Biodiversity Conservation Alliance

EG-2

Working to Protect Native Species and Their Habitats

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February 11, 2008

VIA EMAIL: WYMail_PAPA_YRA@blm.gov

Caleb Hiner, Project Lead
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Pinedale Field Office
P. O. box 768
Pinedale, WY 82941

RECEIVED PINEDALE BLM
2008 FEB 13 AM 10: 13

Re: Pinedale Anticline RDSEIS Comments

Dear Mr. Hiner:

Below are the comments of Biodiversity Conservation Alliance, Center for Native Ecosystems, and Suzanne H. Lewis in response to the *Revised Draft Supplemental Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project* (RDSEIS) which was released in December 2007.

The Revised DSEIS contains some changes from the earlier DSEIS which was released in early 2007. We wish to thank the Bureau of Land Management (BLM) for recognizing the critical importance of conducting a thorough environmental analysis and developing a range of alternatives which respond to public comments received. We also thank BLM for taking the additional necessary time to do so. The primary changes from the DSEIS to the RDSEIS are the two additional alternatives which were analyzed, Alternatives D and E, and revised mitigation measures. These comments will respond directly to the two new alternatives and added mitigation measures.

We are encouraged that BLM has acknowledged the need to "do it right" with the Pinedale Anticline, as shown by the supplementary analysis conducted for the RDSEIS. We believe, however, that BLM still has neither accepted the magnitude of environmental impacts that will occur under the proposed alternatives, nor accepted its duty to avoid those impacts where possible and, where not possible, to require on-site mitigation to the fullest extent possible. In other words, BLM has not taken the requisite "hard look" at the consequences of the proposed impacts. It is not enough to disclose the impacts under the NEPA analysis but ignore the devastating consequences those impacts will have—many of which could be avoided or minimized by taking certain precautions. BLM seems to believe that it can allow intense development over an extended period of time with undisputed significant impacts to the resources, without first requiring the operators to avoid impacts where possible and to mitigate

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impacts on-site. BLM's acceptance of a pot of money from the operators for off-site mitigation in lieu of adequate avoidance and onsite mitigation is simply unacceptable. This model violates the Federal Land Policy and Management Act and BLM acts illegally when it endorses such actions.

BLM must balance energy development with protection of the other resources—the resources which make the Upper Green River Valley such a unique and special place. These are the resources which the people of Wyoming value and demand to see protected. With current development levels on the PAPA and the adjacent Jonah Field, we have watched the mule deer population decline by 46% in just a few years; we have observed the greater sage-grouse population plummet toward a predicted extirpation in the area in fewer than 20 years. Indeed, listing of the sage-grouse as threatened or endangered looms on the horizon unless BLM takes immediate and adequate actions to protect these birds. The impacts to visibility from current levels of development are already noticeable and will deteriorate further with the added intensity of development. Unacceptable impacts to Class I airsheds will occur.

It is possible to balance energy extraction with protection of other resources by incorporating not only the positive operator-proposed components in Alternative D, but also the timing stipulations and additional protections in Alternative E, as well as other provisions which will afford stronger guards against the significant impacts disclosed in the RDSEIS. Inclusion of these provisions in a modified Alternative D will slow the pace of development while allowing greater protection for wildlife, air quality, and other resources throughout the life of the project. A slower pace of drilling is absolutely essential as part of the balancing of competing interests. The energy resources will not leave; they will still be there when the right time comes.

It seems inconceivable that BLM would want this project to go down in history as an industrial sacrifice zone. Yet that is what will occur if the Pinedale Anticline is allowed to proceed as proposed in Alternative D, the BLM Preferred Alternative. This can be avoided with the requirement of balanced energy production in tandem with real environmental protections from beginning to end. This is the stage of the NEPA process at which such changes must be made, for once a Final SEIS is released and a subsequent Record of Decision signed, the ability to make meaningful changes to the project diminishes.

I. ALTERNATIVE D

Unlike the original PAPA SEIS and PAPA ROD in which the pace of development was slower and protection of resources was paramount, Alternative D proposes to push development of the Anticline through as quickly as possible, with construction, drilling, completion and production occurring simultaneously. While an argument has been made by the operators that the faster they get in and finish the development phase, the lighter will be the impacts to wildlife and other resources, there is absolutely no sound or scientific basis for this approach. Alternative D proposes a plan of development and production which is untried and untested.

When it has been demonstrated through scientific studies that even the current seasonal wildlife restrictions are inadequate to protect wildlife populations, what possible justification is there for removing even these protections and moving forward with development at an unprecedented pace and intensity?

G-1 EG-2-1 Alterative D has some components which we support and which are improvements over the action alternatives in the DSEIS of 2007. We strongly support the use of directional drilling and would request that directional drilling and clustered wellpads be required by BLM. To obtain exceptions to this requirement, we recommend that operators have to clearly demonstrate on a case-by-case basis that directional drilling or clustered wellpads are technologically not feasible.

We also support the liquids gathering system (LGS) proposed by Shell, Ultra and Questar to reduce traffic and human activity on the Anticline. Along with the LGS we support the consolidated production facilities and computer assisted operations which will further reduce traffic and pollution.

LS-1 EG-2-2 The voluntary suspension of leases and term No Surface Occupancy (NSO) leases outside of the Core Area and PDA in Alternative D we also support. We commend BLM and the leaseholders for recognizing that there must be large, continuous areas that are subject to no (or little) development for a period of time. The period of five years, however, is entirely too short. These suspended and term NSO leases must extend for the duration of the concentrated development of the Core Area and PDA. Review after the initial five years is appropriate and desirable for many reasons, chief among these being to determine if even these measures have proven adequate to provide for the critical habitat needs of wildlife. A review after five years for the purpose of removing the suspensions and terms is not acceptable.

LS-2 EG-2-3 We also point out that the suspended leases and term NSO leases would occur in areas that for the most part have low potential for development (See Map 2.4-4) and thus would not cause hardship to the leaseholders. Even for the duration of concentrated development in the Core Area and PDA, we would expect little or no hardship to leaseholders from suspended or NOS leases. We therefore request that the suspensions and terms be modified to extend for as long as development is occurring in the Core Area and PDA.

G-2 EG-2-4 We commend the Proponents for proposing to take these the above steps; we would like to see all operators on the Anticline join in these efforts. We ask BLM to set these as conditions for all leases. Even with these substantial steps forward in attempting to avoid impacts and providing more on-site mitigation, however, the level of destruction of habitat and the direct, indirect and cumulative impacts to all resources, is still unacceptable. The pace of development is still too fast.

We oppose removal of seasonal wildlife restrictions and the faster pace of development. Research has demonstrated that these restrictions are insufficient by themselves to prevent plunging wildlife populations.[1] Additional protections are needed, not removal of wildlife

[1] *See for example* Sawyer, H., R.M. Neilson, F. Lindzey and L.L. McDonald. 2006. Winter Habitat Selection of Mule Deer Before and During Development of a Natural Gas Field. Journal of Wildlife Management 70:396-403. Berger, K., J. Beckman and J. Berger. 2007. Wildlife and Energy Development: Pronghorn of the Upper Green River Basin – Year 2 Summary. The Wildlife Conservation Society. Jackson, Wyoming. Holloran, M.J. 2005.

protections. By the time industry and BLM discover through their monitoring efforts that impacts to wildlife are causing further population declines, and a response is developed and implemented, it may be too late. One need only look at Figure 2.4-1 to understand that a timely response will be almost impossible. It is also troubling that thresholds for population numbers and viability have not been set, nor have response scenarios been developed ahead of time to ensure timely responses.

The BLM's analysis assumes there will be year-round development in the PDA, and we have no reason to question this assumption. (*See* RDSEIS at 2-45.) We oppose the expansion of the Core Area in Alternative D to include the PDA and we oppose year-round drilling in this area. Alternative D already proposes an expanded Core Area over Alternatives A, B and C. To further extend the Core Area by including the PDA for year-round drilling is unacceptable. We believe most, if not all, areas in the PDA can be accessed by directional drilling from the Core Area and it is only for the convenience of the operators that the PDA area has been proposed. There is no justification for creation of the PDA.

A. Wildlife Impacts

The people of Wyoming treasure the world-class wildlife populations that are found in the Upper Green River Valley. Indeed, many in the area make their living from guiding, hunting and fishing. Many others simply enjoy the thrill of viewing the wildlife and the deep satisfaction of knowing they are there. People come from all over the world to view Wyoming's wildlife; they don't come to Wyoming to see oil and gas development. Comments BLM received on the Draft SEIS in 2007 were overwhelmingly in favor of a slower pace of drilling and reduced impacts to wildlife. Diminishment of wildlife in the Pinedale Anticline is unacceptable.

Under the FLPMA mandate of "multiple use and sustained yield," BLM is directed to manage the public lands and their resources in a way which sustains resources such as wildlife. BLM clearly violates FLPMA when it not only stands by and allows mule deer herds in the Upper Green River Valley to diminish by 46%, but then takes unprecedented and unsupported actions which it knows will have further significant impacts on mule deer in the area.

One of the weaknesses of the PAPA ROD was the allowance of waivers and exceptions to the lease stipulations and conditions of approval. Primary among these exceptions was the waiver of seasonal restrictions for big game, raptors and greater sage-grouse. In fact, BLM's granting of requested exceptions became seemingly automatic, with few requests being denied. We have seen the consequences of these waivers with plummeting wildlife numbers recorded just since the PAPA ROD was implemented. We pointed out in our earlier comments to the Draft SEIS that the current seasonal wildlife restrictions were inadequate to

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Greater Sage-grouse Population Response to Natural Gas Field Development in Western Wyoming. Ph.D. Dissertation. University of Wyoming. Copies of these studies are attached hereto and incorporated herein as Attachments 1, 2 and 3, respectively.

prevent declines of wildlife populations. We find no basis in the RDSEIS for BLM's belief that complete removal of such restrictions will re-establish historical levels of wildlife populations, let alone enhance those former numbers. Much of the PAPA is crucial winter range for mule deer. The allowance of permanent exceptions to seasonal wildlife restrictions is indefensible.

The exceptions to be granted to seasonal wildlife stipulations will be a blanket waiver written into the PAPA FEIS and ROD. This violates BLM's own policies. The Onshore Oil and Gas Order No. 1 § XI states that an exception to a stipulations must be granted on a case by case basis. BLM has not considered these exceptions on a case by case basis; BLM intends to grant a blanket waiver for all seasonal stipulations in leases. Until BLM conducts a case by case analysis of each lease stipulation it intends to waive, it cannot grant exceptions to lease stipulations. BLM therefore cannot issue a blanket exception for all leases to authorize year-round development.

