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Reducing Impacts of Energy Development to Sagebrush Wildlife Habitats in Wyoming

This bulletin provides general information appropriate for all Wyoming ecological sites.

Fourth in a series by the University of Wyoming Cooperative Extension Service Reclamation Issue Team and the Wyoming Reclamation and Restoration Center that describes strategies for restoring ecological functions to disturbed Wyoming lands. For this series, reclamation means restoration of components that support desired ecological functions, such as forage for livestock grazing, wildlife forage and cover, water supply, water quality protection, and aesthetic values.

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This bulletin provides information most relevant to reducing impacts of energy developments to sagebrush wildlife habitats in Wyoming. The information applies to sites where energy development is planned, is progressing, or has occurred. The bulletin is framed to provide information to avoid or lessen impacts to sagebrush wildlife habitats including fragmentation and human disturbance that could adversely affect wildlife habitats and populations.

Summary

Habitats are those areas that provide resources and conditions necessary for occupancy, survival, and reproduction by wildlife species (Hall et al., 1997). Resources critical for wildlife include food, water, and cover for refugia from predators and protection from inclement weather. Wildlife obtain resources from many sources including herbaceous and woody plants, soils (for burrowing wildlife), topography, and other animals that are preyed upon for food. Conditions necessary for survival and reproduction could include the amount and configuration of vegetation communities and the relative level of disturbances (noise, traffic, visual obstruction) within otherwise suitable habitats. Some wildlife such as the common raven (*Corvus corax*) habituate to human-disturbed areas (Boarman & Heinrich, 1999), while others such as the greater sage-grouse (*Centrocercus urophasianus*) cannot tolerate increased human activities (e.g., Swenson et al., 1983; Lyon & Anderson, 2003; Walker et al., 2007; Doherty et al., 2008).

In general, energy development projects with small footprints and minimal human disturbances are more conducive for native wildlife and the habitats they rely upon. Principal considerations for wildlife habitats in areas undergoing energy development are to: (1) limit the amount of physical disturbance to the landscape to conserve wildlife habitat and promote future habitat restoration (i.e., reduce direct habitat loss), and (2) minimize factors during development and production phases such as roads, traffic, noise, dust, and visual obstructions that create conditions that lead to wildlife avoidance of otherwise suitable habitats (i.e., reduce indirect habitat loss).

Searchable key words: energy development, habitat fragmentation, habitat mitigation, restoration ecology, wildlife habitat, Wyoming.

Scope of bulletin (what it does and does not cover)

This bulletin describes general information on reducing impacts of energy development to sagebrush (*Artemisia* spp.) wildlife habitats. Basic definitions are defined as well as principal considerations for wildlife habitats undergoing energy development. Energy development impacts and potential mitigation techniques are addressed. Our bulletin is not specific to a particular type of energy development such as wind or uranium, but, instead, provides a basic overview of implications and considerations of energy development across sagebrush habitats. We provide specific information for well-studied wildlife species that rely on sagebrush habitats, including greater sage-grouse, mule deer (*Odocoileus heminonus*), and pronghorn (*Antilocapra americana*). However, we encourage the reader to further consult relevant literature to learn more about these and other wildlife species found in sagebrush habitats in Wyoming.

Summary of components to promote wildlife habitat restoration

Activity	Critical components
Planning	Planning before development can minimize disturbances within energy fields including phased development, directional drilling, and siting of energy infrastructure
Habitat assessment	An assessment of wildlife habitat should be completed prior to disturbance activities. Include evaluation of critical habitat areas such as sage-grouse leks, raptor nests, ungulate winter range, or migration corridors that may exist on or near areas to be developed
Wildlife surveys	Conduct wildlife surveys to document baseline information about wildlife that exist in the area planned for energy development. Knowing the species and relative numbers of those species will help with the planning process, mitigation, and monitoring after disturbance has occurred
Disturbance	Limit disturbance as much as possible to maintain undisturbed and connected habitat to conserve as many species as possible within the energy footprint and to enable the success of future restoration efforts
Disturbance mitigation	Many options exist to mitigate impacts to wildlife habitats within energy developments. Please consult with relevant agencies in Wyoming including the Bureau of Land Management (http://www.blm.gov/wy/st/en.html) and Wyoming Game and Fish Department (http://gf.state.wy.us/) about critical habitats, sage-grouse core areas, and seasonal timing stipulations. Consider additional techniques within the footprint of development including speed limit restrictions, trash collection procedures to discourage scavengers, spraying magnesium chloride on roads to reduce dust, installation of liquid gathering systems to remove condensate from oil and gas development fields, remote telemetry to monitor oil and gas field production, revegetating disturbed sites with native plant species, placing reflectors on fences to avoid avian collisions, burying transmission lines, placing floating plastic balls on settling ponds to discourage waterfowl use, installing wildlife underpasses under busy roads, and modifying fences to facilitate easier ungulate passage
Monitoring	Monitoring of wildlife and habitat should be implemented during and after activity has ceased

