage grouse were described.

sort criteria: sage grouse, sagebrush, qualitative, prescriptive, western U.S.

Connelly, J.W., S.T. Knick, M.A. Schroeder, and S.J. Stiver. 2004. Conservation assessment of greater sage-grouse and sagebrush habitats. Western Association of Fish and Wildlife Agencies. Unpublished Report. Cheyenne, Wyoming.

The goal of this report was to "present an unbiased and scientific documentation of dominant issues and their effects on greater sage-grouse populations and sagebrush habitats." "Oil and natural gas well pads, pipelines, and roads influenced 28% of the sagebrush habitats within the Conservation Assessment study area." Stipulations intended to reduce disturbances to wildlife are in place on 14.6% of federal lands, however exceptions may be granted. The proportion of wells on private lands, within the 5 major geologic basins, range from 33% in the Greater Green River Basin to 77% in the Montana Thrust Belt. Mitigation of effects from oil and gas development is not required on private lands, and could shift the importance of maintaining sagebrush habitats on public lands.

sort criteria: sage grouse, oil & gas, sagebrush, quantitative, research-based, western U.S.

Connelly, J.W., S.T. Knick, M.A. Schroeder, and S.J. Stiver. 2004. Synthesis. Pages 13-1 to 13-22 in Conservation assessment of greater sage-grouse and sagebrush habitats. Western Association of Fish and Wildlife Agencies. Unpublished Report. Cheyenne, Wyoming.

Information on greater sage grouse habitats and populations in the western U.S. was synthesized. The abundance and distribution of the greater sage grouse population declined greatly in North America between the 1960s and the mid-1980s, however it then seemed to stabilize. Interstate highways and roads cover a minimum of 14,272 km^2 of sagebrush ecosystems. No leks were found within 2 km of Interstate 80, 34 leks were documented within 7.5 km, and 84 leks were found between 7.5 and 15 km of the interstate. An estimated 9,510 communication towers have been built recently, which provide perches for raptors. Oil and gas wells and pipelines have disturbed twenty-eight percent of sagebrush habitats.

sort criteria: sage grouse, oil & gas, roads, sagebrush, quantitative, research-based, western U.S.

Connelly, J.W., S.T. Knick, M.A. Schroeder, and S.J. Stiver. 2004. The human footprint across the sage-grouse conservation assessment area: A large-scale analysis of anthropogenic impacts. Pages 12-1 to 12-23 in Conservation assessment of greater sage-grouse and sagebrush habitats. Western Association of Fish and Wildlife Agencies. Unpublished Report. Cheyenne, Wyoming.

Anthropogenic impacts upon sagebrush habitats were analyzed and evaluated. Four habitat models were designed to evaluate "how the invasion of exotic plants, human-caused fires, energy extraction, and anthropogenic fragmentation influence the spatial distribution and fragmentation of sagebrush habitats."

sort criteria: sage grouse, oil & gas, fragmentation, sagebrush, quantitative, research-based, western U.S.

Crawford, J.A., R.A. Olson, N.E. West, J.C. Moseley, M.A. Schroeder, T.D. Whitson, R.F. Miller, M.A. Gregg, and C.S. Boyd. 2004. Ecology and management of sage-grouse and sage-grouse habitat. Journal of Range Management 57:2-19.

Current issues in sage grouse ecology and management were examined. Multiple causative factors were implicated in the present sage grouse decline. Fire, in high elevation sagebrush habitat, results in invasion of conifers and loss of canopy cover and herbaceous understory. Intensity and timing of livestock grazing are of concern regarding habitat quality. Light to moderate grazing can be beneficial, however heavier use decreases herbaceous cover. Heavy levels of chemical control methods may result in lower habitat quality. Other sagebrush obligate species (e.g., Brewer's sparrow, pygmy rabbit, and sagebrush vole) are also declining.

sort criteria: sage grouse, sagebrush obligates, sagebrush treatment, fire, livestock grazing, sagebrush, quantitative, research-based, western U.S., Canada

Eng, R.L., E.J. Pitcher, S.J. Scott, and R.J. Greene. 1979. Minimizing the effect of surface coal mining on a sage grouse population by a directed shift of breeding activities. Pages 464-468 in G.A. Swanson, ed., The mitigation symposium: a national workshop on mitigating losses on fish and wildlife habitats. U.S. Department of Agriculture, Forest Service General Technical Report. RM-65.

In southern Montana, an artificial lek was created 2 miles from an area scheduled for surface coal mining. The experimental lek was created using decoys and a sound system producing sounds of an active lek. The first year 7 cocks and 8 hens attended, with 16 cocks and 18 hens attending the second year.

<u>sort criteria</u>: sage grouse, mining, sagebrush, mitigation, quantitative, research-based, Montana

Eng, R.L., and P. Schladweiler. 1972. Sage grouse winter movements and habitat use in central Montana. Journal of Wildlife Management 36(1):141-146.

Habitat use and movements of sage grouse were examined in central Montana during the 1965-66 and 1966-67 winters. Eighty-two percent of the grouse observed were located in dense sagebrush stands exceeding 20% canopy coverage. Grouse used sagebrush canopy coverage exceeding 20% significantly more than areas of less than 20% canopy. This indicated a preference for dense stands of sagebrush. Authors concluded removal of large expanses of dense sagebrush would greatly reduce sage grouse populations.

<u>sort criteria</u>: sage grouse, sagebrush treatment, sagebrush, quantitative, research-based, Montana

Garton, E.O., J.W. Connelly, M.A. Schroeder, S.T. Knick, and S. Stiver. 2004. Evaluating range-wide population changes in greater sage-grouse. Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee. Wenatchee, Wa. Abstract only.

The historical range of greater sage grouse included parts of 14 states and 3 provinces. A comprehensive analysis of grouse population changes throughout this historical range was conducted. Male counts at more than 5,600 leks range-wide were analyzed. Varying degrees of decline were noted in all regions with complete extirpation in 3 states and 1 province. "Eighty three percent of populations showed declines in males per lek with statistically significant declines in 69% of the populations." "Sage-grouse populations overall declined at a rate of 2.0% per year from 1965 to 2003. This annual rate of decline was much higher during the first 2 decades (3.5% in 1965-86) compared to the last 2 decades (0.37% in 1986-2003)."

<u>sort criteria</u>: sage grouse, sagebrush, quantitative, research-based, western U.S.

Hayden-Wing Associates. 1991b. Review and evaluation of the effects of geophysical exploration on some wildlife species in Wyoming. Unpublished Report for Geophysical Acquisition Workshop. Laramie, Wy.

A review of previous studies on the effects of geophysical exploration on pronghorn, mule deer, elk, raptors, and sage grouse was presented. The information examined indicated that big game are temporarily affected by seismic exploration causing increased energy expenditure and utilization of sub-optimal habitats. Characteristics for evaluating potential sage grouse nesting habitat in relation to proposed oil and gas development included: "1) distance relationships to leks, 2) presence, distance, and characteristics of existing disturbances, 3) characteristics of shrubs and vegetation that could serve in nest concealment and nest-site selection, and 4) distance to water and to potential brood-rearing areas." Mitigation strategies for protecting raptor-nesting habitat were also presented.

sort criteria: sage grouse, raptors, pronghorn, mule deer, elk, oil & gas, seismic exploration, sagebrush, quantitative, research-based, Wyoming

Hayden-Wing, L.D., D.B. Costain, J.L. Hull, M.R. Jackson, and T.B. Segerstrom. 1986. Movement patterns and habitat affinities of a sage grouse population in northeastern Wyoming. Pages 207-226 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

Potential impacts from mining on a sage grouse population were examined in northeastern Wyoming. Nests were observed from 0.71 miles to 3.25 miles from a lek on the proposed mine site. Vegetation coverage averaged 71% with big sagebrush the dominant shrub type. "Results suggest that sage grouse can survive the extensive mining development in the Powder River Basin if adequate habitats or refugia are maintained at the regional or inter-mine level."

sort criteria: sage grouse, mining, sagebrush, quantitative, research-based, Wyoming.

Hemmer, L.G. 2004. Conservation Reserve Program: effects of capping enrollment. Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee. Wenatchee, Wa. Abstract only.

The federal Conservation Reserve Program (CRP) supports many bird, reptile, and mammal species including sage grouse and sharp-tailed grouse. "Most leks and nests in north-central Washington are located in CRP or in areas dominated by CRP." One questionable CRP rule limits enrollment to 25% of total cropland in a county.

sort criteria: sage grouse, sharp-tailed grouse, mitigation, qualitative, prescriptive, Washington

Hemstrom, M.A., M.J. Wisdom, W.J. Hann, M.M. Rowland, B.C. Wales, and R.A. Gravenmier. 2002. Sagebrush-steppe vegetation dynamics and restoration potential in the Interior Columbia Basin, U.S.A. Conservation Biology 16:1243-1255.

Changes in the amount and quality of sage grouse habitat on U.S. Forest Service (FS) and Bureau of Land Management (BLM) lands were evaluated and the dynamics and restoration of sagebrush habitats were modeled. Changes from historical to current conditions were estimated as were changes from current conditions to those projected 100 years in the future (taking into account the proposed management plan and two restoration scenarios). "Under the two scenarios," (50% and 100% reduction of livestock grazing) "the amount of FS-BLM habitat for sage grouse within treated areas declined by 17-19% 100 years in the future compared with the current period, but was 10-14% higher than the 100-year projection under proposed management."

<u>sort criteria</u>: sage grouse, grazing, sagebrush treatment, quantitative, research-based, western U.S.

Holloran, M.J., and S.H. Anderson. 2004. Sage-grouse response to natural gas field development in northwestern Wyoming. Western Sage and Columbian Sharp-tailed Grouse Technical Committee. Wenatchee, Wa. Abstract only.

Responses of sage grouse to natural gas development were examined in northwestern Wyoming. A positive correlation was found between annual declines on road-disturbed leks and traffic volume. "Mean annual declines in the maximum number of males attending leks impacted by a drilling rig within 3.2 km or a road within 500 m were 32 and 19% respectively, compared to 2% average annual declines for leks > 6.5 km from gas field disturbance (controls)." "… the data suggests that the presence of a drilling rig within 5.5 km directly and indirectly influenced sage-grouse."

<u>sort criteria</u>: sage grouse, oil & gas, sagebrush, quantitative, research-based, Wyoming

Hupp, J.W., and C.E. Braun. 1989. Topographic distribution of sage grouse foraging in winter. Journal of Wildlife Management 53(3):823-829.

Topographic variations in snow depth and sagebrush structure were evaluated to determine how they influence distribution of sage grouse foraging in southern Colorado. Southwest slopes and drainages were used proportionally more than other topographic areas (e.g. northeast slopes, low flat areas, or high flat areas). "Between 46 and 75% of foraging occurred in drainages and on southwest slopes." This distribution of foraging was influenced by sagebrush height relative to snow depth. Maintenance of sagebrush in drainages and southwest slopes should be stressed to assure quality forage is available for sage grouse.

<u>sort criteria</u>: sage grouse, sagebrush treatment, sagebrush, quantitative, research-based, Colorado

Johnson, K.H., and C.E. Braun. 1999. Viability and conservation of an exploited sage grouse population. Conservation Biology 13:77-83.

The viability of the sage grouse population of North Park, Colorado was evaluated to determine the effects of hunting pressure and habitat degradation. Adult and juvenile survival and reproduction were described as the most limiting demographic factors. However, with appropriate habitat manipulation measures (e.g., increasing sagebrush canopy cover to 15-20%) juvenile and adult survival could be enhanced and population viability conserved without reducing harvest by hunters.

<u>sort criteria</u>: sage grouse, grazing, sagebrush, quantitative, research-based, Colorado

Klebenow, D.A. 1969. Sage grouse nesting and brood habitat in Idaho. Journal of Wildlife Management 33(3):649-662.

Factors influencing selection of brood-rearing habitat by sage grouse were evaluated in southeastern Idaho between 1964 and 1966. Grouse selected areas with denser and taller shrubs, however nests were located in areas of greater than 35% shrub cover. The average height of shrubs under which sage grouse nested was 17 inches. Controlling tall, dense sagebrush with little understory could benefit sage grouse.

<u>sort criteria</u>: sage grouse, sagebrush treatment, sagebrush, quantitative, research-based, Idaho

Klott, J.H., and F.G. Lindzey. 1990. Brood habitats of sympatric sage grouse and Columbian sharp-tailed grouse in Wyoming. Journal of Wildlife Management 54:84-88.

A comparison of habitats in south-central Wyoming used by sage grouse and Columbian sharp-tailed grouse was presented. "Sage grouse broods occurred most often (68%) in sagebrush (*Artemisia* spp.)-grass and sagebrush-bitterbrush (*Purshia tritentata*) habitats, whereas sharp-tailed grouse broods occurred most often (73%) in mountain shrub and sagebrush-snowberry (*Symphoicarpos oreophilus*) habitats." No difference was found between sage grouse and sharp-tailed grouse brood sites in regard to total shrub cover, sagebrush cover, or sagebrush canopy. Management suggestions included constraining vegetation treatments to narrow strips (< 30 m) and reduction of livestock grazing.

<u>sort criteria</u>: sage grouse, sharp-tailed grouse, sagebrush treatment, sagebrush, quantitative, research-based, Wyoming

Knick, S.T., D.S. Dobkin, J.T. Rotenberry, M.A. Schroeder, W.M. Vander Haegen and C. van Riper III. 2003. Teetering on the edge or too late? Conservation and research issues for avifauna of sagebrush habitats. Condor 105:611-634.

Oil and gas wells in Wyoming are located predominately in ecosystems dominated by sagebrush. Road networks, pipelines, and powerline transmission corridors associated with oil and gas development cause habitat fragmentation. Density of sagebrush-obligate birds was 50% lower within 100m of roads used for natural gas development than at greater distances.

<u>sort criteria</u>: sage grouse, sagebrush obligates, oil & gas, roads, sagebrush, quantitative, research-based, Wyoming

Kolada, E.J., M.L. Casazza, J.S. Sedinger, M.A. Farinha, S. Gardner, and T. Taylor. 2004. Breeding ecology of greater sage-grouse in Mono County, California. Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee. Wenatchee, Wa. Abstract only.

Breeding ecology of greater sage grouse is being investigated in Mono County, California. In 2003, 70% of hens initiated nests, nest success was 34%, and fledging success was 33%. Sixty-four percent of hens fledged chicks to > 50 days old. Average brood size was 6 at hatching, with 53% surviving at least 50 days.

<u>sort criteria</u>: sage grouse, sagebrush, quantitative, research-based, California

Krementz, D.G., and J.R. Sauer. 1982. Avian communities on partially reclaimed mine spoils in south-central Wyoming. Journal of Wildlife Management 46:761-765.

Differences in avian community structure between a reclaimed mine site and a native shrub-steppe were investigated in south-central Wyoming. Composition, abundance, and diversity between sites were likely due to variation in habitat structure. Foliage-gleaning omnivores were virtually absent from the reclaimed site, however ground-gleaning omnivores and insectivores were common. "The absence of nesting by all species except the horned lark indicates that the reclamation treatments did not fulfill nesting requirements of northern desert shrub-steppe avifauna." Authors suggest "… future reclamation plans should emphasize prompt reintroduction of sagebrush and other species that provide nesting habitat."

<u>sort criteria</u>: sage grouse, raptors, non-game birds, mining, sagebrush, quantitative, research-based, Wyoming

Kuipers, J.L. 2004. Grazing system and linear corridor influences on greater sage-grouse (*Centrocercus urophasianus*) habitat selection and productivity. M.S. Thesis, University of Wyoming, Laramie.

The influence of linear corridors on sage grouse nest selection and success was examined in central Wyoming. Livestock and wildlife trails within 25 m decreased nest success, had no affect at 50 m, and increased nest success at 100 m. "Maintained roads and 2-tracks had positive influences on nest success at 100 m." Two-track roads increased the likelihood of nest selection at 25 m, as did trails at 50 m. However, 2-tracks decreased the likelihood of nest selection at 100 m. Nest success could be negatively affected by livestock trailing, however nest success was not reduced due to 2-track or maintained roads.

sort criteria: sage grouse, roads, sagebrush, quantitative, research-based, Wyoming

Lyon, A.G. 2000. The potential effects of natural gas development on sage grouse (*Centrocercus urophasianus*) near Pinedale, Wyoming. M.S. Thesis, University of Wyoming, Laramie.

Effects of natural gas and oil development on sage grouse were investigated on the Pinedale Mesa in northwestern Wyoming. The limiting factor in sage grouse population stability appeared to be extreme early brood survival. Forty percent of broods from disturbed areas survived the first 3 weeks, while 50% from undisturbed sites survived through early brood rearing. Ninety-one percent of hens from undisturbed leks nested within 3 km of the capture lek, while 74% from disturbed leks nested > 3 km from the lek. Average distance from a road to a nest for disturbed hens was 726 m and 2360 m for undisturbed hens. Nest initiation rates were 55 and 82% for disturbed and undisturbed hens respectively. Author suggests "restricting development activities during hours of lek attendance could reduce negative impacts to breeding grouse."

sort criteria: sage grouse, oil & gas, sagebrush, quantitative, research-based, Wyoming

Lyon, A. G., and S. H. Anderson. 2003. Potential gas development impacts on sage grouse initiation and movement. Wildlife Society Bulletin 31(2):486-491.

This study was conducted on the Pinedale Mesa in an area dominated by sagebrush and high desert vegetation. Forty-eight hens were captured and radio-collared from leks classified as disturbed (≤ 3 km of natural gas development) and undisturbed (> 3 km from gas development). On average hens that bred on disturbed leks, and initiated nests, selected sites 4,116 m from the lek. Hens from undisturbed leks moved 2,090 m to nest sites. Hens from disturbed and undisturbed leks initiated nests 65% and 89% respectively. Hatching success did not differ between groups. Light road traffic (1-12 vehicles per day) seemed to be a factor causing hens to nest farther from the capture lek, however habitat factors did not appear to influence hen movement. Nominal traffic disturbance (1-12 vehicles/day) could reduce nest-initiation rates and increase distance of nest-site selection.

sort criteria: sage grouse, oil & gas, roads, sagebrush, quantitative, research-based, Wyoming

Martin, N.S. 1970. Sagebrush control related to habitat and sage grouse occurrences. Journal of Wildlife Management 34(2):313-320.

Effects on sage grouse from chemical treatment of sagebrush were investigated on a 1900-acre study area during the summers of 1962 through 1964 in Montana. Ninety-seven percent of the sagebrush was dead in the sprayed area and only 4% of observed sage grouse were located in that sector. The numbers of grouse observed in the sprayed and unsprayed areas were related to vegetation composition (favored food was more abundant in the unsprayed area).

sort criteria: sage grouse, sagebrush treatment, sagebrush, quantitative, research-based, Montana

Martin, N.S. 1976. Life history and habitat requirements of sage grouse in relation to sagebrush treatment. Proceedings of the Western Association of State Game and Fish Commissioners 56:289-294.

Habitat requirements for sage grouse were investigated in central Montana. Observations of hens occurred 75% of the time on the strutting ground where the bird was tagged. Canopy coverage of 20-50% was noted at 80% of feeding and loafing sites. ". . . 68 percent of all radio marked hens nested within one and five tenths miles of a strutting ground." Sagebrush was the nesting cover for all nests, and 20-30% canopy, averaging 15.9 inches in height was most commonly selected. On treated areas numbers of male grouse increased 28% from pre-to post-treatment years, however male grouse numbers increased 323% during the same period on non-treated areas.

sort criteria: sage grouse, sagebrush treatment, sagebrush, quantitative, research-based, Montana

McAdoo, J.K., G.A. Acordagoita, and C.R. Aarstad. 1989. Reducing impacts of hard-rock mining on wildlife in northern Nevada. Pages 95-97 in Proceedings IV: Issues and Technology in the Management of Impacted Wildlife. Thorne Ecological Institute, Boulder, Co.

Reduction of wildlife impacts from mineral exploration in northern Nevada was examined. Mitigation actions included: minimizing erosion through the use of sediment catchment basins, silt screens, and seeding of road cuts and fill slopes, minimizing construction activity near raptor nests, avoiding aspen wildlife habitat, using culverts for crossing trout streams, and monitoring ground and surface water. Offsite mitigation and concurrent reclamation efforts were also evaluated.

sort criteria: wildlife, mule deer, sage grouse, raptors, mining, sagebrush, riparian, qualitative, prescriptive, mitigation, Nevada

Montana Sage Grouse Work Group. 2002. Management plan and conservation strategies for sage grouse in Montana: DRAFT.

A management plan along with conservation strategies for sage grouse in Montana were presented. Conservation actions for minimizing impacts on sage grouse and sagebrush habitat, from oil and gas development, included: (1) "Encourage development in incremental stages to stagger disturbance…." (2) "Remove facilities and infrastructure when use is completed." (3) "Use off site mitigation…." (4) "Allow no surface occupancy within 0.25 miles of an active lek." (5) "Allow no surface use in nesting habitat within 2 miles of an active lek during a period of breeding and nesting—15 March-15 June." (6) "Allow no surface use activities within crucial sage grouse wintering areas during 1 December-15 March." (7) "… minimize road densities." (8) "Avoid locating roads and power lines in crucial sage grouse breeding, nesting, and wintering areas."

sort criteria: sage grouse, oil & gas, mining, roads, sagebrush, qualitative, prescriptive

Morton, P., C. Weller, J. Thomson, M. Haefele, and N. Culver. 2004. Drilling in the Rocky Mountains: How much and at what cost? The Wilderness Society, Washington, D.C.

An analysis examining the impacts associated with large-scale energy development determined that significant fragmentation of wildlife habitat occurs with development activities. Non-market costs of drilling included "erosion, loss of wildlife and fish habitat, decline in quality of recreational experiences, proliferation of noxious weeds, and increased air and water pollution." A habitat fragmentation analysis of the Big Piney-LaBarge oil and gas field (in northwestern Wyoming) produced results indicating " a direct physical footprint of 1,400 miles of linear features and 3.8 square miles of polygon features, resulting in an overall density of 8.43 miles of roads and pipelines per $mile^2$." Also, 97% of the area falls within ¼ mile of some infrastructure and only 27% of the study area was more than 500 feet from infrastructure, with only 3% more than ¼ mile away.

sort criteria: sage grouse, mule deer, pronghorn, elk, raptors, non-game birds, fish, wildlife, oil & gas, fragmentation, quantitative, research-based, prescriptive, western U.S.

Moynahan, B.J. 2004. Landscape-scale nesting behavior of greater sage-grouse (*centrocercus urophasianus*) in north-central Montana. Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee. Wenatchee, Wa. Abstract only.

Sage grouse nesting and brood rearing in relation to leks were examined at a landscape scale in north-central Montana. In this study, sage grouse nested farther from leks than expected. Re-nesting attempts were generally close to the first nest location, typically within several hundred meters. Management practices focusing on particular areas centered on leks may be effective.

<u>sort criteria</u>: sage grouse, sagebrush, quantitative, research-based, Montana

Nelle, P.J., K.P. Reese, and J.W. Connelly. 2000. Long-term effects of fire on sage-grouse habitat. Journal of Range Management 53:586-591.