W-1 EG-2-5

Providing further reinforcement to Onshore Oil and Gas Order No. 1 § XI is the recent BLM Instruction Memorandum 2008-032, *Exceptions, Waivers, and Modifications of Fluid Minerals Stipulations and Conditions of Approval, and Associated Rights-of-way Terms and Conditions*. This IM provides guidance for how exceptions to stipulations can be granted: (1) if the authorized officer determines that the factors leading to its inclusion have changed sufficiently to make protection unjustified; or (2) if the proposed operations would not cause unacceptable impacts. Clearly, this IM anticipates case by case analysis of each stipulation. Attachment 1 to the IM provides examples of circumstances in which a lease stipulation might be waived or excepted. For example, a seasonal stipulation could be granted if elk no longer use the area for winter range, or a mild winter occurred and elk left their winter range early, or elk are arriving at their winter range later than usual. We have seen no evidence in the RDSEIS that such analysis has been undertaken by BLM for all of the seasonal stipulations it intends to except or waive. BLM cannot issue a ROD which grants exceptions to all seasonal stipulations until this case by case analysis is conducted. As part of the analysis, each lease stipulation must meet the criteria that factors have changed and protection is unwarranted or that the operations would cause no unacceptable impacts. Given the degree of impacts to wildlife disclosed in the RDSEIS, we cannot imagine how BLM could waive any seasonal stipulations under IM 2008-032.

In February of 2007 the Western Governors Association (WGA) stressed the need for Congress and the Administration to use more environmental review before they allow drilling in sensitive wildlife habitat and wildlife migration corridors. They called for the urgent need to first identify wildlife migration corridors and crucial wildlife habitat and then develop the necessary tools and policies needed to preserve these areas in the face of intense oil and gas development. The WGA will consider the recommendations of the Oil and Gas Working Group and adopt its final guidelines at their June 2008 meeting The WGA did not call for an end to drilling; rather they called for ***balance***—something we have demanded for years, yet it has fallen on deaf ears. The BLM, as reflected in the PAPA RDSEIS, is not listening to voices of wisdom and caution. Instead, it has thrown caution to the wind and is listening only to commercial interests which want to proceed an unwise pace and intensity despite the best available science to the contrary.

But even if BLM is not listening to public input, the agency itself has policies which it is ignoring with regard to oil and gas development: the Wyoming Landscape Conservation Initiative and consolidation of management of the southwest Wyoming Field Offices Pinedale, Kemmerer, Rawlins and Rock Springs) into a single district office. This latter move signals BLM's recognition of the need to coordinate oil and gas development in this part of the state in a cohesive and unified manner. The Wyoming Landscape Conservation Initiative "is a long-term ***science based effort*** to enhance aquatic and terrestrial habitats at a landscape scale in Southwest Wyoming, while facilitating responsible energy development." (*See* BLM Wyoming website: http://www.wlci.gov/fact_sheet.htm) (Emphasis added.) Both initiatives respect the interconnectedness of landscapes and wildlife populations on a broad landscape scale. We hope that the acknowledgment implicit in both these initiatives brings with it the commitment to proceed with oil and gas development in a deliberative and careful manner, considering the consequences of each project with full recognition of the impacts from all other projects within the district. The PAPA RDSEIS, however, is definitely not a step in the right direction and it belies BLM's commitment to these infant initiatives.

W-2 EG-2-6

It is clear that wildlife will not be protected under Alternative D when year-round drilling, completions, equipment transportation, pipeline installation, road building, facility construction, traffic, and other development activities are allowed, and seasonal wildlife stipulations are eliminated in the proposed Core Area of Alternative D. It is imperative that all seasonal wildlife restrictions be retained not only in the Core Area, but also in the Flank Area and other parts of the Pinedale Anticline throughout the development and production phases. We request that changes be made to Alternative D to implement retention of seasonal wildlife stipulations without exceptions and waivers.

1. Big Game

As mentioned above, the Sublette mule deer herd utilizes the Pinedale Anticline for crucial winter range (25% of PAPA), winter range, and to a much lesser extent for spring/summer/fall range. Pronghorn use the entire PAPA for different seasonal ranges, including crucial winter range (24% of PAPA) which partially overlaps the mule deer crucial winter range. In spring, summer and fall, all of the PAPA except crucial winter range, is used by pronghorn. The Pinedale Anticline is vital to the sustainability of pronghorn herds in the area. Elk also occupy a small portion of the PAPA as winter range. Additionally, moose utilize the areas surrounding the Green and New Fork Rivers year-round and for crucial winter range (9% of PAPA). A portion of moose territory overlaps both mule deer and pronghorn crucial winter range. Sensitive Resource Management Zones have been established for mule deer, pronghorn and moose in the PAPA. A large portion of the upper half of the PAPA is managed as a Sensitive Resource Management Zone (SRMZ) for mule deer. Much of the surface disturbance occurring from development is in big game crucial winter range.

Impacts of oil and gas development on wildlife have been, and are being, studied, but for the most part these studies have lagged behind the pace of development and detrimental effects have been experienced by wildlife before they are noticed. We applaud the operators and BLM for the research that has been conducted to date and for the ongoing research. We believe, however, that additional research should occur ***prior to*** the level of development proposed for the Pinedale Anticline, so that wildlife biologists have the benefit of the results to help design and implement a plan of development that will work to protect wildlife populations. The breakneck pace and intensity of development proposed in Alternative D cannot be justified by the current scientific data.

The State of Wyoming has had in place for some time its *Wyoming Mitigation Policy* which expresses the State's viewpoint with regard to disturbing crucial wildlife habitats. The State's policy recognizes that there can be no significant decline in crucial wildlife habitats and that these areas must remain essentially unchanged. Crucial winter ranges, such as those that exist in the PAPA, are considered vital for the survival of the species that utilize those habitats. Under the definition of "vital" habitat, it is habitat which "directly limits a wildlife community, population, or subpopulation. . ." It also notes that it may not be possible to replace this habitat. Disturbance of this habitat may make it impossible for wildlife populations to maintain and reproduce themselves. Studies have shown that it takes 50 to 100 years to re-establish a sagebrush community, if it can be done at all. Experience in other gas fields indicates that it is nearly impossible to reclaim disturbed lands with sagebrush. But it is clear from other studies cited in these comments that without this crucial habitat, wildlife populations will decline, and they may be extirpated.

It is clear that abandoning seasonal wildlife stipulations is not in conformance with Wyoming's policy with regard to crucial wildlife habitats, yet there is no explanation offered by BLM as to why it does not need to acknowledge and adhere to such policy. Nor is there any explanation or scientific basis offered to support deviating from the State's policies. BLM would like us to blindly place our trust in its supposed superior wisdom. This we cannot do.

It is of grave concern to us that big game populations are being pushed from their traditional prime habitat into areas with less suitable habitat by oil and gas development on the PAPA. These impacts are well documented in the studies.

Drops in wildlife population (some precipitous), decreased hunter success rates, decreased fawn and adult survival rates on the PAPA are strong indicators that current development levels are too much for wildlife. We can only speculate what impacts the proposed development levels of Alternative D, including elimination of seasonal wildlife stipulations, will have, but the outcome cannot be in keeping with BLM's mandate to manage for sustained wildlife resources. It cannot be argued that oil and gas development is at least in part to blame. The Hall Sawyer mule deer study clearly demonstrated that the 46% drop in mule deer population in the Upper Green River Valley occurred where there was development, but did not occur in the control population where deer were on undeveloped lands.

The Wyoming Game and Fish Department in 2004 issued its "Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats" policy. This guidance recommends more than the standard seasonal wildlife stipulations which BLM uses. In addition to the seasonal stipulations, the policy recommends a number of management practices, including phased development, clustered development, and regulated pattern and rate of development. Moreover, The State of Wyoming has a policy relative to disturbance of crucial habitats, including crucial winter ranges. Exhibit 6. Wyoming Mitigation Policy lists crucial habitats as "vital." Vital habitat "directly limits a wildlife community, population, or subpopulation" and replacement of this habitat "may not be possible." Crucial habitat is habitat "which is the determining factor in a population's ability to maintain and reproduce itself . . ." The State of Wyoming's policy is that there should be no significant decline in habitat function in these vital crucial habitats, and even though some modification may be allowed, the location, essential features, and species supported must remain "unchanged." Abandoning winter drilling stipulations is clearly not in conformance with official state policy, and BLM has nowhere acknowledged that its policy is contrary to this state policy.

W-3 EG-2-7

Because of the impacts of oil and gas development, more measures must be included in the Final SEIS to provide adequate protections for big game. These measures should include at a minimum: (1) mandatory requirement for directional drilling and clustered wellpads when technologically feasible; (2) use by ***all*** operators of liquids gathering system throughout the PAPA; (3) use by ***all*** operators of remote monitoring—especially in winter months; (4) retention of all big game seasonal wildlife restrictions throughout the LOP; (5) use of centralized facilities by all operators; (6) slower pace of drilling with a limit of 250 new well pads; (7) suspension of leases in the Flanks for the duration of development in the Core Area; (8) stronger protections for wildlife migration corridors, starting with identification and mapping of corridors; and (9) elimination of the ½ mile PDA around the Core Area.

2. Grater Sage-grouse

For reasons of greater sage-grouse alone, nearly the entire PAPA should not be developed at all, if one followed the guidelines of a very recent synthesis of the current scientific literature and conservation strategies for sage-grouse.[2] The concentration of sage-grouse

[2] Apa, T., J. Bohne, T. Christiansen, J. Herbert, B. James, R. Northrup, D. Olsen, A. Robinson, P. Schnurr, T. Smith, and B. Walker. January 2007. *Using the Best Available Science to Coordinate Conservation Actions that Benefit Greater Sage-Grouse Across States Affected by Oil and Gas Development in Management Zones I-II (Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming).* (Hereafter "Using the Best Available Science.") A copy is attached hereto and incorporated herein as Attachment 4. We also incorporate all the literature cited in this article into our comments by reference.
See also Braun, C. 2006. A Blueprint for Sage-grouse Conservation and Recovery. Grouse, Inc.. Tucson, Arizona. Doherty, K.E., D.E. Naugle, B.L. Walker, and J.M. Graham. Greater sage-grouse winter habitat selection and energy development. Journal of Wildlife Management: In Press. Walker, B.L., D.E. Naugle, and K.E. Doherty.

leks and year-round habitat makes it impossible to develop this area without having measurable impacts to the species. Whether those impacts will be significant enough to cause further declines of the species, or a trend toward listing, remains to be seen. It is imperative, however, to design avoidance and mitigation measures ***now*** that give better assurance that this will not happen. There are several steps which must be incorporated in a modified Alternative D that can help to alleviate some of the pressures on the species from oil and gas development.