Introduction

Brief history

Energy development within big sagebrush (*A. tridentata*) habitat is occurring at a rapid pace across Wyoming and the Intermountain West. Because of arid conditions and difficulties with shrub reclamation, restoration practitioners face many challenges in restoring these landscapes. The amount of time needed to extract energy resources may be less than the time needed to reclaim disturbed sagebrush sites. The footprints of our most common energy resources – coal, oil, and natural gas – are important to understand within a restoration perspective but so are those related to mining of bentonite, trona, and uranium. Wind energy development presents a new form of disturbance to wildlife habitats and a need to better understand how it may affect habitat restoration and function of impacted wildlife habitats. This information may also provide useful insights for wildlife habitat restoration associated with increasing residential development and an expanding road, communication, and utility infrastructure required by the work force that constructs and services energy developments.

Much of the energy development in Wyoming is in sagebrush systems, with sagebrush encompassing more than 50 percent of Wyoming's total land area (Wyoming Interagency Vegetation Committee, 2002; Figure 1). Sagebrush communities contain a diverse composition of shrubs, forbs, and grasses that provide food and cover for wildlife. Restoring wildlife habitat involves restoring the structure of vegetation such as shrub cover, density, height, community composition, and species diversity (Olson et al., 2000) as well as restoring the function of these habitats to support wildlife species that formerly inhabited impacted areas. Habitat function refers to the attributes provided by habitat that make it usable and productive to wildlife including abundant high-quality food resources and security from human disturbances including excessive noise, dust, and traffic.

