Human–Wildlife Interactions 8(2):284–290, Fall 2014

Commentary

Oil and gas impacts on Wyoming's sage-grouse: summarizing the past and predicting the foreseeable future

David H. Applegate, Anadarko Petroleum Corporation, 900 Werner Court, Casper, WY, 82601, USA *dave.applegate@anadarko.com*

Nicholas L. Owens, Anadarko Petroleum Corporation, 1099 18th Street, Suite 1800, Denver, CO, 80202, USA *nick.owens@anadarko.com*

Abstract: Historical impacts from oil and gas development to greater sage-grouse (*Centrocercus urophasianus*) habitat are well-documented in some areas of Wyoming, in particular within natural gas development fields, such as the Powder River Basin and Jonah-Pinedale. The drilling techniques and pad densities in these fields have been extrapolated to estimate future oil and gas impacts in the U. S. Fish and Wildlife Service (2010) warranted-but-precluded listing determination for the sage-grouse under the Endangered Species Act. Further, assumptions regarding the scale of oil and gas development are incorporated within various resource management plan amendments by the Bureau of Land Management (BLM) throughout the range of the sage-grouse. We evaluated the status of Wyoming sage-grouse leks by quantifying the scale of oil and gas impacts across the state of Wyoming and the extent that sage-grouse persistence is impacted by oil and gas development using the impact analysis lens of well-pad density within a 3.2-km radius of a lek (Doherty et al. 2010). The analysis provides that 75% (1,770 out of 2,356 leks analyzed) of identified leks (active and inactive) have <12 wells within a 3.2-km radius of a lek and are expected to have indiscernible impacts from oil and gas development in terms of lek attendance (Doherty et al. 2010). As to future development of oil and gas in Wyoming, 64% of Wyoming leks (1,508 leks) are protected from oil and gas development densities of >12 wells per 32.2-km^2, due to prescriptive density and disturbance restrictions within the Wyoming Core Area Policy. The Wyoming Core Area Policy protects priority sage-grouse habitats by limiting surface disturbance to an average of 5%. Specific to oil and gas development, a prescriptive density standard allows an average of 1 well pad per square mile. Thus, the combination of core area protections with the technological shift to directional and horizontal drilling that is being deployed in both existing and new fields to recover hydrocarbons (i.e., technologies that dramatically reduce the fragmentation and disturbance profiles of oil and gas development), suggests that threat projections in the U.S. Fish and Wildlife Service (2010) listing decision on sage-grouse due to future oil and gas development have been overstated.

Key words: *Centrocercus urophasianus*, human–wildlife conflicts, lek counts, oil and gas, sage-grouse, Wyoming

The scale of development

The negative impacts from intensive oil and gas development on sage-grouse (*Centrocercus urophasianus*) lek attendance and population dynamics are well-documented (Walker et al. 2007, Holloran et al. 2010). One area of focused research has been the effects of well-pad density on lek attendance and lek abandonment rates (Walker et al. 2007, Doherty et al. 2010, Hess and Beck 2012). The combined effects of well-pad density and West Nile virus in the Powder River Basin were examined by Taylor et al. (2013). One method to evaluate the scale of oil and gas impacts on sage-grouse is through a review of well-pad development density within a 3.2-km buffer around a lek (Doherty et al. 2010). When the well count within a 3.2-km radius around a lek is <60 well pads, there is >50% probability that leks will persist in the Powder River Basin and 80% probability that leks will persist in southwest Wyoming (Doherty et al. 2010). Perhaps more importantly, their results indicate that at a well pad density corresponding to as many as 12 wells within a 3.2-km radius around a lek, effects on sage-grouse lek attendance are indiscernible. This result is consistent with the proposed well-pad density criterion for sage-grouse core areas outlined in the Wyoming Core Area Policy (State of Wyoming 2011) and provides insight