AL-1 EG-2-8

First, as we have stated repeatedly, a slower and phased pace of development must occur. The slower pace of Alternative E would be preferable for sage-grouse—for all species—than the pace in Alternative D, but we question whether even Alternative E's pace would be slowed enough to provide adequate protection. It is critical that when one area is being developed, there be adequate undeveloped areas with sufficient forage and habitat for the species to survive and thrive. An attempt to partially phase development in Alternative D has been made, but it falls far short of achieving meaningful protection for sage grouse. At any point in time, there will be development or delineation occurring in all parts of the Core Area and likely the PDA. In addition, the patchy scheme proposed in Alternative D will fragment the habitat more than if one Development Area at a time were fully developed and reclamation begun. We reiterate that the gas will still be in the ground at whatever point an area is developed.

W-4 EG-2-9

Second, seasonal wildlife stipulations for sage-grouse must be retained and enforced. There cannot be the current pattern by BLM of waiving or excepting these restrictions. But seasonal stipulations alone will not protect sage-grouse populations; they must be used in conjunction with other actions discussed immediately above and below. The ¼ mile buffers for leks are insufficient. As demonstrated in the Holloran study (Attachment 3), road-related activity within 0.8 mile of the lek caused declines in male attendance. There will be ***100 miles of new*** roads under Alternatives D. Females which breed on leks within 1.9 miles of gas development have lower nest initiation rates and nested farther from the leks. ("Using the Best Available Science" at 7.) Nesting habitat around leks should be protected for 3-4 miles from the lek.

W-5 EG-2-10

Third, wellpad density throughout the PAPA must be reduced by maximum use of directional drilling and clustered wellpads. The Holloran and Naugle studies established

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Greater sage-grouse population response to energy development and habitat loss. Journal of Wildlife Management: In Press. Walker, B.L., D.E. Naugle, K.E. Doherty, and T.E. Cornish. 2007. West Nile virus and greater sage-grouse: estimating infection rate in a wild bird population. Avian Diseases 51:In Press. Naugle, D.E., B.L. Walker, and K.E. Doherty. 2006. Sage Grouse Population Response to Coal-bed Natural Gas Development in the Powder River Basin: Interim Progress Report of Region-Wide Lek-Count Analyses. College of Forestry and Conservation, University of Montana. Missoula, Montana. 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 28:967-985. Holloran, M.J., R.Kaiser, and W. Hubert. Population response of yearling greater sage-grouse to the infrastructure of natural gas fields in southwestern Wyoming. Completion Report, August 2007, U.S. Geological Survey, Wyoming Cooperative Fish and Wildlife Research Unit.

EG-2-10

that when wellpads are within 1.9 miles of leks and wellpad density is greater than 1 pad/square mile, leks tend to go inactive. (Holloran 2005; Naugle et al. 2006) Wellpad density should not be greater than 1 pad /square mile when a lek is within 2 miles of a wellpad.

RC-1 EG-2-11

Fourth, reclamation must restore sage-grouse habitat to its full functionality. This means revegetating disturbed areas with the natural, native vegetation that as closely as possible approximates the pre-development landscape. This includes revegetation with native grasses, forbs and shrubs to replicate the sagebrush-grassland habitats that sustained sage-grouse prior to development. This requirement must be mandatory; "or otherwise approved" plant communities cannot be substituted. This requirement must be enforced and operators should not be released from their bonds or legal obligations under the plan until all reclamation is fully functional.

AL-2 EG-2-12

Fifth, the PDA, which would be an expanded Core Area, must be eliminated. There is little question there will be development in the PDA. Full-field development of the Core Area will have significant impacts already, without enlarging the area of impacts. We maintain that any access to the PDA area must be through use of directional drilling, without surface disturbance in the PDA area.

A study cited in the "Using the Best Available Science" on sage-grouse response to energy development in the Powder River Basin[3] found that seasonal restrictions on drilling and construction do not address impacts caused by loss of sagebrush. Their study also concluded that incursion of infrastructure can affect populations over long periods of time. Their recommendations were increased spatial restrictions on development imposed by agencies, and rapid implementation by industry of more effective mitigation measures.

The proposed Bird Canyon corridor and alternative corridor go directly through prime sage grouse habitat and likely very close to leks. They also extend well beyond the PAPA. The ¼ mile buffer for construction around sage-grouse leks is inadequate; buffers of 1 mile must be maintained, at a minimum. The seasonal sage-grouse stipulations must be retained and enforced.

We also have important concerns about the liquids gathering plant being located in DA-5, an area with the heaviest concentration of sage-grouse leks and habitat in the Core Area. Liquids gathering plant

3. Sagebrush Obligate Songbirds

Sagebrush obligate songbirds, such as the Brewer's sparrow, sage thrasher and sage sparrow, are all present in the Pinedale Anticline Project Area. These birds are designated by BLM as Sensitive Species and by Wyoming Game and Fish Department (WGFD) as Species of Special Concern; thus, they warrant special attention and

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[3] Walker, B., D. Naugle, and K. Doherty. Nov. 2007. *Greater Sage-Grouse Population Response to Energy Development and Habitat Loss*, Journal of Wildlife Management.

protection due to their sensitive status in the PAPA. The study of Inglefinger, for instance, shows that habitat fragmentation is particularly harsh on passerines such as the Brewer's sparrow, sage sparrow and sage thrasher.[4]

4. Pygmy Rabbit

W-6 EG-2-13

The pygmy rabbit is listed in Table 3.21-2 as a BLM Sensitive Species and a WGFD Species of Special Concern. The BLM makes no mention of the fact that the pygmy rabbit (*Brachylagus idahoensis*) was petitioned for listing under the Endangered Species Act on April 21, 2003. Although the RDSEIS was released before U.S. Fish and Wildlife Service made its 90-day finding pursuant to Court order[5] that listing of the species may be warranted (January 8, 2008), BLM still is presumed to have knowledge of the petition and the court proceedings regarding the pending petition, especially in light of the fact that the pygmy rabbit is present on the PAPA. The information relied upon by BLM from USFWS was from 2005, at which time USFWS identified the species as sensitive. There is no excuse for BLM not using the most up-to-date information in its environmental analysis.

Under the RDSEIS there would be no protection afforded the pygmy rabbit. The RDSEIS discloses at page 4-136 that it has no information to indicate how the species will respond to winter drilling. The RDSEIS further reveals that pygmy rabbits have been killed by vehicles in the PAPA and the level of vehicle-caused deaths is expected to increase under all Alternatives, but it is unknown how much such deaths might increase. BLM cannot proceed with proposed year-round drilling without first obtaining necessary information about impacts. It is unclear if BLM has ever surveyed the area for the species or that it knows locations for the species, although it discloses in the RDSEIS the species is present. Since pygmy rabbits are highly dependent on sagebrush to provide both food and shelter throughout the year (their diet in the winter consists of up to 99 percent sagebrush), destruction of much of their habitat on the PAPA could have disastrous consequences to the species.

W-7 EG-2-14

Before issuance of the FSEIS BLM must: (1) survey the entire PAPA for the species and inventory and map their locations; (2) designate critical habitat for the species; (3) design adequate plans to avoid impacts in the FSEIS and, when impacts cannot be avoided, design on-site mitigation to afford the necessary degree of protection to ensure sustainability and survival of the species. These steps are absolutely vital to the survival of this population of pygmy rabbit and they must be taken prior to allowing any further activities on the PAPA. BLM has a duty to do no less than this.

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[4] Ingelfinger, F. 2001. The Effects of Natural Gas Development on Sagebrush Steppe Passerines in Sublette County, Wyoming. Master's Thesis, Univ. of Wyoming, Laramie, WY. *See also* Knick, S.T., et al. 2003. Teetering On The Edge Or Too Late? Conservation and Research Issues for Avifuana of Sagebrush Habitats. The Condor 105:611-634.

[5] *See Western Watersheds Project et al.v. Gale Norton and U.S. Fish and Wildlife Service* (CV 06-CV-00127-S-EJL) (D. Idaho), Judgment and Memorandum issued September 26, 2007, holding that the Service improperly imposed a higher standard than required for a 90-day petition finding and therefore found the Service's denial of the petition was contrary to the applicable law.

5. Prairie Dog Colonies

White-tailed prairie dogs are present on the PAPA and are a BLM Sensitive Species, as well as a WGFD Species of Special Concern. The current fragmentation of their habitat is already of concern to us, but we have heightened concerns now because there is no provision in the DSEIS for protection of this species. Prairie dogs are keystone species, providing a food source for many other species present on the PAPA and providing homes for other species such as burrowing owls and black-footed ferrets. The increasing fragmentation of habitat with its concomitant impacts is of grave concern to us.

Prairie dogs are lumped with a number of other species in the RDSEIS as "Special Status Wildlife Species" all of which (excluding the bald eagle) are given a scant 1½ pages of discussion under environmental consequences in the chapter on "Environmental Consequences." Pp. 4-135 to 137. Does this reflect the importance and value BLM places on these species?

The PAPA encompasses some 11,600 acres of white-tailed prairie colonies; USFWS has determined that about 64 square miles of the PAPA are within the Big Piney Prairie Dog Complex which it considers potential habitat for black-footed ferrets. Prairie dogs are almost the exclusive food for black-footed ferrets. This area has not been surveyed for black-footed ferrets. A recently discovered ferret skull found in the prairie dog colonies suggests that ferrets have been present in the area, and may still be present.

W-8 W-9 EG-2-15

We urge BLM to conduct surveys for black-footed ferrets before a final SEIS is issued and additional development is approved. We also exhort BLM to provide specific protection measures for both species, and particularly for prairie dogs which are an essential food source for not only black-footed ferrets, but also many other species. BLM cannot allow activities on the PAPA which would prevent the area from becoming a relocation site for the endangered black-footed ferret. Additionally, BLM has a duty to take steps which will remove prairie dogs (and other BLM Sensitive Species) from the Sensitive Species list. BLM cannot simply track the impacts on Sensitive Species from project to project while the species continue to decline. The agency has an affirmative duty to ensure the various Sensitive Species are protected in a manner which will lead to their eventual delisting as Sensitive Species. BLM has the added legal duty not to allow activities on public lands it administers which could lead to the listing of white-tailed prairie dogs under the ESA.

W-10 W-11 EG-2-16

It is well known that some man-made facilities at oil and gas development sites provide perches for raptors, which are given an unnatural advantage in preying upon prairie dogs. We therefore request that no facilities above ground be permitted within ¼ mile of prairie dog colonies unless they are fitted with anti-raptor devices to discourage perching. As a further protection for prairie dogs, BLM should allow no surface disturbing activities within 50 meters of white-tailed prairie dog colonies and no telephone poles or other such structures should be allowed in prairie dog colonies at all.

6. Raptors

Astonishingly, the WGFD has recommended eliminating seasonal restrictions for raptors in the PAPA. In Alternative D these restrictions are left in place, although all other seasonal wildlife stipulations are cast off in favor of year-round drilling. We absolutely cannot concur with WGFD's recommendation. Their only justification for getting rid of raptor seasonal stipulations is because the project proposes implementation without all the others restrictions. This is not logical, and it only highlights the illogical thinking behind doing away with all other seasonal wildlife stipulations. It if is imperative to retain seasonal protections for raptors, then it is imperative to retain all seasonal wildlife protections. The point is not that BLM should get rid of raptor restrictions because it eliminated all other seasonal restrictions; the point is that ***none of the seasonal wildlife restrictions should be waived or excepted.*** These are minimum protections that must be paired with a suite of other conservation practices. The voice of WGFD is at odds with the USFWS, which has the obligation to oversee federally protected species, and the voice of WGFD is at odds with its own policies.