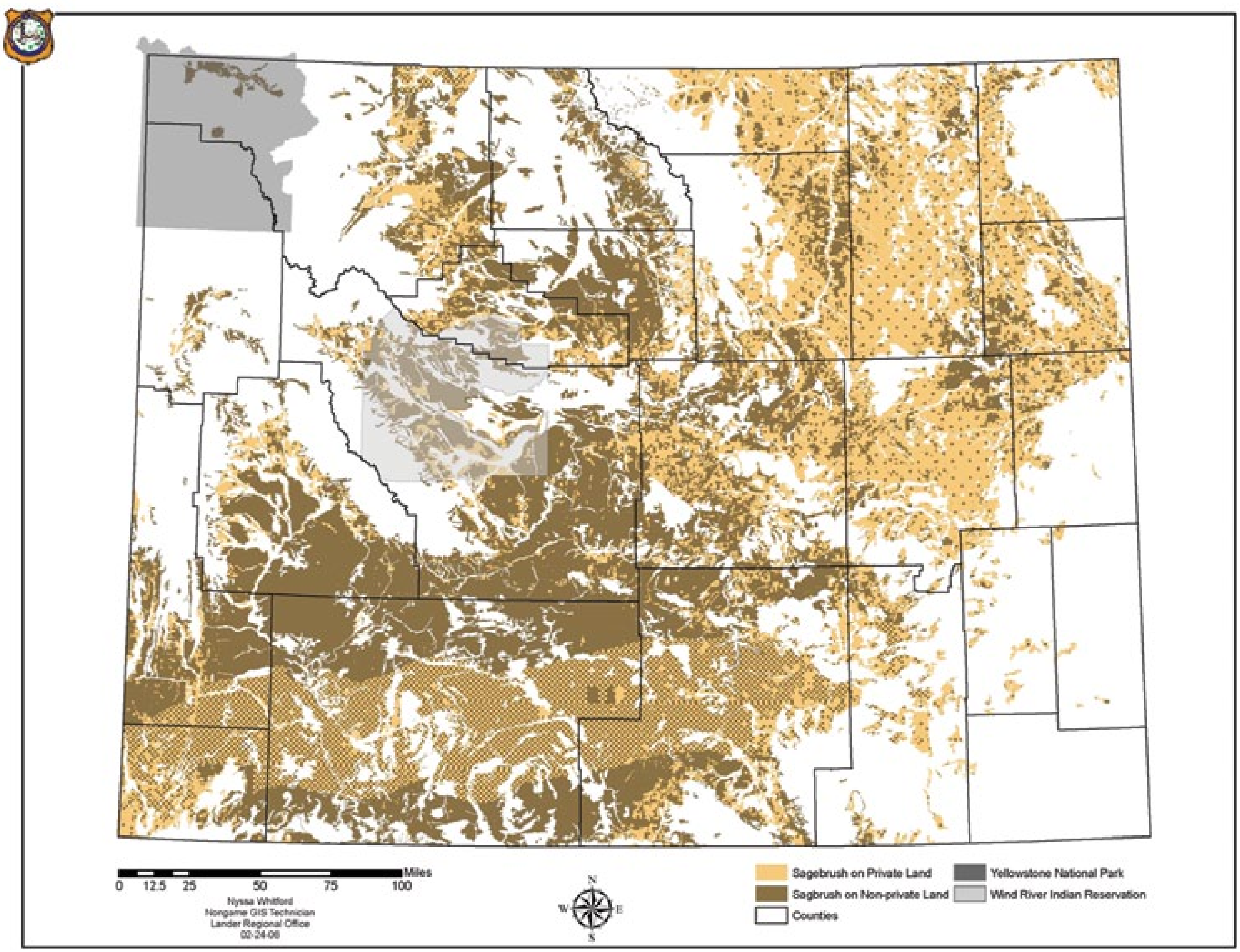


Figure 1. Distribution of sagebrush in Wyoming on public and private lands. Image from Wyoming Game and Fish Department.

One of the greatest interests in protecting and enhancing sagebrush habitats is preserving species dependent on sagebrush such as the greater sage-grouse. Federal listing of sagebrush-dependent species could have major impacts on the progression of energy developments and the economic livelihood of Wyoming. By reducing negative impacts to wildlife and their habitats, it may be possible for wildlife to successfully coexist with energy development in sagebrush habitats.

1. Brief definition of wildlife habitat

Wildlife habitats are areas that provide resources necessary for species to survive and reproduce. Habitat includes migration and dispersal corridors and the land animals occupy during breeding and non-breeding seasons (Morrison, 2009).

2. What is habitat fragmentation?

Habitat fragmentation refers to once continuous habitat that is now fragmented or broken into smaller habitat patches and often isolated from other patches of similar habitat (Figure 2). Habitat loss has consistent negative effects on biodiversity whereas habitat fragmentation has weaker effects, which are as likely to be positive as they are negative (Fahrig, 2003). This dichotomy in responses suggests the need to evaluate influences of habitat loss and fragmentation separately (Fahrig, 2003). However, studies suggest populations of sagebrush obligate and dependent wildlife species do not respond favorably to substantial loss, degradation, or fragmentation of habitat (Braun, 1998; Ingelfinger & Anderson, 2004; Sawyer et al., 2006). Many factors including home range size, seasonal habitat requirements, dispersal, migratory status, and ability to habituate to sources of human disturbance influence the levels of habitat loss and fragmentation that negatively influence individual wildlife species. Discontinuity of habitat can affect species occupancy, reproduction, or survival. Human encroachment such as energy development can displace wildlife as barriers and other impacts affect wildlife movement and survival across landscapes.

3. What is habitat connectivity and why is it important?

Habitat connectivity allows species to move among landscapes to forage, establish territories, breed, and maintain genetic diversity (Morrison, 2009). Specific spatial and temporal aspects of habitat connectivity, such as access to seasonal ranges or migration routes, or nesting/brood-rearing sites, may require a diverse array of habitats to facilitate safe movement of a species. By protecting critical habitats and linking habitats to facilitate wildlife movement, habitat connectivity can be established and assist in conserving species.