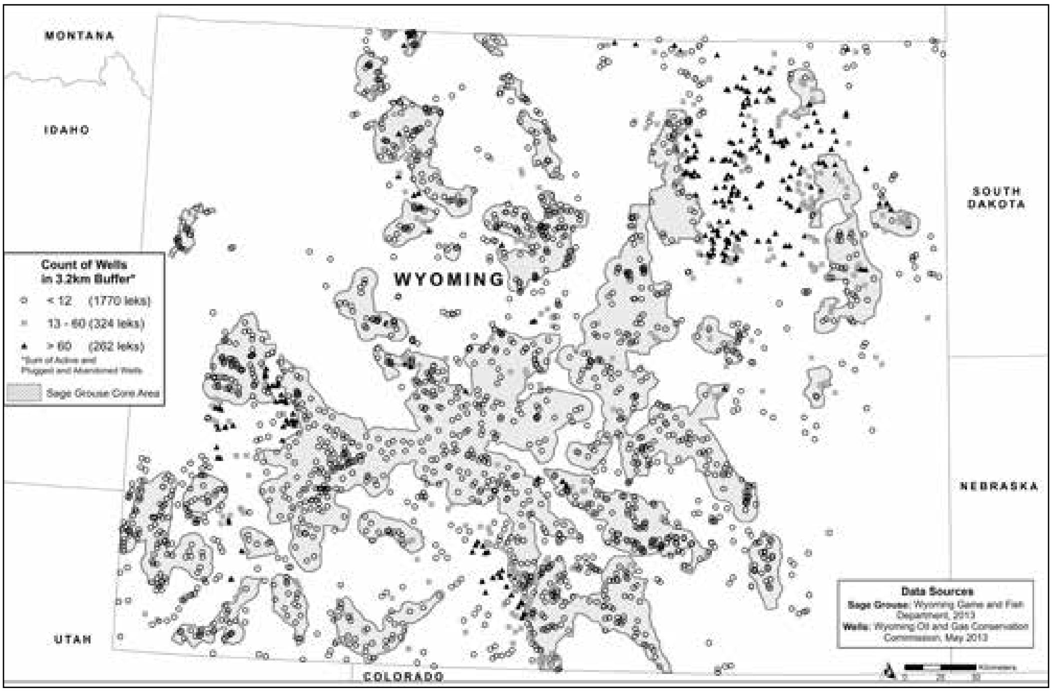

Figure 1. Oil and gas wells within the 3.2-km lek buffer in Wyoming. Open circles represent leks with indiscernible impacts from oil and gas well-pad density per the impact analysis lens of Doherty et al. (2010).

into the nature of localized impacts associated with development of hydrocarbon reservoirs within 3.2-km of a lek.

In Wyoming, 75% of all identified leks are not expected to have discernable impacts from past and existing oil and gas activities, given the well-density criteria of <12 wells within a 3.2-km radius of identified leks (Figure 1). Beck and Hess (2012) developed a correlation in north-central Wyoming, relating oil and gas pad density within a 1-km radius of leks that indicates pad densities >3 within this smaller lek buffer (3.14 km^2) have a >50% probability of lek abandonment. This impact analysis lens, when applied statewide, indicates that approximately 13% of leks in Wyoming have well-pad densities within a 1-km radius that potentially increases the risk of lek abandonment to rates >50% (Figure 2). The applicability of this correlation statewide is uncertain, given its derivation from a single basin in Wyoming, but the results from both the 3.2-km impact analysis lens (Doherty et al. 2010) and the 1-km impact analysis lens (Hess and Beck 2012) show significant overlap of highly impacted leks (208 leks in Wyoming had both >3 wells in the 1-km lek buffer and >60 wells within the 3.2-m-lek buffer). This suggests that 15% (354) of identified Wyoming leks have been impacted by oil and gas well-pad density to the extent that the probability of lek abandonment is greater than the probability of lek persistence. In other words, they either meet one or both of the well-density criteria within a lek buffer, suggesting that lek abandonment is >50%.