W-12 EG-2-17 Seasonal protections for raptors must be retained.

7. Other Sensitive Species

As noted above, a number of the BLM Sensitive Species were lumped together in a 1½ page analysis entitled "Special Status Wildlife Species." Under all Alternatives, additional surface disturbance will have direct and indirect impacts on a number of species, including ferruginous hawk, mountain plover, long-billed curlew, burrowing owl, sage thrasher, loggerhead shrike, grasshopper sparrow, Brewer's sparrow, sage sparrow, pygmy rabbit, white-tailed prairie dog, and spotted bats. P. 4-136 to 137. For other than the most hearty individuals of each species, it is expected that there will be greater abandonment of nests and decreased production of young. This does not bode well for any Sensitive Species in the PAPA. At least some of the Sensitive Species were surveyed by Ecosystem Research Group in 2006, and reference is made of annual wildlife surveys prior to 2001, but there is no data comparison for any species. Thus, it is impossible to know what is really going on with any of these species. Are populations stable or declining? What is the current rate of nest abandonment? How does it compare with observations prior to 2001? What decrease in production of young has occurred, and over what observed period of time?

W-13 EG-2-18 Answers to these questions and many more must be answered before a Final SEIS is released. Much more analysis is needed for these Sensitive Species. BLM cannot simply sweep them under the rug with the brush of the broom. Although BLM may believe these species are dispensible, each occupies a niche in the PAPA ecosystem, and each is vital to the fragile balance that exists there.

8. Aquatic Species

EG-2-19 W-14

Stronger measures are needed in the SEIS to control sediment run-off in the New Fork River and Green River watersheds. Further analysis is also needed to assess impacts of interrupted stream flow and habitat modification on Colorado River fish species (pikeminnow, humpback chub, bonytail and razonback sucker), which will be impacted by the full-field development. We recognize that the Recovery and Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (RIP) was established to mitigate for water depletion impacts; we do not agree that the payment of a depletion fee alone will ameliorate impacts of full-field development. A fee will do nothing to regulate stream flow, unblock migration corridors, or clean up pollution released in the watersheds. These impacts all contribute to the success of nonnative fish species in the Upper Colorado River Basin and the ultimate demise of native fish species. Regardless of the RIP, BLM has a duty to design the project in a way that will avoid these impacts to native fish, and other native aquatic, species. We request that stronger measures be included in the FSEIS for protection of native aquatic species.

B. Wildlife Migration Corridors

EG-2-20 W-15

All of the big game species that utilize the PAPA migrate in and out of the area at different seasons of the year. These migration corridors are critical for wildlife to reach their seasonal ranges and obtain the necessary forage for survival. We discussed above in the "Big Game" section the need to survey, identify and map all wildlife migration corridors. These steps must be finished before the project can be implemented.

Year-round concentrated development may also have significant impacts on migration corridors. Some changes in migration routes in response to oil and gas development, and other human activities such as subdivisions, have already been observed by researchers. Migration corridors have historically been used by wildlife for centuries. The impacts from forcing changes in these patterns are unknown, but we doubt they could be favorable since they are likely to shift wildlife away from traditional crucial ranges to habitat that is less favorable and less able to sustain wildlife populations. In fact, that behavior has already occurred to some extent.

C. Habitat Fragmentation

EG-2-21 W-16

Habitat fragmentation under Alternative D will be nearly 2½ times the level existing in 2006. Table 4.20-1. Two hundred fifty new wellpads are anticipated under Alternative D, with an increased average wellpad size from 6.9 acres in 2006 to 17.7 acres. To the extent the increased average wellpad size is from clustered wells, we have no complaint. Still, 250 new wellpads is huge. Continuing fragmentation of previously undisturbed land has led to reduced use by wildlife. For instance, pronghorn appear to abandon habitat in parcels of 600 acres or less. (Berger et al., 2006) Yet Alternative D proposes up to 3 wellspads per acre. This level of wellpad spacing not only fragments prime wildlife habitat, but it also creates more miles of edge, both of which have significant impacts to wildlife. The proposed wellpad density in Alternative D cannot be permitted. Directional drilling must be mandatory unless the operator can clearly demonstrate that it is not technologically feasible to do so. We

W-16 EG-2-21 strongly advocate for one wellpad per section to reduce the impacts to sensitive wildlife below the significant level.

As habitat becomes more fragmentated, wildlife resort to more avoidance of that habitat. Where avoidance is already occurring with seasonal stipulations in place, what will be the response of wildlife when those stipulations are removed? The real question is, however, what will be the impacts to wildlife from avoidance of habitat as it becomes more fragmented? No answer is provided in the RDSEIS and, consequently, no solutions are offered.

D. Air Quality Issues

The comments filed February 11, 2008, authored by Wyoming Outdoor Council, and which include Biodiversity Conservation Alliance, contain extensive supplemental comments on air quality issues. We incorporate those comments in their entirety by reference into these comments as our comments on air quality.

E. Reclamation

We have discussed previously our position that the PDA should be eliminated and that area should be part of the Flanks. It should not incur surface disturbance for the duration of development of the Core Area. If deemed desirable by the operators, the proposed PDA area could be access through directional drilling, thereby making surface disturbance unnecessary. This said, we do not support and development on the Flanks (including the PDA) until at least interim reclamation is completed in the Core Area. It is most desirable that not only interim reclamation be completed, but also significant permanent reclamation be underway before any development on the Flanks is allowed.

RC-2 EG-2-22 We have discussed previously, and reiterate here, that reclamation must be undertaken and successfully completed using only native species, and that the landscape must be returned to its natural condition existing immediately prior to development. No exceptions should be made to this policy. It is not acceptable to reclaim the landscape to anything less than this standard. For example, if the sagebrush community with its associated grasses, forbs and shrubs, is not replicated, many wildlife species will not be able to return to the PAPA. This thwarts the purpose of reclamation and violates the expectations of the owners of these lands—the public.

RC-3 EG-2-23 Reclamation success is measured against a reference site. It should go without saying, but we will say it anyway, that the reference site must truly reflect the character and plant components of the disturbed area.

The "Release Criteria for Suspended and Term NSO Leases" for Alternative D states important goals for reclamation. We are concerned nonetheless that "providing sustainable forage for wildlife and/or livestock" could allow reclamation for the primary benefit of livestock (e.g., grasses) rather than providing forage for wildlife. We would object to such an interpretation. Restoring habitat to functionality means restoring the habitat which will sustain the wildlife that has historically used the PAPA. If livestock benefit from this as well, we have no objection.

F. Monitoring and Mitigation

EG-2-24

The Wildlife Monitoring and Mitigation Matrix contained in Appendix 10 takes a large step forward in addressing some of the concerns we raised in our comments to the DSEIS. For the first time, BLM has established some threshold of decline of a particular species which will trigger a mitigation response to be selected from a suite of responses. We welcome the change of approach. We have issues with some of the thresholds and responses, however. W-17 We would like scientific verification that the specific changes which require mitigation are based on sound scientific data, starting with accurate numbers of each species which are monitored annually. For instance, a 15% change in the mule deer population in one year can be huge. The mule deer herd has already plummeted by 46% since the PAPA ROD was implemented. Fifteen percent of the remaining 54% may be too drastic a drop in a single year to permit an adequate and timely mitigation response. W-18 We emphasize that the delay in selecting, recommending and implementing any mitigation response may also be too long. See Figure 2.4-1.

EG-2-25

W-19 We would also like scientific verification that the criteria for each species is the appropriate one to monitor. For example, is the change in mule deer numbers the key factor in predicting viability and sustainability, or would another factor be a truer barometer of the viability and sustainability of the population? Or if the number of sage-grouse leks declines but numbers remain the same, is this the most important factor to predict sage-grouse viability or sustainability? W-20 And speaking of viability, the BLM still has not determined what comprises a viable population of any species on the PAPA, a determination that must be precedent to planning the Monitoring and Mitigation Matrix.

EG-2-26

We are also concerned that BLM states that the mitigation responses "utilize(s) performance-based measures to proactively react to ***emerging impact changes*** early enough to assure both effective mitigation responses and a fluid pace of development . . ." P. 10-5. (Emphasis added.) First, one can hardly consider a 15% decline in mule deer or pronghorn populations in a single year to be an "emerging impact change." Rather, such a change would be dramatic. Second, maintaining a fluid pace of development (whatever that may mean) cannot be the dominant consideration when wildlife populations are at stake. The pace of development can be slowed dramatically and the gas resource will still be in the ground. If wildlife populations are plummeting, an urgent response is called for—one that will be effective. It may be that the only viable responses are to reduce the pace and/or intensity of development. Such a response should ***not*** be the response of last resort. What "other resources" will be taken into account before BLM would adjust spatial arrangement or pace of development? We can understand the reasoning behind BLM's mitigation responses, but we cannot agree with it. Too little is known about wildlife viability and sustainability at this point in time to "wait and see." W-21 BLM must acknowledge that it may have to take dramatic action quickly to forestall devastating impacts to wildlife, action such as changing slowing

W-22 W-23 EG-2-26 pace of development. BLM does not know at what point a species crosses the line and cannot recover. This resource is too valuable to play waiting games with. BLM must take the actions necessary to protect wildlife, not the actions desired by the operators. Since it is oil and gas development which is creating the impacts, consideration of reduction of development activities must be given at the outset of any warning sign of trouble. What is meant by the language in Option 4 "Recommend, for consideration by Operators and BLM?" Does this mean that if the Operators don't agree to the recommendation, it cannot be implemented? If this is what the intent is, it is absurd. Who is in charge here? BLM administers public lands, not the Operators.

EG-2-27 W-24 On what scientific basis does BLM estimate that modification of spatial arrangement of year-round development would be more effective in mitigating impacts than changing the pace of development? This is nothing more than a bald statement of hope that this will be case; there is absolutely no scientific basis for it. And what habitat enhancements are proposed as the first step of mitigation? These are not spelled out anywhere, nor is there any scientific basis for making this the first step of mitigation. The whole suite of mitigation responses should be available at any time a response is triggered; mitigation should not be sequential.

EG-2-28 W-25 We also take issue with BLM's statement that "Levels of change would be based on current conditions rather than changes that have already occurred." P. 4-160. BLM has a legal obligation to consider the cumulative impacts of oil and gas development, which includes the impacts which have already occurred. To exclude impacts prior to 2005-2006 gives a skewed view of the impacts to wildlife.

