Feasibility of Establishing a Conservation Bank to Benefit Greater Sage-Grouse in Montana

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Photo by the American Prairie Reserve, 2016

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This Group Project is required of all students in the Master of Environmental Science and Management (MESM) Program. The project is a year-long activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Group Project Final Report is authored by MESM students and has been reviewed and approved by:

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Date

Executive Summary

This project analyzes the feasibility for the American Prairie Reserve (APR), an independent nonprofit organization focused on preserving Montana's Northern Great Plains, to establish a conservation bank to increase habitat protection for the Greater Sage-grouse (*Centrocercus urophasianus*). As a conservation-oriented organization, APR's willingness to create a conservation bank hinges on the conservation value for Sage-grouse as well as the market potential of a successful credit exchange. We propose a multi-tiered approach involving a thorough background literature review, an analysis of potential local credit supply, projections of statewide credit demand and supply, a financial cost-benefit analysis of a proposed bank on one of APR's properties, a review of potential impacts to the species, and a suite of best management practice suggestions for APR.

In the absence of conservation efforts, destruction and disruption of sagebrush habitats have caused the population of Greater Sage-grouse to diminish greatly (Schroeder et al., 2004). Greater Sage-grouse once ranged across 12 western U.S. states and three Canadian provinces (Connelly et al., 2010). Montana currently has the second largest population of Sage-grouse among western states, with 70% of all Sage-grouse habitat within the state on private and state lands (State of Montana Office of the Governor, 2015). In 2015 the US Fish and Wildlife Service (USFWS) made a controversial decision against listing the sage-grouse as endangered under the Endangered Species Act (ESA) of 1973 (Fears, 2015). In reaching this decision the USFWS cited ongoing conservation efforts by federal and state agencies, nonprofit organizations, corporate interests, and private ranchers. Seeking to avoid the economic restrictions that would likely follow an endangered listing, development interests have indicated support for plans to protect and rehabilitate Sage-grouse populations and habitat. The Montana Sage Grouse Habitat Conservation Program was mandated by Governor Steve Bullock in 2014 (Zuckerman, 2014). His executive order created the Montana Sage Grouse Oversight Team (MSGOT), allocated state funds for conservation efforts, and mandated protection of designated core habitat areas. MSGOT is tasked with the creation and oversight of a compensatory mitigation program which includes offsite mitigation through conservation banking and habitat exchanges (State of Montana Office of the Governor, 2014).

To determine the financial needs, credit market, and potential effects of a conservation bank, we use APR's White Rock property as a "model bank" due to the quality of habitat contained, potential for habitat uplift through targeted management, and proximity to grouse habitat on the reserve. The quantity of credits was estimated through a combination of on-the-ground vegetation surveys and a simplified spatial habitat quantification tool (HQT) based on the Wyoming Conservation Exchange draft HQT. Where available, onsite estimates were compared with spatial land cover data to assess vegetation functionality in all of Phillips County to estimate credits on properties receiving state funds for conservation easements. We find the establishment and perpetual management of a conservation bank would be financially profitable (1.24 benefit-cost ratio), based on expected demand from the oil and gas industry and an estimated credit price of about $236. The upfront cost of bank establishment is substantial (roughly $1 million) due to the need to develop an endowment large enough to earn annual interest equal to operating costs. APR properties already contain high quality habitat, yet there is still room for habitat uplift through targeted management practices and removal of features that threaten grouse survival. If habitat improvements are unlikely with current funding sources, then the establishment of a conservation bank would provide additional benefits to Greater Sage-grouse populations on and near the White Rock property. Region and statewide benefits from the use of conservation banking however, are heavily dependent on the regulatory

framework developed by the State of Montana. Through a literature review, we infer that benefits to the species from conservation banks are highest when credits have long-term certainty, low transaction costs during quantification and price negotiation, and provide equivalent habitat value to the habitat disturbed (debits). The fundamental order of operations- avoid first, then reduce impact before allowing for mitigation- is still essential for habitat protection. To provide additionality on a credit-by-credit basis, the state should use offset ratios larger than 1:1 (debit: credit) for restored or created habitat and even larger ratios (greater than 1:2) for protected habitat, with the consideration of additional “distance’ multipliers for disturbances offset away from the initial impact. Lastly, due to the slow growing nature of sagebrush habitat, restoration and habitat creation projects must only receive credits once the habitat is deemed functional by the HQT.