Projected impacts to sage-grouse from future oil and gas development

Both technological changes in how oil and gas wells are drilled and protective regulatory mechanisms and policies that have been developed since the 2010 U.S. Fish and Wildlife Service (USFW) sage-grouse listing decision, suggest that future oil and gas surface impacts to sage-grouse will be reduced from former predictions.

Future oil and gas development impacts on sage-grouse in the state of Wyoming will be avoided and reduced by the Wyoming Core Area Policy (State of Wyoming 2011). The Wyoming Core Area Policy is designed to protect sage-grouse and the habitats on which they depend. A recent analysis of future urbanization and energy development in Wyoming concluded

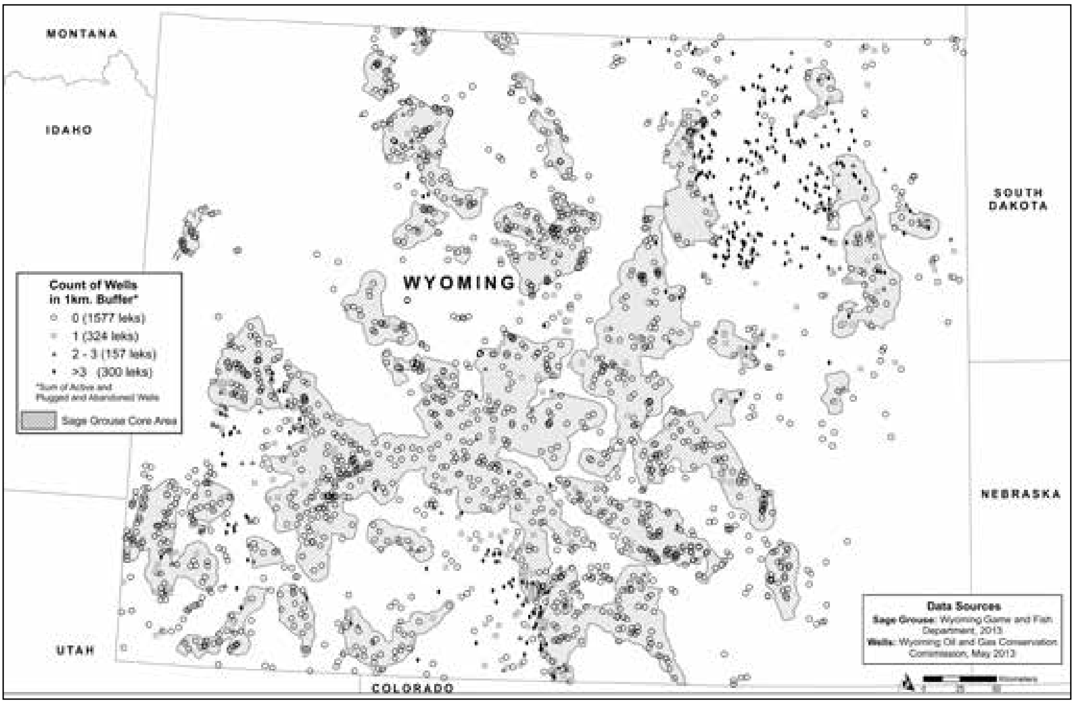

Figure 2. Oil and gas wells within the 1-km lek buffer in Wyoming. Diamonds represent leks where the probability of lek abandonment is >50% per the impact analysis lens of Hess and Beck 2012.

that lek attendance would decline by as much as 29% with only the Wyoming Core Area Policy in place. The analysis also noted that no leks located within core areas are predicted to be extirpated with the policy in place (Copeland et al. 2013). Copeland et al. (2013) evaluated the additional benefits of implementing a conservation easement strategy in parallel to the Wyoming Core Area Policy, but they did not evaluate the shift in drilling technology with its associated reduction in habitat modification that is occurring in Wyoming and which is the focus of this paper.