The long-term impact of fire on sage grouse nesting and brood-rearing habitats in southeastern Idaho was examined. Fourteen years post-burn mean sagebrush canopy cover was less than ½ that of unburned areas while mean sagebrush height was 69% of unburned brush. "Eighty-six percent of transects from 36-year old burns were clustered with unburned vegetation, suggesting that 36 years is sufficient time to recover." The effects of burning on nesting and brood-rearing sites could be harmful to sage grouse populations due to sub-optimal vegetative conditions.

<u>sort criteria</u>: sage grouse, fire, sagebrush, quantitative, research-based, Idaho

Oyler-McCance, S.J., K.P. Burnham, and C.E. Braun. 2001. Influences of changes in sagebrush on Gunnison sage grouse in southwestern Colorado. Southwestern Naturalist 46:323-331.

Changes (between the 1950s and 1990s) in sagebrush-dominated areas in southwestern Colorado were compared using low-level aerial photographs. A 20% loss (approximately 155,673 ha) of sagebrush-dominated areas between 1958 and 1993 was documented. Thirty-seven percent of sampled plots showed substantial fragmentation of sagebrush habitats, which was often the result of road development. Suggestions for future protection of sage grouse included assessing management and conservation strategies in regard to "…land mitigation, habitat restoration, connecting fragmented habitats, and reintroduction of sagebrush obligates into previously occupied habitats."

<u>sort criteria</u>: sage grouse, sagebrush obligates, fragmentation, roads, sagebrush, quantitative, research-based, Colorado

Paige, C., and S.A. Ritter. 1999. Birds in a sagebrush sea: managing sagebrush habitats for bird communities. Partners in Flight Western Working Group, Boise, ID.

Recommendations are presented for land management practices to help bird communities in sagebrush habitats. Shrubland and shrub-dependent bird species have declined 63% across the U.S. "Sagebrush obligates include the sage sparrow, Brewer's sparrow, sage thrasher, sage grouse, pygmy rabbit, sagebrush vole, sagebrush lizard, and pronghorn. Management guidelines are classified using different scales (landscape, stand, and patch). The level of effects on birds ranges from populations to individuals and pairs. A summary of bird management goals and recommendations is provided.

sort criteria: sage grouse, sharp-tailed grouse, raptors, sagebrush obligates, non-game birds, oil & gas, agriculture, human activity, sagebrush, quantitative, prescriptive, western U.S.

Phillips, R.L., D.E. Biggins, and A.B. Hoag. 1986. Coal surface mining and selected wildlife – a 10-year case study near Decker, Montana. Pages 235-245 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

Mule deer, pronghorn, sage grouse, and golden eagles were monitored to determine their responses to mining activities in southeastern Montana and northern Wyoming. "Mule deer and pronghorn populations thrived throughout the study period despite increasing mining activity and human disturbance." Sage grouse habitat was lost, but mitigation efforts (e.g., relocation of a lek) seemed to be successful. Golden eagle numbers remained relatively stable. Four nesting pairs near active mines had a 10-year nesting success of 67.5% compared to 56.6% for pairs nesting elsewhere on the study area. "If the primary post mining land use is wildlife, permanent reclamation can be designed to maximize the mixture of plant species and thereby provide greater habitat diversity than native prairie."

sort criteria: sage grouse, mule deer, pronghorn, raptors, mining, sagebrush, quantitative, research-based, Wyoming, Montana, mitigation

PIC Technologies and Bureau of Land Management, Pinedale Field Office. 1999. Draft Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project. Bureau of Land Management, Pinedale, Wyoming, USA.

Management objectives, monitoring and mitigation recommendations for the Pinedale Anticline Oil and Gas Exploration and Development Project in northwestern Wyoming were presented. The standard stipulation alternative (SS) was explained as well as a resource protection alternative (RP), which included all spatial and temporal restrictions contained in the SS alternative. The RP alternative offered additional protection measures to "be applied to wildlife habitats on Federal lands and minerals."

sort criteria: sage grouse, pronghorn, mule deer, elk, moose, non-game birds, raptors, wildlife, oil & gas, noise, roads, quantitative, research-based, Wyoming

Rowland, M. 2004. Effects of management practices on grassland birds: greater sage-grouse. Northern Prairie Wildlife Research Center, Jamestown, N.D.

Information from over 800 sources was used to evaluate habitat requirements and effects of habitat management on greater sage grouse. "Keys to management are maintaining expansive stands of sagebrush (*Artemisia* spp.), especially varieties of big sagebrush (*A. tridentata*), with abundant forbs in the understory, particularly during spring; undisturbed and relatively open sites for leks; and healthy perennial grass and forb stands intermixed with sagebrush for brood rearing." Management recommendations include: minimize human disturbance (e.g., traffic and recreation), avoid construction of powerlines within 3 km of seasonal habitats, protect lek sites and adjacent habitat up to 18 km around lek, and reduce or avoid resource-extraction development.

sort criteria: sage grouse, oil & gas, human activity, roads, agriculture, sagebrush treatment, sagebrush, quantitative, research-based, western U.S.

Schroeder, M.A. 1997. Unusually high reproductive effort by sage grouse in a fragmented habitat in north-central Washington. Condor 99:933-941.

Reproductive productivity of sage grouse in north-central Washington was investigated from 1992-1996. Generally, sage grouse in this study displayed more reproductive effort than grouse in other regions (they laid more eggs and were more likely to nest and re-nest). "Although the overall rate of nest success was only 36.7%, all females apparently nested at least once, and at least 87.0% of females re-nested following predation of their first nest. As a result of re-nesting, annual breeding success was estimated as 61.3%. Percent of all females that produced a brood at least 50 days old was 49.5%; at least 33.4% of 515 chicks survived ≥ 50 days following hatch."
sort criteria: sage grouse, fragmentation, grassland, sagebrush, quantitative, research-based, Washington

Strickland, D. 1999. Petroleum development versus wildlife in the overthrust. Transactions of the North American Wildlife and Natural Resources Conference 64:28-35.

Controversies concerning impacts to wildlife from petroleum development in Wyoming are discussed. To date (1999) an estimated 2,100 producing oil and gas wells are located in southwestern Wyoming, with a large potential for further development. The BLM (Bureau of Land Management) estimates an additional 4,837 wells will be developed. Since 1984, 24,112 acres of habitat has been lost due to oil and gas development, and an additional 53,000 acres would be disturbed by future development from direct impacts (e.g., roads, pipelines, etc.). "The potential area of direct and indirect disturbance is 2.7 million acres, or approximately 16 percent of southwestern Wyoming." Author suggests the BLM modify its leasing strategy using long-range and strategic planning with an adaptive approach.

<u>sort criteria</u>: elk, bighorn sheep, moose, pronghorn, mule deer, sage grouse, oil & gas, sagebrush, qualitative, prescriptive, Wyoming

Sveum, C.M., W.D. Edge, and J.A. Crawford. 1998. Nesting habitat selection by sage grouse in south-central Washington. Journal of Range Management 51:265-269.

Sage grouse nesting habitat characteristics were examined in south-central Washington. "Nest habitat was characterized by greater shrub cover, shrub height, vertical cover height, residual cover, and litter than at random locations." Big sagebrush/bunchgrass was selected 71% of the time for nest sites. Successful nest sites had greater residual cover than depredated nest areas. Two factors distinguishing successful from depredated nests were tall grass cover and medium height (40-80 cm) shrub cover. Management objectives should include "…maintaining a balance between shrub and herbaceous understory" and "increasing native perennial bunchgrasses and forbs."

<u>sort criteria</u>: sage grouse, roads, fire, grazing, sagebrush treatment, sagebrush, quantitative, research-based, Washington

Swenson, J.E., C.A. Simmons, and C.D. Eustace. 1987. Decrease of sage grouse (*Centrocercus urophasianus*) after ploughing of sagebrush steppe. Biological Conservation 41:125-132.

Authors studied the effects plowing sagebrush steppe had on sage grouse in south-central
Montana. The project duration was 1973 to 1984. In the study area, 30% of sage grouse winter habitat had been plowed by 1984. Sixteen percent of this area was utilized for farming. Lek attendance by males declined 73% from 1973 to 1984 (from 241 to 65 cocks). Although a relatively small area was plowed, it represented a large portion of sage grouse wintering habitat. Plowing, as well as other land uses (e.g. mining) that destroy relatively small areas of important winter habitat could have broad effects on sage grouse populations.

<u>sort criteria</u>: sage grouse, sagebrush treatment, sagebrush, quantitative, research-based, Montana

USGS. 2002. Fact sheet: Loss of sagebrush ecosystems and declining bird populations in the Intermountain West: priority research issues and information needs. USGS FS-122-02. U.S. Department of the Interior, U.S. Geologic Survey.

Priority needs to identify causes and mechanisms of shrubland bird declines were evaluated. Sage grouse have declined 33% from their long-term average population size. Four primary issues were identified: 1. Bird response to habitat and landscape features. 2. Monitoring and survey designs. 3. Effects of land use practices. 4. Wintering ground and migration.

sort criteria: sage grouse, sagebrush obligates, non-game birds, oil & gas, agriculture, qualitative, prescriptive, western U.S.

Vander Haegen, W.M., M.A. Schroeder, and R.M. Degraaf. 2002. Predation on real and artificial nests in shrubsteppe landscapes fragmented by agriculture. Condor 104:496-506.

Artificial nests were monitored to examine effects of fragmentation, distance to edge, and vegetation cover on nest predation rates, as well as to identify predators of grouse and passerines. Nests in fragmented landscapes were approximately 9 times more likely to be depredated than nests in continuous landscapes. Predation rate was 26% for artificial nests. Nest-sites with greater vegetation coverage were less likely to be depredated.

sort criteria: sage grouse, sharp-tailed grouse, non-game birds, sagebrush obligates, agriculture, fragmentation, sagebrush, grassland, quantitative, research-based, Washington

Wakkinen, W.L., K.P. Reese, and J.W. Connelly. 1992. Sage grouse nest locations in relation to leks. Journal of Wildlife Management 56:381-383.

The potential effectiveness of a guideline to protect sage grouse nesting habitat in southeastern Idaho was evaluated. Investigators tested 2 predictions about nest locations in relation to leks. Ninety-two percent of nests were ≤ 3km from a lek, however only 55% were ≤ 3km from the capture lek. Evidence did not indicate leks were part of a "breeding complex". "In grouse populations with lower lek density, the nearest lek to the nest site may be the lek of capture." The results also failed to support the theory that hens nest midway between leks, and that predation is higher near leks.

sort criteria: sage grouse, sagebrush treatment, sagebrush, quantitative, research-based, Idaho

Wallestad, R.O. 1971. Summer movements and habitat use by sage grouse broods in central Montana. Journal of Wildlife Management 35:129-136.

Movements and habitat use of sage grouse broods were examined in Montana during the summers of 1968 and 1969. Three sagebrush densities were identified: scattered, common and dense. Broods utilized scattered and common sagebrush densities most heavily throughout both summers. Broods used sagebrush-grassland areas averaging 213 acres in early summer, and they used sagebrush areas averaging 128 acres in late summer. Sage grouse depend on varying densities of sagebrush during different periods of the year.

sort criteria: sage grouse, sagebrush treatment, sagebrush, quantitative, research-based, Montana

Wallestad, R.O., and D. Pyrah. 1974. Movement and nesting of sage grouse hens in central Montana. Journal of Wildlife Management 38:630-633.

Nesting cover and movements of sage grouse hens were examined in central Montana during the springs of 1969 through 1972. Sixty-eight percent of 22 nests were located within 1.5 miles of the lek where the hens were captured. "Successful nests were located in sagebrush stands with a higher average canopy coverage than those of unsuccessful nests, and had significantly greater sagebrush cover within 24 inches (60cm) of nest and within a 100-square foot (9-m^2) plot around nest." Authors recommend a buffer zone of at least 2 miles should be maintained around a strutting ground.

sort criteria: sage grouse, sagebrush treatment, sagebrush, quantitative, research-based, Montana

Wallestad, R.O., and P. Schladweiler. 1974. Breeding season movements and habitat selection of male sage grouse. Journal of Wildlife Management 38:634-637.

Habitat requirements and movements of male sage grouse were studied during the breeding seasons of 1968 and 1972 in Montana. Eighty-two percent of the locations showed male grouse movements beyond 0.2 mile. Canopy coverage ranged from 20 to 50% at 80% of the locations. In an unpublished manuscript, Wallestad reported, " a 31 percent reduction in sagebrush with canopy coverage exceeding 15 percent adjacent to a strutting ground resulted in a 63 percent decrease in strutting males over a 2-year period while male numbers on other grounds in the area remained stable."

sort criteria: sage grouse, sagebrush treatment, sagebrush, quantitative, research-based, Montana

Wambolt, C.L., A.J. Harp, B.L. Welch, N. Shaw, J.W. Connelly, K.P. Reese, D.E. Braun, D.A. Klebenow, E.D. McArthur, J.G. Thompson, L.A. Torell, and J.A. Tanaka. 2002. Conservation of greater sage-grouse on public lands in the western U.S.: implications of recovery and management policies. Executive Summary. Policy Analysis Center for Western Public Lands Policy Paper SG-02-02. Caldwell, ID.

Actions taken on public lands to maintain enhance, and restore sage grouse populations were evaluated. Variables to evaluate policy criteria included: fire, maintaining and protecting habitat, invasive plant species, physical changes in habitat, predation, hunting, inventory and monitoring, livestock grazing, social issues, and economics of livestock grazing.

<u>sort criteria</u>: sage grouse, agriculture, roads, sagebrush, qualitative, prescriptive, western U.S.

Ward, S., and T.A. Messmer. 2004. Gunnison sage-grouse in San Juan County, Utah: winter ecology, effects of grazing, and insect abundance. Western Agencies Sage and Sharp-tailed Grouse Technical Committee. Wenatchee, Wa. Abstract only.

The only known populations of Gunnison sage grouse are found in southwestern Colorado and southeastern Utah, with less than 10% occurring in Utah. The estimated range-wide population is 3,500-4,000 birds. The objectives of this research are to: "1) determine winter habitat use patterns for Gunnison sage-grouse, 2) determine nesting, brood-rearing, and reproductive success of Gunnison sage-grouse, 3) determine Gunnison sage-grouse use of grazed and ungrazed CRP fields; compare vegetation structure and percent canopy cover, and 4) compare insect abundance and diversity in brood locations to adjacent areas within the study site."

<u>sort criteria</u>: sage grouse, agriculture, sagebrush, quantitative, research-based, Utah

Welch, B.L., F.J. Wagstaff, and J.A. Roberson. 1991. Preference of wintering sage grouse for big sagebrush. Journal of Range Management 44:462-465.

The preference of sage grouse in Utah for big sagebrush was investigated. Sage grouse preferred in order – mountain big sagebrush, Wyoming big sagebrush, and basin big sagebrush. "…when leaves and buds of the preferred plants became limited, the birds shifted to lesser liked plants." Sage grouse can expand their food base by shifting to less preferred plants.

<u>sort criteria</u>: sage grouse, sagebrush, quantitative, research-based, Utah

Weller, C., J. Thomson, P. Morton, and G. Aplet. 2002. Fragmenting our lands: The ecological footprint from oil and gas development. The Wilderness Society, Washington, D.C.

Habitat fragmentation resulting from resource extraction practices was examined in the Upper Green River Basin of Wyoming. Average road densities and other linear features were 8.43 miles per square mile. An effect zone of ½ mile was constructed and analyzed. The analysis showed the entire 166 square mile study area to be within ½ mile of a road or other development related infrastructure. "The ecological footprint varies depending upon which disturbance is measured. A disturbance that reaches a quarter of a mile beyond the infrastructure creates a footprint of 160 square miles, affecting 97% of the study area. Even a more localized disturbance that only reaches 100 feet beyond the infrastructure affects 28% of the study area (47 square miles)."
sort criteria: sage grouse, mule deer, pronghorn, elk, moose, oil & gas, sagebrush, quantitative, research-based, Wyoming

Wisdom, M.J., B.C. Wales, M.M. Rowland, M.G. Raphael, R.S. Holthausen, T.D. Rich, and V.A. Saab. 2002. Performance of greater sage-grouse models for conservation assessment in the Interior Columbia Basin, U.S.A. Conservation Biology 16:1232-1242.

The performances of 2 landscape condition assessment models (designed to assess habitat conditions for sage grouse) were evaluated. The environmental index model predicted conditions at the sub-watershed scale based on habitat density and quality, and effects of human disturbance. The population outcome model predicted range-wide conditions based on environmental index values and measures of range extent and connectivity. The "models provided reliable landscape predictions for the conditions tested."

sort criteria: sage grouse, human activity, grazing, sagebrush, quantitative, research-based, western U.S.

Wisdom, M.J., M.M. Rowland, B.C. Wales, M.A. Hemstrom, W.J. Hann, M.G. Raphael, R.S. Holthausen, R.A. Gravenmier, and T.D. Rich. 2002. Modeled effects of sagebrush-steppe restoration on greater sage-grouse in the Interior Columbia Basin, U.S.A. Conservation Biology 16:1223-1231.

The potential benefits of 2 restoration scenarios to sage grouse on U.S. Forest Service (FS) and Bureau of Land Management (BLM) lands in the interior Columbia Basin were evaluated. Scenario 1 assumed a 50% reduction in livestock grazing, whereas scenario 2 was based on a 100% reduction of grazing. "Our results indicate that an extensive and sustained combination of passive and active restoration, as outlined under the two restoration scenarios, would minimize further degradation and loss of habitat for sage grouse on FS-BLM lands in the future." Also, areas not targeted for restoration would not recover or would continue to degrade.

sort criteria: sage grouse, grazing, fire, sagebrush, quantitative, research-based, western U.S.

Wyoming Game & Fish Department. 1976. Considerations for wildlife in industrial development and reclamation. Cheyenne, Wy.

Mitigation and monitoring considerations for protecting wildlife and wildlife habitat with regard to industrial development were presented. Habitat development and reclamation were examined and recommendations were provided for specific habitat types (e.g., shrubland, rimrocks, etc.), and for individual wildlife species (e.g., mule deer, pronghorn, etc.).

sort criteria: sage grouse, mule deer, pronghorn, elk, bighorn sheep, wildlife, sagebrush, qualitative, prescriptive, mitigation, Wyoming

Wyoming Sage-Grouse Working Group. 2003. Wyoming greater sage-grouse conservation plan. Wyoming Game and Fish Department, Cheyenne, Wy.

Goals and recommended management practices to encourage conservation of sage grouse and their habitats in Wyoming were presented. Recommended management practices regarding mineral development included: (1) "Develop a plan for roads, pipelines, etc. to minimize impacts to sage grouse." (2) "… travel management plans that would allow seasonal closure of roads for all but permitted uses (i.e. recreation and hunting) and encourage the reclamation of unnecessary or redundant roads." (3) "Avoid construction of overhead lines and other perch sites in occupied sage grouse habitat." (4) "Reduce noise from industrial development or traffic…." (5) "…tailor reclamation to restore, replace or augment needed habitat types." (6) "… do not drill or permit new or expand existing sand and gravel activities within two miles of active leks between March 15 and July 15." (7) "Avoid surface disturbance or occupancy on or within ¼ mile of known active lek sites. (8) "… avoid human activity adjacent to leks during the breeding season between the hours of 8 p.m. and 8 a.m."

sort criteria: sage grouse, oil & gas, mining, roads, quantitative, research-based, prescriptive, Wyoming

Zablan, M.A. 2003. Estimation of greater sage-grouse survival in North Park, Colorado. Journal of Wildlife Management 67:144-154.

Survival rates of sage grouse in north-central Colorado were examined. The sage grouse population was essentially stable from 1973 to 1975, increased 56% from 1975 to 1979, showed a slight decrease then remained stable from 1980 to 1983, and decreased 62% in 1984. "Based on lek counts, the sage-grouse population in North Park, Colorado, increased 63% decreased 69%, and remained relatively low during the long-term (1973-1990) banding study."

sort criteria: sage grouse, sagebrush, quantitative, research-based, Colorado

MULE DEER

Brown, C.G. 1992. Movement and migration patterns of mule deer in southeastern Idaho. Journal of Wildlife Management 56:246-253.

Migration patterns and movement of mule deer in southeastern Idaho were monitored using radio telemetry. "Migration between summer and winter ranges averaged 19.7 km and did not differ ($P>0.05$) between sexes. Twenty-six percent of the marked deer were not migratory." Both males (92%) and females (100%) showed high fidelity to summer ranges. Winter severity appeared to strongly influence deer use of winter range. "During mild winters with low snow accumulation, some migratory deer (48% in 1986-87 and 19% in 1987-88) did not move to traditional winter ranges."

sort criteria: mule deer, sagebrush, quantitative, research-based, Idaho

Easterly, T., A. Wood, and T. Litchfield. 1991. Responses of pronghorn and mule deer to petroleum development on crucial winter range in the Rattlesnake Hills. Unpublished Completion Report. Wyoming Game and Fish Department, Cheyenne.

Impacts of petroleum-related activities on pronghorn and mule deer were examined in central Wyoming. Distribution of pronghorn indicated avoidance of areas where drilling and well maintenance activities occurred. Displacement of mule deer in the study was not noted. Pronghorn numbers within 1 km of the well site decreased with the advent of road construction and drilling activity. However, once human activity subsided, numbers of pronghorn returned to pre-disturbance levels. "Displacement of animals may result in use of sub-optimal winter habitat, overcrowding, increased intraspecific competition, deterioration of habitat, and decreased physical condition of the population." Authors suggest drilling during summer on critical winter range.

sort criteria: pronghorn, mule deer, oil & gas, sagebrush, quantitative, research-based, Wyoming

Eberhardt, L.E., E.E. Hanson, and L.L. Cadwell. 1984. Movement and activity patterns of mule deer in the sagebrush-steppe region. Journal of Mammalogy 65:404-409.

Movements and activity patterns of mule deer were examined in the sagebrush-steppe region of south-central Washington. Activity peaks were observed twice per day—once in the morning and once in the evening.

sort criteria: mule deer, sagebrush, quantitative, research-based, Washington

Fala, R.A., J.P. Ward, J.W. June, L.L. Apple. 1986. Mule deer winter range study on a proposed coal lease site. Pages 15-21 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

Mule deer densities, distribution, habitat type utilization, and group size were examined in and near a proposed mine lease area in Wyoming. Sagebrush-grasslands were the principal habitat type (92.2%), however 63% of mule deer sightings were in juniper-sagebrush habitat with only 31% in sagebrush-grassland. Rough topography, juniper and sagebrush stands characterized important winter deer habitat.

sort criteria: mule deer, mining, sagebrush, quantitative, research-based, Wyoming, mitigation

Freddy, D.J. 1986a. Responses of adult mule deer to human harassment during winter. Page 286 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co. Abstract only.

Female mule deer responses to persons afoot and to snowmobiles were examined in Colorado. Responses to persons afoot were longer in duration, with more frequent running and greater energy costs. Threshold distances to minimize all responses by deer were > 334 m for persons afoot and > 470 m for snowmobiles.

sort criteria: mule deer, human activity, sagebrush, quantitative, research-based, Colorado

Freddy, D. J., W.M. Bronaugh, and M.C. Fowler. 1986b. Responses of mule deer to disturbance by persons afoot and snowmobiles. Wildlife Society Bulletin 14:63-68.

