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Original Research

Landscape-Scale Approach to Quantifying Habitat Credits for A Greater Sage-grouse Habitat Conservation Bank[☆]Chad W. LeBeau^{a,*}, M. Dale Strickland^a, Gregory D. Johnson^a, Michael S. Frank^b^a Western EcoSystems Technology, Inc., Cheyenne, WY 82001, USA^b Galileo Group, Inc., Melbourne, FL 32901, USA

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ABSTRACT

The greater sage-grouse (*Centrocercus urophasianus*) is experiencing range-wide population declines and was previously classified as a candidate for protection under the Endangered Species Act. While policies regulating anthropogenic development are important in the conservation of greater sage-grouse, additional programs to conserve and enhance greater sage-grouse habitats are necessary to sustain populations. When impacts to habitat cannot be adequately avoided or minimized, conservation banking is a viable species conservation strategy. A key component to the development and monitoring of a conservation bank is the quantification of conservation value. We estimated seasonal resource selection functions to identify the relative probability of female greater sage-grouse habitat selection as a function of environmental and infrastructure covariates to identify habitat suitability categories and subsequent habitat conservation value across a landscape in central Wyoming to be used in a conservation bank. The methods we employed to develop habitat conservation value, together with the management and monitoring plan, provide a robust framework for accurately quantifying, monitoring, and managing the habitat value and therefore the number of habitat conservation credits for a greater sage-grouse bank.

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Introduction

The greater sage-grouse (*Centrocercus urophasianus*), hereafter sage-grouse, is a gallinaceous bird endemic to the sagebrush (*Artemisia* spp.) steppe and occurs in 11 western US states and 2 Canadian provinces. The species currently occupies 56% of its historical range (Schroeder et al., 2004), and populations have decreased throughout most of their range over the past few decades (Garton et al., 2011) due to habitat fragmentation and removal as a result of agricultural development, large-scale attempts at range managements for livestock (sagebrush control), urban and exurban development, wildfires, invasion of exotic plants, and energy development (Aldridge et al., 2008).

The US Fish and Wildlife Service (Service) determined in 2010 that listing the sage-grouse was warranted due to habitat loss and fragmentation and inadequacy of regulatory mechanisms that govern habitat loss and fragmentation. On 22 September, 2015 the Service determined that protection of the sage-grouse under the Endangered Species Act was no longer warranted primarily because current conservation practices and regulatory mechanisms significantly reduced threats throughout their range. While policies regulating anthropogenic development

are important in the conservation of sage-grouse, additional programs to conserve and enhance sage-grouse habitats are necessary to sustain sage-grouse populations.

The Service developed a range-wide mitigation framework for sage-grouse that begins with avoidance of impacts, followed by minimization of impacts that cannot be avoided (USFWS 2014). Impacts from some anthropogenic disturbances to sage-grouse and their habitats can occur over relatively large areas, beyond the development's direct impacts, making on-site or near-site mitigation ineffective. In these cases, off-site mitigation is considered the best remaining option to offset impacts (USFWS 2014). Off-site mitigation also may be preferable because it is possible to take advantage of existing conservation management programs to locate the mitigation offset or consolidate several offsets in one location (Kiesecker et al., 2010). Off-site mitigation for a development impacting sage-grouse should ensure the continued existence of functional habitat in the distribution and quantity necessary to sustain a demographically viable population. Such assurances require protection of substantial areas of existing habitat managed such that the functional habitat is sustained and improved in perpetuity (USFWS 2014).

Compensatory mitigation within a conservation bank (bank) program may be used if minimization practices are not sufficient to limit the direct and indirect impacts from development (USFWS 2014). The Service's logic in developing conservation banking was that when impacts cannot be adequately avoided or minimized, conservation banking becomes a viable mitigation and species conservation option

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because it is implemented on a landscape scale, within a market framework, and species are treated as a benefit rather than a liability (USFWS 2003). The Service's guidance on conservation banks includes habitat preservation as a form of compensatory mitigation, even though clearly there is a net loss of habitat with simple preservation of existing habitat. Notwithstanding, the Service recognized the difficulty in producing new or enhanced sage-grouse habitat on a large scale and incentivizing the development of conservation banks without giving landowners credit for habitat preservation. Furthermore, the preservation of large parcels of functional sage-grouse habitat, while often not benefiting the local populations affected by a development, has a significant benefit to the overall conservation of a landscape-scale species such as sage-grouse.

Banks are land parcels containing natural resource values permanently conserved and managed for at-risk species (USFWS 2003). Credits are defined as a unit of trade and are generated upon bank establishment by instituting a perpetual conservation easement with financial assurances. The Service approves the release of bank credits and credit purchase is arranged between the banker and the project proponent, usually in a regulated credit for debit transaction, where the debit is the impact being offset by credits. The bank must be managed by an approved comprehensive management plan to control invasive exotic species, control fire, manage grazing, replicate natural disturbance regimes, and address other threats to the species and the species habitats. The status of the habitat and species (e.g., credits) must be monitored as long as the bank exists.

Effective mitigation should have a measurable benefit to the species being impacted. In the case of the habitat conservation bank, the benefit is considered to be the preservation and enhancement of existing habitat with long-term conservation value to mitigate habitat loss (USFWS 2003). Consequently, the purpose of banking is not to encourage development of listed species' habitats, but to provide an ecologically effective alternative to small, highly dispersed and isolated preserves that are not defensible or sustainable (USFWS 2012).