EG-2-29 MF-1 We are confused by the meaning of BLM's statement about the offsite mitigation fund that compliance activities "do not fit the intended purpose of the fund." P. 11-2. How does BLM define "compliance activities?" No hint is given in Appendix 11 as to the meaning of this statement. We ask that BLM define what compliance activities will not be covered by the offsite mitigation fund.

While the $36 million mitigation/monitoring fund Proponents committed to is not a small sum by most standards, it is an exceedingly small portion (1.9%) of the total profits anticipated to be made by the operators on the PAPA. This fact should not go unnoticed.

Much work remains to be done with respect to the Wildlife Monitoring and Mitigation Matrix. We trust BLM will give careful consideration to the questions and points we have raised and respond appropriately.

G. Removal of Seasonal Wildlife Stipulations Violates RMP

The Pinedale Resource Management Plan (RMP) states that, "Seasonal restrictions will be incorporated into all land use authorizations where appropriate." RMP Record of Decision at p. 9. There is nothing in this language which would permit the issuance of a supplemental ROD in the PAPA without seasonal restrictions, unless it was plainly demonstrated that seasonal restrictions were ***inappropriate***. There has been no such showing in the RDSEIS.

In fact, there is nothing in the RDSEIS to support BLM's recommendation of removal of seasonal stipulations. Such recommendation is nothing short of an untried, untested experiment which may well be conducted at the expense of the various wildlife populations. On the other hand, however, there is sound and unchallenged science which reveals that even with seasonal restrictions in place, significant and devastating wildlife impacts are occurring. There is nothing in the best available science to suggest that permanently waiving seasonal restrictions while ramping up the pace and intensity of development will lessen the impacts to wildlife. We reiterate that nothing scientifically supports this theory. Permanent waiver of seasonal restrictions will therefore violate the RMP.

H. Development Areas

The Alternative D Development Areas (DAs) are quite complex and have obviously been crafted to minimize the impacts to wildlife and other resources at any point in time during development of the Core Area. We commend BLM and industry for the thoroughness with which they have approached plans for these extremely sensitive areas. That said, we do not believe even the complexity of the plan and the care which was taken will reduce the impacts below the level of significant. The impacts will still be extreme and will still occur within critical wildlife habitat, for the most part without even seasonal wildlife stipulations. What is most troublesome about the plan for Development Areas is that there is ***no*** scientific basis for it. Current scientific data plainly contradicts the assumptions made by BLM in the Development Area scheme. Where exceptions to wildlife restrictions have been granted year-round, there have been continuous declines of wildlife populations.

The Development Areas as proposed have much to recommend them in terms of protections, but they can be only a starting point. We are concerned, for instance, that nearly every good point of the plan can be excepted or waived; thus eliminating any real safety net. We have seen too many examples of BLM granting exceptions with detrimental impacts, to believe BLM will act in the best interests of wildlife or other resources.

Along the same lines, it appears that even when meaningful restrictions are put in place, there are exceptions to them right up front. For example, In DA-1, which is entirely within big game crucial winter ranges, it looks like there will be a 24-month transition period during which no new development would occur. But then one discovers that Anschutz can begin development of its leases immediately and delineation drilling (with up to 22 new wells) can occur immediately. Even though the intensity of development might be lower during the first 2 years, there still will be development activity in DA-1.

W-26 EG-2-30 DA-4 which is quite close to several sage-grouse leks and very likely has nesting and brood-rearing habitat, has no seasonal restrictions for sage-grouse. This flies in the face of the "Using the Best Available Science" article cited above in Footnote 2, which advocates delineating core areas to "capture the range required by a defined population to maintain itself." (P. 2) We strongly echo the recommendations of the article and urge BLM to apply not only the customary seasonal sage-grouse restrictions, but also other measures supported by the best available science and detailed in the article.

DA-5 which has the greatest concentration of sage-grouse leks in and around the PAPA, will have no seasonal restrictions for sage-grouse, will allow a wellpad on every 40 acres, will have the standard¼ mile buffers around leks, and will allow full concentrated development within 1 mile of occupied leks. This is inconceivable, unsupportable, and sheer madness. It is directly contrary to the conservation strategies summarized in "Using the Best Available Science." We emphasize that none of the information contained in "Using the Best Available Science" is new; the article is simply a summary of what is already out there and conservation strategies relating to oil and gas development that are supported by the current literature. Most of these studies were commissioned by BLM and/or industry and the contents were undeniably known to both at the time the RDSEIS was being written. Neither can make an excuse that it didn't have the information for use in designing Alternative D.

Not only does Alternative D propose 40-acre spacing for wellpads, but exceptions can be made to this, allowing even denser spacing in critical sage-grouse habitat. The scientists and wildlife experts concur that scientific data supports no more than 1 wellpad ***per square mile***. (See p. 2) More than that leads to calculable impacts on breeding populations. Breeding, summer and winter habitat is essential to survival of breeding populations, and for this reason, these areas should not be developed at all.

DA-5 is also proposed for the liquids gathering system. Have plans been developed for construction of this facility? We are deeply concerned that with no seasonal restrictions for sage-grouse in DA-5, construction of the system will impose unacceptable levels of pressure on the birds, causing them to possible abandon the leks, abandon their nests, be unsuccessful in brood-rearing, have poor over-winter survival rates, and/or otherwise incur impacts which will further drive the species toward extirpation.

We understand the reasons for including the ½ mile PDA areas around the Core Area, but we disagree, and continue to call for elimination of the PDA altogether and the exclusive use of directional drilling to access those areas for the duration of development of the Core Area. In addition, BLM must insist that all seasonal wildlife restrictions apply not only to what currently are PDA areas, but to the entire PAPA. There should be no exceptions to seasonal wildlife stipulations.

G-3 EG-2-31

The Stewart Point to Pinedale/Gobblers Knob Compressor Station will have two pipelines which are co-located, yet they will be constructed at separate times. This is nonsense. Is there any justification for not constructing the pipelines at the same time? This simply causes double the amount of human activity, traffic, noise, pollution, impacts to wildlife, impacts to soils and vegetation, and also delays reclamation of the land back to functionality.

With most components in Alternative D moving targets, it is difficult to anticipate the impacts to other resources, and nearly impossible to calculate the degree of impacts. This is unacceptable.

II. ALTERNATIVE E

Since Alternative E is not the Preferred Alternative, we will not provide as detailed discussion of it as we did with Alternative D. We will highlight the provisions which we deem worthwhile and which we recommend be incorporated into Alternative. We reiterate that Alternative D as proposed is unacceptable without the modifications we have indicated above and indicate in the following discussion.

G-4 EG-2-32

We fully support a slower pace of development. Although we have repeated this throughout our comments, it bears repeating yet again that all seasonal wildlife restrictions must be retained, with no exceptions. If exceptions are to be allowed, then they must conform to the requirements IM 2008-032. Wellpad density must continue to be limited. Ideally, there would be one wellpad per square mile with required directional drilling, but recognizing that this will not happen, we can support 80 acre wellpad spacing. The Buffer Area should be eliminated and this area incorporated into the Flanks. No development should be allowed in the Flanks (including Buffer Area) until all development in the Core Area is completed and reclamation is established. This will require suspension of leases and term NSO leases which will continue until the Core Area is fully developed and reclamation established to a functioning level. The liquids gathering system throughout the PAPA must be retained as proposed in Alternative D. The number of new wellpads should be limited to 250. There is no justification for increasing new wellpads in Alternative E (415) over the number proposed in Alternative D (250). Directional drilling and clustered wellpads can be utilized to the same degree in Alternative E as in Alternative D. We would urge restricting initial disturbance to the limits placed in Alternative E (10,427 acres). We support the smaller Core Area defined in Alternative C; we find no justification for the expanded Core Area defined in Alternatives D and E. Bigger is not better in this instance.

We hereby incorporate by reference the previous comments submitted by us in response to the Draft SEIS on April 7, 2007, and all attachments included with those comments. Those should be considered in their entirety by BLM as part of these comments.

Sincerely,

Suzanne H. Lewis

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Invited Article

Winter Habitat Selection of Mule Deer Before and During Development of a Natural Gas Field

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Abstract

*Increased levels of natural gas exploration, development, and production across the Intermountain West have created a variety of concerns for mule deer (*Odocoileus hemionus*) populations, including direct habitat loss to road and well-pad construction and indirect habitat losses that may occur if deer use declines near roads or well pads. We examined winter habitat selection patterns of adult female mule deer before and during the first 3 years of development in a natural gas field in western Wyoming. We used global positioning system (GPS) locations collected from a sample of adult female mule deer to model relative frequency or probability of use as a function of habitat variables. Model coefficients and predictive maps suggested mule deer were less likely to occupy areas in close proximity to well pads than those farther away. Changes in habitat selection appeared to be immediate (i.e., year 1 of development), and no evidence of well-pad acclimation occurred through the course of the study; rather, mule deer selected areas farther from well pads as development progressed. Lower predicted probabilities of use within 2.7 to 3.7 km of well pads suggested indirect habitat losses may be substantially larger than direct habitat losses. Additionally, some areas classified as high probability of use by mule deer before gas field development changed to areas of low use following development, and others originally classified as low probability of use were used more frequently as the field developed. If areas with high probability of use before development were those preferred by the deer, observed shifts in their distribution as development progressed were toward less-preferred and presumably less-suitable habitats.* (JOURNAL OF WILDLIFE MANAGEMENT 70(2):396–403; 2006)

Key words

generalized linear model (GLM), Global Positioning System (GPS), habitat selection, mule deer, natural gas development, negative binomial, Odocoileus hemionus*, resource selection probability function (RSPF), Wyoming.*

Natural gas development on public lands in Wyoming has steadily increased since 1984 (Bureau of Land Management 2002) and created much concern over potential impacts to wildlife. Public lands with high gas potential often coincide with regions of Wyoming that support large mule deer (*Odocoileus hemionus*) populations, such as the Green River Basin (Bureau of Land Management 2000*a*), Great Divide Basin (Bureau of Land Management 2000*b*), and Powder River Basin (Bureau of Land Management 2003). Impacts of natural gas development on mule deer may include the direct loss (i.e., surface disturbance) of habitat to well pad, access road, and pipeline construction. Additional indirect habitat losses may occur if increased human activity (e.g., traffic, noise) associated with infrastructure cause mule deer to be displaced or alter their habitat use patterns. Although it is relatively easy to quantify the direct habitat losses that result from conversion of native vegetation to infrastructure, it is much more difficult to document indirect habitat losses. Nonetheless, because indirect impacts can affect a substantially larger area than direct impacts, understanding them may be a key component to maintaining mule deer seasonal ranges and populations in regions with high levels of natural gas development. Accordingly, there is a need among land management and wildlife agencies to better understand how natural gas development can lead to indirect habitat loss to ensure informed land-use decisions are made, reasonable and effective mitigation measures identified, and appropriate monitoring programs implemented. Our objective was to determine whether natural gas development affected the habitat selection patterns and, thus, distribution of wintering mule deer in western Wyoming.