Market factors drive development

Future impacts from oil and gas development often are based on project-level environmental impact statement well counts (Knick et al. 2011) or build-out scenarios from BLM resource management plans (Copeland et al. 2013). Using land planning documents to estimate future well-counts across the landscape is highly speculative. Copeland et al. (2013) estimate short- and long-term oil and gas drilling in Wyoming as 52,000 and 155,000 wells, respectively. These upper bound limits are far from foreseeable and fail to recognize fundamental realities of the oil and gas industry or the application of drilling and completion technologies that reduce disturbance and fragmentation profiles on the landscape.

Development of hydrocarbon reservoirs is a competitive, capital intensive endeavor that shifts capital deployment to the most economical locations, both domestically and abroad, to recover oil and gas resources. The shale gas revolution in North America shifted a significant percentage of industry capital from public lands in the western United States to development areas in other regions of the country, such as the Marcellus Shale in Pennsylvania or the Wattenberg field in Colorado, where minerals are primarily privately-owned. Unconventional resource development also has dramatically increased oil production in the United States in such areas as the Bakken shale in western North Dakota and the Eagle Ford shale in Texas. Oil production is increasing in Wyoming as the result of: (a) unconventional development at existing oil fields (i.e., brown fields), such as the Salt Creek carbon dioxide (CO^2) enhanced oil-recovery project at Midwest, Wyoming, within a 100-year-old oil field where habitat

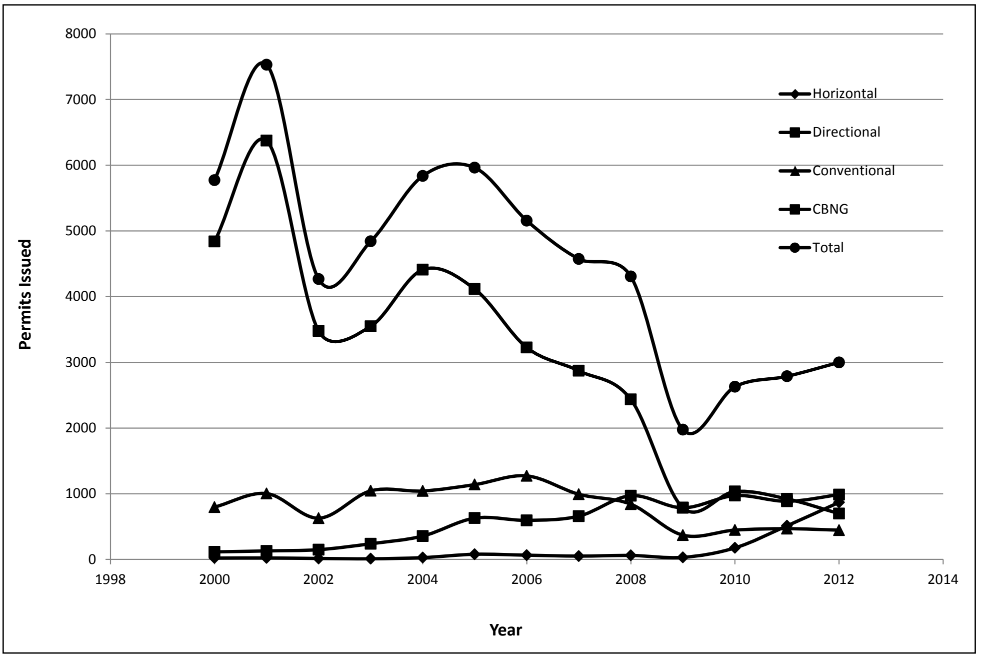

Figure 3. Wyoming Oil and Gas Conservation Commission permits issued (WOGCC; unpublished data).

impacts were realized 80 to 100 years ago; (b) horizontal drilling on the edges of historic oil fields; or c) in new shale development areas, where horizontal drilling is allowing resource recovery with well-pad densities that are typically at 1 well pad per 259 ha, such as that occurring in the Powder River Basin.