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Introduction

This project assesses the financial feasibility and discusses ecological benefits of establishing a conservation bank for Greater Sage-grouse (GSG) in Montana on a property owned by our client, the American Prairie Reserve (APR). As a conservation minded non-profit organization, this project intends to assist APR in deciding whether if they should invest in a conservation bank, and what actions they can take to make it as beneficial to the species as possible. If the bank is expected to be self-sustaining through credit sales (provide a benefit-cost ratio of 1 or greater), the Montana state government establishes careful regulations on habitat offsets, and the bank is expected to provide additional protections to GSG, we recommend that APR move forward with this investment. To accomplish this goal, we conduct a literature review on the governing framework of conservation banks to date, legality and ability of this mitigation option to provide the regional habitat needs for GSG, and the best management practices for preserving GSG habitat through bank establishment and perpetual management. To estimate the financial needs and potential habitat benefits of a theoretical “model bank” on one of APR’s properties, we assess the quality of GSG habitat on deeded properties, quantify the current and future credit market in Montana, and quantify financial requirements for establishing and perpetually managing a conservation bank for GSG. For our recommendation, we review the bank’s expected profitability, potential benefits to GSG habitat and highlight regulatory red flags to look out for while Montana develops its statewide credit mitigation protocols. If the proposed project is expected to be profitable, APR still may choose to not implement a bank based on questions over whether conservation banking is the best way to conserve the prairie ecosystem. However, confirming the project’s feasibility on purely financial grounds is a prerequisite for being considered an option by APR.

GSG is one of the true sagebrush obligates. That is, this species is dependent upon sagebrush habitats for all phases of the life cycle, and is not found outside of sagebrush ecosystems (Rowland et al., 2006). Since the early 20th century, destruction, disruption and fragmentation of sagebrush habitats have resulted in diminished GSG populations, and drastically reduced their range (Manier et al., 2013). While much of the GSG current range is on federal land, in Montana it occurs primarily on private and state land (State of Montana Office of the Governor, 2015), making it a prime candidate for state-led conservation efforts. In 2015, the United States Fish and Wildlife Service (USFWS) decided against listing GSG under the Endangered Species Act of 1973, citing efforts by state agencies, nonprofit organizations, corporate interests and private ranchers (Fears, 2015). Taking the forefront on GSG conservation in Montana, the state government is in the process of establishing a compensatory mitigation program. This program would require off-site mitigation of projects disturbing core GSG habitat through conservation banking and habitat exchanges (State of Montana Office of the Governor, 2014). While the Montana Sage-grouse Oversight Team (MSGOT) is still formulating the regulatory framework for this mitigation program, it is important for potential participants to start planning now, so they can be ready to act when the rules are finalized.

APR is a non-profit organization founded in 2001 to restore and preserve Montana’s Great Plains region. Their long-term goal is to create an unbroken, healthy prairie ecosystem encompassing 3.5 million acres of public and private land. Currently, APR manages 350,000 acres of deeded and leased lands, nearly all within state designated “core habitat” for GSG. This location in core habitat provides APR with the opportunity to create a conservation bank under the new state framework, generating mitigation credits through enhanced habitat protection or restoration. As an environmental nonprofit, APR's primary concern is promoting the overall health of the prairie landscape, and conservation banking is just one of several options that this organization is considering. These analyses will assist APR in determining the most efficient way to leverage limited resources in pursuit of APR's overall goals.

Problem Statement

What are the financial costs and benefits of establishing, certifying, and operating a conservation bank for Greater Sage-grouse on deeded lands of the American Prairie Reserve, and how might it provide benefits to GSG?

Objectives

We answer this question by performing a thorough literature review of current conservation banking and habitat exchange systems (Part 1), estimating available credits of model bank using an augmented version of the Wyoming Habitat Quantification Tool (Part 2), and analyzing the financial requirements of establishing a successful bank (Part 3).

Part 1. Literature Review

Introduction to Greater Sage-grouse and Market Based Conservation

I. Greater Sage-grouse Ecology and Threats

A. Habitat and Lifestyle

The ground-dwelling Sage-grouse (*Centrocercus* spp.) is the largest grouse in North America. The exact taxonomy of Sage-grouse has been a subject of debate among ornithologists for decades. Most recently, in 2000, the American Ornithologists' Union classified Sage-grouse into two species: Gunnison Sage-grouse (*Centrocercus minimus*), which resides in the area of the Utah-Colorado border, and Greater Sage-grouse (*Centrocercus urophasianus*), which includes all other Sage-grouse populations (Manier et al., 2013). Adult male sage-grouse can range in length from 26-30" and weight between 4.4 and 6.6 lbs, while adult females range in size from 19-23" and 2.2-4.4 lbs. Both genders have dark gray-brown plumage on their bodies speckled with white and grey spots. Males specifically have black chin and throat feathers, specialized erective feathers called phylloplumes at the back of the head and neck, and white feathers around the neck and upper torso. Males display fleshy bare patches of skin on their chests during breeding season (Schroeder et al., 1999).

Greater Sage-grouse (GSG) use an iconic mating ritual, in which males congregate in "leks" and perform strutting displays while inflating large air sacs in their chests. In this ritual, females observe the displays and select the most impressive males to mate with (Johnsgard, 2008). Males generally gather in leks to display for several hours in the early morning and evening during the spring months (Emmons, 1984). Leks can be found at any site suitable for nesting habitat, and are generally areas of bare soil, short-grass steppes, or other relatively open sites (Hansen et al., 2016). Lek sites tend to be in close proximity to dense sagebrush cover, which is used for predator avoidance, feeding, and to protect the birds from thermal stress (Dinkins et al., 2014).