Responses of female mule deer were studied during controlled disturbance trials in north-central Colorado during the winters of 1979 and 1980. Responses to persons afoot were longer, involved more running, and caused greater energy expenditure than responses to snowmobiles (likely because persons afoot were in the area longer than snowmobiles). Deer moved 907 m with energy costs of 54-127 kcal when fleeing from persons afoot, and 158 m with energy costs of 10-22 kcal when running from snowmobiles. Neither mortality nor fecundity of female deer was markedly affected. Threshold distances of > 334 m and > 470 m for persons afoot and snowmobiles respectively should minimize all responses by deer (or > 191 m and > 133 m to prevent locomotor responses), and ". . . could be used to establish corridors of human activity within sagebrush winter ranges occupied by deer."

<u>sort criteria</u>: mule deer, human activity, snowmobiles, sagebrush, quantitative, research-based, Colorado

Garrott, R.A., G.C. White, R.M. Bartmann, L.H. Carpenter, and A.W. Alldredge. 1987. Movements of female mule deer in northwest Colorado. Journal of Wildlife Management 51:634-643.

Seasonal movements of female mule deer in northwest Colorado were monitored from November 1980 through October 1984. In October all deer migrated from summer range to lower elevations and occupied southerly aspects. Deer concentrated around meadows during spring until migrating to summer range. "Timing of spring migration varied annually and was related to winter severity." Agricultural meadows were used extensively in spring and fall, which suggests that high quality forage areas influence seasonal movement patterns.

<u>sort criteria</u>: mule deer, shrubland, quantitative, research-based, Utah

Girard, M., and B. Stotts. 1986. Managing impacts of oil and gas development on woodland wildlife habitats on the Little Missouri Grasslands, North Dakota. Pages 128-130 <u>in</u> Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

Impacts from oil and gas development (e.g., construction activities, toxic fumes, chemical spills, and wildlife displacement) on woodland wildlife habitat were evaluated on the Little Missouri Grasslands in North Dakota. Approximately 10,884 acres had been directly disturbed by oil and gas activity. A sphere of influence surrounds all roads and well pads, and is estimated to be a minimum of 100 yards in all directions. Mitigation efforts included: (1) No well pads or roads placed in woodlands. (2) Roads crossing "draws" must be at right angles to minimize disturbance. (3) Extra heavy pit liners were to be used in areas with porous substrates to prevent saltwater seepage.

<u>sort criteria</u>: wildlife, mule deer, elk, oil & gas, forested, quantitative, research-based, North Dakota, mitigation

Hayden-Wing Associates. 1991a. Final review and evaluation of the effects of Triton Oil and Gas Corporation's proposed coal bed methane field development (Great Divide prospect) on elk and other big game species. Triton Oil and Gas Corporation, Dallas, Tx.

Pronghorn, mule deer, and elk responses to disturbances associated with petroleum development in southwestern Wyoming were examined. Elk numbers decreased near drilling activities but returned to previous levels post-disturbance. However, elk were most sensitive to disturbances during winter and calving periods, and tended to avoid activity up to at least ½ mile away depending on whether or not the disturbance was visible. Pronghorn and mule deer seemed to habituate to most types of human disturbance unless they had been hunted or harassed. Mitigation measures for reducing impacts were presented.

<u>sort criteria</u>: pronghorn, mule deer, elk, oil & gas, sagebrush, quantitative, research-based, Wyoming

Hayden-Wing Associates. 1991b. Review and evaluation of the effects of geophysical exploration on some wildlife species in Wyoming. Unpublished Report for Geophysical Acquisition Workshop. Laramie, Wy.

A review of previous studies on the effects of geophysical exploration on pronghorn, mule deer, elk, raptors, and sage grouse was presented. The information examined indicated that big game are temporarily affected by seismic exploration causing increased energy expenditure and utilization of sub-optimal habitats. Characteristics for evaluating potential sage grouse nesting habitat in relation to proposed oil and gas development included: "1) distance relationships to leks, 2) presence, distance, and characteristics of existing disturbances, 3) characteristics of shrubs and vegetation that could serve in nest concealment and nest-site selection, and 4) distance to water and to potential brood-rearing areas." Mitigation strategies for protecting raptor-nesting habitat were also presented.

<u>sort criteria</u>: sage grouse, raptors, pronghorn, mule deer, elk, oil & gas, seismic exploration, sagebrush, quantitative, research-based, Wyoming

Henderson, R.E., and A. O'Herren. 1992. Winter ranges for elk and deer: victims of uncontrolled subdivisions? Western Wildlands 18:20-25.

Authors described impacts created by increasing human habitation of elk and deer winter ranges in Montana. Human disturbance can interrupt, and displace the movements between summer and winter ranges for both mule deer and elk.

<u>sort criteria</u>: mule deer, elk, rural subdivisions, agricultural, forested, qualitative, prescriptive, Montana

Kuck, L. 1986. The impacts of phosphate mining on big game in Idaho: a cooperative approach to conflict resolution. Transactions of the 51st North American Wildlife and Natural Resources Conference 51:90-97.

Evaluation of impacts of phosphate mining on big game in Idaho was the objective of this study. "Results of this study indicate that elk, deer and moose may be capable of adapting to many phosphate mining activities in southeastern Idaho, but cannot compensate for disturbance on important seasonal ranges or for increased mortality associated with industrial development."

sort criteria: mule deer, elk, moose, mining, forested, grassland, quantitative, research-based, Idaho

Lowry, D.A., and K.L. McArthur. 1978. Domestic dogs as predators on deer. Wildlife Society Bulletin 6:38-39.

Direct and indirect effects of dogs chasing deer were examined. The most obvious and detrimental direct effect was deer mortality. Indirect effects included deer running onto highways, being cut or entangled in barbed-wire fences, being crippled, and expending critical energy needed for winter survival.

sort criteria: mule deer, rural subdivision, forested, quantitative, research-based, Idaho

McAdoo, J.K., G.A. Acordagoita, and C.R. Aarstad. 1989. Reducing impacts of hard-rock mining on wildlife in northern Nevada. Pages 95-97 in Proceedings IV: Issues and Technology in the Management of Impacted Wildlife. Thorne Ecological Institute, Boulder, Co.

Reduction of wildlife impacts from mineral exploration in northern Nevada was examined. Mitigation actions included: minimizing erosion through the use of sediment catchment basins, silt screens, and seeding of road cuts and fill slopes, minimizing construction activity near raptor nests, avoiding aspen wildlife habitat, using culverts for crossing trout streams, and monitoring ground and surface water. Offsite mitigation and concurrent reclamation efforts were also evaluated.
sort criteria: wildlife, mule deer, sage grouse, raptors, mining, sagebrush, riparian, qualitative, prescriptive, mitigation, Nevada

Medcraft, J.R., and W.R. Clark. 1986. Big game habitat use and diets on a surface mine in northeastern Wyoming. Journal of Wildlife Management 50:135-142.

Seasonal use of habitats by deer and pronghorn were studied at a coal surface mine near Gillette, Wyoming. Native vegetation was dominated by big sagebrush. Mule deer used reclaimed land more than un-mined land, however the opposite was true for pronghorns. Because reclaimed land provided sufficient, high-quality forage, authors believed habitat could be improved over time.

sort criteria: mule deer, pronghorn, mining, sagebrush, quantitative, research-based, Wyoming

Merril, E.H., T.P. Hemker, K.P. Woodruff, and L. Kuck. 1994. Impacts of mining facilities on fall migration of mule deer. Wildlife Society Bulletin 22:68-73.

Mule deer movements from summer to winter ranges were monitored for 5 years to determine if mining facilities and activities hindered migration. The study area in southeastern Idaho was dominated by fir forest and sagebrush. Different accumulations of snow in different years affected migration patterns. When little snow was present, deer moved south of the mine, but deer moved through the mine site when deep snow accumulated. The observations support prior findings ". . . that corridors through human-built obstacles facilitate migration of ungulates.

sort criteria: mule deer, mining, forested, sagebrush, quantitative, research-based, Idaho

Morton, P., C. Weller, J. Thomson, M. Haefele, and N. Culver. 2004. Drilling in the Rocky Mountains: How much and at what cost? The Wilderness Society, Washington, D.C.

An analysis examining the impacts associated with large-scale energy development determined that significant fragmentation of wildlife habitat occurs with development activities. Non-market costs of drilling included "erosion, loss of wildlife and fish habitat, decline in quality of recreational experiences, proliferation of noxious weeds, and increased air and water pollution." A habitat fragmentation analysis of the Big Piney-LaBarge oil and gas field (in northwestern Wyoming) produced results indicating " a direct physical footprint of 1,400 miles of linear features and 3.8 square miles of polygon features, resulting in an overall density of 8.43 miles of roads and pipelines per mile^2." Also, 97% of the area falls within ¼ mile of some infrastructure and only 27% of the study area was more than 500 feet from infrastructure, with only 3% more than ¼ mile away.

sort criteria: sage grouse, mule deer, pronghorn, elk, raptors, non-game birds, fish, wildlife, oil & gas, fragmentation, quantitative, research-based, prescriptive, western U.S.

Oedekoven, O.O., and F.G. Lindzey. 1987. Winter habitat-use patterns of elk, mule deer, and moose in southwestern Wyoming. Great Basin Naturalist 47:638-643.

Mule deer, elk, and moose winter habitat use patterns were examined in southwestern Wyoming. Mule deer used sagebrush extensively, moose favored aspen, willow, and mixed-shrub vegetation, and elk preferred alpine grass/moss vegetation. Elk and mule deer showed a preference for areas with mild snow conditions, whereas moose were often observed in areas with deep snow. “Our results suggested that although deer, elk, and moose often used the same areas, they selected differing habitats within shared areas.”

sort criteria: mule deer, elk, moose, sagebrush, quantitative, research-based, Wyoming

Parker, K.L., C.T. Robbins, and T.A. Hanley. 1984. Energy expenditures for locomotion by mule deer and elk. Journal of Wildlife Management 48:474-488.

Energy expenditures were measured on mule deer and elk to determine energy costs for several activities. Logging activities affected energy expenditures of both elk and deer by removal of canopy and subsequent increased snow depth. Human activity (i.e. winter recreation) caused excessive energy expenditure by inducing elk and deer to flee when approached. Management considerations should include restricting human access to deer and elk winter use areas.

sort criteria: mule deer, elk, human activity, logging, forested, quantitative, research-based

Phillips, R.L., D.E. Biggins, and A.B. Hoag. 1986. Coal surface mining and selected wildlife – a 10-year case study near Decker, Montana. Pages 235-245 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

Mule deer, pronghorn, sage grouse, and golden eagles were monitored to determine their responses to mining activities in southeastern Montana and northern Wyoming. “Mule deer and pronghorn populations thrived throughout the study period despite increasing mining activity and human disturbance.” Sage grouse habitat was lost, but mitigation efforts (e.g., relocation of a lek) seemed to be successful. Golden eagle numbers remained relatively stable. Four nesting pairs near active mines had a 10-year nesting success of 67.5% compared to 56.6% for pairs nesting elsewhere on the study area. “If the primary post mining land use is wildlife, permanent reclamation can be designed to maximize the mixture of plant species and thereby provide greater habitat diversity than native prairie.”

sort criteria: sage grouse, mule deer, pronghorn, raptors, mining, sagebrush, quantitative, research-based, Wyoming, Montana, mitigation

PIC Technologies and Bureau of Land Management, Pinedale Field Office. 1999. Draft Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project. Bureau of Land Management, Pinedale, Wyoming, USA.

Management objectives, monitoring and mitigation recommendations for the Pinedale Anticline Oil and Gas Exploration and Development Project in northwestern Wyoming were presented. The standard stipulation alternative (SS) was explained as well as a resource protection alternative (RP), which included all spatial and temporal restrictions contained in the SS alternative. The RP alternative offered additional protection measures to "be applied to wildlife habitats on Federal lands and minerals."

<u>sort criteria</u>: sage grouse, pronghorn, mule deer, elk, moose, non-game birds, raptors, wildlife, oil & gas, noise, roads, quantitative, research-based, Wyoming

Rost, G.R., and J.A. Bailey. 1979. Distribution of mule deer and elk in relation to roads. Journal of Wildlife Management 43(3):634-641.

Deer and elk responses to roads were assessed on winter ranges in Colorado during the winters of 1973 and 1974. The principal habitats were mountain shrub and pine forests. Data were obtained by counting fecal-pellet groups within 400m transects parallel to roads. Based upon pellet group distributions, elk and deer avoided roads, especially areas within 200m. Deer avoided roads more in shrublands than in forested areas, however elk responses did not differ based on habitat type. At some sites, deer avoided roads even though snow likely restricted available habitat. Therefore, propensity to avoid roads may be detrimental to deer and elk.

<u>sort criteria</u>: mule deer, elk, roads, mountain shrub, forested, quantitative, research-based, Colorado

Stephenson, T.R., M.R. Vaughan, and D.E. Anderson. 1996. Mule deer movements in response to military activity in southeast Colorado. Journal of Wildlife Management 60:777-787.

Home range fidelity of mule deer was studied on the U.S. Army's Pinon Canyon Maneuver Site (PCMS) in southeastern Colorado. This area of short-grass prairie was used intermittently for military maneuvers. Sectors were designated maneuver, previous-maneuver, and non-maneuver (control), and studied seasonally. Sizes of doe home ranges were up to 4.6-fold greater in maneuver areas than non-maneuver areas. Seasonal home ranges of bucks did not differ significantly, but bucks had a significantly larger annual home range in maneuver area than in non-maneuver sectors. This type of disturbance is unpredictable (i.e. not routine) in contrast to oil and gas activities.

sort criteria: mule deer, human activity, grassland, quantitative, research-based, Colorado

Stewart, K.M., R.T. Bowyer, J.G. Kie, N.J. Cimon, and B.K. Johnson. 2002. Temporospatial distributions of elk, mule deer, and cattle: resource partitioning and competitive displacement. Journal of Mammalogy 83(1): 229-244.

Resource partitioning and competitive displacement among mule deer, elk, and cattle were examined in northeastern Oregon and southeastern Washington. Resource partitioning was strongly evident among all 3 species, however mule deer and elk selected similar slopes and elevations, whereas cattle avoided steep slopes and high elevations. Although mule deer and elk selected similar slopes and elevations, they used different vegetation communities. At higher densities, resource partitioning could be more difficult leading to increased competition.

sort criteria: mule deer, elk, grazing, forested, grassland, quantitative, research-based, Oregon, Washington

Strickland, D. 1999. Petroleum development versus wildlife in the overthrust. Transactions of the North American Wildlife and Natural Resources Conference 64:28-35.

Controversies concerning impacts to wildlife from petroleum development in Wyoming are discussed. To date (1999) an estimated 2,100 producing oil and gas wells are located in southwestern Wyoming, with a large potential for further development. The BLM (Bureau of Land Management) estimates an additional 4,837 wells will be developed. Since 1984, 24,112 acres of habitat has been lost due to oil and gas development, and an additional 53,000 acres would be disturbed by future development from direct impacts (e.g., roads, pipelines, etc.). "The potential area of direct and indirect disturbance is 2.7 million acres, or approximately 16 percent of southwestern Wyoming." Author suggests the BLM modify its leasing strategy using long-range and strategic planning with an adaptive approach.

sort criteria: elk, bighorn sheep, moose, pronghorn, mule deer, sage grouse, oil & gas, sagebrush, qualitative, prescriptive, Wyoming

Thomas, T., and L. Irby. 1990. Habitat use and movement patterns by migrating mule deer in southeastern Idaho. Northwest Science 64:19-27.

Habitat use and movement of migrating mule deer in southeastern Idaho were investigated. Most deer migrated along established corridors and used the same corridors in spring and fall. Deer were not exposed to excessive hunting pressure during migration, and human land use was not a factor. Authors recommend protecting migration corridors from overgrazing and conversion of native vegetation to cropland.

sort criteria: mule deer, roads, rural subdivision, agriculture, sagebrush, quantitative, research-based, Idaho

Weisenberger, M.E., P.R. Krausman, M.C. Wallace, D.W. DeYoung, and E.O. Maughan. 1996. Effects of simulated jet aircraft noise on heart rate and behavior of desert ungulates. Journal of Wildlife Management 60(1):52-61.

The effects of simulated low-altitude jet aircraft noise on the behavior and heart rate of mule deer and mountain sheep in Arizona were evaluated. "The heart rates of ungulates increased related to dB levels during simulated overflights ($P \leq 0.05$), but they returned to pre-disturbance levels in 60-180 seconds. Animal behavior also changed during overflights but returned to pre-disturbance conditions in < 252 seconds ($P \leq 0.005$). All animal responses decreased with increased exposure suggesting that they habituated to simulated sound levels of low-altitude aircraft."

sort criteria: mule deer, bighorn sheep, noise, quantitative, research-based, Arizona

Weller, C., J. Thomson, P. Morton, and G. Aplet. 2002. Fragmenting our lands: The ecological footprint from oil and gas development. The Wilderness Society, Washington, D.C.

Habitat fragmentation resulting from resource extraction practices was examined in the Upper Green River Basin of Wyoming. Average road densities and other linear features were 8.43 miles per square mile. An effect zone of ½ mile was constructed and analyzed. The analysis showed the entire 166 square mile study area to be within ½ mile of a road or other development related infrastructure. "The ecological footprint varies depending upon which disturbance is measured. A disturbance that reaches a quarter of a mile beyond the infrastructure creates a footprint of 160 square miles, affecting 97% of the study area. Even a more localized disturbance that only reaches 100 feet beyond the infrastructure affects 28% of the study area (47 square miles)."

sort criteria: sage grouse, mule deer, pronghorn, elk, moose, oil & gas, sagebrush, quantitative, research-based, Wyoming

Western EcoSystems Technology, Inc. 2003. An evaluation of the 1988 BLM Pinedale Resource Management Plan, 2000 BLM Pinedale Anticline Final EIS and recommendations for the current revision of the Pinedale Resource Management Plan. The Wilderness Society, Washington, D.C.

An analysis of the 1988 Bureau of Land Management (BLM) Resource Management Plan and the 2000 BLM Pinedale Anticline Environmental Impact Statement (EIS) was presented. Recommendations for the current revision of the Pinedale Resource Management Plan were also given. Overall planning and adaptive management recommendation included: 1) limiting the density of roads and wells per section, 2) protecting a minimum amount of significant big game habitat from disturbance, 3) identify areas where future oil and gas leases should be prohibited, 4) coordinate habitat management, and 5) apply adaptive management.

sort criteria: pronghorn, mule deer, elk, oil & gas, roads, sagebrush, quantitative, research-based, Wyoming

White, G.C., R.A. Garrott, R.M. Bartmann, L.H. Carpenter, and A.W. Alldredge. 1987. Survival of mule deer in northwest Colorado. Journal of Wildlife Management 51:852-859.

Mule deer survival in northwest Colorado was monitored for 3 years on 1 study area and 4 years on another. "From 46 to 76% of fawns on 1 area died from predation each year, whereas 49-83% of those on the other area starved." Body size of fawns depredated was more variable, whereas fawns dying from starvation were smaller animals.

sort criteria: mule deer, shrubland, quantitative, research-based, Colorado

Wood, A.K. 1988. Use of shelter by mule deer during winter. Prairie Naturalist 20:15-22.

Shelter use by mule deer in prairie habitat was evaluated during winter 1984 in eastern Montana. Deer used shelter more as wind chill increased in an attempt to minimize energy loss and optimize energy budget. "Wind velocity seemed to be the most important factor influencing selection of both bedding and feeding sites." In prairie environments mule deer tend to select habitat (at least partially) on the basis of topographic features.

sort criteria: mule deer, environmental factors, grassland, quantitative, research-based, Montana

Wyoming Game & Fish Department. 1976. Considerations for wildlife in industrial development and reclamation. Cheyenne, Wy.

Mitigation and monitoring considerations for protecting wildlife and wildlife habitat with regard to industrial development were presented. Habitat development and reclamation were examined and recommendations were provided for specific habitat types (e.g., shrubland, rimrocks, etc.), and for individual wildlife species (e.g., mule deer, pronghorn, etc.).

sort criteria: sage grouse, mule deer, pronghorn, elk, bighorn sheep, wildlife, sagebrush, qualitative, prescriptive, mitigation, Wyoming

PRONGHORN

Barrett, M.W. 1982. Distribution, behavior, and mortality of pronghorns during a severe winter in Alberta. Journal of Wildlife Management 46:991-1002.

Pronghorn distribution, behavior, and mortality in southeastern Alberta, Canada were investigated during a severe winter (1977-1978). Mortality was estimated at 48.5% for the approximately 14,360 pronghorn in the study. Pronghorn used areas with less snow accumulation and where vegetation was visible above the snow. Mobility (absence of obstacles) was found to be an important requirement for the survival of pronghorn during severe winter conditions.

sort criteria: pronghorn, sagebrush, quantitative, research-based, Canada

Bruns, E.H. 1977. Winter behavior of pronghorns in relation to habitat. Journal of Wildlife Management 41:560-571.

Behavior of pronghorn antelope was studied in southeastern Alberta and northern Montana during the winter of 1969. Grasslands with interspersed sagebrush dominated the area. Roads played an important role in determining pronghorn usage of winter range. Ditches adjacent to high graded roads acted as snow traps and produced feeding areas nearby.

sort criteria: pronghorn, roads, grassland, quantitative, research-based, Canada, Montana

Cook, J.G. 1984. Pronghorn winter ranges: habitat characteristics and a field test of a habitat suitability model. M.S. Thesis, University of Wyoming, Laramie.

Habitat characteristics of pronghorn winter ranges and a habitat suitability model were evaluated. Pronghorn density was influenced primarily by shrub canopy coverage (i.e., Wyoming big sagebrush), and shrub cover influenced carrying capacity of pronghorn winter ranges.

sort criteria: pronghorn, mining, agriculture, rural subdivision, oil & gas, sagebrush, quantitative, research-based, Western U.S.

Easterly, T., A. Wood, and T. Litchfield. 1991. Responses of pronghorn and mule deer to petroleum development on crucial winter range in the Rattlesnake Hills. Unpublished Completion Report. Wyoming Game and Fish Department, Cheyenne.

Impacts of petroleum-related activities on pronghorn and mule deer were examined in central Wyoming. Distribution of pronghorn indicated avoidance of areas where drilling and well maintenance activities occurred. Displacement of mule deer in the study was not noted. Pronghorn numbers within 1 km of the well site decreased with the advent of road construction and drilling activity. However, once human activity subsided, numbers of pronghorn returned to pre-disturbance levels. "Displacement of animals may result in use of sub-optimal winter habitat, overcrowding, increased intraspecific competition, deterioration of habitat, and decreased physical condition of the population." Authors suggest drilling during summer on critical winter range.

<u>sort criteria</u>: pronghorn, mule deer, oil & gas, sagebrush, quantitative, research-based, Wyoming

Hayden-Wing Associates. 1991a. Final review and evaluation of the effects of Triton Oil and Gas Corporation's proposed coal bed methane field development (Great Divide prospect) on elk and other big game species. Triton Oil and Gas Corporation, Dallas, Tx.

Pronghorn, mule deer, and elk responses to disturbances associated with petroleum development in southwestern Wyoming were examined. Elk numbers decreased near drilling activities but returned to previous levels post-disturbance. However, elk were most sensitive to disturbances during winter and calving periods, and tended to avoid activity up to at least ½ mile away depending on whether or not the disturbance was visible. Pronghorn and mule deer seemed to habituate to most types of human disturbance unless they had been hunted or harassed. Mitigation measures for reducing impacts were presented.