Cost-competitiveness for a given development area can be driven by a number of factors, such as depth of reservoir, reservoir properties, proximity to market, available pipeline networks and capacity, commodity prices, and regulatory constraints that impact ramp-up (i.e., how quickly drilling permits can be acquired to support rig count), and running room (i.e., whether necessary permit acquisition pace can be sustained), to name but a few. Companies develop capital deployment plans annually and use 5-year strategic plans to assess capital deployment. Estimating sage-grouse populations 50 or 100 years into the future (U.S. Fish and Wildlife Service 2010) is not compatible with a foreseeable future for oil and gas development where forward predictions are perhaps reliable for 5 to 10 years, at the most. The foreseeable future extends only so far as threat predictions are reliable. Although it seems fairly certain that oil and gas production will sustain itself over the next 30 to 50 years, the percentage of that development that takes place in Wyoming or within sage-grouse habitat in general, is not foreseeable over that time frame.

Technological advances in oil and gas development

The cyclic and dynamic nature of oil and gas development is related to the emergence and decline of oil and gas plays driven by market factors and technological advances. The coal bed natural gas development area in the Powder River Basin was the dominant gas development area in Wyoming from 1998 throuth 2008 (Figure 3). Technological advances over the past 10 years have dramatically shifted drilling technology from vertical well bores to directional and horizontal well bores. In Wyoming, horizontal drilling permits have increased 40-fold over the last decade, while directional drilling permits have increased by a factor of 8 (Figure 4). Conventional vertical well permits and completions have decreased by approximately 50% over that same time period.

Horizontal and directional drilling change the disturbance, fragmentation, and activity profiles associated with modern oil and gas development. Disturbance and fragmentation levels are declining at the same time that

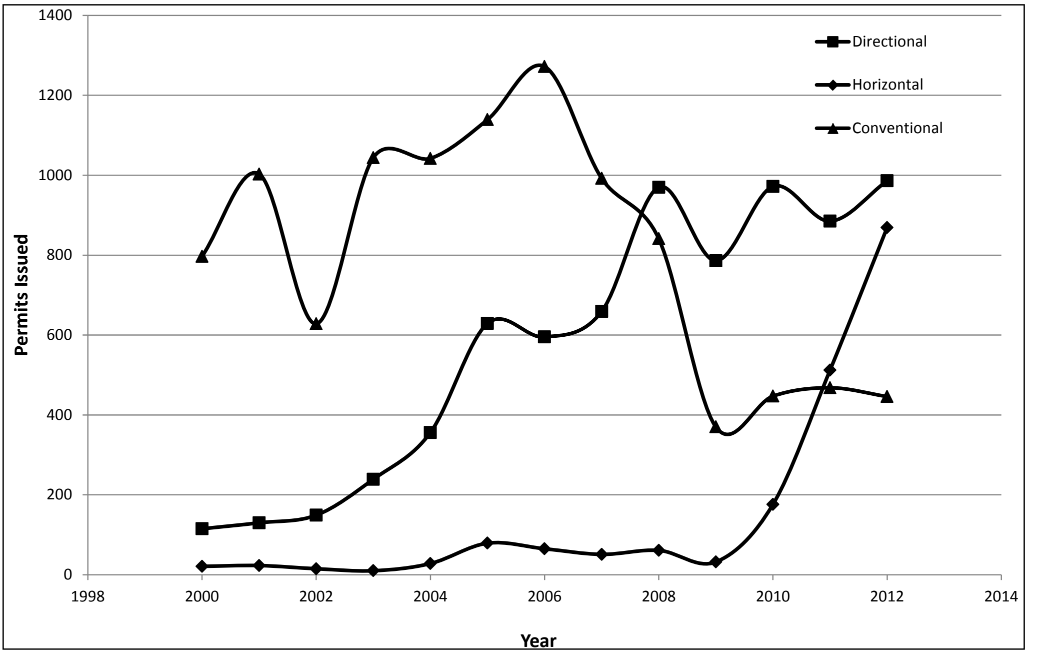

Figure 4. Wyoming Oil and Gas Conservation Commission (WOGCC) permits issued (excludes coal bed natual gas; WOGCC, unpublished data).