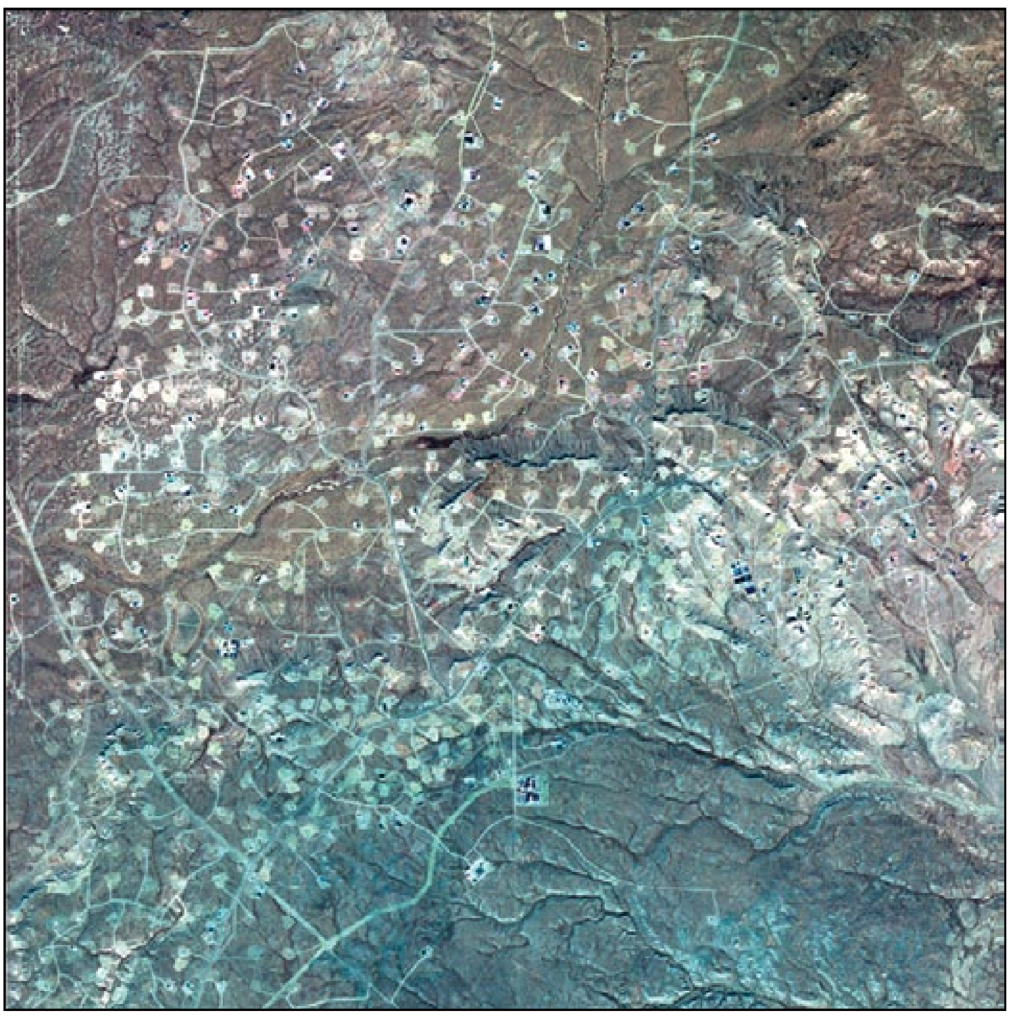


Figure 2. Well pad development causes fragmentation and loss of wildlife habitat. Photograph of the Jonah Field in western Wyoming, 2008 (Image by SkyTruth - www.skytruth.org).

4. Energy development effects on sagebrush wildlife and habitats

A large portion of the expanding landscape disturbance in the Intermountain United States is related to energy extraction including coal, oil, natural gas, and wind in arid and/or semi-arid regions dominated by sagebrush (Copeland et al., 2009). Additional sources of energy disturbance include solar power and uranium development. Energy development and the associated infrastructure (i.e., compressor stations, fences, pipelines, power lines, roads, settling ponds, well pads, and wind turbines and rotors) directly alter wildlife habitats at the site of operation (Braun et al., 2002) through habitat loss, fragmentation, and degradation. Other influences of energy development on wildlife habitats include exotic plant establishment, changes in soil fertility, vegetation cover, and diversity (Bergquist et al., 2007) and potential disruption of migration corridors (Berger, 2004).

Fragmented sagebrush habitats and increased human activity have affected many sagebrush-dependent birds and ungulate populations (Ingelfinger & Anderson, 2004; Sawyer et al., 2006; Aldridge & Boyce, 2007; Walker et al., 2007; Doherty, 2008; Hebblewhite, 2008). Fragmentation can lead to the isolation of a species population, lowering dispersal, and the effective size of the breeding population (Morrison, 2009).

Elevated human activity can restrict an animal's movements to narrow or limited regions causing population bottlenecks and ultimately a decline in the population. Migration corridors are important in that they allow animals to access critical foraging areas (i.e., stopover sites) along their journey (Sawyer et al., 2009b) and access high-quality resources in non-winter months. Without migration routes, many of the seasonal ranges in central and western Wyoming would be inaccessible to mule deer and pronghorn, and it is unlikely current populations could be maintained (Sawyer et al., 2005; Figure 3). The relative success of ungulate populations to negotiate rugged terrain and anthropogenic influences such as agricultural lands, cities and towns, fences, reservoirs, roads, and energy development facilities to access food supplies and milder climatic conditions influences survival and concomitant population productivity. Evaluating the influences of energy development for ungulates on winter ranges is particularly critical given that they often must negotiate narrow migration corridors (Sawyer et al., 2005) to access winter ranges where they occur at higher densities and experience elevated energetic demands.