<u>sort criteria</u>: pronghorn, mule deer, elk, oil & gas, sagebrush, quantitative, research-based, Wyoming

Hayden-Wing Associates. 1991b. Review and evaluation of the effects of geophysical exploration on some wildlife species in Wyoming. Unpublished Report for Geophysical Acquisition Workshop. Laramie, Wy.

A review of previous studies on the effects of geophysical exploration on pronghorn, mule deer, elk, raptors, and sage grouse was presented. The information examined indicated that big game are temporarily affected by seismic exploration causing increased energy expenditure and utilization of sub-optimal habitats. Characteristics for evaluating potential sage grouse nesting habitat in relation to proposed oil and gas development included: "1) distance relationships to leks, 2) presence, distance, and characteristics of existing disturbances, 3) characteristics of shrubs and vegetation that could serve in nest concealment and nest-site selection, and 4) distance to water and to potential brood-rearing areas." Mitigation strategies for protecting raptor-nesting habitat were also presented.

sort criteria: sage grouse, raptors, pronghorn, mule deer, elk, oil & gas, seismic exploration, sagebrush, quantitative, research-based, Wyoming

Hoskinson, R.L., and J.R. Tester. 1980. Migration behavior of pronghorn in southeastern Idaho. Journal of Wildlife Management 44:132-144.

Seasonal migration patterns of pronghorn were investigated from December 1975 through August 1977 in southeastern Idaho. Moisture content of vegetation was a stimulus for fall migration to begin. This migratory behavior could afford selective advantages to pronghorn because they are utilizing the best available food sources.

sort criteria: pronghorn, drought, sagebrush, quantitative, research-based, Idaho

Krausman, P.R., L.K. Harris, C.L. Blasch, K.K.G. Koenen, and J. Francine. 2004. Effects of military operations on behavior and hearing of endangered Sonoran pronghorn. Wildlife Monographs 157:1-41.

Military activities were monitored to determine the effects of noise and human activity on Sonoran pronghorn in Arizona. Based on the results: "(1) behavior patterns of pronghorn were similar with and without the presence of military stimuli, (2) behavior patterns of pronghorn exposed to military activity were similar to that of pronghorn not exposed to regular military activity, and (3) auditory characteristics were similar for ungulates that have and have not been exposed to sound pressure levels typical of military activities."

sort criteria: pronghorn, desert shrubland, human activity, noise, quantitative, research-based, Arizona

Landon, D.M., P.R. Krausman, K.K.G. Koenen, and L.K. Harris. 2003. Pronghorn use of areas with varying sound pressure levels. Southwestern Naturalist 48:725-728.

Pronghorn use of areas with varying noise levels (from military aircraft training) was evaluated in Arizona. "In general, pronghorn used areas with lower levels of noise (< 45 decibels [dB]) more than expected and areas with higher levels (≥ 55dB) less than expected." Vegetation and cover could also have influenced pronghorn use of these areas.

sort criteria: pronghorn, noise, quantitative, research-based, Arizona

Medcraft, J.R., and W.R. Clark. 1986. Big game habitat use and diets on a surface mine in northeastern Wyoming. Journal of Wildlife Management 50:135-142.

Seasonal uses of habitats by deer and pronghorn were studied at a coal surface mine near Gillette, Wyoming. Native vegetation was dominated by big sagebrush. Mule deer used reclaimed land more than un-mined land, however the opposite was true for pronghorns. Because reclaimed land provided sufficient, high-quality forage, authors believed habitat could be improved over time.

sort criteria: mule deer, pronghorn, mining, sagebrush, quantitative, research-based, Wyoming

Morton, P., C. Weller, J. Thomson, M. Haefele, and N. Culver. 2004. Drilling in the Rocky Mountains: How much and at what cost? The Wilderness Society, Washington, D.C.

An analysis examining the impacts associated with large-scale energy development determined that significant fragmentation of wildlife habitat occurs with development activities. Non-market costs of drilling included "erosion, loss of wildlife and fish habitat, decline in quality of recreational experiences, proliferation of noxious weeds, and increased air and water pollution." A habitat fragmentation analysis of the Big Piney-LaBarge oil and gas field (in northwestern Wyoming) produced results indicating " a direct physical footprint of 1,400 miles of linear features and 3.8 square miles of polygon features, resulting in an overall density of 8.43 miles of roads and pipelines per mile^2." Also, 97% of the area falls within ¼ mile of some infrastructure and only 27% of the study area was more than 500 feet from infrastructure, with only 3% more than ¼ mile away.

sort criteria: sage grouse, mule deer, pronghorn, elk, raptors, non-game birds, fish, wildlife, oil & gas, fragmentation, quantitative, research-based, prescriptive, western U.S.

Phillips, R.L., D.E. Biggins, and A.B. Hoag. 1986. Coal surface mining and selected wildlife – a 10-year case study near Decker, Montana. Pages 235-245 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

Mule deer, pronghorn, sage grouse, and golden eagles were monitored to determine their responses to mining activities in southeastern Montana and northern Wyoming. "Mule deer and pronghorn populations thrived throughout the study period despite increasing mining activity and human disturbance." Sage grouse habitat was lost, but mitigation efforts (e.g., relocation of a lek) seemed to be successful. Golden eagle numbers remained relatively stable. Four nesting pairs near active mines had a 10-year nesting success of 67.5% compared to 56.6% for pairs nesting elsewhere on the study area. "If the primary post mining land use is wildlife, permanent reclamation can be designed to maximize the mixture of plant species and thereby provide greater habitat diversity than native prairie."

<u>sort criteria</u>: sage grouse, mule deer, pronghorn, raptors, mining, sagebrush, quantitative, research-based, Wyoming, Montana, mitigation

PIC Technologies and Bureau of Land Management, Pinedale Field Office. 1999. Draft Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project. Bureau of Land Management, Pinedale, Wyoming, USA.

Management objectives, monitoring and mitigation recommendations for the Pinedale Anticline Oil and Gas Exploration and Development Project in northwestern Wyoming were presented. The standard stipulation alternative (SS) was explained as well as a resource protection alternative (RP), which included all spatial and temporal restrictions contained in the SS alternative. The RP alternative offered additional protection measures to "be applied to wildlife habitats on Federal lands and minerals."

<u>sort criteria</u>: sage grouse, pronghorn, mule deer, elk, moose, non-game birds, raptors, wildlife, oil & gas, noise, roads, quantitative, research-based, Wyoming

Riddle, P., and C. Oakley. 1973. The impacts of a severe winter and fences on antelope mortality in southcentral Wyoming. Proceedings of the Western Association of State Game and Fish Commissioners 53:174-188.

The influence of fencing on the mortality of pronghorn during a severe winter in south-central Wyoming was investigated. Highest mortality of pronghorn was associated with 4W Rouse-type woven wire fence. "Although woven wire fences represented only 53% of all fenceline transects, they accounted for 83% of the fenceline mortality." Modification or removal of fences was recommended to minimize pronghorn mortality.

<u>sort criteria</u>: pronghorn, fragmentation, fences, sagebrush, quantitative, research-based, Wyoming

Ryder, T.J. 1983. Winter habitat selection of pronghorn in south-central Wyoming. M.S. Thesis, University of Wyoming, Laramie.

Pronghorn selection of winter habitat was investigated in south-central Wyoming from 1978-1982. Pronghorn habitat use was associated with forage quantity, noticeably big sagebrush density and height but varied with weather conditions. During a mild winter 54% of pronghorn observations were in draws, 21% in greasewood-saltbush flats, and the remaining 25% were observed on benches and ridges.

<u>sort criteria</u>: pronghorn, mining, sagebrush, quantitative, research-based, Wyoming

Strickland, D. 1999. Petroleum development versus wildlife in the overthrust. Transactions of the North American Wildlife and Natural Resources Conference 64:28-35.

Controversies concerning impacts to wildlife from petroleum development in Wyoming are discussed. To date (1999) an estimated 2,100 producing oil and gas wells are located in southwestern Wyoming, with a large potential for further development. The BLM (Bureau of Land Management) estimates an additional 4,837 wells will be developed. Since 1984, 24,112 acres of habitat has been lost due to oil and gas development, and an additional 53,000 acres would be disturbed by future development from direct impacts (e.g., roads, pipelines, etc.). "The potential area of direct and indirect disturbance is 2.7 million acres, or approximately 16 percent of southwestern Wyoming." Author suggests the BLM modify its leasing strategy using long-range and strategic planning with an adaptive approach.

<u>sort criteria</u>: elk, bighorn sheep, moose, pronghorn, mule deer, sage grouse, oil & gas, sagebrush, qualitative, prescriptive, Wyoming

Sundstrom, C. 1969. Some factors influencing pronghorn antelope distribution in the Red Desert of Wyoming. Proceedings of the Western Association of State Game and Fish Commissioners 49:225-264.

Factors influencing pronghorn distribution in south-central Wyoming were examined. Fences in the study area generally had no long-term negative effects on pronghorn populations. This was due to the fact that these herds did not have to migrate from summer to winter range because of plentiful food, water, and cover in the area. Six percent (987 of 15,940) of pronghorn observations were in grass vegetative type, 2% in meadow type, 78% in sagebrush type, 5% in saltbush type, 9% in greasewood type, and < 1% in waste type.

<u>sort criteria</u>: pronghorn, fragmentation, fences, sagebrush, quantitative, research-based, Wyoming

Weller, C., J. Thomson, P. Morton, and G. Aplet. 2002. Fragmenting our lands: The ecological footprint from oil and gas development. The Wilderness Society, Washington, D.C.

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Western EcoSystems Technology, Inc. 2003. An evaluation of the 1988 BLM Pinedale Resource Management Plan, 2000 BLM Pinedale Anticline Final EIS and recommendations for the current revision of the Pinedale Resource Management Plan. The Wilderness Society, Washington, D.C.

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sort criteria: pronghorn, mule deer, elk, oil & gas, roads, sagebrush, quantitative, research-based, Wyoming

Wyoming Game & Fish Department. 1976. Considerations for wildlife in industrial development and reclamation. Cheyenne, Wy.

Mitigation and monitoring considerations for protecting wildlife and wildlife habitat with regard to industrial development were presented. Habitat development and reclamation were examined and recommendations were provided for specific habitat types (e.g., shrubland, rimrocks, etc.), and for individual wildlife species (e.g., mule deer, pronghorn, etc.).

sort criteria: sage grouse, mule deer, pronghorn, elk, bighorn sheep, wildlife, sagebrush, qualitative, prescriptive, mitigation, Wyoming

ELK

Allred, W.J. 1950. Re-establishment of seasonal elk migrations through transplanting. Wyoming Wildlife. March 1950.

Reasons for the discontinuation of seasonal migration of elk (between high country and desert areas) and re-establishment of historical migratory routes were examined. Severe winters, agriculture activities, hunting pressure, and fences were factors contributing to the halt of seasonal migrations. To re-establish migratory patterns, young elk that had not formed migratory habits were transplanted along the historic migratory route. The transplanting experiment seemed to be successful with increasing numbers of elk traveling along the old migratory routes.

sort criteria: elk, agriculture, fences quantitative, research-based, Wyoming

Altman, M. 1958. The flight distance in free-ranging big game. Journal of Wildlife Management 22(2):207-209.

Distances moose and elk fled from human intruders were investigated in Wyoming. Reactions were quite varied depending on species, sex, season (e.g. parturition, mating, hunting, etc.), and acclimation to human presence (e.g. tourists, fishermen, etc.). Flight distances ranged from a low of 10 feet for both cows and bulls during rut to a maximum of 300 feet for both sexes during hunting season.

sort criteria: moose, elk, human activity, quantitative, research-based, Wyoming

Cassirer, E.F., D.J. Freddy, and E.D. Ables. 1992. Elk responses to disturbance by cross-country skiers in Yellowstone National Park. Wildlife Society Bulletin 20:375-381.

Elk responses to cross-country skiers were examined in Yellowstone National Park. "The median distance at which elk in Lamar and Stephen's Creek started to move when skiers approached was 400 m, whereas the median flight distance of elk in Mammoth Hot Springs was 15 m." This difference was likely due to habituation of Mammoth elk to predictable human activity. Authors suggest skiers remain at distances >1,700 m to effectively avoid disturbing elk.

sort criteria: elk, human activity, sagebrush, grassland, forested, quantitative, research-based, Wyoming

Cole, E.K., M.D. Pope, and R.G. Anthony. 1997. Effects of road management on movement survival of Roosevelt elk. Journal of Wildlife Management 61:1115-1126.

The movement and survival of female Roosevelt elk were studied in Oregon (from 1991 to 1995) before designation of Road Management Areas (RMAs), and afterward, when access was restricted. In 1992, 35% of the study area was designated open to access. Home ranges of elk within the RMAs decreased from 761 ha during pre-treatment to 650 ha during the RMA phase. Fourteen elk were alive during both phases of the study. The average distances all of these elk moved decreased during RMA phases compared to the pre-treatment phase. Limited-access could increase survival and reproduction of elk due to reduced energy expenditure.

sort criteria: elk, roads, forested, quantitative, research-based, Oregon

Edge, W.D., C.L. Marcum, and S.L. Olson. 1985. Effects of logging activities on home-range fidelity of elk. Journal of Wildlife Management 49:741-744.

Logging and its effects upon home-range fidelity of elk were examined in a forested area east of Missoula, Montana, between 1977 and 1983. Logging activities did not cause a significant decrease in home-range size. The mean home range was 4,418 ha during years of disturbance and 4,506 ha when disturbance was absent. Authors concluded, "Logging activities that are restricted as much as possible in time and space, or conducted on seasonal ranges during periods when elk are not present, will be least disruptive."

sort criteria: elk, logging, forested, quantitative, research-based, Montana

Gillin, C. 1989. Response of elk to seismograph exploration in the Wyoming Range. M.S. Thesis, University of Wyoming, Laramie.

Elk responses to seismic exploration were investigated in northwestern Wyoming. For each period of seismic activity, comparisons of movement and habitat use were examined before, during and after disturbance. Elk were displaced an average of 1.2 km by seismic activity. Elk moved less daily during (1.8 km) and after (1.56 km) seismic disturbance than before (2.84 km). No range abandonment was observed. Elk tended to move from open areas to dense (> 70% canopy) timbered areas. "Elk detected and moved away from seismic activity up to 3.2 km away."

sort criteria: elk, seismic exploration, forested, quantitative, research-based, Wyoming

Girard, M., and B. Stotts. 1986. Managing impacts of oil and gas development on woodland wildlife habitats on the Little Missouri Grasslands, North Dakota. Pages 128-130 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

Impacts from oil and gas development (e.g., construction activities, toxic fumes, chemical spills, and wildlife displacement) on woodland wildlife habitat were evaluated on the Little Missouri Grasslands in North Dakota. Approximately 10,884 acres had been directly disturbed by oil and gas activity. A sphere of influence surrounds all roads and well pads, and is estimated to be a minimum of 100 yards in all directions. Mitigation efforts included: (1) No well pads or roads placed in a woodland. (2) Roads crossing "draws" must be at right angles to minimize disturbance. (3) Extra heavy pit liners were to be used in areas with porous substrates to prevent saltwater seepage.

sort criteria: wildlife, mule deer, elk, oil & gas, forested, quantitative, research-based, North Dakota, mitigation

Hayden-Wing Associates. 1990a. Response of elk to Exxon's field development in the Riley Ridge area of western Wyoming, 1979-1988. Final Report prepared for Exxon Company, U.S.A. and Wyoming Game and Fish Department, Cheyenne, Wy.

Distribution patterns and elk numbers were monitored to determine responses of wintering and calving elk to development of a natural gas well field in western Wyoming. During calving season (in calving areas) elk moved away from construction activities, but returned following the completion of drilling. Numbers of wintering elk declined in areas closest to the well except after construction when snow depths were greater than average. "Proper siting of wells, roads, and other facilities is crucial to maintaining elk use of winter and calving ranges." Recommendations were given to minimize impacts of oil and gas development on elk habitat.

sort criteria: elk, oil & gas, sagebrush, quantitative, research-based, Wyoming

Hayden-Wing Associates. 1990b. Summary of elk responses to oil well drilling and associated disturbances. Hayden-Wing Associates, Laramie, Wy.

A review of quantitative research on elk responses to well drilling, seismic exploration, roads, and mining was presented. "Most studies, however, point out that levels of elk occurrence near drilling activities decrease during drilling operations but return to former levels after a well site is abandoned." The presence or absence of security cover influences the magnitude of elk response to oil well drilling and associated activities.

sort criteria: elk, oil & gas, sagebrush, quantitative, research-based, Wyoming

Hayden-Wing Associates. 1991a. Final review and evaluation of the effects of Triton Oil and Gas Corporation's proposed coal bed methane field development (Great Divide prospect) on elk and other big game species. Triton Oil and Gas Corporation, Dallas, Tx.

Pronghorn, mule deer, and elk responses to disturbances associated with petroleum development in southwestern Wyoming were examined. Elk numbers decreased near drilling activities but returned to previous levels post-disturbance. However, elk were most sensitive to disturbances during winter and calving periods, and tended to avoid activity up to at least ½ mile away depending on whether or not the disturbance was visible. Pronghorn and mule deer seemed to habituate to most types of human disturbance unless they had been hunted or harassed. Mitigation measures for reducing impacts were presented.

<u>sort criteria</u>: pronghorn, mule deer, elk, oil & gas, sagebrush, quantitative, research-based, Wyoming

Hayden-Wing Associates. 1991b. Review and evaluation of the effects of geophysical exploration on some wildlife species in Wyoming. Unpublished Report for Geophysical Acquisition Workshop. Laramie, Wy.

A review of previous studies on the effects of geophysical exploration on pronghorn, mule deer, elk, raptors, and sage grouse was presented. The information examined indicated that big game are temporarily affected by seismic exploration causing increased energy expenditure and utilization of sub-optimal habitats. Characteristics for evaluating potential sage grouse nesting habitat in relation to proposed oil and gas development included: "1) distance relationships to leks, 2) presence, distance, and characteristics of existing disturbances, 3) characteristics of shrubs and vegetation that could serve in nest concealment and nest-site selection, and 4) distance to water and to potential brood-rearing areas." Mitigation strategies for protecting raptor-nesting habitat were also presented.

<u>sort criteria</u>: sage grouse, raptors, pronghorn, mule deer, elk, oil & gas, seismic exploration, sagebrush, quantitative, research-based, Wyoming

Henderson, R.E., and A. O'Herren. 1992. Winter ranges for elk and deer: victims of uncontrolled subdivisions? Western Wildlands 18:20-25.

Authors described impacts created by increasing human habitation of elk and deer winter ranges in Montana. Human disturbance can interrupt, and displace the movements between summer and winter ranges for both mule deer and elk.

sort criteria: mule deer, elk, rural subdivisions, agricultural, forested, qualitative, prescriptive, Montana

Irwin, L.L., and J.M. Peek. 1979. Relationship between road closures and elk behavior in northern Idaho. Pages 199-204 in M.S. Boyce and L.D. Hayden-Wing, eds. North American elk: ecology, behavior and management. University of Wyoming, Laramie. 294 pp.

Habitat use patterns related to forest management, hunters, and roads were investigated in northern Idaho from 1975 through 1977. There was no restricted access in 1975, 40 km^2 was closed to vehicles in 1976, and 75 km^2 was closed in 1977 (all closures were during hunting season). Elk were displaced to more extensive stands of trees when roads were open, however with road closures elk utilized smaller stands for longer periods. The larger ($75m^2$) closed area allowed elk to stay even longer. Authors recommend road closures would mitigate displacement of elk, especially during hunting season.

sort criteria: elk, roads, forested, quantitative, research-based, Idaho

Irwin, L.L., and C.M. Gillin. 1984. Response of elk to seismic exploration in the Bridger-Teton Forest, Wyoming. Progress Report. Bureau of Land Management, International Association of Geophysical Contractors, U.S. Forest Service, and Wyoming Game and Fish Department.

Responses of elk to seismic disturbance were investigated in western Wyoming. During one disturbance event, some elk were displaced and moved to summer range early while other elk used topographic barriers as buffers to the disturbance. Elk at distances greater than 2.5 km from disturbance showed no visible reactions. Elk abandoned the study area (Snider Basin) during calving.

sort criteria: elk, seismic exploration, forested, quantitative, research-based, Wyoming

Johnson, B., and L. Wolrab. 1987. Response of elk to development of a natural gas field in western Wyoming, 1979-1987. Wyoming Game & Fish Department Report.

The distribution and use of elk winter ranges and calving areas were monitored in western Wyoming from 1979 through 1987. In an area where 3 wells were drilled, 6,000 acres of winter range was abandoned. Elk returned to the area once drilling activities ceased, but use was unpredictable. Elk calving areas were also affected, with abandonment of calving sites during intense drilling activity. Mitigation and management recommendations included: road closures, placing wells outside crucial habitats, reducing human activity, and placing restrictions on seasonal activity around wells.

sort criteria: elk, oil & gas, sagebrush, quantitative, research-based, Wyoming

Johnson, B.K., and D. Lockman. 1979. Response of elk during calving to oil/gas drilling activity in Snider, Basin, Wyoming. WGFD Report 14pp.

A two-year comparison to assess effects of drilling activities on elk was conducted in southwest Wyoming. Elk use of the area was monitored during calving season in 1979 and 1980. In 1979, a wildcat well was drilled in the area. "Elk moved calves at an earlier age in 1979 than in 1980, moved calves away from drilling activity in 1979, avoided meadows visible from roads with high traffic volume more in 1979 than in 1980 and avoided the drill site in 1979." Authors suggest disturbance can affect elk populations by: increased mortality in calves, delayed maturity, decreased body size, and reduced body fat reserves. Recommendations for minimizing impacts are given.

sort criteria: elk, oil & gas, sagebrush, forested, quantitative, research-based, Wyoming

Johnson, T.K. 1986. Impacts of surface coal mining on calving elk. Pages 255-269 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

Elk calving behavior in relation to habitat disturbance from surface coal mining activities was investigated in northern Colorado. No significant differences between control elk and elk using the mine site were found in relation to reproductive productivity, calving, home-range size, fidelity, or habitat utilization and selection patterns. During spring and summer reclaimed sites were used in proportion to availability and were selected for during fall and early winter.

sort criteria: elk, mining, forested, quantitative, research-based, Colorado

Knight, J.E. 1981. Effect of oil and gas development on elk movements and distribution in northern Michigan. North American Wildlife and Natural Resources Conference 46:349-357.

Effects of oil and gas development on the movements and distribution of elk were studied in northern Michigan. Seismic activity had a significant effect on elk movement, but not distribution. However, oil well activity did not significantly affect either movement or distribution. The mean distance moved by all elk during seismic activity was 1320.7 yards when disturbance was 1000 m away, and 1563.2 yards when disturbance was 400 m away. Calving and rut are two situations when seismic activity could have the greatest implications.

sort criteria: elk, oil & gas, seismic exploration, forested, quantitative, research-based, Michigan

Kuck, L. 1986. The impacts of phosphate mining on big game in Idaho: a cooperative approach to conflict resolution. Transactions of the 51st North American Wildlife and Natural Resources Conference 51:90-97.