GSG are reliant upon sagebrush (*Artemisia spp.)* ecosystems for breeding, forage, and shelter, and usually preferring mountain big Sagebrush (*A. tridentate*) for survival (Johnsgard, 2008). Due to this dependence on sagebrush-rich habitat, the current GSG range closely mirrors sagebrush-grassland distributions across 11 US states and two Canadian provinces: central Washington, southern Idaho, Montana, southern British Columbia and Alberta, western North and South Dakota, as well as parts of Oregon, California, Nevada, Utah, Colorado and Wyoming (Johnsgard, 2008). The species requires large areas of contiguous sagebrush for reproductive success and survival (Hansen et al., 2016). GSG have been extirpated from Nebraska, British Columbia, and Arizona and changes from their estimated historical distribution are the result of sagebrush alteration and degradation (Schroeder et al., 2004).

Sagebrush is considered the most prevalent and widespread vegetation in the intermountain wester United States (Entwhistle et al., 2000). Due to variation in temperature and precipitation, sagebrush systems are generally divided into two major regions. The first is the sagebrush-steppe system which dominates the northern portion of sage-grouse range throughout the Columbia Basin, northern Great Basin, Snake River Plain, Wyoming Basin, and the grasslands of eastern Montana and Wyoming. The second is the Great Basin sagebrush system which occupies the southern portion of sage-grouse range and encompasses from the Colorado Plateau west into Nevada, Utah, and California (Miller et al., 2011).

Females select nest sites that have a mix of shrub, mainly sagebrush, tall grass such as native bunchgrass, and other vegetation that provide cover and nourishment (Hansen et al, 2016). Since nests are laid on the ground, this obstruction helps conceal nests and young from visually-cued avian predators (Hansen et al., 2016). It has been shown that dense vegetation also provides insulation to incubating females (Hansen et al., 2016). Clutch sizes range from six to nine eggs with an average of seven eggs, and males do not participate in egg incubation or rearing of chicks (Connelly et al., 2011). Nest success varies widely by location and habitat quality, with average success of 51% in non-altered habitats and 37% in altered habitats (Connelly et al., 1999). Brood rearing occurs near the nest site for 2-3 weeks after hatching, with chicks depending on forbs and insects for essential nutrition (Connelly et al., 2004). Due to this requirement, early brood-rearing habitats need to have adequate cover from predators and be adjacent to areas with abundant forbs and insects.

After mating season, GSG eat mostly insects and forbs, rarely straying far from the edge of sagebrush cover (Johnsgard, 2008). Once these sources of food begin to dwindle in the fall, the bird depends entirely to sagebrush. During the winter season, GSG prefer habitats at lower elevations and with greater than 15-20% sagebrush canopy cover for concealment and thermal protection (Connelly et al., 2000).

Some GSG populations can migrate very long distances seasonally between winter, breeding, and summer areas, while others tend to stay in the same general locations year round (Connelly et al., 2000). It has been estimated that some individuals or small flocks can migrate fifty to one hundred miles between seasons (Johnsgard, 2008). Migratory GSG populations have been shown to occupy areas that exceed 2,700 km^2 on an annual basis (Connelly et al., 2000). Movements are more confined during each particular season, however. Studies have shown, for example, that up to 99% of GSG brood sites/nests lie within 7 km of the lek where mating occurred (Coates et al., 2013). Finally, GSG have also been reported to return to the same nest area each year (Connelly et al., 2000). The species' mobility needs, variation, and preferences makes GSG habitat management and conservation especially difficult. Conserved areas must include a variety of sagebrush habitat types to meet GSG's seasonal needs, and even then may not be able to provide adequate habitat for migratory populations.

GSG in the region of Montana have been less impacted by modern human development than elsewhere in its range, but there is still cause for significant concern. The Western Associate and Fish and Wildlife Agencies (WAFWA) has classified the GSG range into seven management zones, based on ecological similarity and population connectivity. The Northern Great Plains Management Zone, Management Zone I (MZI), which includes Northern Montana, contains some of the highest densities of strutting male GSG to be found anywhere in the range. However, GSG range in this zone has been significantly reduced, and population trends indicate a 24% chance of the total male population dropping below 200 by year 2107 (Manier et al., 2013). While historical populations are difficult to estimate, the best available evidence indicates that GSG breeding populations in Montana specifically have declined by 30% (Montana Sage Grouse Work Group, 2005). Across this management zone, the majority (69%) of GSG habitat lies on private land (Manier et al., 2013), creating the need for management strategies that incentivize private conservation.