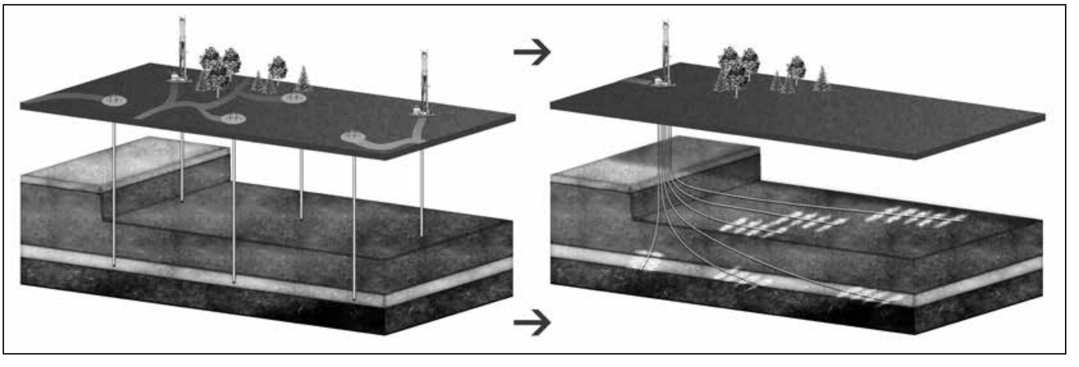

Figure 5. Surface footprint comparison, vertical (left) versus horizontal and directional (right) drilling operations.

reservoir recovery rates are increasing. A single horizontal well now takes the place of 8 to 16 vertical wells depending on spacing. Horizontal drilling requires average initial disturbances of 4.05 to 4.86 ha for the well pad and takes approximately 3 to 4 months to construct, drill, and complete (assumes 1 well pad). Conversely, each vertical well pad (deep conventional drilling not coal bed natural gas) averages 1.62 to 2.02 ha in size and takes 1 to 2 months to construct, drill, and complete. A full section development with horizontal wells could be developed by multiple wells on 1 to 2 pads over the course of 6 to 12 months, with 4.05 to 9.71 ha of disturbance, whereas vertical development of a section would require 8 to 16 wells on 8 to 16 pads over the course of 8 to 32 months, with a total disturbance of 12.9 to 32.4 ha (Figure 5).

A similar reduction in linear disturbance is expected with this shift in oil and gas drilling technology. Roads, power lines, and product pipelines often are associated with individual well pads. The proposed action for the Greater Natural Buttes, Utah, gas development area described a vertical well field with 32 pads per section and assumed 0.40 km of access roads per vertical well, or approximately 12.9 km of roads per section (Bureau of Land Management 2012). A new horizontal oil development area