Evaluation of impacts of phosphate mining on big game in Idaho was the objective of this study. "Results of this study indicate that elk, deer and moose may be capable of adapting to many phosphate mining activities in southeastern Idaho, but cannot compensate for disturbance on important seasonal ranges or for increased mortality associated with industrial development."

sort criteria: mule deer, elk, moose, mining, forested, grassland, quantitative, research-based, Idaho

Kuck, L., G.L. Hompland, and E.H. Merrill. 1985. Elk calf response to simulated mine disturbance in southeast Idaho. Journal of Wildlife Management 49(3):751-757.

Mine disturbance was simulated to study responses by elk calves in southeast Idaho in an area dominated by aspen forest. Disturbed calves tended to move farther, higher in elevation, and used larger areas than did undisturbed calves. Elk cow/calf pairs were sensitive to human and simulated mine disturbance. Consequent abandonment of calf-rearing areas by disturbed cow/calf pairs led to habitation of more marginal habitats. Avoidance of disturbance did not result in calf abandonment or lower survival rates between disturbed and undisturbed groups.

sort criteria: elk, mining, forested, quantitative, research-based, Idaho

Kuhn, J.A., and B. Martens. 1985. Coal mine development and elk biology: Environmental impact assessment in Alberta and British Columbia. Pages 273-282 in M.S. Boyce and D. Hayden-Wing eds. North American elk: ecology, behavior, and management. University of Wyoming, Laramie.

Impacts of coal mine development on elk were assessed in Alberta and British Columbia, Canada. Habitat alteration (i.e., reclamation) of development areas caused underutilization of habitat near development and potential over-utilization elsewhere. However, authors suggest
". . . concentrated use by elk of habitats close to development, for example, use of drillhole seepages as mineral licks, use of road and powerline rights-of-way through dense, regenerating or deadfall littered forests, increased use of habitats within the

perimeter of restricted shooting zones near development, and foraging on reclaimed lands . . ..” Increased hunting pressure and harassment from recreationists are secondary effects of development.

sort criteria: elk, mining, forested, quantitative, research-based, Canada

Lees, A.T. 1989. The effect of recreational activity on elk use and distribution along a pipeline right-of-way. Pages 133-143 in Proceedings IV: Issues and Technology in the Management of Impacted Wildlife. Thorne Ecological Institute, Boulder, Co.

Elk response to recreational activity along a pipeline right-of-way was investigated in west-central Alberta, Canada. Elk used the right-of-way as a feeding area year round, but showed a preference for areas with minimal human activity. Elk use of habitat adjacent to the right-of-way was marginally affected by human activity along the right-of-way. Elk adapted to human activity by using cover types that provided security.
sort criteria: elk, oil & gas, roads, human activity, forested, quantitative, research-based, Canada

Lyon, L.J. 1979. Habitat effectiveness for elk as influenced by roads and cover. Journal of Forestry. 79(10):658-660.

Data from a previous study of elk pellet distribution in western Montana was used to “. . . develop (1) a model of habitat effectiveness in relation to roads and cover density, and (2) a method for estimating habitat effectiveness under various levels of road density and cover.” When road densities reached 3 miles per square mile even very dense canopy cover was not effective elk habitat. “Effective habitat” is a relative term and activities other than road management can modify the quality and productive potential of habitat.

sort criteria: elk, roads, forested, quantitative, research-based, Montana

Lyon, L.J. 1983. Road density models describing habitat effectiveness for elk. Journal of Forestry 81:592-595.

Response of elk to roads was investigated in Montana and Idaho in regard to road densities. In areas of road density of 5 ½ miles per square mile, elk used 18.8% of the potential habitat. Authors conclude the full impact of roads does not take place until 3 or more years after road construction, and road closures are the best way to assure effectual fall use of habitat by elk.

sort criteria: elk, roads, forested, quantitative, research-based, Montana, Idaho

McCorquodale, S.M., K.J. Raedeke, and R.D. Taber. 1986. Elk habitat use patterns in the shrub-steppe of Washington. Journal of Wildlife Management 50:664-669.

Habitat use and behavior of elk were studied on the ALE (Arid Lands Ecology) Reserve (public access is prohibited) in south-central Washington. An introduced population of elk inhabits this sagebrush steppe ecosystem. Over 75% of cow elk selected lower elevation areas all seasons except during calving, and male elk selected sagebrush areas during spring, summer, and fall. The lack of human presence on the Reserve (i.e. no human disturbance) may influence the limited cover needs of the elk. "The behavior of this population suggested that under conditions of infrequent disturbance and adequate forage, elk can be successful in habitats with limited thermal or security cover, even in severe climates.

sort criteria: elk, human activity, sagebrush, quantitative, research-based, Washington

Morgantini, L.E., and R.J. Hudson. 1978. Human disturbance and habitat selection in elk. Pages 132-139 in M.S. Boyce and L.D. Hayden-Wing eds. North American elk: ecology, behavior, and management. University of Wyoming, Laramie.

Selection and utilization of resources by elk were studied in western Alberta during the winter/spring of 1975-1976. Elk distribution and behavior were significantly altered by human activity. "The amount of time the elk spent in shrubland while moving toward the open in evening, appeared related to traffic activity taking place on the road. Once on the grassland, grazing took place within 100-200 m of cover. With darkness, the elk moved closer to the main road making better use of the potentially available range." Elk reacted to human activity by using marginal sectors of the grassland in the study area, which led to overgrazing in these locations.

sort criteria: elk, human activity, roads, forested, grassland, quantitative, research-based, Canada

Morrison, J.R., W.J. de Vergi, A.W. Alldredge, A.E. Byrne, and W.A. Andree. 1995. The effects of ski area expansion on elk. Wildlife Society Bulletin 23(3):481-489.

Responses of 2 populations of elk to physical and human disturbances associated with ski-area expansion in Colorado were investigated. "Results from Vail and Beaver Creek study sites indicate that elk may be acclimating behaviorally to physical disturbances and human activity. In areas where elk use decreased, a linear increase in use followed, although rates of recovery differed by area." Authors recommend minimizing human activities during times of heavy elk use to reduce the effects of development.

sort criteria: elk, human activity, forested, quantitative, research-based, Colorado

Morton, P., C. Weller, J. Thomson, M. Haefele, and N. Culver. 2004. Drilling in the Rocky Mountains: How much and at what cost? The Wilderness Society, Washington, D.C.

An analysis examining the impacts associated with large-scale energy development determined that significant fragmentation of wildlife habitat occurs with development activities. Non-market costs of drilling included "erosion, loss of wildlife and fish habitat, decline in quality of recreational experiences, proliferation of noxious weeds, and increased air and water pollution." A habitat fragmentation analysis of the Big Piney-LaBarge oil and gas field (in northwestern Wyoming) produced results indicating " a direct physical footprint of 1,400 miles of linear features and 3.8 square miles of polygon features, resulting in an overall density of 8.43 miles of roads and pipelines per $mile^2$." Also, 97% of the area falls within ¼ mile of some infrastructure and only 27% of the study area was more than 500 feet from infrastructure, with only 3% more than ¼ mile away.

<u>sort criteria</u>: sage grouse, mule deer, pronghorn, elk, raptors, non-game birds, fish, wildlife, oil & gas, fragmentation, quantitative, research-based, prescriptive, western U.S.

Oedekoven, O.O., and F.G. Lindzey. 1987. Winter habitat-use patterns of elk, mule deer, and moose in southwestern Wyoming. Great Basin Naturalist 47:638-643.

Mule deer, elk, and moose winter habitat use patterns were examined in southwestern Wyoming. Mule deer used sagebrush extensively, moose favored aspen, willow, and mixed-shrub vegetation, and elk preferred alpine grass/moss vegetation. Elk and mule deer showed a preference for areas with mild snow conditions, whereas moose were often observed in areas with deep snow. "Our results suggested that although deer, elk, and moose often used the same areas, they selected differing habitats within shared areas."

<u>sort criteria</u>: mule deer, elk, moose, sagebrush, quantitative, research-based, Wyoming

Parker, K.L., C.T. Robbins, and T.A. Hanley. 1984. Energy expenditures for locomotion by mule deer and elk. Journal of Wildlife Management 48:474-488.

Energy expenditures were measured on mule deer and elk to determine energy costs for several activities. Logging activities affected energy expenditures of both elk and deer by removal of canopy and subsequent increased snow depth. Human activity (i.e. winter recreation) caused excessive energy expenditure by inducing elk and deer to flee when approached. Management considerations should include restricting human access to deer and elk winter use areas.

sort criteria: mule deer, elk, human activity, logging, forested, quantitative, research-based

Phillips, G.E., and A.W. Alldredge. 2000. Reproductive success of elk following disturbance by humans during calving season. Journal of Wildlife Management 64(2):521-530.

Interrelationships between human disturbance and recruitment of calf elk were investigated in central Colorado during 1 pretreatment year and 2 treatment years (1995-1997). Average production from treatment elk was 0.225 calves/cow lower than that of control elk. Based on this study, 8.3 disturbances per cow were enough to reduce annual population growth by 1%. The results ". . . do not prove cause and effect, but they support treatment as a causal mechanism for decreased reproductive success on the Beaver Creek study area in 1996 and 1997."

sort criteria: elk, human activity, forested, quantitative, research-based, Colorado

PIC Technologies and Bureau of Land Management, Pinedale Field Office. 1999. Draft Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project. Bureau of Land Management, Pinedale, Wyoming, USA.

Management objectives, monitoring and mitigation recommendations for the Pinedale Anticline Oil and Gas Exploration and Development Project in northwestern Wyoming were presented. The standard stipulation alternative (SS) was explained as well as a resource protection alternative (RP), which included all spatial and temporal restrictions contained in the SS alternative. The RP alternative offered additional protection measures to "be applied to wildlife habitats on Federal lands and minerals."

sort criteria: sage grouse, pronghorn, mule deer, elk, moose, non-game birds, raptors, wildlife, oil & gas, noise, roads, quantitative, research-based, Wyoming

Powell, J.H. 2003. Distribution, habitat use patterns and elk response to human disturbance in the Jack Morrow Hills. M.S. Thesis, University of Wyoming, Laramie.

Elk distribution, habitat use, and effects of human disturbance were examined in southwestern Wyoming. Elk avoided areas within 2,000 m of active oil and gas wells and major roads. During calving and the summer season elk selected habitats associated with security cover (e.g., mountain shrub and tall sagebrush). Daily movements of disturbed elk were approximately 4 times greater than undisturbed elk. Elk avoidance of areas adjacent to oil and gas wells and major roads can cause greater effective habitat loss than merely the area occupied by the structure.

sort criteria: elk, oil & gas, roads, sagebrush, quantitative, research-based, Wyoming

Rost, G.R., and J.A. Bailey. 1979. Distribution of mule deer and elk in relation to roads. Journal of Wildlife Management 43(3):634-641.

Deer and elk responses to roads were assessed on winter ranges in Colorado during the winters of 1973 and 1974. The principal habitats were mountain shrub and pine forests. Data were obtained by counting fecal-pellet groups within 400m transects parallel to roads. Based upon pellet group distributions, elk and deer avoided roads, especially areas within 200m. Deer avoided roads more in shrublands than in forested areas, however elk responses did not differ based on habitat type. At some sites, deer avoided roads even though snow likely restricted available habitat. Therefore, propensity to avoid roads may be detrimental to deer and elk.

sort criteria: mule deer, elk, roads, mountain shrub, forested, quantitative, research-based, Colorado

Rowland, M.M., M.J. Wisdom, B.K. Johnson, and J.G. Kie. 2000. Elk distribution and modeling in relation to roads. Journal of Wildlife Management 64(3):672-684.

The effectiveness of a road density model (HE-habitat effectiveness) was evaluated in northeast Oregon during spring and summer, 1993-1995. Female elk consistently selected areas away from roads in spring and summer. The distance at which road effects dissipated could not be defined because few locations within the study area were sufficiently far from roads, however selection ratios were comparable to a distance of 1.2 km. The relationship between elk distribution and roads is likely to vary as elk population densities change. The results of this study suggest ". . . management of roads and related human activities during spring and summer should remain an important consideration for modeling and managing the elk resource. . ."

sort criteria: elk, roads, forested, quantitative, research-based, Oregon

Stewart, K.M., R.T. Bowyer, J.G. Kie, N.J. Cimon, and B.K. Johnson. 2002. Temporospatial distributions of elk, mule deer, and cattle: resource partitioning and competitive displacement. Journal of Mammalogy 83(1): 229-244.

Resource partitioning and competitive displacement among mule deer, elk, and cattle were examined in northeastern Oregon and southeastern Washington. Resource partitioning was strongly evident among all 3 species, however mule deer and elk selected similar slopes and elevations, whereas cattle avoided steep slopes and high elevations. Although mule deer and elk selected similar slopes and elevations, they used different vegetation communities. At higher densities, resource partitioning could be more difficult leading to increased competition.

sort criteria: mule deer, elk, grazing, forested, grassland, quantitative, research-based, Oregon, Washington

Strickland, D. 1999. Petroleum development versus wildlife in the overthrust. Transactions of the North American Wildlife and Natural Resources Conference 64:28-35.

Controversies concerning impacts to wildlife from petroleum development in Wyoming are discussed. To date (1999) an estimated 2,100 producing oil and gas wells are located in southwestern Wyoming, with a large potential for further development. The BLM (Bureau of Land Management) estimates an additional 4,837 wells will be developed. Since 1984, 24,112 acres of habitat has been lost due to oil and gas development, and an additional 53,000 acres would be disturbed by future development from direct impacts (e.g., roads, pipelines, etc.). "The potential area of direct and indirect disturbance is 2.7 million acres, or approximately 16 percent of southwestern Wyoming." Author suggests the BLM modify its leasing strategy using long-range and strategic planning with an adaptive approach.

sort criteria: elk, bighorn sheep, moose, pronghorn, mule deer, sage grouse, oil & gas, sagebrush, qualitative, prescriptive, Wyoming

Van Dyke, F., and W. C. Klein. 1996. Response of elk to installation of oil wells. Journal of Mammalogy 77(4):1028-1041.

Seasonal and annual use of range and habitat were compared in a population of elk in south-central Montana prior to, during, and after installation of an exploratory oil-gas well. Absolute shifts of activity centers were small, however the shift was more than twice as large when humans were present (320 m) compared to only equipment activity (130 m). Elk tended to occupy locations screened from the well site by a physical barrier. Drilling activity was limited from June 15 to October 15, which could explain why resident elk did not abandon summer ranges.

sort criteria: elk, oil & gas, sagebrush, forested, quantitative, research-based, Montana

Ward, A.L. 1973. Elk behavior in relation to multiple uses on the Medicine Bow National Forest. Proceedings of the Western Association of State Game Commissions 43:125-141.

Elk behavior in relation to multiple uses was monitored in southern Wyoming. Uses included: livestock grazing, timber harvesting, recreation, and traffic. Elk were compatible with livestock when an adequate food supply was available. Elk were not significantly affected by traffic beyond 300 yards, however Interstate 80 did act as a barrier to elk movement. Elk preferred a ½ mile buffer from people associated with out-of-vehicle activities (e.g., camping, fishing, harvesting timber, etc.).

sort criteria: elk, roads, logging, human activity, forested, quantitative, research-based, Wyoming

Ward, L.A. 1986. Displacement of elk related to seismograph activity in south-central Wyoming. Pages 246-254 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

A hunted elk population in south-central Wyoming was monitored to evaluate responses to seismograph activity. Three different types of seismograph activity (i.e. above ground explosions, truck vibrators, drill and shoot) displaced elk, however people walking caused the most extreme responses. In rough topography and when seismic lines were run in the bottom of a draw, elk stayed at least 800 m from the activity and out of sight of seismic crews. When seismic operations occurred on open ridges, elk stated approximately 3.2 km away and out of sight of seismic crews. Elk returned to the seismograph use areas within a few days of activity cessation.

sort criteria: elk, seismic exploration, sagebrush, quantitative, research-based, Wyoming

Ward, A.L., J.J. Cupal, A.L. Lea, C.A. Oakley, and R.W. Weeks. 1973. Elk behavior in relation to cattle grazing, forest recreation, and traffic. Transactions of the North American Wildlife Conference 38:327-337.

Effects of human behavior on wildlife were examined in southeastern Wyoming to aid in land use planning operations. Interstate 80 acted as a barrier to movement, but had little effect on behavior within 300 yards. Authors suggest roads be kept away from elk feeding sites or along streams. Elk preferred approximately a ½ mile buffer from recreational users. Authors suggest ½ mile distance between recreation areas and feeding sites and adequate cover buffer zones.

sort criteria: elk, human activity, roads, forested, quantitative, research-based, Wyoming

Weller, C., J. Thomson, P. Morton, and G. Aplet. 2002. Fragmenting our lands: The ecological footprint from oil and gas development. The Wilderness Society, Washington, D.C.

Habitat fragmentation resulting from resource extraction practices was examined in the Upper Green River Basin of Wyoming. Average road densities and other linear features were 8.43 miles per square mile. An effect zone of ½ mile was constructed and analyzed. The analysis showed the entire 166 square mile study area to be within ½ mile of a road or other development related infrastructure. "The ecological footprint varies depending upon which disturbance is measured. A disturbance that reaches a quarter of a mile beyond the infrastructure creates a footprint of 160 square miles, affecting 97% of the study area. Even a more localized disturbance that only reaches 100 feet beyond the infrastructure affects 28% of the study area (47 square miles)."

sort criteria: sage grouse, mule deer, pronghorn, elk, moose, oil & gas, sagebrush, quantitative, research-based, Wyoming

Western EcoSystems Technology, Inc. 2003. An evaluation of the 1988 BLM Pinedale Resource Management Plan, 2000 BLM Pinedale Anticline Final EIS and recommendations for the current revision of the Pinedale Resource Management Plan. The Wilderness Society, Washington, D.C.

An analysis of the 1988 Bureau of Land Management (BLM) Resource Management Plan and the 2000 BLM Pinedale Anticline Environmental Impact Statement (EIS) was presented. Recommendations for the current revision of the Pinedale Resource Management Plan were also given. Overall planning and adaptive management recommendation included: 1) limiting the density of roads and wells per section, 2) protecting a minimum amount of significant big game habitat from disturbance, 3) identify areas where future oil and gas leases should be prohibited, 4) coordinate habitat management, and 5) apply adaptive management.

sort criteria: pronghorn, mule deer, elk, oil & gas, roads, sagebrush, quantitative, research-based, Wyoming

Witmer, G.W., and D.S. deCalesta. 1985. Effect of forest roads on habitat use by Roosevelt elk. Northwest Science 59:122-125.

Effects of roads on habitat use by elk were investigated in the central Coast Range of Oregon. Roads affected distributions most during calving and hunting seasons, and elk were not as affected by spur (dirt or gravel) roads than paved roads. Authors recommend road closures during rut and calving seasons to reduce harassment of elk.

sort criteria: elk, roads, forested, quantitative, research-based, Oregon

Wyoming Game & Fish Department. 1976. Considerations for wildlife in industrial development and reclamation. Cheyenne, Wy.

Mitigation and monitoring considerations for protecting wildlife and wildlife habitat with regard to industrial development were presented. Habitat development and reclamation were examined and recommendations were provided for specific habitat types (e.g., shrubland, rimrocks, etc.), and for individual wildlife species (e.g., mule deer, pronghorn, etc.).

sort criteria: sage grouse, mule deer, pronghorn, elk, bighorn sheep, wildlife, sagebrush, qualitative, prescriptive, mitigation, Wyoming

SHARP-TAILED GROUSE

Applegate, R.D. 2000. In my opinion: Use and misuse of prairie chicken lek surveys. Wildlife Society Bulletin 28(2):457-463.

Methods and accuracy of lek surveys were evaluated. The author suggested surveys be referred to as indices (indicators of population trends) but not used to calculate absolute estimates of population size.

sort criteria: sage grouse, sharp-tailed grouse, wildlife, sagebrush, quantitative, prescriptive

Baydack, R.K., and D.A. Hein. 1987. Tolerance of sharp-tailed grouse to lek disturbance. Wildlife Society Bulletin 15:535-539.

Human activity and its effects on sharp-tailed grouse were examined from March 1984 to May 1985 in southwestern Manitoba, Canada. " Mean displacement distance of sharptail males from individual leks ranged from 240 to 765 m during all human disturbances . . ." Female sharp-tailed grouse were not observed at leks during disturbances, which could indicate limited reproductive opportunities.

sort criteria: sharp-tailed grouse, human activity, grassland, quantitative, research-based, Canada

Berger, M.T., R. Whitney, and D. Antoine. 2004. Columbian sharp-tailed grouse management on the Colville Indian Reservation. Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee. Wenatchee, Wa. Abstract only.

Protection, restoration, and enhancement of Columbian sharp-tailed grouse and their habitat were examined in Washington. Expert opinion, data, and past studies were reviewed to design a method to restore and conserve sharp-tailed grouse and associated habitats.

<u>sort criteria</u>: sharp-tailed grouse, mitigation, quantitative, research-based, prescriptive, Washington

Giesen, K.M., and J.W. Connelly. 1993. Guidelines for management of Columbian sharp-tailed grouse habitats. Wildlife Society Bulletin 21:325-333.

Breeding complexes (leks and nesting areas) are typically located on land surfaces that are higher than the surrounding area and ". . . include all lands within a 2-km radius of lek sites, because most nesting occurs within this area." Habitat alterations such as grazing and herbicide spraying have negative effects on sharp-tailed grouse, while prescribed burning and chaining can be beneficial. When disturbances cannot be avoided within the breeding complex, restrictions should include: prohibiting "physical, mechanical, and audible disturbances within the breeding complex during breeding season (Mar-Jun)" and avoiding "manipulation or alteration of vegetation within the breeding complex during the nesting period (May-Jun)."

<u>sort criteria</u>: sharp-tailed grouse, sagebrush, sagebrush treatment, quantitative, prescriptive, western U.S.

Greer, R.D. 2004. Columbian sharp-tailed grouse: distribution, status, habitat use, and population dynamics in Utah. Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee. Wenatchee, Wa. Abstract only.

Habitat use and population distribution of Columbian sharp-tailed grouse is being investigated in Utah. "Defining population trends and identifying previously unknown populations in historic ranges is being done. Habitat improvement projects are being implemented and monitored."

<u>sort criteria</u>: sharp-tailed grouse, quantitative, research-based, Utah

Hemmer, L.G. 2004. Conservation Reserve Program: effects of capping enrollment. Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee. Wenatchee, Wa. Abstract only.

The federal Conservation Reserve Program (CRP) supports many bird, reptile, and mammal species including sage grouse and sharp-tailed grouse. "Most leks and nests in north-central Washington are located in CRP or in areas dominated by CRP." One questionable CRP rule limits enrollment to 25% of total cropland in a county.

<u>sort criteria</u>: sage grouse, sharp-tailed grouse, mitigation, qualitative, prescriptive, Washington

Klott, J.H., and F.G. Lindzey. 1990. Brood habitats of sympatric sage grouse and Columbian sharp-tailed grouse in Wyoming. Journal of Wildlife Management 54:84-88.

A comparison of habitats in south-central Wyoming used by sage grouse and Columbian sharp-tailed grouse was presented. "Sage grouse broods occurred most often (68%) in sagebrush (*Artemisia* spp.)-grass and sagebrush-bitterbrush (*Purshia tritentata*) habitats, whereas sharp-tailed grouse broods occurred most often (73%) in mountain shrub and sagebrush-snowberry (*Symphoicarpos oreophilus*) habitats." No difference was found between sage grouse and sharp-tailed grouse brood sites in regard to total shrub cover, sagebrush cover, or sagebrush canopy. Management suggestions included constraining vegetation treatments to narrow strips (< 30 m) and reduction of livestock grazing.