Study Area

Beginning in 2000, the Bureau of Land Management (BLM) approved the construction of 700 producing well pads, 645 km of pipeline, and 444 km of roads to develop a natural gas field in the Pinedale Anticline Project Area (PAPA; Bureau of Land Management 2000*a*). The PAPA contains one of the largest and highest density (19 to 30 deer/km^2) mule deer winter ranges in Wyoming (S. Smith, Wyoming Game and Fish Department, Cheyenne, Wyo., USA, unpublished data). The PAPA is located in the upper Green River Basin of western Wyoming, approximately 5 km southwest of Pinedale. The PAPA consists primarily of federal lands (80%) and minerals administered by the BLM (83%). The state of Wyoming owns 5% (39 km^2) of the surface and another 15% (121 km^2) is private (Bureau of Land Management 2000*a*). The study area contains abundant deep gas reserves, supports a variety of agricultural uses, and provides winter range for 4,000 to 5,000 migratory mule deer that summer in portions of 4 different mountain ranges 80 to 200 km away (Sawyer and Lindzey 2001). Although the PAPA covers 799 km^2, most mule deer wintered in the northern one-third, an area locally known as the Mesa. The Mesa is 260 km^2 in size, bounded by the Green River on the west and the New Fork River on the north, south, and east, and vegetated primarily by Wyoming big sagebrush (*Artemisia tridentata*) and sagebrush–grassland communities. Elevation ranges from 2,070 to 2,400 m. Our study was restricted to the Mesa portion of the PAPA.

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Methods

Capture

We captured adult (≥1 year) female mule deer using helicopter net-gunning in the northern portion of the PAPA where deer congregated in early winter before moving to their individual winter ranges throughout the Mesa (Sawyer and Lindzey 2001). We believed attempting to randomly capture deer in this area during early winter provided the best opportunity to achieve a representative sample from the wintering population. In years before development (winters 1998–1999 and 1999–2000), we fitted deer with standard, very high frequency (VHF) radio collars (Advanced Telemetry Systems, Isanti, Minnesota). We located radio-collared deer from the ground or air every 7 to 10 days during the 1998–1999 and 1999–2000 winters (1 Dec to 31 Mar). During years of gas field development (winters 2000–2001, 2001–2002, and 2002–2003), we fitted deer with store-on-board global positioning system (GPS) radio collars (Telonics, Inc., Mesa, Arizona) equipped with VHF transmitters and remote-release mechanisms programmed to release at specified dates and times. We fitted GPS radio collars to a sample of different deer each winter; however, 3 deer had collars that collected GPS locations for both the 2001–2002 and 2002–2003 winters. We programmed GPS radio collars to attempt location fixes every 1 or 2 hrs, depending on model type. We did not differentially correct GPS locations because 3-dimensional fixes typically have <20 m error (Di Orio et al. 2003), and previous work in the study area indicated 99% fix-rate success with 80% of successful fixes 3-dimensional locations (Sawyer et al. 2002). Potential fix-rate bias was not a concern because of the high fix-rate success of the GPS collars.

Modeling Procedures

Defining availability.—We defined the study area by mapping 39,641 locations from 77 mule deer over a 6-year period (1998 to 2003), creating a minimum convex polygon (MCP), and then clipping the MCP to the boundary of the PAPA. This was consistent with the McClean et al. (1998) recommendation that the study-area level of habitat availability should be based on the distribution of radio-collared animals.

Habitat variables.—We identified 5 variables as potentially important predictors of winter mule deer distribution, including elevation, slope, aspect, road density, and distance to well pad. We did not include vegetation as a variable because the sagebrush–grassland was relatively homogeneous across the study area and difficult to divide into finer vegetation classes. Further, we believed differences in sagebrush characteristics could be largely explained by elevation, slope, and aspect. We used the SPATIAL ANALYST extension for ArcView (Environmental Systems Research Institute, Redlands, California) to calculate slope and aspect from a 26 × 26-m digital elevation model (U.S. Geologic Survey 1999). Grid cells with slopes >2 degrees were assigned to 1 of 4 aspect categories: northeast, northwest, southeast, or southwest. Grid cells with slopes of ≤2 degrees were considered flat and assigned to a fifth category that was used as the reference (Neter et al. 1996) during habitat modeling. We obtained elevation, slope, and aspect values for each of the sampled units using the GET GRID extension for ArcView. The sample units consisted of approximately 4,500 circular units with 100-m radii distributed across the study area. We annually digitized roads and well pads from LANDSAT thematic satellite images acquired from the U.S. Geologic Survey and processed by SkyTruth (Sheperdstown, West Virginia). The LANDSAT images were obtained every fall, before snow accumulation, but after most annual development activities were complete. We calculated road density by placing a circular buffer with a 0.5-km radius on the center of the sample unit and measuring the length of road within the buffer. We used the NEAREST NEIGHBOR extension for ArcView to measure the distance from the center of each sampled unit to the edge of the nearest well pad. We did not distinguish between developing and producing well pads. We assumed habitat loss was similar among all well pads because development of the field was in its early stages (i.e., <5 years), and there was no evidence of successful shrub reclamation. Additionally, there was no evidence that suggested the type of well pad was an accurate indicator of the amount of human activity (e.g., traffic) that occurred at each site. Without an accurate measure of human activity, we believed it was inappropriate to distinguish between producing and developing well pads.

Statistical analyses.—Our approach to modeling winter habitat use consisted of 4 basic steps: 1) estimate the relative frequency of use (i.e., an empirical estimate of probability of use) for a large sample of habitat units for each radiocollared deer, during each winter; 2) use the relative frequency as the response variable in a multiple regression analysis to model the probability of use for each deer as a function of predictor variables; 3) develop a population-level model from the individual deer models, for each winter; and 4) map predictions of population-level models from each winter. Our analysis treated each winter period separately to allow mule deer habitat use and environmental characteristics (e.g., road density or number of well pads) to change through time. We treated radiocollared deer as the experimental unit to avoid pseudo-replication (i.e., spatial and temporal autocorrelation) and to accommodate population-level inference (Otis and White 1999, Johnson et al. 2000, Erickson et al. 2001).

We estimated relative frequency of use for each radio-collared deer using a simple technique that involved counting the number of deer locations in each of approximately 4,500 randomly sampled, circular habitat units across the study area. We took a simple random sample with replacement for each winter to ensure independence of the habitat units (Thompson 1992:51). We chose circular habitat units that had a 100-m radii; an area small enough to detect changes in animal movements but large enough to ensure multiple locations could occur in each unit. Previous analyses suggested model coefficients were similar across a variety of unit sizes, including 50, 75, and 150-m radii (R. Nielson, Western Ecosystems Technology, Inc., Cheyenne, Wyo., USA, unpublished data). We measured predictor variables on each of the sampled habitat units and conducted a Pearson's pairwise correlation analysis (PROC CORR; SAS 2000) before modeling to identify multicolinearities and to determine whether any variables should be excluded from the modeling ($|r| > 0.60$).

The relative frequency of locations from a radio-collared deer found in each habitat unit was an empirical estimate of the probability of use by that deer and was used as a continuous response variable in a generalized linear model (GLM). We used an offset term (McCullagh and Nelder 1989) in the GLM to estimate probability of use for each radiocollared deer as a function of a linear combination of predictor variables, plus or minus an error term assumed to have a negative binomial distribution (McCullagh and Nelder 1989, White and Bennetts 1996). We preferred the negative binomial distribution over the more commonly used Poisson because it allows for overdispersion (White and Bennetts 1996).

We obtained a population-level model for each winter by first estimating coefficients for each radiocollared deer. We used PROC GENMOD (SAS 2000) and the negative binomial distribution to fit the following GLM for each radiocollared deer during each winter period:

$$\ln[E(r_i)] = \ln(total) + \beta_0 + \beta_1 X_1 + \ldots + \beta_p X_p, \qquad (1)$$

which is equivalent to

$$\ln[E(r_i/total)] = \ln[E(\text{Relative frequency}_i)] = \beta_0 + \beta_1 X_1 + \ldots + \beta_p X_p \qquad (2)$$

where r_i is the number of locations for a radio-collared deer within habitat unit i ($i = 1, 2, \ldots, 4{,}500$), *total* is the total number of locations for the deer within the study area, β_0 was an intercept term, $\beta_1, \ldots, \beta_p$ are unknown coefficients for habitat variables $X_1, \ldots, X_p$, and $E(.)$ denotes the expected value. We used the same offset term for all sampled habitat units of a given deer, thus the term ln(*total*) was absorbed into the estimate of β_0 and ensured we were modeling relative frequency of use (e.g., 0, 0.003, 0.0034, ...) instead of integer counts (e.g., 0, 1, 2, ...). Because some locations for each deer were not within a sampled habitat unit, inclusion of the offset term in Eq. (1) was not equivalent to conditioning on the total number of observed locations (i.e., multinomial distribution). In fact, one could drop the offset term and simply scale the resulting estimates of frequency of use by the total number of observed locations to obtain predictions of relative frequency identical to those obtained by Eq. (1). This approach to modeling resource selection estimates the relative frequency or absolute probability of use as a function of predictor variables, so we refer to it as a resource selection probability function (RSPF; Manly et al. 2002).

We assumed GLM coefficients for predictor variable k, for each deer, were a random sample from a normal distribution (Seber 1984, Littell et al. 1996), with the mean of the distribution representing the average or population-level effect of predictor variable k on probability of use. We estimated coefficients for the population-level RSPF for each winter using

$$\hat{\bar{\beta}}_k = \frac{1}{n}\sum_{j=1}^{n} \hat{\beta}_{kj}, \qquad (3)$$

Where $\hat{\beta}_{kj}$ was the estimate of coefficient k for individual j ($j = 1, \ldots, n$). We estimated the variance of each population-level model coefficient using the variation between radiocollared deer and the equation

$$\text{var}(\hat{\bar{\beta}}_k) = \frac{1}{n-1}\sum_{j=1}^{n} (\hat{\beta}_{kj} - \bar{\beta}_k)^2. \qquad (4)$$

This method of estimating population-level coefficients using Eqs. (3) and (4) was used by Marzluff et al. (2004) and Glenn et al. (2004) for evaluating habitat selection of Steller's jays (*Cyanocitta stelleri*) and northern spotted owls (*Strix occidentalis caurina*), respectively. Population-level inferences using Eqs. (3) and (4) are unaffected by potential autocorrelation because temporal autocorrelation between deer locations or spatial autocorrelation between habitat units do not bias model coefficients for the individual radiocollared deer models (McCullagh and Nelder 1989, Neter et al. 1996).