B. Anthropogenic Influences

The current distribution of GSG encompasses an estimated 56% of its estimated pre-European settlement range (Schroeder et al., 2004). The main factors in the decline of the species' area of occupation "appears to be related to habitat conversion and degradation" (Schroeder et al., 2004). Since GSG populations rely so heavily on large expanses of sagebrush cover, land conversion for farming, residential use, energy development, fence and road construction, intensive grazing, and other anthropogenic factors can fragment or otherwise damage vital habitat (Johnson et al., 2011).

i. Energy Development

The most important current threat to GSG habitat in Montana is oil and gas development. Development of oil and gas resources requires the construction of well pads, access roads, flow lines and other infrastructure, and results in increased traffic and noise from vehicles and machinery. Studies have shown a reduction in male lek attendance of 13-79% associated with energy development densities of 4-8 wells per square mile, and densities as low as 0.4 wells per square mile have been shown to negatively impact GSG populations. Negative population trends have been shown when "greater than eight active wells occurred within 5 km of leks, or when more than 200 active wells occurred within 18 km of leks" (Mainer, 2014). Concentrated oil and gas development areas exceeding 10 wells per square mile are common across the WAFWA Northern Great Plains Management Zone (Manier et al., 2013).

Negative impacts to GSG are not exclusively found in areas of high well density. Each individual well seems to have significant impacts on a large surrounding area as well. According to Mainer (2014), the "level of the human footprint within 5 km (3.1 miles) of a lek is negatively associated with lek persistence." Indirect influences of energy development have been shown to extend out to 19 km from leks (Mainer, 2014). Well density is also important, with negative population trends when "greater than eight active wells occurred within 5 km of leks, or when more than 200 active wells occurred within 18 km of leks" (Mainer, 2014). Finally, the noise from oil/gas drilling and the roads associated with these operations negatively affects lek attendance as well. Blickley et al. (2012) found that attendance at leks experimentally treated with noise from drilling fell 29%, and those treated with noise from roads fell 73% relative to controls. The core area stipulations outlined in Montana Executive Order 2014-10 set specific ambient noise decibel limits on new activities near sage grouse leks.

In addition to direct impacts from oil and gas extraction, large transmission infrastructure projects may also occur within GSG habitat. There are at least two potential pipeline projects pending in Montana, according to the State's database of current environmental impact assessments. The Chelin LLC Skelly Pipeline will be built in Toole County, MT. The Somont Oil Company is planning a Pipeline and Comingling project as well. Initial plans indicate that these projects do not cross into GSG Core Area, but that "marginal habitat… for grassland birds" may be affected. For the latter project, seasonal timing restrictions will be implemented to mitigate harm to Sage-grouse. Energy development in the region is likely to continue in the foreseeable future, as demand for oil and natural gas is projected to grow by 33% and over 50%, respectively, by 2025 (Manier et al., 2013).

ii. Agriculture and Livestock Grazing

Across the historical GSG range, 75% of shrub-steppe vegetation growing on deep soils has been converted to agriculture, and much of the rest was exposed to heavy overgrazing in the 1800s and early 1900s, which contributed to the reduced dominance of native forbs and grasses, and the spread of invasive Eurasian grasses. Much of the remaining shrub-steppe is still grazed today, but much less intensively. Despite the reduced grazing intensity, inappropriate livestock management still has the potential to reduce habitat quality and impact GSG populations (Manier et al., 2013). There are several ways in which livestock can be managed to coexist with GSG and other sagebrush obligate species. All fences should be flagged to reduce in-flight collisions, especially near known leks and population centers, and livestock should be managed in a rest-rotation system to allow grazed habitat to recover before it is grazed again (Braun, 2006). Recommendations for the percent of herbaceous vegetation that should be grazed annually range from 25% to 50% (Braun, 2006; Holechek et al., 1999; NRCS, 2012). The Natural Resource Conservation Service (NRCS) provides suggested management plans and formulas for calculating appropriate stocking rates based on estimated forb production per acre (NRCS, 2012), but regular vegetation monitoring is necessary to ensure adequate protection of native forb and shrub cover.

Cropland conversion has also been shown to be a major factor contributing to decline in GSG populations and lek persistence. Since settlement of the Western United States by European-Americans, the sagebrush landscapes sage-grouse rely upon have changed dramatically (Knick and Connelly, 2011). Some estimates have upwards of 50-60% historic sagebrush altered or lost due to direct conversion to cropland (Knick et al. 2003). The loss and fragmentation of sagebrush has changed the configuration of the landscape which has resulted in increased risk of population isolation, predation due to increased edges and infiltration of invasive plant species (Gelbard and Belnap 2003, Knick and Connelly, 2011). Agricultural conversion of sagebrush in particular has been cited as one of the primary causes of the fragmentation of sage-grouse habitat (Connelly et. al 2004).

Although not considered suitable sage-grouse habitat, some crops can be used as a source of food and water during the late brood-rearing season when natural sources have gone dry (Connelly et. al 2004). The risks to birds from higher predation along increased habitat edges and increased nest predator species found in close proximity to anthropogenic structures, possible exposure to pesticides, and collisions with fences may outweigh any benefits provided by cultivated cropland and pastures (Aldridge and Boyce, 2007).

