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Source: Rangeland Ecology & Management, 67(4):369-379. 2014.
Published By: Society for Range Management
DOI: http://dx.doi.org/10.2111/REM-D-13-00136.1
URL: http://www.bioone.org/doi/full/10.2111/REM-D-13-00136.1

Rangeland Ecol Manage 67:369–379 | July 2014 | DOI: 10.2111/REM-D-13-00136.1

Seasonal Resource Selection and Distributional Response by Elk to Development of a Natural Gas Field

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Abstract

Global energy demand is predicted to increase dramatically, suggesting the need to understand the role of disturbance from energy development better and to develop more efficient conservation strategies for affected wildlife populations. We evaluated elk (*Cervus elaphus*) response to disturbance associated with natural gas development in summer and winter, including shifts in resource selection and concomitant distribution. We collected elk locations prior to (1992–1995) and during (2008–2010) coal bed natural gas (CBNG) development in the ~498-km^2 Fortification Creek Area (FCA) of northeastern Wyoming, USA, where approximately 700 CBNG wells and 542 km of collector, local, and resource roads were developed from 2000 through 2010. We developed resource selection functions for summer and winter using coordinate data from VHF-collared female elk prior to CBNG development and similar location data from GPS-collared female elk during CBNG development to assess spatial selection shifts. By pooling across all locations we created population level models for each time period (e.g., pre- and during development) and incorporated individual variation through bootstrapping standard errors for parameter estimates. Comparison of elk resource selection prior to and during natural gas development demonstrated behavioral and distributional shifts whereby during development, elk demonstrated a higher propensity to use distance and escape cover to minimize exposure to roads. Specifically, during-development elk selected areas with greater Rocky Mountain juniper (*Juniperus scopulorum* Sarg.) cover, increased terrain ruggedness, and farther from CBNG roads than prior to development. Elk distributional changes resulting from avoidance behavior led to a loss of high-use areas by 43.1% and 50.2% in summer and winter, respectively. We suggest reducing traffic, protecting woody escape cover, and maintaining refugia within the energy-development footprint to promote persistence of elk within energy fields.

Key Words: *Cervus elaphus*; coal bed natural gas; elk habitat; roads; resource selection functions; wildlife and energy development

INTRODUCTION

Generally, the distribution of wildlife is the result of animals selecting for or against surrounding habitat characteristics (Boyce and McDonald 1999). Animals must often balance trade-offs between acquiring resources and reducing risk from predation or disturbance (Lima and Dill 1990; Schmitz et al. 1997; Frid and Dill 2002). Increasingly, animal resource selection is influenced by human disturbance, including energy-extraction activities, which is a rapidly expanding source of disturbance for a variety of species across the globe (e.g., Cameron et al. 2005; Bayne and Dale 2011; Smith et al. 2014). Large populations of ungulates overlap the distribution of extensive energy resources in forest and rangeland ecosystems across western North America (Sawyer et al. 2006; Hebblewhite 2008; Sorensen et al. 2008; Sawyer et al. 2009a, 2009b;), providing scientists and natural resource managers opportunities to evaluate the influences of energy development on these populations and to identify factors that may provide options for mitigation.

Much of the Intermountain Region of western North America has low human population densities and thus wildlife experience relatively low disturbance from anthropogenic activities (Sanderson et al. 2002). However, the US Energy Information Administration has predicted a 44% increase in the world consumption of energy between 2006 and 2030 (Energy Information Administration [EIA] 2009). In contrast to land-use practices such as ranching, the development and extraction of energy resources includes substantial infrastructure and anthropogenic activity. For example, the Bureau of Land Management (BLM) has stated that one natural gas well is, on average, accompanied by 2 km of roads, which does not include the disturbance incurred by connecting pipelines, tanker truck transport of hydrocarbon products, or electrical power lines (Bureau of Land Management [BLM] 2003). Copeland et al. (2011) predicted the overall influence of energy development could directly or indirectly affect up to 21% or 96 million ha of the five major ecosystems in western North America, including grassland, boreal forest, shrubland, temperate forest, and wetland. A critical concern for wildlife conservation is the direct habitat loss resulting from energy extraction; however, the indirect impacts of energy development on ungulate species may be of greater concern than the direct loss of habitat (Van Dyke and Klein 1996; Sawyer et al. 2006; Hebblewhite 2008; Festa-Bianchet et al. 2011). Previous

Research was funded in part by Bureau of Land Management, the School of Energy Resources and the Wyoming Reclamation and Restoration Center at the University of Wyoming, Anadarko Petroleum Corporation, Petro-Canada, Marathon Oil Company, and Wyoming Game and Fish Department.

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Manuscript received 13 September 2013; manuscript accepted 21 April 2014.