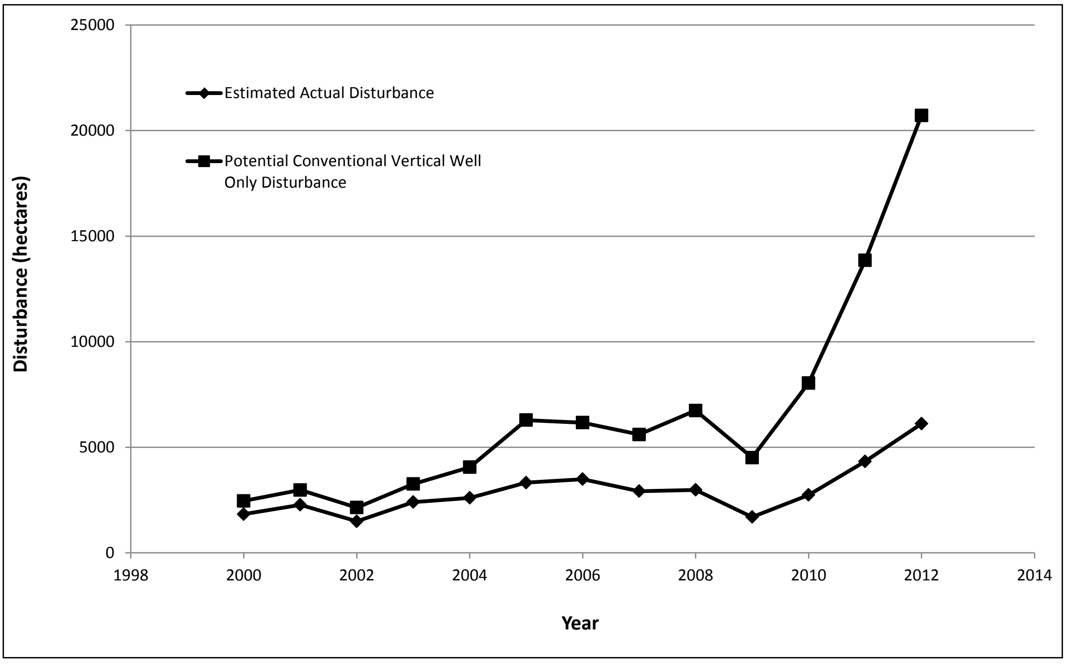

Figure 6. Disturbance estimate comparison of conventional vertical well only versus estimated actual disturbance with directional and horizontal well.

opening in Converse County, Wyoming, is expected to have an average of 1 pad per section developed and 1.6 km of access roads per well pad. As well pads increase in a section, the length of road needed to access each well-pad decreases.

In Wyoming, the potential disturbance avoided annually over the last 10 years with this technological shift is illustrated in Figure 5. The potential conventional vertical well pad disturbance (Figure 6) was estimated assuming that each horizontal well (4.86 ha of disturbance assumed) replaces 8 vertical wells (2.02 ha of disturbance assumed per vertical well) and that each directional well pad (4.05 ha of disturbance assumed) contains 4 directional wells. In 2012, the percentage reduction in landscape disturbance due to the shift from vertical to directional and horizontal drilling could have been 70% (approximately 6,100 ha disturbed, rather than 20,700 ha). This does not include the associated reduction in road, pipeline, and power line disturbance and fragmentation.

The U.S. Fish and Wildlife Service (2010) listing decision takes sage-grouse impacts developed primarily from intensive coal bed natural gas or closely-spaced vertically-drilled fields and projects these impacts into the foreseeable future across the geologic basins of Wyoming. Even if the upper-bound limits of drilling were to occur, well-counts outlined in existing land-use documents (Copeland et al. 2013) or National Environmental Policy Act planning documents, dramatically overestimate the number of future well-pads per section. Improved reclamation practices and reductions in traffic due to remote monitoring should also reduce oil and gas field impacts to wildlife, but often are not incorporated into analyses.

Summary

Oil and gas impacts to sage-grouse from dense vertical development have been well-documented. This type of development, however, has not occurred on a range-wide basis in Wyoming. The extent of high-density energy development (>60 oil and gas well pads within a 3.2-km buffer around a lek or >3 well pads within 1 km of a lek) impacts only approximately 15% of all identified leks in Wyoming. Previous reviews of energy development provide that high-density development will continue to threaten sage-grouse populations in Wyoming, and that the impacts of these developments will negatively affect the ability of sage-grouse to persist in the foreseeable future in its eastern range (U.S. Fish and Wildlife Service 2010).