<u>sort criteria</u>: sage grouse, sharp-tailed grouse, sagebrush treatment, sagebrush, quantitative, research-based, Wyoming

Leupin, E., and D. Jury. 2004. Columbian sharp-tailed grouse in British Columbia: status and conservation efforts. Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee. Wenatchee, Wa. Abstract only.

Loss and degradation of native climax grasslands are the major factors responsible for the decline of Columbian sharp-tailed grouse in British Columbia. Sharp-tailed grouse also inhabit large burn areas and cut block habitats associated with sedge-meadow complexes. "… little is known regarding population status and distribution of birds in sedge meadow/cutover habitats. Preliminary inventory work in the spring of 2004 in the cutover habitats suggests that these populations may be abundant and wide spread."

<u>sort criteria</u>: sharp-tailed grouse, grassland, quantitative, research-based, Canada

Paige, C., and S.A. Ritter. 1999. Birds in a sagebrush sea: managing sagebrush habitats for bird communities. Partners in Flight Western Working Group, Boise, ID.

Recommendations are presented for land management practices to help bird communities in sagebrush habitats. Shrubland and shrub-dependent bird species have declined 63% across the U.S. "Sagebrush obligates include the sage sparrow, Brewer's sparrow, sage thrasher, sage grouse, pygmy rabbit, sagebrush vole, sagebrush lizard, and pronghorn. Management guidelines are classified using different scales (landscape, stand, and patch). The level of effects on birds ranges from populations to individuals and pairs. A summary of bird management goals and recommendations is provided.

sort criteria: sage grouse, sharp-tailed grouse, raptors, sagebrush obligates, non-game birds, oil & gas, agriculture, human activity, sagebrush, quantitative, prescriptive, western U.S.

Saab, V.A., and J.S. Marks. 1992. Summer habitat use by Columbian sharp-tailed grouse in western Idaho. Great Basin Naturalist 52:166-173.

Summer habitat use by Columbian sharp-tailed grouse in western Idaho was examined from 1983-85. Grouse used big sagebrush cover type more in proportion to any of 8 other cover types in the study area. Characteristics of the big sagebrush cover type included: "… moderate vegetative cover, high plant species diversity, and high structural diversity." Grouse selected areas least modified by livestock grazing. Authors suggest protecting habitats within 2.5 km of dancing grounds.

sort criteria: sharp-tailed grouse, agriculture, sagebrush quantitative, research-based, Idaho

Vander Haegen, W.M., M.A. Schroeder, and R.M. Degraaf. 2002. Predation on real and artificial nests in shrubsteppe landscapes fragmented by agriculture. Condor 104:496-506.

Artificial nests were monitored to examine effects of fragmentation, distance to edge, and vegetation cover on nest predation rates, as well as to identify predators of grouse and passerines. Nests in fragmented landscapes were approximately 9 times more likely to be depredated than nests in continuous landscapes. Predation rate was 26% for artificial nests. Nest-sites with greater vegetation coverage were less likely to be depredated.

sort criteria: sage grouse, sharp-tailed grouse, non-game birds, sagebrush obligates, agriculture, fragmentation, sagebrush, grassland, quantitative, research-based, Washington

Waage, B.C. 1989. Sharp-tailed grouse lek (dancing ground) establishment on reclaimed mined lands. Pages 116-122 in Proceedings IV: Issues and Technology in the Management of Impacted Wildlife. Thorne Ecological Institute, Boulder, Co.

Establishment of sharp-tailed grouse leks on reclaimed mine lands was examined in southeastern Montana. Acoustical luring was successful at 2 of 3 experimental sites, however permanent lek establishment was not achieved. One lek established within auditory distance of the luring locations was successful with an average male attendance of 15 grouse. "Grouse have established leks on reclaimed lands at densities that meet or exceed pre-mined conditions."

sort criteria: sharp-tailed grouse, mining, sagebrush, quantitative, research-based, Montana

MOOSE

Altman, M. 1958. The flight distance in free-ranging big game. Journal of Wildlife Management 22(2):207-209.

Distances moose and elk fled from human intruders were investigated in Wyoming. Reactions were quite varied depending on species, sex, season (e.g. parturition, mating, hunting, etc.), and acclimation to human presence (e.g. tourists, fishermen, etc.). Flight distances ranged from a low of 10 feet for both cows and bulls during rut to a maximum of 300 feet for both sexes during hunting season.

sort criteria: moose, elk, human activity, quantitative, research-based, Wyoming

Kuck, L. 1986. The impacts of phosphate mining on big game in Idaho: a cooperative approach to conflict resolution. Transactions of the 51st North American Wildlife and Natural Resources Conference 51:90-97.

Evaluation of impacts of phosphate mining on big game in Idaho was the objective of this study. "Results of this study indicate that elk, deer and moose may be capable of adapting to many phosphate mining activities in southeastern Idaho, but cannot compensate for disturbance on important seasonal ranges or for increased mortality associated with industrial development."

sort criteria: mule deer, elk, moose, mining, forested, grassland, quantitative, research-based, Idaho

Oedekoven, O.O., and F.G. Lindzey. 1987. Winter habitat-use patterns of elk, mule deer, and moose in southwestern Wyoming. Great Basin Naturalist 47:638-643.

Mule deer, elk, and moose winter habitat use patterns were examined in southwestern Wyoming. Mule deer used sagebrush extensively, moose favored aspen, willow, and mixed-shrub vegetation, and elk preferred alpine grass/moss vegetation. Elk and mule deer showed a preference for areas with mild snow conditions, whereas moose were often observed in areas with deep snow. "Our results suggested that although deer, elk, and moose often used the same areas, they selected differing habitats within shared areas."

sort criteria: mule deer, elk, moose, sagebrush, quantitative, research-based, Wyoming

PIC Technologies and Bureau of Land Management, Pinedale Field Office. 1999. Draft Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project. Bureau of Land Management, Pinedale, Wyoming, USA.

Management objectives, monitoring and mitigation recommendations for the Pinedale Anticline Oil and Gas Exploration and Development Project in northwestern Wyoming were presented. The standard stipulation alternative (SS) was explained as well as a resource protection alternative (RP), which included all spatial and temporal restrictions contained in the SS alternative. The RP alternative offered additional protection measures to "be applied to wildlife habitats on Federal lands and minerals."

<u>sort criteria</u>: sage grouse, pronghorn, mule deer, elk, moose, non-game birds, raptors, wildlife, oil & gas, noise, roads, quantitative, research-based, Wyoming

Rudd, L.T. 1985. Wintering moose vs. oil/gas activity in western Wyoming. Alces 21:279-298.

Moose responses to activities associated with oil and gas development were examined in western Wyoming during winters of 1981-82 and 1982-83. Approximately 55 oil company trucks traveled an access road daily both winters, and recreationists (snowmobilers, skiers, hunters, and snowshoers) also used the plowed road. Average approach distances causing moose to escape were: 15.6 m from trucks, 9.7 m from snowmobiles, and 15.3 m from snowshoers/skiers. The average distances of moose displacement were: 156 m when disturbed by trucks, 54.7 m when disturbed by snowmobiles, and 74.5 m when disturbed by snowshoers/skiers. Preferred moose habitat should be avoided when areas are selected for placement of oilrig access roads.

<u>sort criteria</u>: moose, oil & gas, roads, forested, riparian, quantitative, research-based, Wyoming

Rudd, L.T. 1986. Winter relationships of moose to oil and gas development in western Wyoming. M.S. Thesis, University of Wyoming, Laramie.

Impacts to wintering moose, resulting from oil and gas activity in northwestern Wyoming were examined. Approximately 55 oil company trucks/day traveled the plowed access road (no roads in the area were plowed prior to drilling). Winter recreationists also used the roads. The mean distance moose moved away from trucks was 15.5 m, from snowmobiles 9.7 m, and from skiers/snowshoers 15.3 m. The author states "… access roads should not be placed within 800 m of moose winter habitat."

<u>sort criteria</u>: moose, oil & gas, roads, forested, quantitative, research-based, Wyoming

Strickland, D. 1999. Petroleum development versus wildlife in the overthrust Transactions of the North American Wildlife and Natural Resources Conference 64:28-35.

Controversies concerning impacts to wildlife from petroleum development in Wyoming are discussed. To date (1999) an estimated 2,100 producing oil and gas wells are located in southwestern Wyoming, with a large potential for further development. The BLM (Bureau of Land Management) estimates an additional 4,837 wells will be developed. Since 1984, 24,112 acres of habitat has been lost due to oil and gas development, and an additional 53,000 acres would be disturbed by future development from direct impacts (e.g., roads, pipelines, etc.). "The potential area of direct and indirect disturbance is 2.7 million acres, or approximately 16 percent of southwestern Wyoming." Author suggests the BLM modify its leasing strategy using long-range and strategic planning with an adaptive approach.

sort criteria: elk, bighorn sheep, moose, pronghorn, mule deer, sage grouse, oil & gas, sagebrush, qualitative, prescriptive, Wyoming

BIGHORN SHEEP

Hicks, L.L., and J.M. Elder. 1979. Human disturbance of Sierra Nevada bighorn sheep. Journal of Wildlife Management 43(4):909-915.

Human/bighorn sheep interactions were observed during summer (1976) in the Sierra Nevada Mountains of California. Bighorn populations were not adversely affected by human encounters. Meadows used by humans were typically avoided by bighorns because of differences in vegetation composition rather than human presence.

sort criteria: bighorn sheep, human activity, alpine meadow, quantitative, research-based, California

Hook, D.L. 1986. Impacts of seismic activity on bighorn movements and habitat use. Biennial Symposium of the Northern Wild Sheep and Goat Council 5:292-297.

Impacts of seismic activity on bighorn sheep were evaluated along the Rocky Mountain Front in Montana. Average annual home range size declined from 25.9 to 18.6 square miles (28% decrease) then increased to 29.7 square miles following disturbance. Helicopter activity was apparently responsible for bighorn abandonment of a large portion of their fall range. Increased energy expenditure could result in lower winter survival rates and decreased reproductive success. The author recommends termination of oil and gas activities after September 15 each year.

sort criteria: bighorn sheep, seismic activity, mountain grasslands, quantitative, research-based, Canada

MacArthur, R.A., V. Geist, and R.H. Johnston. 1982. Cardiac and behavioral responses of mountain sheep to human disturbance. Journal of Wildlife Management 46(2):351-358.

Heart rates (HR) and behavioral responses of mountain sheep to human activity were examined in southwestern Alberta, Canada. Strongest reactions by sheep occurred when approached by a person with a dog, or when approached from over a ridge. Road traffic produced minimal reaction with only 8.8% of vehicle passes eliciting HR responses. Management recommendations included, restricting human activities to roads and trails, and discouraging the presence of dogs on sheep ranges.

sort criteria: bighorn sheep, human activity, quantitative, research-based, Canada

Mead, D.A., and L.E. Morgantini. 1988. Drilling in sheep country: gas development at Prairie Bluff, Alberta. Biennial Symposium of the Northern Wild Sheep and Goat Council 6:165-167.

Impacts of industrial activity on bighorn sheep were investigated in southwestern Alberta. Some preliminary results indicated road and well-site construction activities temporarily displaced bighorns, but animals quickly returned to the area when construction ended. Also, helicopter activity caused more disturbance than blasting, heavy machinery or human activity.

sort criteria: bighorn sheep, oil & gas, quantitative, research-based, Canada

Morgantini, L.E., and E. Bruns. 1988. Attraction of bighorn sheep to wellsites and other man-made mineral licks along the eastern slopes of Alberta: a management concern. Biennial Symposium of the Northern Wild Sheep and Goat Council 6:135-140.

The attraction of bighorn sheep to man-caused mineral licks was investigated in west-central Alberta. "On all wellsites, bighorn sheep licked and ate soil containing minerals used during gas well drilling and testing. Sodium appeared to be the major attraction." Management concerns included: crowding, range depletion, altered distribution, tameness, toxic chemicals, and hunting. Authors recommended permanent fencing around the entire site as the only effective mitigation practice.

sort criteria: bighorn sheep, oil & gas, forested, mountain grasslands, quantitative, research-based, Canada

Morgantini, L.E., and B.W. Worbets. 1988. Bighorn use of a gas wellsite during servicing and testing: a case study of impact and mitigation. Biennial Symposium of the Northern Wild Sheep and Goat Council 6:159-164.

This case study investigated the impacts to bighorn sheep at a gas wellsite in west-central Alberta. Mitigation actions were also evaluated. The attraction of bighorns to mineral deposits on wellsites can alter distribution and movement patterns, and expose animals to potentially toxic chemicals. Active harassment was unsuccessful in keeping bighorns from wellsites. Extensive baiting and actively herding bighorns away from the wellsite was successful, but this approach should not be considered "the answer" in all situations.

sort criteria: bighorn sheep, oil & gas, forested, mountain grasslands, quantitative, research-based, prescriptive, Canada

Morgantini, L.E., and D.A. Mead. 1990. Industrial development on prime bighorn sheep range in southwest Alberta. Biennial Symposium of the Northern Wild Sheep and Goat Council 7:56-66.

Bighorn sheep distribution and behavior were examined before and during construction activities of 2 gas wells in southwest Alberta. Helicopter activity caused an increased level of alertness with reactions ranging from interrupted feeding to panic fleeing. In general, construction activities did not seem to significantly impact bighorn movements or distribution. However, the attraction to materials used during industrial operations could be a potential problem, which may affect bighorn distribution and expose animals to potentially toxic chemicals.

sort criteria: bighorn sheep, oil & gas, mountain grasslands, quantitative, research-based, Canada

Strickland, D. 1999. Petroleum development versus wildlife in the overthrust. Transactions of the North American Wildlife and Natural Resources Conference 64:28-35.

Controversies concerning impacts to wildlife from petroleum development in Wyoming are discussed. To date (1999) an estimated 2,100 producing oil and gas wells are located in southwestern Wyoming, with a large potential for further development. The BLM (Bureau of Land Management) estimates an additional 4,837 wells will be developed. Since 1984, 24,112 acres of habitat has been lost due to oil and gas development, and an additional 53,000 acres would be disturbed by future development from direct impacts (e.g., roads, pipelines, etc.). "The potential area of direct and indirect disturbance is 2.7 million acres, or approximately 16 percent of southwestern

Wyoming." Author suggests the BLM modify its leasing strategy using long-range and strategic planning with an adaptive approach.

<u>sort criteria</u>: elk, bighorn sheep, moose, pronghorn, mule deer, sage grouse, oil & gas, sagebrush, qualitative, prescriptive, Wyoming

Weisenberger, M.E., P.R. Krausman, M.C. Wallace, D.W. DeYoung, and E.O. Maughan. 1996. Effects of simulated jet aircraft noise on heart rate and behavior of desert ungulates. Journal of Wildlife Management 60(1):52-61.

The effects of simulated low-altitude jet aircraft noise on the behavior and heart rate of mule deer and mountain sheep in Arizona were evaluated. "The heart rates of ungulates increased related to dB levels during simulated overflights ($P \leq 0.05$), but they returned to pre-disturbance levels in 60-180 seconds. Animal behavior also changed during overflights but returned to pre-disturbance conditions in < 252 seconds ($P \leq 0.005$). All animal responses decreased with increased exposure suggesting that they habituated to simulated sound levels of low-altitude aircraft."

<u>sort criteria</u>: mule deer, bighorn sheep, noise, quantitative, research-based, Arizona

Wyoming Game & Fish Department. 1976. Considerations for wildlife in industrial development and reclamation. Cheyenne, Wy.

Mitigation and monitoring considerations for protecting wildlife and wildlife habitat with regard to industrial development were presented. Habitat development and reclamation were examined and recommendations were provided for specific habitat types (e.g., shrubland, rimrocks, etc.), and for individual wildlife species (e.g., mule deer, pronghorn, etc.).

<u>sort criteria</u>: sage grouse, mule deer, pronghorn, elk, bighorn sheep, wildlife, sagebrush, qualitative, prescriptive, mitigation, Wyoming

<u>RAPTORS</u>

Anderson, D.E., O.J. Rongstad, and W.R. Mytton. 1990. Home-range changes in raptors exposed to increased human activity levels in southeastern Colorado. Wildlife Society Bulletin 18:134-142.

An assessment of home-range changes due to increased human activity levels was conducted in southeastern Colorado. Raptors exposed to high levels of human activity shifted their home-range centers and activity areas, moved outside areas normally used, and increased the size of the area they used. Birds not exposed to human activity did not exhibit these changes to the same extent. Repeated or prolonged disturbance could increase energy costs for raptors, reproductive productivity could decrease with changes in home range, and community composition may change with less tolerant species declining.

sort criteria: raptors, human activity, grasslands, quantitative, research-based, Colorado

Fitzner, R.E. 1986. Responses of birds of prey to large-scale energy development in southcentral Washington. Pages 287-294 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

Nesting ecology of raptors and the common raven was investigated at the U.S. Department of Energy's Hanford Site in south-central Washington. Power poles provided nesting sites for red-tailed hawks and ravens in areas lacking nesting structures. However, Swainson's hawks were totally dependent on trees for nesting. Several Swainson's hawk nests located within 1.5 km of construction activity were deserted. The author suggests that planting trees could increase Swainson's hawk nesting densities.

sort criteria: raptors, powerlines, machine activity, quantitative, research-based, Washington

George, W.G. 1974. Domestic cats as predators and factors in winter shortages of raptor prey. Wilson Bulletin 86:384-396.

The impact of domestic cats on raptor prey was investigated in southern Illinois. Three cats were monitored to determine their predatory success, and the type and number of prey caught. "Annually, from March through November, the cats removed from each acre of their combined home range (25 acres) an average of over 27 mammals-and-fetuses, of which 22.2 per acre were microtines." Predation by domestic cats could result in depleted winter populations of prey for raptors.

sort criteria: raptors, agricultural lands, quantitative, research-based, Illinois

Hayden-Wing Associates. 1991b. Review and evaluation of the effects of geophysical exploration on some wildlife species in Wyoming. Unpublished Report for Geophysical Acquisition Workshop. Laramie, Wy.

A review of previous studies on the effects of geophysical exploration on pronghorn, mule deer, elk, raptors, and sage grouse was presented. The information examined indicated that big game are temporarily affected by seismic exploration causing increased energy expenditure and utilization of sub-optimal habitats. Characteristics for evaluating potential sage grouse nesting habitat in relation to proposed oil and gas development included: "1) distance relationships to leks, 2) presence, distance, and characteristics of existing disturbances, 3) characteristics of shrubs and vegetation that could serve in nest concealment and nest-site selection, and 4) distance to water and to potential brood-rearing areas." Mitigation strategies for protecting raptor-nesting habitat were also presented.

<u>sort criteria</u>: sage grouse, raptors, pronghorn, mule deer, elk, oil & gas, seismic exploration, sagebrush, quantitative, research-based, Wyoming

Holmes, T.L., R.L. Knight, L. Stegall, and G.R. Craig. 1993. Responses of wintering grassland raptors to human disturbance. Wildlife Society Bulletin 21:461-468.

Effects of human disturbance upon wintering grassland raptors were investigated during the winters of 1990-91 and 1991-92 in northeastern Colorado. "Kestrels, merlins, rough-legged hawks, ferruginous hawks, and golden eagles were more likely to flush when approached by a human on foot than an automobile . . ., but prairie falcons (*F. mexicanus*) were equally sensitive to both disturbance types." Authors suggested maintaining buffer zones of 75 m for American kestrels, 125 m for merlins, 160 m for prairie falcons, 210 m for rough-legged hawks, 140 m for ferruginous hawks, and 300 m for golden eagles would prevent flushing approximately 90% of the time.

<u>sort criteria</u>: raptors, human activity, grassland, quantitative, research-based, Colorado

Holthuijzen, A.M.A., W.G. Eastland, A.A. Ansell, M.N. Kochert, R.D. Williams, and L.S. Young. 1990. Effects of blasting on behavior and productivity of nesting prairie falcons. Wildlife Society Bulletin 18:270-281.

Effects of construction/mining activities (blasting) upon prairie falcons were investigated in southwestern Idaho. Falcons behaviorally reacted to blasting 54% of the time. Incubating and brooding falcons flushed from aeries 22% of the time. The behavior of falcons exposed to experimental blasting was similar to that of control falcons (exposed to construction blasting). Authors recommend avoiding blasting within 125 m of prairie falcon aeries, and restricting blasting to greater distances if noise levels exceed 140dB at the aerie. No more than 3 blasts per day or 90 blasts during the nesting season should take place.

<u>sort criteria</u>: raptors, mining, seismic exploration, sagebrush, quantitative, research-based, Idaho

Kennedy, P.L. 1980. Raptor baseline studies in energy developments. Wildlife Society Bulletin 8:129-135.

The current status of raptor baseline programs associated with energy development projects was reviewed. Justifications for studying raptors include: industrial impacts could accelerate decline of species that are threatened or endangered, and raptors are indicators of environmental contamination because of their position in food chains. Long-term, site-specific studies are recommended to improve raptor baseline programs.

sort criteria: raptors, oil & gas, roads, qualitative, prescriptive, western U.S.

Knight, R.L., and J.Y. Kawashima. 1993. Responses of raven and red-tailed hawk populations to linear right-of ways. Journal of Wildlife Management 57:266-271.

The relationship between linear right-of-ways and raven and red-tailed hawk populations was examined in the Mojave Desert of California. Ravens were more common along highway and powerline transects than control areas (i.e. no linear right-of-ways within 3.2 km). Carrion provided by vehicles was the probable reason for the abundance of ravens along highways. Red-tailed hawks were most abundant along powerlines, which provide superior perch and nesting sites. Authors suggest land managers monitor sensitive prey species populations to determine if linear right-of-ways increase predator populations to undesirable numbers.

sort criteria: raptors, non-game birds, roads, powerlines, desert shrubland, quantitative, research-based, California

Krementz, D.G., and J.R. Sauer. 1982. Avian communities on partially reclaimed mine spoils in south-central Wyoming. Journal of Wildlife Management 46:761-765.

Differences in avian community structure between a reclaimed mine site and a native shrub-steppe were investigated in south-central Wyoming. Composition, abundance, and diversity between sites were likely due to variation in habitat structure. Foliage-gleaning omnivores were virtually absent from the reclaimed site, however ground-gleaning omnivores and insectivores were common. "The absence of nesting by all species except the horned lark indicates that the reclamation treatments did not fulfill nesting requirements of northern desert shrub-steppe avifauna." Authors suggest "… future reclamation plans should emphasize prompt reintroduction of sagebrush and other species that provide nesting habitat."

sort criteria: sage grouse, raptors, non-game birds, mining, sagebrush, quantitative, research-based, Wyoming

Luckenbach, R.A. 1978. An analysis of off-road vehicle use on desert avifaunas. North American Wildlife Conference 43:157-162.

The impact of off-road vehicle (ORV) use on desert birds was investigated. ORVs can directly and indirectly affect birds by nest destruction, direct mortality, harassment, noise, and habitat alteration. Destruction or elimination of plants can affect limited available winter food resources. The preferred management alternative was to concentrate ORV activities to areas already impacted.

sort criteria: non-game birds, raptors, human activity, ORVs, desert, quantitative, research-based, mitigation, southwestern U.S.