In the WAFWA zone that includes our study area in Montana (MZ I), an estimated 19 percent of sagebrush has been converted to some form of agricultural production (Knick et. al, 2011). This differs from other management zones as the quality of soil and precipitation are the driving factors behind which areas are suitable for crops. The conversion of the most productive soils areas from sagebrush to agriculture have displaced some sage-grouse populations into less productive and more fragile sagebrush habitats (Manier et. al 2013). With the majority of sagebrush suitable for agriculture already converted, the rate of conversion has slowed over the past fifty years (Baker et. al, 1976), however bioengineering of crops, technological advances in irrigation and agriculture, and increased demand for biofuels may cause an increase in cropland conversion rates in the future (Knick et. al 2011).

Lipsey et al (2015) created a comparison of cropland conversion risk in MZ I with a Population Index model for sage-grouse that showed nearly 87 percent of the grouse population in MZ I occur in sagebrush habitats that are unlikely to be converted to cropland due to soil, climate or other factors. This model confirms the assumption that the most suitable agricultural lands have already been converted from sagebrush and also highlights the relative importance of considering energy development as the main driver of future sagebrush fragmentation in our study area.

In 2010 the Natural Resource Conservation Service (NRCS) created the Sage Grouse Initiative (SGI) to reduce threats to sage-grouse on private lands. The SGI offers technical expertise in grazing management plan formation and funding for conservation easements to retire active croplands from production. The NRCS has estimated that from 2010-2015 approximately 451,884 acres have been protected by conservation easements throughout the overall range of sage-grouse (NRCS 2015a). Additionally, SGI has created a map of sage-grouse habitat facing the highest risk of cropland conversion (APPENDIX 2, Figure 1). Montana's Greater Sage-Grouse Stewardship Fund, created in 2014, will also provide grant money to purchase conservation easements on private properties that may be vulnerable to agricultural conversion.

iii. Climate Change

Climate change is a current and increasing threat to GSG and the ecosystems of the Northern Great Plains. Between 1951 and 2002, average annual temperatures increased in the region by 2.6 degrees Celsius, with temperatures increasing more rapidly in the winter and spring than in the summer and fall. These trends are projected to continue, with additional temperature increases projected between 1.4 and 7.2 degrees Celsius over the next century. Temperature changes are expected to be most extreme in the northern portion of the region (Schrag & Forrest, 2012), in the vicinity of APR. Predictions of precipitation changes are far less uniform than temperature, but in general, climate models project that the northern and eastern portions of the Northern Great Plains, an area that includes APR, will experience increased precipitation, as well as increased frequency and intensity of extreme weather events. Southern and western portions of the Northern Great Plains, on the other hand, are projected to experience decreased precipitation (Shrag & Forrest, 2012). In addition to its direct effects, climate change is expected to exacerbate other threats to GSG (Schrag et al., 2011).

With such a wide range of projections, it is difficult to predict any specific effect with certainty. However, many possible impacts have been suggested. Drought, which is expected to increase in frequency, has been shown to directly decrease the survival rate of GSG broods and adults. Temperature changes and shifts in GSG behavior based on changing water availability may increase the exposure to and spread of West Nile virus in GSG populations (Schrag et al., 2011). Regional climate change in general may lead to changes in species composition, primary productivity, and range contractions or expansions for some species. Some studies have suggested increased invasion of grassland and shrubland by forest vegetation, as suitable conditions for woody plants move from west to east. Other studies have suggested that many vegetation types may shift northward, resulting in completely novel plant communities (Shrag & Forrest, 2012). In addition, many agricultural crops are temperature-limited at northern latitudes. As temperatures increase, some sagebrush habitat may see increased risk of cropland conversion (Schrag et al., 2011). Finally, climate change may increase the invasion of native shrublands by non-native grasses such as cheatgrass (Bromus tectorum). Cheatgrass provides poor nutrition to grazing species, increases the risk of wildfire and subsequent loss of native shrubs and grasses, and spreads rapidly in suitable habitat. It is already severely impacting GSG habitat in Utah and Nevada, and elsewhere in the southern portions of the range. Where this threat materializes in the future depends on how the precipitation regime changes over time. Areas where precipitation increases should become less vulnerable to cheatgrass, but areas where precipitation decreases, especially in summer, should see increased risk of invasion (Bradley, 2009).