Standard criteria for model selection such as Akaike's Information Criterion (Burnham and Anderson 2002) might be appropriate for individual deer but do not apply for building a model for population-level effects because the same model (i.e., predictor variables) is required for each deer within a winter. Therefore, we used a forward-stepwise model-building procedure (Neter et al. 1996) to estimate population-level RSPFs for winters 2000–2001, 2001–2002, and 2002–2003. The forward-stepwise model-building process required fitting the same models to each deer within a winter and using Eqs. (3) and (4) to estimate population-level model coefficients. We used a *t*–statistic to determine variable entry ($\alpha \leq 0.15$) and exit ($\alpha > 0.20$; Hosmer and Lemeshow 2000). We considered quadratic terms for road density, distance to nearest well pad, and slope during the model-building process and following convention, the linear form of each variable was included if the model contained a quadratic form.

We conducted stepwise model building for all winters except for the predevelopment period that included winters 1998–1999 and 1999–2000. The limited number of locations recorded for radio-collared deer during that period precluded fitting individual models. Rather, we estimated a population-level model for the predevelopment period by pooling location data across 45 deer that had a minimum of 10 locations. We took simple random samples of 30 locations from deer with >30 locations to ensure that approximately equal weight was given to each deer in the analysis. We fit a model containing slope, elevation, distance to roads, and aspect for the predevelopment period. Distance to well pad was not included as a variable in the predevelopment model because there were only 11 existing well pads on the Mesa before development, and most were >10 years old, with little or no human activity associated with them. We used bootstrapping to estimate the standard errors and P values of the predevelopment population-level model coefficients.

We mapped predictions of population-level RSPFs for each winter on 104 × 104-m grids that covered the study area. We checked predictions to ensure all values were in the [0,1] interval, such that we were not extrapolating outside the range of the model data (Neter et al. 1996). The estimated probability of use for each grid cell was assigned a value of 1 to 4 based on the quartiles of the distribution of predictions for each map. We assigned grid cells with the highest 25% of predicted probabilities of use a value of 1 and classified them as high-use areas, assigned grid cells in the 51 to 75 percentiles a value of 2 and classified them as medium- to high-use areas, assigned grid cells in the 26 to 50 percentiles a value of 3 and classified them as medium- to low-use areas, and assigned grid cells in the 0 to 25 percentiles a values of 4 and classified them as low-use areas. We used contingency tables to identify changes in the 4 habitat-use categories across the 4 winter periods.

Results

Predevelopment: Winters 1998–1999 and 1999–2000

The population-level RSPF was estimated from 953 VHF deer locations collected from 45 adult female mule deer during the winters (1 Dec to 15 Apr) of 1998–1999 and 1999–2000 (Table 1). Units with the highest probability of use (Fig. 1) had an average elevation of 2,275 m, an average slope of 5 degrees, and an average road density of 0.14 km/km^2. Aspects with the highest probability of use were northwest and southwest.

Year 1 of Development: Winter 2000–2001

Individual models were estimated for 10 radiocollared deer during the winter (1 Jan to 15 Apr) of 2000–2001. Eight of the 10 deer had positive coefficients for elevation and negative coefficients for road density, indicating selection for higher elevations and low road densities. Based on the relationship between the linear and quadratic terms for slope and distance-to-well-pad variables, all 10 deer selected for moderate slopes, and 7 of 10 deer selected areas away from well pads.

The population-level RSPF was estimated from 18,706 GPS locations collected from 10 radiocollared deer during the winter of 2000–2001 (Table 1). The RSPF included elevation, slope, road density, and distance to well pad (Table 1). Deer selected for areas with higher elevations, moderate slopes, low road densities, and away from well pads. Habitat units with the highest probability of use (Fig. 2) had an average elevation of 2,266 m, slope of 5 degrees, road density of 0.16 km/km^2, and were 2.7 km away from the nearest well pad. Predictive maps indicate probability of deer use was lowest in areas close to well pads and access roads (Fig. 2). Shifts in deer distribution between predevelopment and year 1 of development were evident through the changes in the 4 deer use categories (Table 2). Of the habitat units classified as high deer use before development, only 60% were classified as high deer use during year 1 of development (Table 2). Of the areas classified as low deer use before development, 58% remained classified as low deer use during year 1 of development (Table 2).

Year 2 of Development: Winter 2001–2002

Individual models were developed for 15 radiocollared deer during the winter (4 Jan to 15 Apr) of 2001–2002. Fourteen of the 15 deer had positive coefficients for elevation, indicating selection of higher elevations. Based on the relationship between the linear and quadratic terms for slope and distance-to-well-pad variables, all 15 deer selected for moderate slopes, and 12 of 15 deer selected areas away from well pads.

The population-level RSPF was estimated from 14,851 GPS locations collected from 15 radiocollared deer during the winter of 2001–2002 (Table 1). The RSPF included elevation, slope, and distance to well pad (Table 1). Deer selected for areas with higher elevations, moderate slopes, and away from well pads. Habitat units with the highest probability of use (Fig. 3) had an average elevation of 2,255 m, slope of 5 degrees, and were 3.1 km away from the nearest well pad. Predictive maps indicate probability of deer use was lowest in areas close to well pads (Fig. 3). Shifts in deer distribution between predevelopment, year 1, and year 2 of development were evident through the changes in the 4 deer-use categories (Table 2). Of the habitat units classified as high deer use before development, only 49% were classified as high deer use during year 2 of development (Table 2). Of the areas classified as low deer use before development, 48% remained classified as low deer use during year 2 of development (Table 2).

Year 3 of Development: Winter 2002–2003

Individual models were developed for 7 radiocollared deer during the winter (20 Dec to 15 Apr) of 2002–2003. All 7 deer had positive coefficients for elevation, indicating selection of higher elevations. Based on the relationship between the linear and quadratic terms for slope and distance-to-well-pad variables, 6 of 7 deer selected for moderate slopes, and 6 of 7 deer selected areas away from well pads.

The population-level RSPF was estimated from 4,904 GPS locations collected from 7 radiocollared deer during the winter of 2002–2003 (Table 1). Our target sample of 10 marked animals was not met because 3 deer died early in the season. The RSPF included elevation, slope, and distance to well pad (Table 1). Deer selected areas with high elevations, moderate slopes, and away from well pads. Habitat units with the highest probability of use (Fig. 4) had an average elevation of 2,233 m, slope of 5 degrees, and were 3.7 km away from the nearest well pad. Predictive maps indicate probability of deer use was lowest in areas close to well

Table 1. Coefficients for population-level winter mule deer resource selection probability functions (RSPF) before and during 3 years of natural gas development in western Wyo., USA, 1998–2003.

	Predevelopment			Year 1			Year 2			Year 3		
	β	SE	*P*	β	SE	*P*	β	SE	*P*	β	SE	*P*
Intercept	−29.649	6.637	<0.001	−84.560	21.124	0.003	−75.712	12.931	<0.001	−104.295	11.316	<0.001
Elevation	0.009	0.001	<0.001	0.031	0.008	0.005	0.027	0.005	<0.001	0.036	0.004	<0.001
Slope	0.098	0.010	<0.001	0.391	0.073	<0.001	0.258	0.046	<0.001	0.342	0.128	0.036
Slope^2	−0.004	0.001	<0.001	−0.022	0.004	<0.001	−0.017	0.003	<0.001	−0.019	0.007	0.042
Well distance	na[a]			3.129	1.899	0.134	3.375	1.264	0.018	6.712	2.394	0.031
Well distance^2	na			−0.465	0.229	0.073	−0.416	0.156	0.019	−0.719	0.289	0.047
Road density	−0.249	0.027	<0.001	−0.827	0.387	0.061	ns[b]			ns		
Aspect = NE	0.012	0.051	0.818	ns			ns			ns		
Aspect = NW	0.399	0.025	<0.001	ns			ns			ns		
Aspect = SE	−0.301	0.022	<0.001	ns			ns			ns		
Aspect = SW	0.194	0.028	<0.001	ns			ns			ns		

[a] Not applicable.
[b] Not significant.

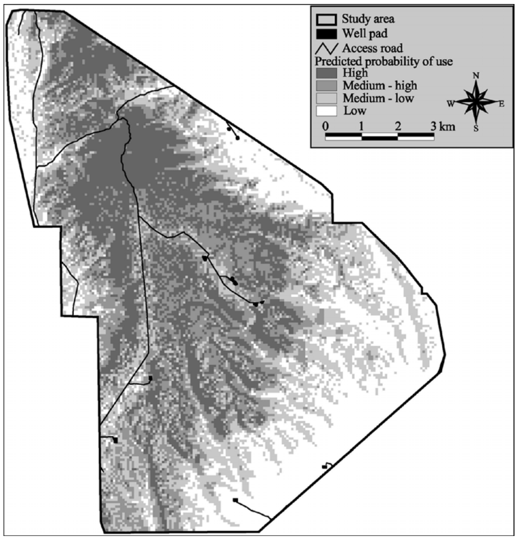

Figure 1. Predicted probabilities and associated categories of mule deer habitat use during 1998–1999 and 1999–2000 winters, before natural gas field development in western Wyo., USA.

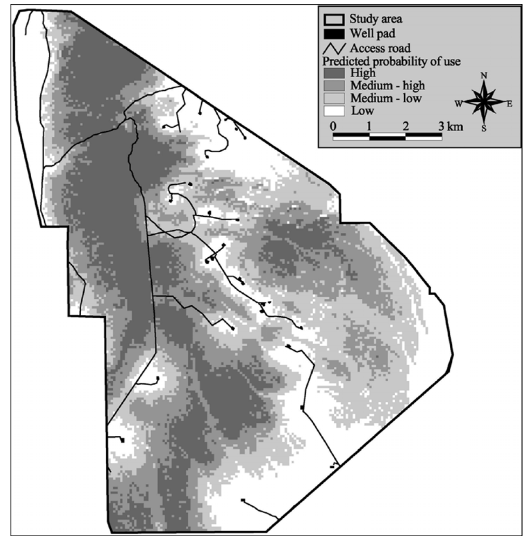

Figure 2. Predicted probabilities and associated categories of mule deer habitat use during year 1 (winter of 2000–2001) of natural gas development in western Wyo., USA.

pads (Fig. 4). Shifts in deer distribution between predevelopment, year 1, year 2, and year 3 of development were evident through the changes in the 4 deer-use categories (Table 2). Of the habitat units classified as high deer use before development, only 37% were classified as high deer use during year 3 of development (Table 2). Of the areas classified as low deer use before development, 41% remained classified as low deer use during year 3 of development (Table 2).

Discussion

Our statistical analysis differs from the typical methods used in the study of habitat selection (Manly et al. 2002) in several important ways. First, our sample size was the number of radiocollared deer during each winter, and our objective was to make statistical inferences to the corresponding population in the study area. Thus, we assumed that our radiocollared deer represented a simple random sample from the population each winter. Second, our response variable was an empirical estimate of the probability of use of a habitat unit, or the volume under an animal's utilization distribution surface. And third, we used a stepwise model-building procedure to develop a population-level model from individual deer models, where the average of the coefficients across deer comprised the population-level model for each winter period.