McAdoo, J.K., G.A. Acordagoita, and C.R. Aarstad. 1989. Reducing impacts of hard-rock mining on wildlife in northern Nevada. Pages 95-97 in Proceedings IV: Issues and Technology in the Management of Impacted Wildlife. Thorne Ecological Institute, Boulder, Co.

Reduction of wildlife impacts from mineral exploration in northern Nevada was examined. Mitigation actions included: minimizing erosion through the use of sediment catchment basins, silt screens, and seeding of road cuts and fill slopes, minimizing construction activity near raptor nests, avoiding aspen wildlife habitat, using culverts for crossing trout streams, and monitoring ground and surface water. Offsite mitigation and concurrent reclamation efforts were also evaluated.

sort criteria: wildlife, mule deer, sage grouse, raptors, mining, sagebrush, riparian, qualitative, prescriptive, mitigation, Nevada

Morton, P., C. Weller, J. Thomson, M. Haefele, and N. Culver. 2004. Drilling in the Rocky Mountains: How much and at what cost? The Wilderness Society, Washington, D.C.

An analysis examining the impacts associated with large-scale energy development determined that significant fragmentation of wildlife habitat occurs with development activities. Non-market costs of drilling included "erosion, loss of wildlife and fish habitat, decline in quality of recreational experiences, proliferation of noxious weeds, and increased air and water pollution." A habitat fragmentation analysis of the Big Piney-LaBarge oil and gas field (in northwestern Wyoming) produced results indicating " a direct physical footprint of 1,400 miles of linear features and 3.8 square miles of polygon features, resulting in an overall density of 8.43 miles of roads and pipelines per mile^2." Also, 97% of the area falls within ¼ mile of some infrastructure and only 27% of the study area was more than 500 feet from infrastructure, with only 3% more than ¼ mile away.

sort criteria: sage grouse, mule deer, pronghorn, elk, raptors, non-game birds, fish, wildlife, oil & gas, fragmentation, quantitative, research-based, prescriptive, western U.S.

Paige, C., and S.A. Ritter. 1999. Birds in a sagebrush sea: managing sagebrush habitats for bird communities. Partners in Flight Western Working Group, Boise, ID.

Recommendations are presented for land management practices to help bird communities in sagebrush habitats. Shrubland and shrub-dependent bird species have declined 63% across the U.S. "Sagebrush obligates include the sage sparrow, Brewer's sparrow, sage thrasher, sage grouse, pygmy rabbit, sagebrush vole, sagebrush lizard, and pronghorn. Management guidelines are classified using different scales (landscape, stand, and patch). The level of effects on birds ranges from populations to individuals and pairs. A summary of bird management goals and recommendations is provided.

<u>sort criteria</u>: sage grouse, sharp-tailed grouse, raptors, sagebrush obligates, non-game birds, oil & gas, agriculture, human activity, sagebrush, quantitative, prescriptive, western U.S.

Phillips, R.L., D.E. Biggins, and A.B. Hoag. 1986. Coal surface mining and selected wildlife – a 10-year case study near Decker, Montana. Pages 235-245 <u>in</u> Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

Mule deer, pronghorn, sage grouse, and golden eagles were monitored to determine their responses to mining activities in southeastern Montana and northern Wyoming. "Mule deer and pronghorn populations thrived throughout the study period despite increasing mining activity and human disturbance." Sage grouse habitat was lost, but mitigation efforts (e.g., relocation of a lek) seemed to be successful. Golden eagle numbers remained relatively stable. Four nesting pairs near active mines had a 10-year nesting success of 67.5% compared to 56.6% for pairs nesting elsewhere on the study area. "If the primary post mining land use is wildlife, permanent reclamation can be designed to maximize the mixture of plant species and thereby provide greater habitat diversity than native prairie."

<u>sort criteria</u>: sage grouse, mule deer, pronghorn, raptors, mining, sagebrush, quantitative, research-based, Wyoming, Montana, mitigation

PIC Technologies and Bureau of Land Management, Pinedale Field Office. 1999. Draft Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project. Bureau of Land Management, Pinedale, Wyoming, USA.

Management objectives, monitoring and mitigation recommendations for the Pinedale Anticline Oil and Gas Exploration and Development Project in northwestern Wyoming were presented. The standard stipulation alternative (SS) was explained as well as a resource protection alternative (RP), which included all spatial and temporal restrictions contained in the SS alternative. The RP alternative offered additional protection measures to "be applied to wildlife habitats on Federal lands and minerals."

sort criteria: sage grouse, pronghorn, mule deer, elk, moose, non-game birds, raptors, wildlife, oil & gas, noise, roads, quantitative, research-based, Wyoming

Rich, T.D. 1986. Habitat and nest-site selection by burrowing owls in the sagebrush steppe of Idaho. Journal of Wildlife Management 50:548-555.

Topography and vegetation around burrowing owl nest sites in south-central Idaho were examined. Seventy-nine percent of burrows were located on slopes ≤ 10°, and cover within 50 m of occupied burrows was principally cheatgrass with large areas of bare ground. "Burrowing owls may be one of only a few avian species that benefit from substantially disturbed habitat in the sagebrush steppe. Cover within 50 m of the burrow in this study indicated sites had been disturbed by fire and grazing." Burrowing owls (in this study) did not occupy continuous, dense stands of sagebrush (10-35% canopy cover).

sort criteria: non-game birds, raptors, sagebrush, quantitative, research-based, Idaho

Steenhof, K., M.N. Kochert, and J.A. Roppe. 1993. Nesting by raptors and common ravens on electrical transmission line towers. Journal of Wildlife Management 57:271-281.

Nesting populations of raptors and ravens in southeastern Idaho and Oregon were monitored to assess the effectiveness of transmission line towers as nesting substrates. Birds used all types of towers, but preferred towers with dense latticework. Between 1983 and 1989 nesting success "… in the eastern study area averaged 65% for golden eagles, 83% for ferruginous hawks, 74% for red-tailed hawks, and 86% for ravens." Nesting success on towers was similar to or higher than on surrounding natural substrates for both raptors and ravens.

sort criteria: raptors, non-game birds, powerlines, quantitative, research-based, Idaho

White, C.M., and T.L. Thurow. 1985. Reproduction of ferruginous hawks exposed to controlled disturbance. Condor 87:14-22.

Nesting success and behavior of ferruginous hawks, in response to disturbance, were examined in south-central Idaho during the breeding/nesting seasons of 1978 and 1979. Disturbances associated with land development were simulated near treated nests. Numbers of young fledged were significantly different between treated and undisturbed nests: ". . . control nests fledged, on average, one young more than successful nests that we disturbed or twice as many young if all disturbed nests are considered." The difference between successful disturbed and control nests was 1.16 young per nesting attempt. Adults did not flush 90% of the time when human activity was restricted to a distance greater than 250m.

sort criteria: raptors, human activity, equipment activity, sagebrush, quantitative, research-based, Idaho

NONGAME BIRDS

Braun, C.E., M.F. Baker, R.L. Eng, J.W. Gaswiler, and M.H. Schroeder. 1976. Conservation committee report on the effects of alteration of sagebrush communities on the associated avifauna. Wilson Bulletin 88:165-171.

Relevant data were reviewed in the mid-1970s to assess the effects reducing sagebrush have on associated avifauna (notably sagebrush obligates). Based on estimates, at least 10% of sagebrush rangelands had been altered in the west at that time. "Development of energy resources, especially coal, will have major impacts on sagebrush communities and dependent avifauna for at least the next 40 years." Recommendations include, confining sagebrush alteration to small areas of 16 ha or less, and scheduling sagebrush control programs to avoid bird nesting seasons.

sort criteria: sage grouse, sagebrush obligates, non-game birds, sagebrush treatment, sagebrush, quantitative, prescriptive, western U.S.

Ingelfinger, R.M. 2001. The effects of natural gas development on sagebrush steppe passerines in Sublette County, Wyoming. M.S. Thesis, University of Wyoming, Laramie.

Impacts of natural gas development on passerines were evaluated in northwestern Wyoming. Songbird densities were reduced by 50% within 100 m of roads. Traffic disturbance and a shift in species composition were associated with declines. Sagebrush obligate bird density was lower within 100 m of roads (66% of observations) with 81% of observations beyond 100 m. Horned lark abundance was higher near roads (31% of observations) than beyond the 100 m zone (16% of observations). "While a 50% reduction in sagebrush obligate bird density along a single road may not be biologically significant, the effect of the construction of multiple roads within a single development area can be substantial."

sort criteria: sagebrush obligates, non-game birds, oil & gas, roads, sagebrush, quantitative, research-based, Wyoming

Knick, S.T., and J.T. Rotenberry. 1995. Landscape characteristics of fragmented shrubsteppe habitats and breeding passerine birds. Conservation Biology 9:1059-1071.

Breeding distributions of sage sparrows, Brewer's sparrows, sage thrashers, horned larks, and western meadowlarks were studied in relation to local and landscape-scale attributes of fragmented habitats in southwestern Idaho. Total shrub cover and abundance of sagebrush were important for shrub-obligate species such as, sage thrashers and sage and Brewer's sparrows. However, horned larks and western meadowlarks (grassland species) were influenced mainly by lack of large expanses of shrub cover. The three shrub-obligate species were ". . . more likely to return to sites that had high shrub cover (particularly sagebrush) and low disturbance, combined with large patch sizes and high within-site spatial similarity."

sort criteria: sagebrush-obligates, non-game birds, fragmentation, sagebrush, quantitative, research-based, Idaho

Knick, S.T., and J.T. Rotenberry. 2000. Ghosts of habitats past: contribution of landscape change to current habitats used by shrubland birds. Ecology 81:220-227.

The effects on passerines to wildfires converting shrublands into exotic annual grasslands in southwestern Idaho were evaluated. "Horned larks, Western Meadowlarks, and Brewer's Sparrows, but not Sage Thrashers or Sage Sparrows, were positively correlated with decreased habitat richness and increased spatial homogeneity at large spatial scales, which have greater inherent stability or persistence for either shrubland or grassland habitats relative to more heterogeneous landscapes." Highly fragmented shrublands within a grassland matrix are more susceptible to wildfire and cheatgrass invasion than large shrubland patches. Non-spatial habitat variables were insignificant in relation to abundance of passerines.

sort criteria: non-game birds, sagebrush obligates, fragmentation, fire, sagebrush, quantitative, research-based, Idaho

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The relationship between linear right-of-ways and raven and red-tailed hawk populations was examined in the Mojave Desert of California. Ravens were more common along highway and powerline transects than control areas (i.e. no linear right-of-ways within 3.2 km). Carrion provided by vehicles was the probable reason for the abundance of ravens along highways. Red-tailed hawks were most abundant along powerlines, which provide superior perch and nesting sites. Authors suggest land managers monitor sensitive prey species populations to determine if linear right-of-ways increase predator populations to undesirable numbers.

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Luckenbach, R.A. 1978. An analysis of off-road vehicle use on desert avifaunas. North American Wildlife Conference 43:157-162.

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Morton, P., C. Weller, J. Thomson, M. Haefele, and N. Culver. 2004. Drilling in the Rocky Mountains: How much and at what cost? The Wilderness Society, Washington, D.C.

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Paige, C., and S.A. Ritter. 1999. Birds in a sagebrush sea: managing sagebrush habitats for bird communities. Partners in Flight Western Working Group, Boise, ID.

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Peterson, K.L., and L.B. Best. 1985. Nest-site selection by sage sparrows. Condor 87:217-221.

Nest site selection by sage sparrows in Idaho was examined to determine nest-site characteristics and preferences. All nests found were located in big sagebrush plants 40-100 cm tall, and "… large, living shrubs were strongly preferred."

<u>sort criteria</u>: non-game birds, sagebrush obligates, sagebrush, quantitative, research-based, Idaho

Petersen, K.L., and L.B. Best. 1987. Effects of prescribed burning on nongame birds in a sagebrush community. Wildlife Society Bulletin 15:317-329.

Responses of non-game birds to prescribed fire treatments were assessed in southeastern Idaho between 1980 and 1985. Total densities of birds were greater on experimental (burned) plots than on control plots. Sage sparrow densities were not affected, however Brewer's sparrow numbers declined for 2 years after fire then more than doubled. Western meadowlarks increased slightly, sage thrashers exhibited no response, and horned larks and vesper sparrows colonized the area after fire.

<u>sort criteria</u>: non-game birds, sagebrush obligates, sagebrush treatment, sagebrush, quantitative, research-based, Idaho

Peterson, K.L., and L.B. Best. 1991. Nest-site selection by sage thrashers in southeastern Idaho. Great Basin Naturalist 51:261-266.

Nest-site selection by sage thrashers in southeastern Idaho was evaluated to determine nest-site characteristics in comparison with available habitat. Big sagebrush plants used for nesting were significantly taller than other available shrubs, and microhabitats within 5 m of nests were denser with taller shrubs and less bare ground (i.e. more grasses, forbs and litter) than surrounding areas.

sort criteria: non-game birds, sagebrush obligates, sagebrush, quantitative, research-based, Idaho

PIC Technologies and Bureau of Land Management, Pinedale Field Office. 1999. Draft Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project. Bureau of Land Management, Pinedale, Wyoming, USA.

Management objectives, monitoring and mitigation recommendations for the Pinedale Anticline Oil and Gas Exploration and Development Project in northwestern Wyoming were presented. The standard stipulation alternative (SS) was explained as well as a resource protection alternative (RP), which included all spatial and temporal restrictions contained in the SS alternative. The RP alternative offered additional protection measures to "be applied to wildlife habitats on Federal lands and minerals."

sort criteria: sage grouse, pronghorn, mule deer, elk, moose, non-game birds, raptors, wildlife, oil & gas, noise, roads, quantitative, research-based, Wyoming

Rich, T.D. 1980. Nest placement in sage thrashers, sage sparrows and Brewer's sparrows. Wilson Bulletin 92:362-368.

Nest-site selection by sage thrashers, sage sparrows, and Brewer's sparrows in Idaho was evaluated. Nests of all 3 species were found either in or beneath sagebrush plants. All 3 species located their nests in unique positions vertically within the habitat.

sort criteria: non-game birds, sagebrush obligates, agriculture, sagebrush, quantitative, research-based, Idaho

Rich, T.D. 1986. Habitat and nest-site selection by burrowing owls in the sagebrush steppe of Idaho. Journal of Wildlife Management 50:548-555.

Topography and vegetation around burrowing owl nest sites in south-central Idaho were examined. Seventy-nine percent of burrows were located on slopes ≤ 10°, and cover within 50 m of occupied burrows was principally cheatgrass with large areas of bare ground. "Burrowing owls may be one of only a few avian species that benefit from substantially disturbed habitat in the sagebrush steppe. Cover within 50 m of the burrow in this study indicated sites had been disturbed by fire and grazing." Burrowing owls (in this study) did not occupy continuous, dense stands of sagebrush (10-35% canopy cover).

sort criteria: non-game birds, raptors, sagebrush, quantitative, research-based, Idaho

Steenhof, K., M.N. Kochert, and J.A. Roppe. 1993. Nesting by raptors and common ravens on electrical transmission line towers. Journal of Wildlife Management 57:271-281.

Nesting populations of raptors and ravens in southeastern Idaho and Oregon were monitored to assess the effectiveness of transmission line towers as nesting substrates. Birds used all types of towers, but preferred towers with dense latticework. Between 1983 and 1989 nesting success
"… in the eastern study area averaged 65% for golden eagles, 83% for ferruginous hawks, 74% for red-tailed hawks, and 86% for ravens." Nesting success on towers was similar to or higher than on surrounding natural substrates for both raptors and ravens.

sort criteria: raptors, non-game birds, powerlines, quantitative, research-based, Idaho

USGS. 2002. Fact sheet: Loss of sagebrush ecosystems and declining bird populations in the Intermountain West: priority research issues and information needs. USGS FS-122-02. U.S. Department of the Interior, U.S. Geologic Survey.

Priority needs to identify causes and mechanisms of shrubland bird declines were evaluated. Sage grouse have declined 33% from their long-term average population size. Four primary issues were identified: 1. Bird response to habitat and landscape features. 2. Monitoring and survey designs. 3. Effects of land use practices. 4. Wintering ground and migration.

sort criteria: sage grouse, sagebrush obligates, non-game birds, oil & gas, agriculture, qualitative, prescriptive, western U.S.

Van der Zande, A.N., W.J. ter Keurs, and W.J. van der Weijden. 1980. The impacts of roads on the densities of four bird species in an open field habitat—evidence of a long-distance effect. Biological Conservation 18:299-321.

The effects of roads and associated human activities on 4 grassland bird species were investigated in the Netherlands. Road building led to a loss of habitat that could extend up to several kilometers away, mainly through the alteration/disturbance of the hydrology of the area.

sort criteria: non-game birds, roads, grassland, quantitative, research-based, Netherlands

Vander Haegen, W.M., M.A. Schroeder, and R.M. Degraaf. 2002. Predation on real and artificial nests in shrubsteppe landscapes fragmented by agriculture. Condor 104:496-506.

Artificial nests were monitored to examine effects of fragmentation, distance to edge, and vegetation cover on nest predation rates, as well as to identify predators of grouse and passerines. Nests in fragmented landscapes were approximately 9 times more likely to be depredated than nests in continuous landscapes. Predation rate was 26% for artificial nests. Nest-sites with greater vegetation coverage were less likely to be depredated.

sort criteria: sage grouse, sharp-tailed grouse, non-game birds, sagebrush obligates, agriculture, fragmentation, sagebrush, grassland, quantitative, research-based, Washington

Wiens, J.A., and J.T. Rotenberry. 1981. Habitat associations and community structure of birds in shrubsteppe environments. Ecological Monographs 51:21-41.

Relationships between bird distribution, abundance, and habitat characteristics at a regional scale were investigated. Widely distributed bird species were not significantly associated with habitat features, however more locally distributed species did display habitat affinities. "Sage Sparrows were positively associated with sagebrush coverage and negatively related to coverage of cottonthorn and greasewood, while the remaining dominant shrubsteppe species, Brewer's Sparrows and Sage Thrashers, exhibited no positive associations but were negatively associated with coverages of hopsage and budsage."

sort criteria: non-game birds, sagebrush obligates, sagebrush, quantitative, research-based, western U.S.

Wiens, J.A., and J.T. Rotenberry. 1985. Response of breeding passerine birds to rangeland alteration in a North American shrubsteppe locality. Journal of Applied Ecology 22:655-668.

Response of passerine bird populations to rangeland treatment in south-central Oregon was examined. Prior to treatment sagebrush cover was 19-24% with 1-4% grass cover. Following treatment sagebrush cover was reduced to 4-12% while grass cover increased to 10-57%. "Comparing the 3 pre-treatment years with the 3 post-treatment years reveals that densities of sage and Brewer's sparrows declined overall, sage thrashers increased in abundance somewhat, and horned larks increased substantially; total species richness also increased following the treatment."

sort criteria: non-game birds, sagebrush obligates, sagebrush treatment, sagebrush, quantitative, research-based, Oregon

SAGEBRUSH OBLIGATES

Braun, C.E., M.F. Baker, R.L. Eng, J.W. Gaswiler, and M.H. Schroeder. 1976. Conservation committee report on the effects of alteration of sagebrush communities on the associated avifauna. Wilson Bulletin 88:165-171.

Relevant data were reviewed in the mid-1970s to assess the effects reducing sagebrush have on associated avifauna (notably sagebrush obligates). Based on estimates, at least 10% of sagebrush rangelands had been altered in the west at that time. "Development of energy resources, especially coal, will have major impacts on sagebrush communities and dependent avifauna for at least the next 40 years." Recommendations include, confining sagebrush alteration to small areas of 16 ha or less, and scheduling sagebrush control programs to avoid bird nesting seasons.

sort criteria: sage grouse, sagebrush obligates, non-game birds, sagebrush treatment, sagebrush, quantitative, prescriptive, western U.S.

Crawford, J.A., R.A. Olson, N.E. West, J.C. Moseley, M.A. Schroeder, T.D. Whitson, R.F. Miller, M.A. Gregg, and C.S. Boyd. 2004. Ecology and management of sage-grouse and sage-grouse habitat. Journal of Range Management 57:2-19.

Current issues in sage grouse ecology and management were examined. Multiple causative factors were implicated in the present sage grouse decline. Fire, in high elevation sagebrush habitat, results in invasion of conifers and loss of canopy cover and herbaceous understory. Intensity and timing of livestock grazing are of concern regarding habitat quality. Light to moderate grazing can be beneficial, however heavier use decreases herbaceous cover. Heavy levels of chemical control methods may result in lower habitat quality. Other sagebrush obligate species (e.g., Brewer's sparrow, pygmy rabbit, and sagebrush vole) are also declining.

sort criteria: sage grouse, sagebrush obligates, sagebrush treatment, fire, livestock grazing, sagebrush, quantitative, research-based, western U.S., Canada

Ingelfinger, R.M. 2001. The effects of natural gas development on sagebrush steppe passerines in Sublette County, Wyoming. M.S. Thesis, University of Wyoming, Laramie.

Impacts of natural gas development on passerines were evaluated in northwestern Wyoming. Songbird densities were reduced by 50% within 100 m of roads. Traffic disturbance and a shift in species composition were associated with declines. Sagebrush obligate bird density was lower within 100 m of roads (66% of observations) with 81% of observations beyond 100 m. Horned lark abundance was higher near roads (31% of observations) than beyond the 100 m zone (16% of observations). "While a 50% reduction in sagebrush obligate bird density along a single road may not be biologically significant, the effect of the construction of multiple roads within a single development area can be substantial."

sort criteria: sagebrush obligates, non-game birds, oil & gas, roads, sagebrush, quantitative, research-based, Wyoming

Knick, S.T., and J.T. Rotenberry. 1995. Landscape characteristics of fragmented shrubsteppe habitats and breeding passerine birds. Conservation Biology 9:1059-1071.

Breeding distributions of sage sparrows, Brewer's sparrows, sage thrashers, horned larks, and western meadowlarks were studied in relation to local and landscape-scale attributes of fragmented habitats in southwestern Idaho. Total shrub cover and abundance of sagebrush were important for shrub-obligate species such as, sage thrashers and sage and Brewer's sparrows. However, horned larks and western meadowlarks (grassland species) were influenced mainly by lack of large expanses of shrub cover. The three shrub-obligate species were ". . . more likely to return to sites that had high shrub cover (particularly sagebrush) and low disturbance, combined with large patch sizes and high within-site spatial similarity."

sort criteria: sagebrush-obligates, non-game birds, fragmentation, sagebrush, quantitative, research-based, Idaho

Knick, S.T., and J.T. Rotenberry. 2000. Ghosts of habitats past: contribution of landscape change to current habitats used by shrubland birds. Ecology 81:220-227.

The effects on passerines to wildfires converting shrublands into exotic annual grasslands in southwestern Idaho were evaluated. "Horned larks, Western Meadowlarks, and Brewer's Sparrows, but not Sage Thrashers or Sage Sparrows, were positively correlated with decreased habitat richness and increased spatial homogeneity at large spatial scales, which have greater inherent stability or persistence for either shrubland or grassland habitats relative to more heterogeneous landscapes." Highly fragmented shrublands within a grassland matrix are more susceptible to wildfire and cheatgrass invasion than large shrubland patches. Non-spatial habitat variables were insignificant in relation to abundance of passerines.

sort criteria: non-game birds, sagebrush obligates, fragmentation, fire, sagebrush, quantitative, research-based, Idaho

Oyler-McCance, S.J., K.P. Burnham, and C.E. Braun. 2001. Influences of changes in sagebrush on Gunnison sage grouse in southwestern Colorado. Southwestern Naturalist 46:323-331.