The Service has approved more than 130 banks nationwide that collectively conserve more than 64 777 ha of habitat for over 70 species. Because habitat loss is a landscape-scale issue for many species, including sage-grouse, due to their seasonal habitat needs, mitigation for habitat loss should be accomplished at a similar scale (USFWS 2014). While the scale of conservation varies with the species and issues, landscape-scale conservation generally covers large ecological and social systems. Sage-grouse, for example, require functional habitat that includes all the resources necessary throughout their life cycle, including the breeding, nesting, brood-rearing, and wintering periods. Average movements between areas supporting these life cycle requirements in Wyoming can vary from 8.1 km to 17.3 km and annual home range sizes can vary from 4 km² to 615 km² (Connelly et al., 2011; Fedy et al., 2012). These large home range sizes and large seasonal movements make sage-grouse a true landscape-level species that uses multiple functional habitats throughout their annual cycle.

The Greater Sage-Grouse Habitat Conservation Bank (GSGHB) is the first sage-grouse and the largest habitat conservation bank in the US and is located in central Wyoming. A review team composed of several state and federal natural resource agencies guided establishment of the GSGHB. As a condition of their approval of the GSGHB, the review team required the owner (Sweetwater River Conservancy [SRC]) to demonstrate that it owned or controlled, through federal and/or state grazing permits, all the lands necessary to protect habitats that are used during the full life-cycle of the sage-grouse population on which credits were developed, including the breeding, summer, and winter periods.

The purpose of this study was to demonstrate that sage-grouse used SRC lands during the full life cycle and develop bank credits that assessed the conservation value of sage-grouse habitats within the GSGHB and surrounding habitats. We describe the science supporting the identification of sage-grouse population segments and their habitat within the GSGHB and use of those data for calculating habitat credits. More specifically, we developed and used a resource selection

framework to quantify habitat credits for a sage-grouse habitat conservation bank.

Bank Area

The GSGHB is located in south-central Wyoming approximately 80 km southwest of the City of Casper within southern Natrona County and northern Carbon County (Fig. 1). The GSGHB encompasses approximately 88 294 ha, which includes 19 657 ha of deeded lands and livestock grazing leases and permits on approximately 11 919 ha of state and 56 718 ha of federal land (see Fig. 1). We collected sage-grouse habitat and use data within the GSGHB and within an area surrounding the GSGHB (the analysis area) to ensure all functional habitats utilized by sage-grouse occupying the GSGHB and surrounding habitats were identified (see Fig 1). The analysis area encompassed 190 661 ha and all occupied leks within 6.4 km of the GSGHB, except for 4 leks that were separated from the other leks by Wyoming Highway 220.

The landscape within the GSGHB is composed of sagebrush valleys surrounded by mountain ranges. The climate is semiarid, with an average of 25 cm annual precipitation. Elevations range from 1 669 to 3 057 m. The GSGHB lies within a relatively undeveloped, rural area. Dominant land uses included livestock grazing and outdoor recreation. Lands surrounding the GSGHB included a mix of deeded, federal, and state trust lands with similar land use.

Vegetation on the GSGHB consisted of shrub steppe plant communities on plains and hills, open woodlands on rocky ridges, and coniferous forest on mountain slopes. Based on extensive vegetation sampling (SRC unpublished data), 41 land cover types were identified on the GSGHB. The dominant land cover types were Wyoming big sagebrush (*Artemisia tridentata* var. *wyomingensis*; 29.0%), black sagebrush (*A. nova*; 24.7%), and plains silver sagebrush (*A. cana* var. *cana*; 14.7%). In all, there were 68 251 ha of sagebrush-dominated cover types, comprising 72.7% of the GSGHB. Areas dominated by other shrub species comprised 2.3% of the GSGHB, and forested areas comprised 13.4% of the GSGHB.

Surface disturbances within the GSGHB were minimal; the total area of disturbance within the GSGHB was 1.04%, below the 5% disturbance threshold identified to potentially impact sage-grouse habitat suitability (State of Wyoming 2015a). The primary sources of disturbance were man-made water sources (345 ha), gravel roads (287 ha), agricultural developments (144 ha), and pipelines (131 ha). No mines or oil and gas wells were present on the GSGHB.

Approximately 3 100 animal units consisting primarily of cow-calf pairs or yearling cattle were grazed on deeded state and federal lands on 13 grazing allotments within GSGHB. Grazing strategies were dictated primarily by the US Bureau of Land Management (BLM) allotment agreements, and each allotment was evaluated by the BLM to establish the timing for grazing and the number of animal unit months associated with the allotment. Depending on the allotment, grazing occurred from 1.5 to 12 months each year.

There were 31 occupied leks on or within 6.4 km of the GSGHB deeded lands, and approximately 51% of the GSGHB overlapped sage-grouse Core Areas (State of Wyoming 2015a; see Fig. 1). Birds from these 31 leks were likely to use seasonal habitats within the GSGHB because of the proximity of their breeding leks to the GSGHB (Schroeder et al., 2004; Holloran and Anderson 2005; Fedy et al., 2012). The mean number of males/lek (mean lek size) on these leks fluctuated between 6 and 20 males from 1985 to 1997. Mean lek size increased steadily after 1997 before peaking in 2005 and 2006 at 62 and 56, respectively. The mean lek size declined from 2006 to 2013, reaching a low of 10 in 2013 before increasing to 18 males in 2016.

Methods

A key component to the development and monitoring of the GSGHB was the quantification of the conservation value of sage-grouse habitat

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