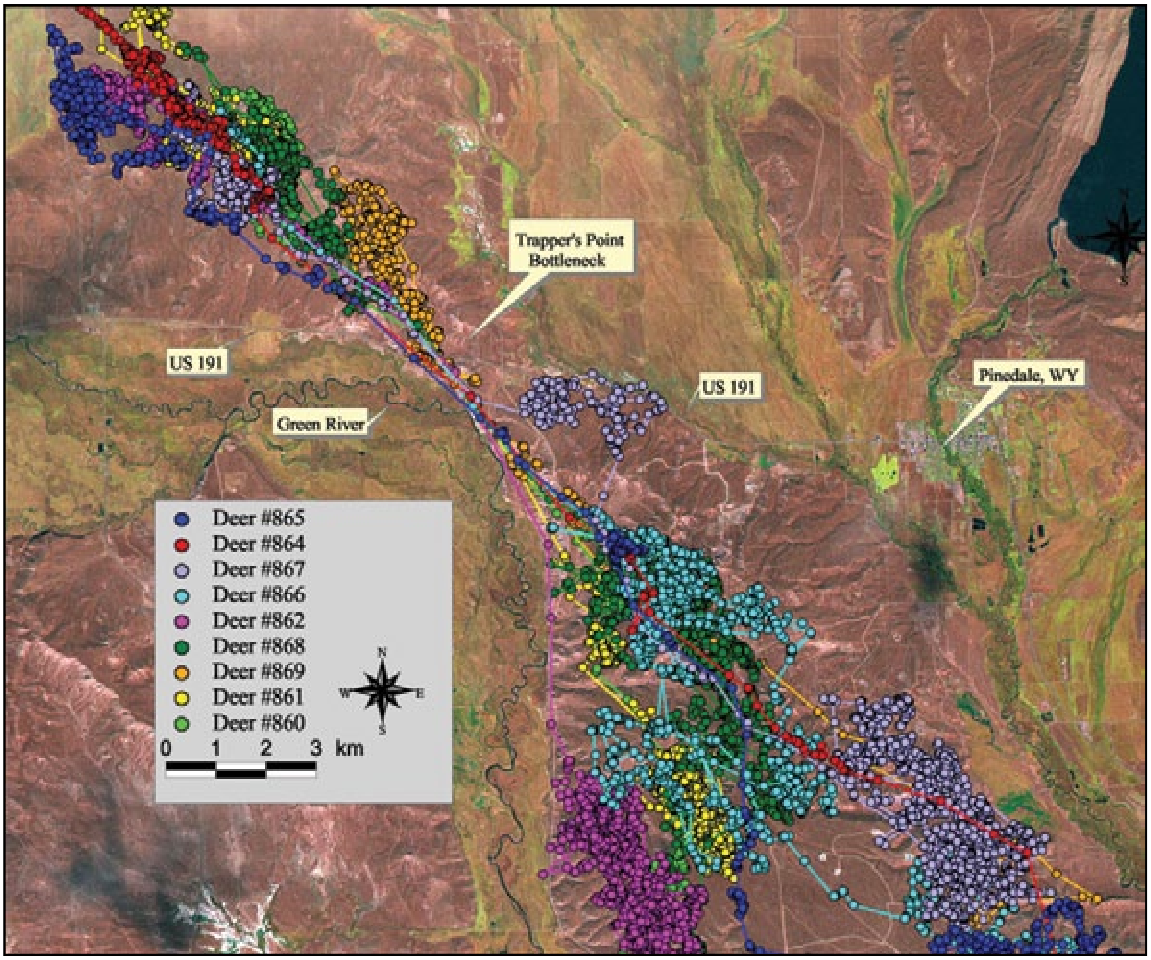


Figure 3. Hourly locations and movement patterns (January–April, 2001) for nine GPS-marked mule deer through Trappers Point in northwest Wyoming (from Sawyer et al., [2005]).

5. Sagebrush wildlife habitats in Wyoming

Sagebrush ecosystems provide habitat for approximately 87 mammal species, 297 bird species, and 63 fish, reptile, and amphibian species (Wyoming Interagency Vegetation Committee, 2002). Many of these animals are dependent on sagebrush. According to the WGFD (2005a), some sagebrush species of greatest conservation need in Wyoming include the Brewer's sparrow (*Spizella breweri*), Ferruginous hawk (*Buteo regalis*), greater sage-grouse, Great Basin pocket mouse (*Perognathus parvus*), plains pocket gopher (*Geomys bursarius*), pygmy rabbit (*Brachylagus idahoensis*), sagebrush vole (*Lemmiscus curtatus*), sage sparrow (*Amphispiza belli*), sage thrasher (*Oreoscoptes montanus*), and white-tailed prairie dog (*Cynomys leucurus*).

Wyoming is home to a diverse ungulate population, but, because of their overlap with sagebrush basins, the most affected by energy development are mule deer and pronghorn. The Upper Green River Basin in western Wyoming is dominated by an expansive sagebrush ecosystem that provides extensive winter habitat for migratory mule deer and pronghorn. However, energy development within the basin is leading to thousands of acres of direct habitat loss and increased habitat fragmentation that reduces the quality of ungulate seasonal ranges and threatens their migration routes.

6. Development effects on focal sagebrush wildlife species

Greater sage-grouse – Sage-grouse populations have declined due to loss, fragmentation, and degradation of sagebrush habitat (Knick et al., 2003; Connelly et al., 2004). Loss and degradation of their habitat may reduce carrying capacity of local breeding populations (Braun, 1998; Connelly et al., 2000), affect persistence of leks (Walker et al., 2007), and cause sage-grouse to avoid suitable habitat as energy development and infrastructure increases (Lyon & Anderson, 2003; Doherty et al., 2008). Enhanced traffic and noise near sage-grouse leks result in the leks becoming inactive due to sage-grouse avoidance (Walker et al., 2007). A variety of factors including large wildfires in the western portion of sage-grouse range and impacts from energy development in the eastern portion of their range have contributed to a recent status change for greater sage-grouse as a warranted, but precluded, species from listing under the Endangered Species Act of 1973 (USDI–FWS, 2010). Several studies in Wyoming have evaluated the impacts of energy development on sage-grouse populations (see Table 1 for an overview of these studies). We encourage the reader to refer to these articles, other publications, and future published articles to become more familiar with specific impacts to sage-grouse populations.