GSG are true obligates of sagebrush ecosystems (Rowland et al., 2006), and any reduction in the range of sagebrush habitats as other plant species encroach would likely have severe impacts on GSG populations. Despite the threat, however, the vegetation communities surrounding APR may be more resilient to climate change than elsewhere in the GSG range. One study projected that as climate change progresses, the most suitable sagebrush habitat will be found in southwestern Wyoming and north-central Montana (Schrag et al., 2011).

iv. Other threats

The presence of other developments also has significant impacts on GSG. The bird can become entangled and even fatally injured by collisions with fences and power lines, introduced invasive weed species increase the risk of fire which reduces sagebrush cover, urban areas and major roads create noise as well as physical barriers which interrupt breeding behavior and population mobility, and human structures increase natural predation of GSG (Johnson et al, 2011). Braun (1998) outlined how residential development and subdivision of land in GSG habitat drastically reduced lek attendance. Human impacts to habitat networks can also increase natural threats to GSG. Although there are no natural predators that specialize in GSG during any point in its life cycle, predators may have increased impacts on the bird's population in fragmented habitat. There are several potentially additive impacts of human development on predation of GSG. First, tall structures such as buildings or power lines can serve as perches for predatory birds such as Golden Eagles and other raptors, or nest scavengers such as crows to locate individuals or their young (Dinkins et al., 2014). Other manmade structures like barns, communication towers and oil and gas structures may serve as nesting sites for these predatory animals as well. Finally, it has also been shown that anthropogenic structures are related to increased numbers of other scavengers that threaten GSG chicks and eggs like red fox and raccoons (Dinkins et al., 2014).

However, some development-related threats to GSG may actually be decreasing. According to the Montana Economic Report of 2016, "construction of single family housing start[ed] slipping in August" and the state showed 2.5% growth in new home construction in 2016 (Larew, 2016) The report also noted a "slowdown of the issuance of building permits" compared to previous years. Less than 25,000 people currently live in the four counties in Montana that contain Sagebrush Focal Areas (Dept. of Interior, 2016). According to the EIS, the population of Montana grew by 29 percent between 1990 and 2015, but the population declined in each of the SFA counties over the same period. Phillips County, where APR is located, experienced the most rapid decline, losing nearly 20 percent of its total population between 1990 and 2015. (Dept. of Interior, 2016).

C. Current Federal Protection Status of GSG and the Economic Implications

In 2010, USFWS determined that the GSG warranted an endangered finding under the Endangered

Species Act (ESA), due to “population declines caused by loss and fragmentation of its sagebrush habitat… coupled with a lack of regulatory mechanisms to control habitat loss” (Dept. of Interior, 2015). Ultimately however, the FWS designated the bird as “warranted, but precluded” due to higher priority candidate species (Dept. of Interior, 2015). In September 2015, after several years of “unprecedented, landscape-scale conservation efforts” by the Bureau of Land Management and the western states that contain the species’ breeding habitat, USFWS concluded the bird did not warrant protection (Dept. of Interior, 2015). In its “not warranted” declaration, the FWS stated that 98 distinct land use plans had “significantly reduced threats” to the bird across “90 percent of the species breeding habitat” (Opar, 2015).

There were many opponents to listing GSG under the ESA, including some ranchers, energy developers, local and state governments, and even certain environmental groups (Wilson, 2014) These groups feared that listing the GSG would severely limit grazing, mining, hunting, and energy development on a very large swath of land in the western United States (Wilson, 2014). Since the GSG covers a range of about 165 million acres, opponents argued that listing the bird would unnecessarily lock out tens of millions of acres from exploration, development and other uses (Wilson, 2014). Currently, the 11 western states that have suitable GSG habitat also account for approximately 27% of the total energy production in the United States (Stoellinger, 2014). Non-economic arguments for opposing federal ESA listing include the potential to undermine voluntary conservation attempts at the state and local level (Wilson, 2014).

Groups concerned with the economic impacts of ESA listing are wary of the requirements mandated under Sections 7 and 9 of the statue. Section 7 requires all federal agencies that conduct or authorize activities that may affect a listed species to ensure its actions are not “likely to jeopardize the existence” of the species; this provision is mainly triggered when a project is proposed on federal land (Stoellinger, 2014). Through a consultation process, the US Fish and Wildlife Service must determine if the proposed action will cause jeopardy to the species, and if so, must suggest “reasonable and prudent alternatives, and issue a reasonable take statement requiring mitigation” (Stoellinger, 2014). This process takes time, significantly delaying the completion of development projects.

Section 9, the take prohibition, “applies to all actions that impact Sage-grouse, regardless of land ownership” (Stoellinger, 2014). This section is more relevant to private property and existing projects, since any “habitat disturbing activity” may be considered a GSG “take” and result in large fines (Stoellinger, 2014). Opponents point out that these time-consuming processes and procedures could have negative impacts on the economy at the state and local level in GSG rangeland. Several governors and congress members from affected states have argued that the strictest conservation measures could cost up to “31,000 jobs and $5.6 billion in annual economic activity” (Wilson, 2014).

Finally, state and local entities argue that they have the knowledge and expertise to protect GSG more effectively than one overarching federal plan from USFWS. To prevent listing, many states have pushed to limit surface disturbances to a maximum of 5% per square mile (Opar, 2015). In this way, states can protect vital GSG habitat while still allowing development to take place. It has also been shown that private landowners are more likely to voluntarily implement management techniques that protect habitat, and therefore GSG populations that rely on that habitat to prevent the bird from being listed (Opar, 2015). Ranchers may do this by donating conservation easements, marking or removing lethal fencing, and altering grazing patterns (Opar, 2015).