We recognize that other techniques may be used to estimate population-level models. Random-coefficients or hierarchical models (Littell et al. 1996) can estimate individual and population-level coefficients; however, model convergence can be problematic. To date, we believe the most appropriate method to obtain a population-level model is to fit a GLM with negative binomial errors to each radiocollared deer and average the coefficients. Seber (1984:486) describes this estimator and notes that identical population-level coefficients can be obtained if one averages the relative frequency of use in each of the sampled habitat units and fits a single model. We prefer to estimate individual models because the variation among individuals is often of biological interest.

We would have preferred the use of GPS radio collars during all years of this study because they can systematically collect thousands of accurate deer locations, regardless of weather conditions or time of day. Although the VHF radio collar locations used for the predevelopment model were collected at irregular intervals and during daylight hours, we believe the resulting model provides a reasonable comparison to models estimated during years of development with GPS radio collar locations. Hayes and Krausman (1993) suggested diurnal use of habitats by female mule deer were representative of overall patterns of habitat use, except in areas with high levels of human disturbance. Because human activity was exceptionally low on the Mesa before development, we believe the 953 VHF locations collected from 45 radiocollared deer accurately reflect overall deer use during that time period.

We view our resource selection analysis as an objective means to document mule deer response to natural gas development and quantify indirect habitat losses through time. Although indirect impacts associated with human activity or development have been documented in elk (*Cervus elaphus*; Lyon 1983, Morrison et al. 1995, Rowland et al. 2000), data that suggest similar behavior in mule deer (Rost and Bailey 1979, Yarmaloy et al. 1988, Merrill et al. 1994) are limited and largely observational in nature. Specific knowledge of how, or whether, mule deer respond to natural gas development does not exist in the literature. Our results suggest winter habitat selection and distribution patterns of mule deer were affected by well pad development. Changes in habitat selection by mule deer appeared to be immediate (i.e., year 1 of development), and through 3 years of development, we found no evidence they acclimated or habituated to well pads. Rather, mule deer had progressively higher probability of use in areas farther away from well pads as development progressed. The nonlinear relationship between probability of deer use and distance to well pad indicates deer selected areas away from well pads, but only up to a certain distance. We believe this reflects the ability of mule

Table 2. Percent change in the 4 predevelopment deer-use categories through 3 years (2001–2003) of natural gas development in western Wyo., USA.

		Deer use category			
Predevelopment category[a]	**Year of development**	**High**	**Medium–high**	**Medium–low**	**Low**
High	Year 1	60%	23%	13%	4%
	Year 2	49%	19%	23%	9%
	Year 3	37%	22%	27%	14%
Medium–high	Year 1	31%	36%	22%	11%
	Year 2	34%	23%	25%	18%
	Year 3	27%	22%	28%	22%
Medium–low	Year 1	9%	34%	31%	26%
	Year 2	16%	35%	25%	25%
	Year 3	25%	27%	25%	23%
Low	Year 1	0%	7%	34%	58%
	Year 2	1%	23%	27%	48%
	Year 3	11%	29%	20%	41%

[a] Category rows may not sum to exactly 100% because of rounding error.

deer to avoid localized disturbances and habitat perturbations without completely abandoning their home ranges.

Population-level RSPFs and associated predictive maps were useful tools for illustrating changes in habitat selection patterns through time. We recognize the 4 levels of habitat use were subjectively defined and could vary depending on study objectives or species information. Nonetheless, we believe RSPFs and associated predictive maps can provide a useful framework for quantifying indirect habitat losses by measuring the changes (e.g., percentage or area) in habitat use categories through time. Predictive maps suggest that some areas categorized as high use before development, changed to low use as development progressed, and other areas initially categorized as low use changed to high use. For example, following year 1 of development, 17% of units classified as high use before development had changed to medium–low or low use, and by year 3 of development, 41% of those areas classified as high use before development had changed to medium–low or low use. Conversely, by year 3 of development, 40% of low-use areas had changed to medium–high or high-use areas. Assuming habitats with high probability of use before development were more suitable than habitats with lower probability of use, these results suggest natural gas development on the Mesa displaced mule deer to less-suitable habitats.

Winter severity and forage availability can influence the distribution patterns of mule deer (Garrott et al. 1987, Brown 1992). However, winter conditions on the Mesa were considered relatively mild during the course of this study (1998–2003) and were unlikely to have precluded deer from using their entire winter range. Gilbert et al. (1970) reported snow depths >61 cm were required to preclude use of an area by mule deer. With the exception of isolated drifts, snow depths were <61 cm across the Mesa during all years of study. If the observed changes in deer distribution were due to severe winter conditions, we would expect deer use to shift to areas with lower elevations and south-facing slopes. Instead, deer always selected for high elevations, and aspect was never a significant predictor variable during years of development, further suggesting the observed shifts in deer distribution

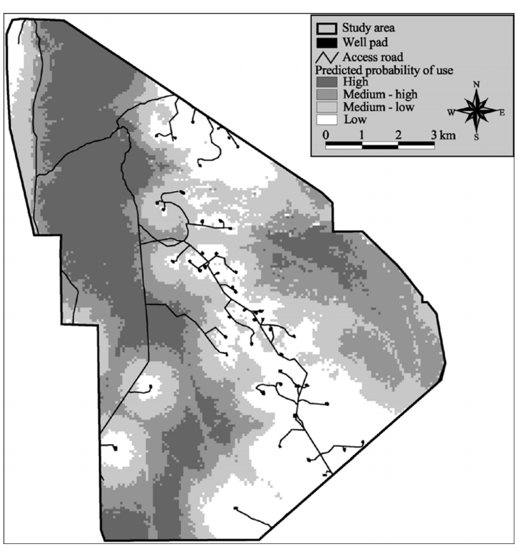

Figure 3. Predicted probabilities and associated categories of mule deer habitat use during year 2 (winter of 2001–2002) of natural gas development in western Wyo., USA.

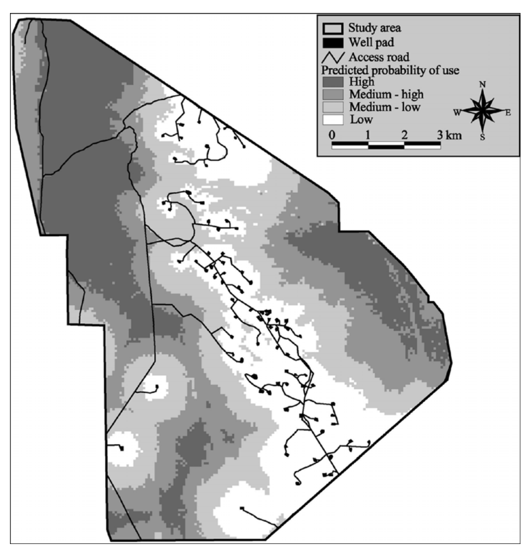

Figure 4. Predicted probabilities and associated categories of mule deer habitat use during year 3 (winter of 2002–2003) of natural gas development in western Wyo., USA.

were due to increased well-pad development and associated human activity rather than winter conditions.

A single well pad typically disturbs 3 to 4 acres of habitat; however, areas with the highest probability of deer use were 2.7, 3.1, and 3.7 km away from well pads during the first 3 years of development, respectively. There are 2 potential concerns with the apparent avoidance of well pads by mule deer. First, the avoidance or lower probability of use of areas near wells creates indirect habitat losses of winter range that are substantially larger in size than the direct habitat losses incurred when native vegetation is removed during construction of the well pad. Habitat losses, whether direct or indirect, have the potential to reduce carrying capacity of the range and result in population-level effects (i.e., survival or reproduction). Second, if deer do not respond by vacating winter ranges, distribution shifts will result in increased density in remaining portions of the winter range, exposing the population to greater risks of density-dependent effects. Consistent with Bartmann et al. (1992), we would expect fawn mortality to be the primary density-dependent population-regulation process because of their high susceptibility to overwinter mortality (White et al. 1987, Hobbs 1989).

Monitoring shifts in distribution or habitat use allows for mitigation measures aimed at reducing impacts to be evaluated and for timely, site-specific strategies to be developed. The current mitigation measure is focused on seasonal-timing restrictions, where drilling activity is limited to nonwinter months. This type of mitigation is common across federal lands and intended to reduce human activity and, presumably, the associated stress to big game during the winter months, typically 15 November to 30 April. Major shifts in the distribution of mule deer on the Mesa occurred even though drilling on federal lands was largely restricted to nonwinter months. Our findings suggest current mitigation measures may not be achieving desired results. Winter-timing restrictions are only imposed on leases that occur in areas designated as crucial winter range, and then, only through the development phase of the well. Consequently, variable levels of human activity may occur throughout the field during winter as producing wells are serviced, and despite the recognition of the uniqueness of crucial winter range, roads may cross or abut these areas, exposing them to human disturbances as well.

Management Implications

In deep-gas fields like the PAPA, where well densities range from 4 to 16 pads per section (2.58 km^2), the number of producing well pads and associated human activity may negate the potential effectiveness of timing restrictions on drilling activities as a means of reducing disturbance to wintering deer. Mitigation measures designed to minimize disturbance to wintering mule deer in natural gas fields should consider all human activity across the entire project area and not be restricted to the development of wells or to crucial winter ranges. Reducing disturbance to wintering mule deer may require restrictions or approaches that limit the level of human activity during both production and development phases of the wells. Directional-drilling technology offers promising new methods for reducing surface disturbance and human activity. Limiting public access and developing road management strategies may also be a necessary part of mitigation plans. Future research and monitoring efforts should evaluate how different levels of human activity (e.g., traffic or noise) at developing and producing well pads influence mule deer distribution. Understanding mule deer response to different levels of human activity and types of well pads would allow mitigation measures to be properly evaluated and improved.

Assuming there is some level of increased energy expenditure required for deer to alter their winter habitat-selection patterns (Parker et al. 1984, Freddy et al. 1986, Hobbs 1989), the apparent displacement of deer from high-use to low-use areas has the potential to influence survival and reproduction. This relationship, however, needs to be documented. Accordingly, we recommend appropriate population parameters (i.e., adult female survival, overwinter fawn survival, recruitment) be monitored in areas with large-scale gas development so that changes in reproduction or survival can be detected. The major shortcoming of efforts to evaluate the impacts of disturbances on wildlife populations is that they seldom are addressed in an experimental framework but, rather, tend to be short-term and observational. Brief, postdevelopment monitoring plans associated with regulatory work generally result in little or no information that allow agencies and industry to assess impacts on wildlife or to improve mitigation measures. We encourage long-term (>5 years) studies that identify habitat-selection patterns and that measure population characteristics in control and treatment areas before and during gas-development projects that occur in sensitive mule deer ranges.

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