Changes (between the 1950s and 1990s) in sagebrush-dominated areas in southwestern Colorado were compared using low-level aerial photographs. A 20% loss (approximately 155,673 ha) of sagebrush-dominated areas between 1958 and 1993 was documented. Thirty-seven percent of sampled plots showed substantial fragmentation of sagebrush habitats, which was often the result of road development. Suggestions for future protection of sage grouse included assessing management and conservation strategies in regard to "…land mitigation, habitat restoration, connecting fragmented habitats, and reintroduction of sagebrush obligates into previously occupied habitats."

<u>sort criteria</u>: sage grouse, sagebrush obligates, fragmentation, roads, sagebrush, quantitative, research-based, Colorado

Paige, C., and S.A. Ritter. 1999. Birds in a sagebrush sea: managing sagebrush habitats for bird communities. Partners in Flight Western Working Group, Boise, ID.

Recommendations are presented for land management practices to help bird communities in sagebrush habitats. Shrubland and shrub-dependent bird species have declined 63% across the U.S. "Sagebrush obligates include the sage sparrow, Brewer's sparrow, sage thrasher, sage grouse, pygmy rabbit, sagebrush vole, sagebrush lizard, and pronghorn. Management guidelines are classified using different scales (landscape, stand, and patch). The level of effects on birds ranges from populations to individuals and pairs. A summary of bird management goals and recommendations is provided.

<u>sort criteria</u>: sage grouse, sharp-tailed grouse, raptors, sagebrush obligates, non-game birds, oil & gas, agriculture, human activity, sagebrush, quantitative, prescriptive, western U.S.

Peterson, K.L., and L.B. Best. 1985. Nest-site selection by sage sparrows. Condor 87:217-221.

Nest site selection by sage sparrows in Idaho was examined to determine nest-site characteristics and preferences. All nests found were located in big sagebrush plants 40-100 cm tall, and "… large, living shrubs were strongly preferred."

<u>sort criteria</u>: non-game birds, sagebrush obligates, sagebrush, quantitative, research-based, Idaho

Petersen, K.L., and L.B. Best. 1987. Effects of prescribed burning on nongame birds in a sagebrush community. Wildlife Society Bulletin 15:317-329.

Responses of non-game birds to prescribed fire treatments were assessed in southeastern Idaho between 1980 and 1985. Total densities of birds were greater on experimental (burned) plots than on control plots. Sage sparrow densities were not affected, however Brewer's sparrow numbers declined for 2 years after fire then more than doubled. Western meadowlarks increased slightly, sage thrashers exhibited no response, and horned larks and vesper sparrows colonized the area after fire.

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USGS. 2002. Fact sheet: Loss of sagebrush ecosystems and declining bird populations in the Intermountain West: priority research issues and information needs. USGS FS-122-02. U.S. Department of the Interior, U.S. Geologic Survey.

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sort criteria: sage grouse, sharp-tailed grouse, non-game birds, sagebrush obligates, agriculture, fragmentation, sagebrush, grassland, quantitative, research-based, Washington

Wiens, J.A., and J.T. Rotenberry. 1981. Habitat associations and community structure of birds in shrubsteppe environments. Ecological Monographs 51:21-41.

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sort criteria: non-game birds, sagebrush obligates, sagebrush treatment, sagebrush, quantitative, research-based, Oregon

MISCELLANEOUS GAME SPECIES / WATERFOWL / OTHER

Allen, M. 1989. Off-site habitat mitigation: a regional approach for resolving conflicts between land development and habitat protection. Pages 167-169 in Proceedings IV: Issues and Technology in the Management of Impacted Wildlife. Thorne Ecological Institute, Boulder, Co.

Off-site habitat mitigation as an alternative to on-site habitat protection was examined in Florida. The Wildlife Resource Acquisition and Management program (WRAM) allows mitigation of wildlife resources to occur off-site through funds collected from developers. These funds are used to acquire acreage equivalent to the area designated for protection on the development site. Through this program many small, isolated parcels are consolidated into a larger habitat preserve.

sort criteria: wildlife, sub-division, qualitative, prescriptive, Florida, mitigation

Apa, A.D., D.W. Uresk, and R.L. Linder. 1990. Black-tailed prairie dog populations one year after treatment with rodenticides. Great Basin Naturalist 50:107-113.

The effects of 3 rodenticide treatments on black-tailed prairie dog populations in west-central South Dakota were evaluated. The 3 treatments included zinc phosphide with prebait, strychnine with prebait, and strychnine without prebait. "Zinc phosphide was the most effective for reducing prairie dog numbers immediately." Initial reductions with zinc phosphide were 95% and continued at 77% the following year. Initial reductions for strychnine alone were 45%, however initial reductions for strychnine with prebait were 83%.

sort criteria: wildlife, black-tailed prairie dogs, grasslands, quantitative, research-based, South Dakota

Applegate, R.D. 2000. In my opinion: Use and misuse of prairie chicken lek surveys. Wildlife Society Bulletin 28(2): 457-463.

Methods and accuracy of lek surveys were evaluated. The author suggested surveys be referred to as indices (indicators of population trends) but not used to calculate absolute estimates of population size.

<u>sort criteria</u>: sage grouse, sharp-tailed grouse, wildlife, sagebrush, quantitative, prescriptive

Bradshaw, C.J.A., S. Boutin, and D.M. Herbert. 1997. Effects of petroleum exploration on woodland caribou in northeastern Alberta. Journal of Wildlife Management 61:1127-1133.

Caribou movement and behavior were examined related to the effects of simulated petroleum exploration in northeastern Alberta, Canada. Caribou exposed to loud noise (i.e., a propane canon) moved significantly faster but not farther than unexposed caribou. Disturbance did not significantly affect time allocated to feeding. Increased movement could result in higher energy payout during winter. Authors suggest total disturbance during winter be limited rather than placing timing restrictions on industrial activities.

<u>sort criteria</u>: caribou, oil & gas, forested, quantitative, research-based, Canada

Bradshaw, C.J.A., S. Boutin, and D.M. Herbert. 1998. Energetic implications of disturbance caused by petroleum exploration to woodland caribou. Canadian Journal of Zoology 76:1319-1324.

Disturbance to woodland caribou from petroleum exploration was investigated in northeastern Alberta, Canada. A model was constructed to estimate energy costs to caribou from multiple encounters with disturbance. To lose >15% mass over winter, caribou must encounter 20-34 (mean = 27) disturbance events, and 41-137 (mean = 89) events to lose >20%. During harsh winters effects of disturbances are likely to increase. Winter mass loss in females can affect calf survival through delayed parturition, undergrowth, and under-nutrition. If disturbance is irregular and unpredictable, caribou may not be able to habituate.

<u>sort criteria</u>: caribou, oil & gas, noise, forested, quantitative, research-based, Canada

Burns, J.W. 1972. Some effects of logging and associated road construction on northern California streams. Transactions of the American Fisheries Society 101:1-17.

The effects of logging and road construction activities on 4 California streams were investigated from 1966 through 1969. Removing too much forest canopy can warm water above temperatures tolerated by salmonids (< 25 C for extended periods is

usually fatal). Excessive erosion from road building activities can be harmful to salmonid reproduction. Mitigation measures included: 1) leaving dense understory or buffer strips along streams to keep temperatures cool, 2) alternating cut and uncut sections along streams, 3) building roads away from streams, and 4) seeding disturbed areas with grass.
sort criteria: fish, logging, roads, forested, quantitative, research-based, mitigation, California

Cote, S.D. 1996. Mountain goat responses to helicopter disturbance. Wildlife Society Bulletin 24(4):681-685.

Mountain goat responses to helicopter activity were investigated in Alberta, Canada. "… mountain goats were disturbed by 58% of the flights and were more adversely affected when helicopters flew within 500 m. Eighty-five percent of flights within 500 m caused the goats to move >100 m; 9% of the flights >1,500 m away caused the goats to move similar distances." Management recommendations included: (1) Helicopter activity should be at least 2 km from mountain goat herds. (2) No seismic lines should be established in goat habitats. (3) Aircraft should stay at least 300 m above ground and avoid landing on treeless ridges.

sort criteria: mountain goats, seismic exploration, oil & gas, alpine meadow, forested, quantitative, research-based, Canada

Dyer, S.J., J.P. O'Neill, S.M. Wasel, and S. Boutin. 2001. Avoidance of industrial development by woodland caribou. Journal of Wildlife Management 65:531-542.

Caribou use of areas adjacent to wellsites, roads, and seismic lines was evaluated in northeastern Alberta, Canada. Maximum avoidance distance of wells was 1,000 m, and 250 m for roads and seismic lines. ". . . the level of avoidance appeared to be related to the level of human activity in the study area." Avoidance was highest during late winter and calving when traffic levels were highest. "Avoidance of industrial infrastructure may result in crowding of caribou into areas not subject to development."

sort criteria: caribou, oil & gas, forested, quantitative, research-based, Canada

Esmoil, B.J., and S.H. Anderson. 1995. Wildlife mortality associated with oil pits in Wyoming. Prairie Naturalist 27:81-88.

Wildlife mortality caused by open oil pits and the effectiveness of deterrence methods were evaluated in the Bighorn Basin of Wyoming. Mortalities increased as pit surface area increased and also where slope of the surrounding banks decreased. In 2 years a total of 616 wildlife mortalities were documented at 35 oil pits. These included: "… 41% passerines, 33% mammals, 14% ducks, 5% shorebirds, 5% shrikes, and 2%

raptors." Mortality levels did not differ among pits with deterrent devices (e.g., flagging, strobe lights, and metal reflectors). The only effective way to prevent wildlife mortality was to completely cover pits.

sort criteria: wildlife, oil & gas, quantitative, research-based, Wyoming

Flickinger, E.L. 1981. Wildlife mortality at petroleum pits in Texas. Journal of Wildlife Management 45:560-564.

Wildlife mortality was evaluated at open petroleum disposal pits in southeastern Texas. From 1977-79, 476 dead animals were observed with approximately 30% of open pits containing dead wildlife. The author suggests: "Sophisticated control and cleanup procedures should be developed to reduce the problem of wildlife mortality at petroleum pits. Wildlife losses could be reduced if petroleum was removed from open pits, the pits were filled with a sufficiently porous material, and were covered whenever seeps begin to appear and until the seepage to the surface ends."

sort criteria: wildlife, oil & gas, quantitative, research-based, Texas

Gelbard, J.L., and J. Belnap. 2003. Roads as conduits for exotic plant invasions in a semiarid landscape. Conservation Biology 17:420-432.

The invasion of exotic plants via roads was investigated in southern Utah. Results from this study supported the idea that "… the effect of road improvement on plant cover and richness is due to factors associated with road construction, road maintenance, and vehicle traffic, not to differences in site characteristics." It was observed that sites > 1000 m from roads ordinarily contained fewer exotic species than sites < 50 m from roads. With road improvements (from 4-wheel drive tracks to paved roads) adjacent verges tended to become wider with increased cover of exotic plants.

sort criteria: wildlife, roads, grasslands, sagebrush, quantitative, research-based, Utah

Girard, M., and B. Stotts. 1986. Managing impacts of oil and gas development on woodland wildlife habitats on the Little Missouri Grasslands, North Dakota. Pages 128-130 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

Impacts from oil and gas development (e.g., construction activities, toxic fumes, chemical spills, and wildlife displacement) on woodland wildlife habitat were evaluated on the Little Missouri Grasslands in North Dakota. Approximately 10,884 acres had been directly disturbed by oil and gas activity. A sphere of influence surrounds all roads and well pads, and is estimated to be a minimum of 100 yards in all directions. Mitigation efforts included: (1) No well pads or roads placed in a woodland. (2) Roads crossing "draws" must be at right angles to minimize disturbance. (3) Extra heavy pit liners were to be used in areas with porous substrates to prevent saltwater seepage.

sort criteria: wildlife, mule deer, elk, oil & gas, forested, quantitative, research-based, North Dakota, mitigation

Hartung, R., and G.S. Hunt. 1966. Toxicity of some oils to waterfowl. Journal of Wildlife Management 30:564-570.

Effects of oil ingestion were studied to determine the lethal doses for ducks. Ducks can acquire 7g of polluting oils on their feathers under natural conditions and will ingest up to 50% of this oil within the first 8 days through preening. Pre-stressed ducks (weighing approximately 0.70 kg) died after ingesting 3 to 4 g/kg of diesel oil and cutting oil.

sort criteria: waterfowl, oil, quantitative, research-based, Michigan

Hodkinson, D.J., and K. Thompson. 1997. Plant dispersal: the role of man. Journal of Applied Ecology 34:1484-1496.

Human activity as a mechanism of plant dispersal was examined. Two major anthropogenic dispersal pathways were identified, each associated with a specific group of species. "Species associated with topsoil, cars and horticulture depend essentially on soil movement, and form a surprisingly homogeneous group." These species are usually small and short-lived, but produce numerous, small, persistent seeds. Garden throw-outs "tend to be tall, spreading perennials with transient seed banks; attributes which are almost the exact opposite of the soil-borne group."

sort criteria: wildlife, fragmentation, quantitative, research-based, England

Knick, S.T., and J.T. Rotenberry. 1997. Landscape characteristics of disturbed shrubsteppe habitats in southwestern Idaho. Landscape Ecology 12:287-297.

Shrubsteppe habitats in southwestern Idaho were compared to determine the effect of disturbance combinations in areas that historically shared similar disturbance regimes. Agriculture, wildfires, and disturbance related to military training activities caused the loss of native shrubs on the landscape. Fires created a more fragmented landscape than agriculture (which produced large square blocks in the area). Military activity (i.e. training with tracked vehicles) resulted in landscape defined by small, closely spaced shrub patches. This patchiness resulted in the invasion of the exotic annual cheatgrass – which could lead to higher fire frequencies.

sort criteria: wildlife, agriculture, human activity, fire, sagebrush, quantitative, research-based, Idaho

McAdoo, J.K., G.A. Acordagoita, and C.R. Aarstad. 1989. Reducing impacts of hard-rock mining on wildlife in northern Nevada. Pages 95-97 in Proceedings IV: Issues and Technology in the Management of Impacted Wildlife. Thorne Ecological Institute, Boulder, Co.

Reduction of wildlife impacts from mineral exploration in northern Nevada was examined. Mitigation actions included: minimizing erosion through the use of sediment catchment basins, silt screens, and seeding of road cuts and fill slopes, minimizing construction activity near raptor nests, avoiding aspen wildlife habitat, using culverts for crossing trout streams, and monitoring ground and surface water. Offsite mitigation and concurrent reclamation efforts were also evaluated.

sort criteria: wildlife, mule deer, sage grouse, raptors, mining, sagebrush, riparian, qualitative, prescriptive, mitigation, Nevada

Morton, P., C. Weller, J. Thomson, M. Haefele, and N. Culver. 2004. Drilling in the Rocky Mountains: How much and at what cost? The Wilderness Society, Washington, D.C.

An analysis examining the impacts associated with large-scale energy development determined that significant fragmentation of wildlife habitat occurs with development activities. Non-market costs of drilling included "erosion, loss of wildlife and fish habitat, decline in quality of recreational experiences, proliferation of noxious weeds, and increased air and water pollution." A habitat fragmentation analysis of the Big Piney-LaBarge oil and gas field (in northwestern Wyoming) produced results indicating " a direct physical footprint of 1,400 miles of linear features and 3.8 square miles of polygon features, resulting in an overall density of 8.43 miles of roads and pipelines per $mile^2$." Also, 97% of the area falls within ¼ mile of some infrastructure and only 27% of the study area was more than 500 feet from infrastructure, with only 3% more than ¼ mile away.

sort criteria: sage grouse, mule deer, pronghorn, elk, raptors, non-game birds, fish, wildlife, oil & gas, fragmentation, quantitative, research-based, prescriptive, western U.S.

Patton, T.M., F.J. Rahel, and W.A. Hubert. 1998. Using historical data to assess changes in Wyoming's fish fauna. Conservation Biology 12:1120-1128.

Fish survey data from the 1960s and 1990s (from 10 drainages in Wyoming) were compared. Comparisons were restricted to locations common to both surveys. "The number of species with distributional changes was similar at site, stream, and subdrainage scales but was noticeably reduced at the drainage scale. Based on both adjusted and unadjusted data, 32-34 species had distributional changes (increases or decreases) at site, stream, and subdrainage scales, whereas 17-22 species had changes at the drainage scale."

sort criteria: fish, wildlife, quantitative, research-based, Wyoming

Penner, D.F. 1988. Behavioral response and habituation of mountain goats in relation to petroleum development at Pinto Creek, Alberta. Biennial Symposium of the Northern Wild Sheep and Goat Council 6:141-158.

Behavioral response and habituation of mountain goats to petroleum exploration were examined in Alberta, Canada. Goats were tolerant of indirect and persistent noise, but were disturbed by unpredictable or unfamiliar stimuli. Nannies were more sensitive to disturbance during kidding and post-kidding. Helicopter overflights elicited greater response than fixed-wing aircraft. As a mitigation measure, the author suggests conditioning of mountain goats to potentially disturbing stimuli before development activities.

sort criteria: mountain goats, oil & gas, noise, forested, quantitative, research-based, Canada

PIC Technologies and Bureau of Land Management, Pinedale Field Office. 1999. Draft Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project. Bureau of Land Management, Pinedale, Wyoming, USA.

Management objectives, monitoring and mitigation recommendations for the Pinedale Anticline Oil and Gas Exploration and Development Project in northwestern Wyoming were presented. The standard stipulation alternative (SS) was explained as well as a resource protection alternative (RP), which included all spatial and temporal restrictions contained in the SS alternative. The RP alternative offered additional protection measures to "be applied to wildlife habitats on Federal lands and minerals."

sort criteria: sage grouse, pronghorn, mule deer, elk, moose, non-game birds, raptors, wildlife, oil & gas, noise, roads, quantitative, research-based, Wyoming

Quayle, C.L. 1986. Wildlife utilization of revegetated surface-mined lands at a coal mine in Northeastern Wyoming. Pages 141-151 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

Re-vegetated surface-mined land and an equal area of undisturbed land were monitored to determine wildlife utilization and diversity. There were greater numbers and diversity of mammals on the undisturbed site, however there were greater numbers and diversity of bird species on the re-vegetated area. Forty-three species of birds were observed on the re-vegetated site, and 34 on the undisturbed site. Twelve mammal species were observed on the undisturbed site and 9 on the re-vegetated site. Overall, wildlife species diversity and use was slightly higher on the re-vegetated site.

sort criteria: wildlife, mining, sagebrush, quantitative, research-based, Wyoming, mitigation

Scott, M.D., and G.M. Zimmerman. 1984. Wildlife management at surface coal mines in the Northwest. Wildlife Society Bulletin 12:364-370.

Wildlife management practices at surface coal mines in northwestern North America were examined. A mail questionnaire was sent to 56 mines (51 were used in the study). Eighty-six percent of respondents claimed wildlife was a major reclamation goal, with 38% targeting specific species. "Reclamation for rangeland uses generally appeared compatible with wildlife interests."

sort criteria: wildlife, game species, quantitative, research-based, western U.S., Canada

Stoecker, R., T. Thompson, and R. Comer. 1986. An evaluation of wildlife mitigation practices on reclaimed lands at four western surface coal mines. Pages 152-168 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

Wildlife mitigation practices were evaluated at 4 operating surface coal mines in Wyoming and Montana. "Big game use of reclaimed surfaces was directly related to the surface shrub cover and rock piles while inversely related to distance to native habitat." A well-developed and diverse vegetative community with trees, shrubs, rock-piles, and ponds interspersed were found to be essential for supporting a diverse wildlife community.

sort criteria: wildlife, mining, sagebrush, mitigation, quantitative, research-based, Wyoming, Montana

Tessman, S.A. 1986. Guidelines for evaluating developmental impacts upon wildlife in Wyoming. Pages 1-14 in Proceedings II: Issues and Technology in the Management of Impacted Western Wildlife. Thorne Ecological Institute, Boulder, Co.

Guidelines for evaluating development impacts on wildlife, and for formulating useful mitigation programs were presented. Mitigation procedures addressed impact sources and appropriate mitigation actions. Issues addressed included: exploration activities, access roads to remote areas, surface strip mines, road construction and highway projects, railroad construction, stream channelization/relocation, fences, powerlines, pipelines, surface facilities, waste treatment ponds/evaporation ponds/sediment retention ponds, timber sales/harvest, grazing allotments, range improvement projects, oil and gas drill pads, water projects, multiple development activities, and employee influxes. Planning considerations and reclamation approaches were identified regarding reclamation of both large and small disturbances.

sort criteria: wildlife, oil & gas, mining, logging, agriculture, roads, mitigation, prescriptive, Wyoming

Theobald, D.M., J.R. Miller, and N.T. Hobbs. 1997. Estimating the cumulative effects of development on wildlife habitat. Landscape and Urban Planning 39:25-36.

The cumulative effects of land use change on wildlife habitat were evaluated in Colorado. "… human related effects decrease with distance from the source of disturbance… (e.g., 50-500 m)," and wildlife habitat is adversely affected within this distance (i.e. a disturbance zone). Roads are also associated with disturbance zones because they degrade habitat and cause fragmentation. Authors suggest that clustered development would reduce disturbance to wildlife habitat and should be required along with decreased development density.

sort criteria: wildlife, fragmentation, rural subdivision, quantitative, research-based, Colorado

Trombulak, S.C., and C.A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14:18-30.

A review of scientific literature regarding ecological effects of roads was conducted. General effects included: "… mortality from road construction, mortality from collision with vehicles, modification of animal behavior, alteration of the physical environment, alteration of the chemical environment, spread of exotics, and increased use of areas by humans." Ecological effects of roads can reach substantial distances and can create habitat fragmentation. "… roads produce a pattern of aquatic habitat loss that differs from the terrestrial pattern yet nevertheless results in the ecological fragmentation of aquatic ecosystems."

sort criteria: wildlife, roads, fragmentation, quantitative, research-based

Vosburgh, T.C., and L.R. Irby. 1998. Effects of recreational shooting on prairie dog colonies. Journal of Wildlife Management 62:363-372.

The effects of recreational shooting as a potential mechanism for population control of black-tailed prairie dogs were evaluated. "Prairie dog population size declined 35% in hunted colonies and 15% in nonhunted colonies from early to late summer 1995." As a management tool, recreational shooting of black-tailed prairie dogs has the potential to limit rather than eradicate populations.

sort criteria: prairie dogs, wildlife, recreational shooting, human activity, sagebrush, quantitative, research-based, Montana

Wyoming Game & Fish Department. 1976. Considerations for wildlife in industrial development and reclamation. Cheyenne, Wy.

Mitigation and monitoring considerations for protecting wildlife and wildlife habitat with regard to industrial development were presented. Habitat development and reclamation were examined and recommendations were provided for specific habitat types (e.g., shrubland, rimrocks, etc.), and for individual wildlife species (e.g., mule deer, pronghorn, etc.).

sort criteria: sage grouse, mule deer, pronghorn, elk, bighorn sheep, wildlife, sagebrush, qualitative, prescriptive, mitigation, Wyoming