II. Montana's Current Framework for GSG Conservation

To provide protection for GSG populations while avoiding the economic impacts associated with an endangered or threatened finding under the ESA, several executive orders and a senate bill have recently been issued to enhance Montana's conservation efforts.

A. Montana Executive Orders and Habitat Conservation Program for GSG

Governor Steve Bullock issued Executive Order No. 10-2014 in September 2014 to create the Montana Sage Grouse Oversight Team (MSGOT), which was tasked with developing the Montana Sage Grouse Habitat Conservation Program (MSGHCP) and incentives to "accelerate or enhance required reclamation" of habitats in and adjacent to core habitat areas (Mont. Exec. Order 10-2014). The MSGHCP is tasked with formulating Montana's strategy for the conservation, regulatory protection, and management of GSG.

This program requires mitigation that results in a net benefit to GSG populations for all new activities subject to agency review, approval, or authorization (Mont. Exec. Order 10-2014). It also allows for "a variety of mitigation tools" to be used, including habitat exchanges, conservation banks, and other approved conservation plans (Mont. Exec. Order 10-2014). Finally, new land uses within core GSG areas will only be approved when it can be demonstrated that the project will not cause declines in GSG populations. Any new developments or land uses permitted or authorized in core areas "shall minimize impacts on suitable habitat, and reclaim and restore any disturbance" (Mont. Exec. Order 10-2014). Existing land uses and activities are not affected by the stipulations of this conservation strategy. These existing activities include "oil and gas, mining, agriculture, processing facilities, power lines, housing, and [the] operation and maintenance of existing energy systems" (Mont. Exec. Order 10-2014). An additional, the 2015 executive order amended Executive Order No. 10-2014 and provided for implementation of the Montana Sage Grouse Conservation Strategy (Mont. Exec. Order No. 12-2015).

Sage Grouse core habitat areas were delineated by Montana Fish, Wildlife and Parks using GIS analysis. According to the metadata for the core area map, sage-grouse core areas are habitats associated with the 25% quartile highest densities of male sage-grouse, and associated habitat important to sage-grouse distribution. This "important habitat" was defined as an area where 75% or more of the surrounding 1,000 acres had a 10% or greater probability of supporting a sage-grouse lek. (Montana Fish, Wildlife & Parks, 2014)

B. Core Area Stipulations

The orders state that MSGOT is "directed to… recommend changes that may be necessary to ensure that 80 percent of the displaying males in Montana are either in delineated core [habitat] areas or otherwise subject to core area stipulations" (Mont. Exec. Order 12-2015). Core area stipulations apply to all new activities in core areas. They are designed to maintain existing levels of suitable GSG habitat by regulating uses and activities in core areas to ensure GSG abundance and distribution. Core area stipulations are broken down into sections relating to seasonal uses, noise, overhead power lines and communication towers, prescribed burns, surface disturbance, transportation, pipelines, conifer expansion, and other disturbances (Mont. Exec. Order 12-2015). For a core area map, see Appendix 2, Figure 2.

i. Seasonal Land Use and Noise levels

There are specific core area stipulations regarding land use related to noise levels at different times of the year due to seasonal GSG behavioral patterns. Activities are prohibited outside of the 'no surface occupancy perimeter' of active leks (0.6 miles) during mating season, March 15 to July 15, to prevent disturbance of mating behavior. When necessary, maintenance and emergency activities may occur during mating season, but are prohibited from occurring between 4 and 8 am, and 7 and 10 pm, since chronic noise from human activities has been shown to reduce GSG attendance at leks (Blickley et al, 2012). Core area stipulations regarding noise also prevent new projects from exceeding 10 decibels (dBA) above ambient noise levels at the perimeter of an active lek from 6pm to 8am during breeding season. Areas where GSG concentrate during winter months are protected from oil/gas exploration and development activity from December 1 to March 15 as well (Blickley et al, 2012).

ii. Power Lines and Conifer Expansion

Executive Order No. 10-2014 states that new power lines within 4 miles of active leks should be buried and communication towers should be located a minimum of 4 miles from leks if economically feasible. GSG often become entangled in overhead power lines, and both lines and communication towers can serve as perches and nesting sites for predatory birds (Dinkins et al, 2014). If locating these structures greater than 4 miles from active leks is not economically feasible, new power lines and communication towers should be sited as far as possible, and preferably greater than 0.6 miles, from active leks. For the same reason, the state has adopted a 'no net conifer expansion' policy for government agencies managing sagebrush in core areas. If conifer expansion is an issue near leks, managers should ensure that all conifers are removed within at least 0.6 miles (Mont. Exec. order 12-2015). MSGOT also established that burying existing overhead lines that have "contributed to a decline in GSG populations" will be considered as a mitigation option (Mont. Exec. Order No. 12-2015).