The habitat management framework provided under the Wyoming Core Area Policy in combination with deployment of directional and horizontal drilling decreases the projected future disturbance, fragmentation, and activity profiles of the oil and gas industry. Increasing well-pad density in proximity to leks has been shown to reduce lek attendance and increase lek abandonment rates. New oil and gas development is being deployed at lower pad densities and should reduce impacts on lek attendance and abandonment. Hence, the threat analysis assumed by synthesis documents such as the USFW (2010) warranted but precluded listing determinations, future projections of impacts from oil and gas development in Wyoming such as those suggested by Copeland et al. (2013), and sage-grouse population modeling estimates that forecast future viability based on the assertion that future conditions will continue the same trajectory or trend observed in the past (Garton et al. 2011) require new scrutiny based on this well-documented shift in drilling technology.

Literature cited

Copeland, H.E., A. Pocewicz, D. Naugle, T. Griffiths, D. Keinath, J. Evans, and J. Platt. 2013. Measuring the effectiveness of conservation: A novel framework to quantify the benefits of sage-grouse conservation policy and easements in Wyoming. PLoS ONE 8(6):e67261.

Bureau of Land Management. 2012. Greater natural buttes final environmental impact statement (FES 12-8). Volume 1. Vernal, Utah, USA.

Doherty, K.E., D.E. Naugle, J.S. Evans. 2010. A currency for offsetting energydevelopment impacts: horse-trading sage-grouse on the open market. PLoS ONE, (5)4: e10339.

Garton, E. O., J. W. Connelly, J. S. Horne, C. A. Hagen, A. Moser, and M. A. Schroeder. 2011. Greater sage-grouse population dynamics and probability of persistence. Pages 293–381 *in* S. T. Knick and J. W. Connelly, editors. Greater sage-grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology. Volume 38. University of California Press, Berkeley, California, USA.

Hess J. and J. Beck . 2012. Disturbance factors influencing greater sage-grouse lek abandonment in north-central Wyoming. Journal of Wildlife Management 76:1625–1634.

Holloran M.J., R.C. Kaiser, and W.A. Hubert. 2010. Yearling greater sage-grouse response to energy development in Wyoming. Journal of Wildlife Management 74:65–72.

Knick, S.T., S.E. Hanser, R.F. Miller, D. A. Pyke, M. J. Wisdom, S. P. Finn, E. T. Rinkes,and C. J. Henry. 2011. Ecological influence and pathway of land use in sagebrush. Pages 203–251 in S. T. Knick and J. W. Connelly, editors. Greater sage-grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology, Volume 38. University of California Press, Berkeley, California, USA.

State of Wyoming. 2011. Greater sage-grouse core area protection. Office of the Governor, Executive Order Number 2011-5. Cheyenne, Wyoming, USA, <http://governor.wy.gov/Documents/Sage%20Grouse%20Executive%20Order.pdf>. Accessed September 22, 2014.

Taylor, R. L., J. D. Tack, D. E. Naugle, and L. S. Mills. 2013. Combined effects of energy development and disease on greater sage-grouse. PLoS ONE 8(8): e71256.

U.S. Fish and Wildlife Service. 2010. Endangered and threatened wildlife and plants; 12-month findings for petitions to list the greater sage-grouse (Centrocercus urophasianus) as threatened or endangered. Federal Register 75(55):13909–14014.

Walker, B. L., D. E. Naugle, and K. E. Doherty. 2007. Greater sage-grouse population response to energy development and habitat loss. Journal of Wildlife Management 71:2644–2654.

David H. Applegate is a regulatory advisor for Anadarko Petroleum Corporation and works in the company's long-term planning group. He holds a B.S. degree in civil engineering from the University of Wyoming and an M.S. degree in environmental engineering from Duke University. He has worked for 25 years in the areas of hazardous waste site remediation and environmental project planning.

Nicholas L. Owens is a senior regulatory analyst with Anadarko Petroleum Corporation and is responsible for addressing high-level wildlife and endangered species concerns across Anadarko's North American assets, including the Gulf of Mexico. He has a B.S. degree in biology from Eastern Illinois University and has 10 years experience supporting large-scale energy infrastructure development projects throughout the United States.