Mule deer – Wintering mule deer have been shown to respond to energy development by selecting habitats 3 kilometers or more from activity (Sawyer et al., 2006). However, avoidance of previously occupied habitat was decreased by 38-63 percent when condensate products were collected in liquid gathering systems (LGS) pipelines rather than being hauled in trucks (Sawyer et al., 2009a). Another advantage of LGS is they can be installed underground in existing roadway or pipeline corridors, thus reducing additional habitat loss or fragmentation. A recent Wyoming study indicates the importance of conserving migration routes and stopover sites for mule deer (Sawyer et al., 2009b).

Pronghorn – Wyoming is home to many populations of pronghorn, comprising 55 percent of the North American and 57 percent of the United States populations in 1997 (Yoakum & O'Gara, 2000). Because of the variable weather conditions in the region, seasonal resource availability has long influenced pronghorn habitat selection and migration patterns. The influence of oil and gas development on pronghorn habitat selection and migration patterns remains largely unknown (Hebblewhite, 2008) and no studies have been published that evaluate the influence of wind energy development on pronghorn habitat selection and migration patterns.

Adult female greater sage-grouse with young-of-the year. Photograph courtesy C.P. Kirol

Sagebrush provides important habitat for mule deer in Wyoming and the Intermountain West. Photograph courtesy Bureau of Land Management, Wyoming.

Table 1. General summary of journal articles published on greater sage-grouse response to energy development in Wyoming. Please consult these articles for specific information.

Article	Location	Study focus
Doherty et al., 2008	NE Wyo.	Winter habitat selection
Doherty et al., 2010a	Statewide	Core region identification and population risk related to future energy development
Doherty et al., 2010b	Statewide (management zones I and II)	Lek persistence and male lek attendance relative to categories of well pad density to quantify currencies for offset mitigation
Harju et al., 2010	Statewide (7 sites)	Male lek attendance relative to well pad density
Holloran et al., 2010	NW Wyo.	Juvenile male and female distribution and recruitment into a breeding population
Lyon & Anderson, 2003	NW Wyo.	Female nest site selection, initiation, and success
Naugle et al., 2004	NE and NW Wyo.	West Nile virus
Naugle et al., 2010	NE Wyo.	Habitat fragmentation and development thresholds
Walker et al., 2007	NE Wyo.	Lek persistence and trends in male lek attendance

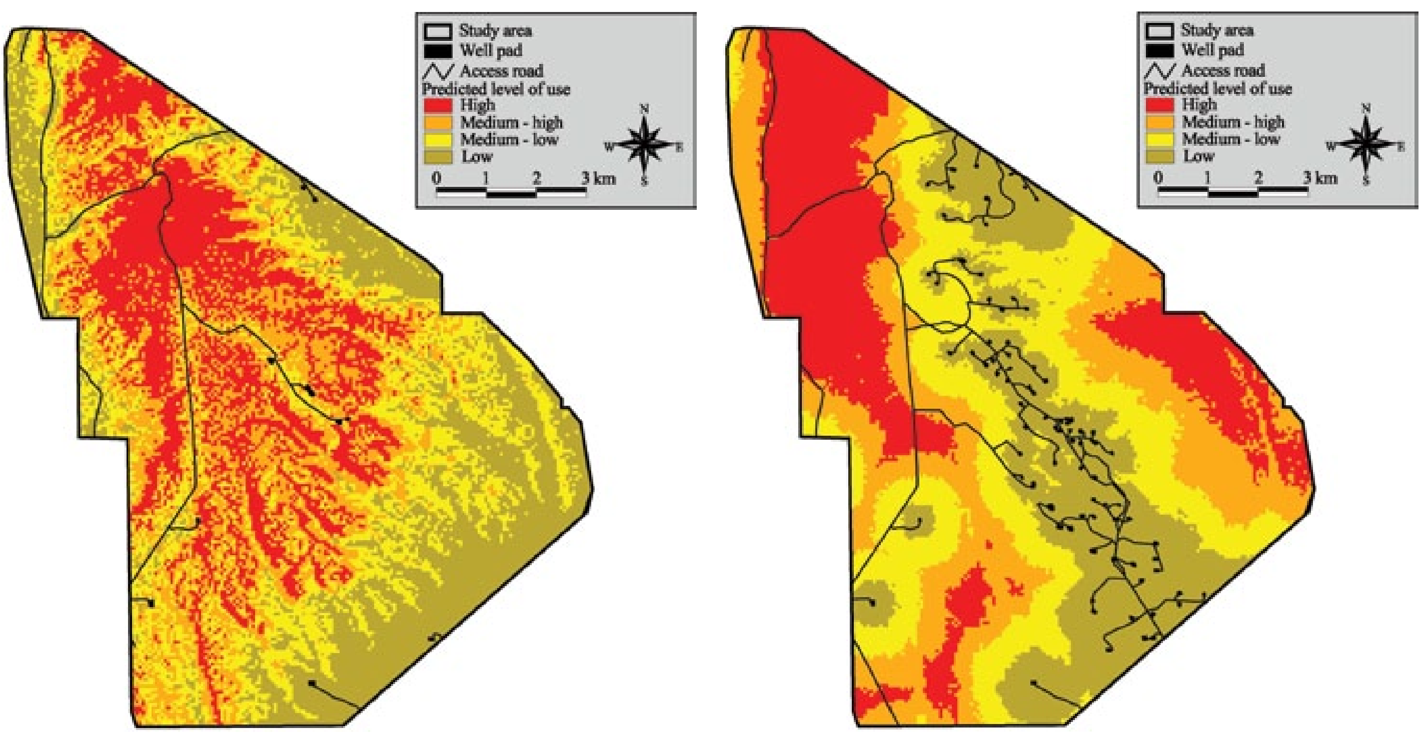
7. How can wildlife habitats be conserved within the footprint of energy developments?

To maintain healthy wildlife populations in localized areas, it is important to mitigate direct and indirect impacts to wildlife habitats impacted by energy development. Primary considerations are to minimize habitat loss and fragmentation, maintain connectivity between wildlife habitats, reduce anthropogenic disturbances such as noise, use technology to remotely monitor well pads to reduce vehicle trips, minimize the number of well pads, and reduce the frequency of vehicle visits within energy development fields (Sawyer et al., 2009a). Because energy development occurs in multiple habitats and potentially affects multiple species, management and monitoring plans are useful to understand impacts to species and institute restorative efforts for impacted habitats. The U. S. Department of the Interior (USDI) Fish and Wildlife Service (http://www.fws.gov/), and field offices of the USDI Bureau of Land Management (find Wyoming field offices under http://www.blm.gov/wy/st/en.html), and Wyoming Game and Fish Department (http://gf.state.wy.us/) provide necessary protocols for mitigation and monitoring of impacted wildlife species within sagebrush habitats.

Conserving connectivity of suitable habitat is important for many species and especially migratory animals. For example, Sawyer et al. (2005) identified the importance of conserving migration corridors and identifying bottlenecks along mule deer and pronghorn migration routes in western Wyoming. Barriers to movements can include man-made structures such as fences that are difficult for passage (Figure 4). Connecting habitat patches is also important to wildlife that depend on different resources to meet their seasonal requirements. Protecting these migration corridors, with special attention to bottleneck locations and connecting necessary habitat patches to increase connectivity, will aid in conserving wildlife habitat.

Figure 4. Anthropogenic obstructions including fences can create barriers to wildlife movements in energy-influenced habitats. Photograph courtesy Joe Riis.

Reducing anthropogenic disturbances such as vehicle traffic and noise will aid in conserving wildlife habitat. Wildlife species such as greater-sage grouse (Holloran et al., 2010) and mule deer (Sawyer et al., 2009a) tend to avoid habitat surrounding energy development (i.e., roads and producing well pads), which may be related to mechanistic disturbances such as noise (Barber et al., 2010; Figure 5).



Low Well Pad Density **High Well Pad Density**

Figure 5. Mule deer winter habitat use on the Pinedale Anticline Project Area in northwestern Wyoming before (left image, winters 1998–1999 and 1999–2000) and after (right image, winter 2002–2003) increase in well pad density (from Sawyer et al., 2006).

Increasing visibility of rotor blades, installing transmission cables underground, marking overhead cables using deflectors, avoiding areas of high animal concentrations such as sage-grouse leks, bird nesting colonies, and calving and fawning grounds, and timing construction to avoid sensitive periods are ways to conserve wildlife habitats and populations from wind energy and other energy development (Drewitt & Langston, 2006). Directional drilling, installation of liquid gathering systems, and increased buffer zones around critical habitats will lead to less roads, traffic, and noise. Timing restrictions are intended to limit energy development activities during sage-grouse breeding season and in crucial winter range for ungulates (BLM, 1997, 2008; Lyon & Anderson, 2003). However, timing restrictions during breeding seasons do not prevent impacts of infrastructure at other times of the year; therefore, timing restrictions appear to be short term, and mitigation measures should focus on long-term efforts to ensure species persist within important habitats.

The arrangement and density of energy development should also be considered to conserve wildlife habitat. For instance, oil and gas development at a density of at least 1 pad/2.6 km^2 (1/1.0 mi^2) impact breeding populations of sage-grouse (Holloran, 2005), while conventional well densities of 8 pads/2.6 km^2 (8/1 mi^2) exceed the threshold of tolerance for sage-grouse (Holloran, 2005; Walker et al., 2007a; Doherty et al., 2008). Most energy development occurs year-round and can impact a particular species at multiple intervals throughout its seasonal cycles. Understanding these seasonal cycles is important when development activities are at their highest (e.g., wind turbine construction, well pad drilling). Such activities should be limited during important seasonal cycles such as bird breeding and nesting seasons, migration periods, and ungulate winter periods.

8. How can impacts be reduced and disturbed wildlife habitats restored?

The primary goal of restoration is to return ecosystem function and structure of disturbed wildlife habitat as close as possible to its original state. Restoration can proceed more successfully if disturbance during development and production phases of energy extraction is minimized. Reducing disturbances such as noise and traffic and revegetating disturbed habitat (Strom et al., 2010) are ways to encourage restoration of habitats and populations to pre-disturbance levels. Seasonal road closures, revegetating former roadways, placing mufflers on pump jacks, and reducing vehicle flow will aid in restoring the function of wildlife habitat by encouraging wildlife to reuse formerly suitable habitats. Restoring the structure of disturbed sagebrush communities often initially involves restoring the original landform to blend in with surrounding landforms, salvaging and reusing all available topsoil, re-vegetating disturbed areas to native species, controlling erosion, controlling invasive non-native plants, and monitoring results (BLM, 2006; see Norton et al., 2009, for general overview of critical restoration components).

Non-native plant species invasion and establishment is very common in disturbed soils such as along new pipelines, well pads, and road edges and can be extremely difficult to control/eradicate once established. Successful revegetation (see Strom et al., 2010, for an overview), which eventually should lead to restoration of wildlife habitat structure, is achieved when a self-sustaining, vigorous, diverse, native plant community is established on the site with a density sufficient to control erosion and non-native plant invasion (BLM, 2006).

9. Conclusion/Summary

Managers can take many steps to conserve the function and structure of sagebrush wildlife habitats impacted by energy development. In general, minimizing the area and time period that habitat is directly impacted by energy development is a first step to lessen effects on wildlife habitats. Ensuring connectivity of important wildlife habitats should receive critical consideration. Mitigating specific impacts can be achieved by careful planning, collaborating with resource managers, and implementing the necessary protocols to protect wildlife and their habitats. Maintaining connectivity of habitats, reducing anthropogenic disturbances, use of technology, implementing seasonal restrictions, and implementing species-specific monitoring plans are all useful tools to conserve wildlife habitat.

The production phase of energy development can continue for decades. Impacts of these activities on wildlife habitats may occur but can be limited by reduced traffic, frequency of visits, and decreasing the density and distribution of units producing energy (e.g., well pads or turbines). There are many management strategies that exist to return disturbed wildlife habitats to near original states such as restoring the original landform and contour, preserving and salvaging the topsoil, re-vegetation including reseeding, and reducing human activity associated with long-term maintenance of producing energy infrastructure.

Glossary

- *Habitat* – an area that provide resources and conditions necessary for occupancy, survival, and reproduction by wildlife species
- *Habitat connectivity* – maintaining adjacent habitat patches to encourage wildlife movement between habitats to preserve the functionality of landscape elements
- *Habitat degradation* – the diminishment of habitat quality and its ability to support biological communities
- *Habitat fragmentation* – the process by which formerly contiguous habitats are broken into smaller isolated patches often resulting in altered biotic or abiotic conditions in remaining patches
- *Habitat function* – the ability of habitats to provide resources and conditions that make habitats suitable for various wildlife species
- *Habitat restoration* – the act of reestablishing structure, function, and composition of habitats to their natural state
- *Habitat structure* – the composition and arrangement of habitat features that make habitats suitable for wildlife
- *Habitat quality* – refers to the ability of the environment to provide conditions (resources) appropriate for reproduction, survival, and population persistence (Hall et al., 1997)
- *Phased development* – energy development activities conducted in discrete pre-determined intervals reducing continuous development activities
- *Sagebrush obligate* – a species that relies on sagebrush plant species to survive through all seasonal life cycles
- *Sagebrush facultative obligate* – a species dependent on sagebrush plant species during some period of their seasonal cycle
- *Vegetation community* – plant species that are ecologically connected and function together in a defined ecosystem
- *Vegetation structure* – the way in which vegetation is arranged in three-dimensional space. Structure is measured as vegetation layers on vertical plains and usually referred to as *vertical structure;* however, *horizontal structure* could also be measured with techniques based on cover, density, or distribution.
- *Wildlife habitat* – resources and conditions present in an area that contribute to animal species occupancy and productivity

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