iii. Surface Disturbance and Prescribed Burns

Core area stipulations limit surface disturbance to 5% or less of suitable GSG habitat averaged across the entire area affected by the project. It is important to note that acres of development in unsuitable habitat are not considered disturbed acres for this calculation. MSGOT must be consulted in advance of any proposal for prescribed broadcast burns in GSG habitat (Mont. Exec. Order No. 12-2015). It has been estimated that sagebrush species take between 35 and 120 or more years to recover from fires, and that fire increases prevalence of noxious forbs such as cheat grass as well (Baker, 2006).

iv. Industry Specific Disturbances

There are industry specific stipulations in the executive orders as well. For example, oil and gas well pad densities are not to exceed an average of 1 per square mile, distributed preferably in a clumped pattern in one general direction from an active lek. Pipelines in core areas are to be buried and the disturbed area should be restored with native grasses, forbs, and shrubs to control for noxious and invasive weeds. In addition, wind energy development is excluded from GSG core areas until the best available science determines that development will not cause a decline in GSG populations (Mont. Exec. Order 12-2015).

It is important to note that although land uses that predate the bill are not subject to this conservation strategy, existing operations may not initiate activities "resulting in new surface occupancy within 0.6 miles of an active sage grouse lek" (Mont. Exec. Order 12-2015). To ensure core area stipulations are having the desired conservation effects, the Montana Sage Grouse Habitat Conservation Advisory Council recommended a target performance standard of 6.9-18.78 males per lek averaged over a 10-year period (Mont. Exec. Order 10-2014).

C. Senate Bill 261 – Montana Greater Sage-Grouse Stewardship Act of 2015

Montana Senate Bill 261 (SB0261), also known as the Montana Greater Sage Grouse Stewardship Act of 2015, expands on the earlier executive orders. The bill's stated purpose is to "provide competitive grant funding" and establish "ongoing free-market mechanisms for voluntary, incentive-based conservation measures that emphasize maintaining, enhancing, restoring, expanding, and benefiting GSG habitat and populations" (SB0261, 2015). SB0261 establishes the Sage Grouse Stewardship Fund, legalizes compensatory mitigation in the state and further defines the powers/duties of MSGOT (SB0261, 2015).

i. Sage Grouse Stewardship Fund

The Sage Grouse Stewardship Fund seeks grant applications for projects that conserve GSG populations and habitat, thereby preventing the need for listing under the ESA in the future. Since 64% of GSG habitat in Montana exists on private property, the state recognizes that voluntary conservation measures on private lands will be necessary for the conservation plan to be successful. As such, the Sage Grouse Stewardship Fund provides incentives for voluntary actions that maintain, enhance, restore, expand or benefit GSG habitat and populations (Mont. Exec. Order 12-2015). The Fund's ultimate goal is to "facilitate free-market mechanisms for voluntary, incentive-based conservation on private lands" in core GSG areas (SB0261, 2015)

The act prioritizes different types of projects to receive grant funds from the Sage Grouse Stewardship Fund. Examples of voluntary conservation measures that received grant priority include reduction of conifer encroachment, reduction of the spread of invasive weeds that harm GSG habitat, maintenance, restoration, or improvement of sagebrush health or quality, incentives to reduce the conversion of grazing land to cropland, and other strategies beneficial GSG populations. Grants may only be awarded to organizations and agencies that hold and maintain conservation easements or leases, or that are directly involved in GSG habitat mitigation and enhancement activities.

ii. Compensatory Mitigation Under SB0261

The bill also legalizes Montana's use of compensatory mitigation to allow project developers to offset environmental disturbances to core habitat by protecting high quality habitat elsewhere (SB0261, 2015). For any project with the potential to negatively impact GSG core habitat, MSGOT is tasked with quantifying the potential debits (quantified damages) of the project, and securing sufficient credits (habitat created or protected to offset the degradation) to be purchased by the developer to compensate for those debits (SB0261, 2015). This process of trading habitat credits and debits requires the use of a habitat quantification tool (HQT), a defined method that estimates and quantifies "the condition… of a given location on the landscape for Greater Sage-grouse" (Holloran et al, 2015). In this method, a functional acre approach is applied using a set of field observations and remote sensing techniques to determine habitat suitability for GSG. The purpose of a habitat quantification tool, such as the one developed for Wyoming's conservation exchange, is to quantify the change in condition of GSG habitat resulting from management actions (Holloran et al, 2015). In this way, projects that have negative impacts can be considered debits and beneficial projects can create credits, and these credits and debits can be compared and traded on a 1:1 basis. As of February, 2017, Montana's HQT is under development.

iii. Powers/Duties of MSGOT

MSGOT is directed to map and outline core habitat areas, evaluate grant applications, appropriate funds from the Sage Grouse Stewardship Fund, review compensatory mitigation plans, and transfer credits to a habitat exchange if one is authorized in Montana (SB0261, 2015).

III. Introduction to the Conservation Economy and Market Based Conservation

A. Ecosystem Services and Economic Benefits: A Conservation Economy

The term "conservation economy" refers to the realization that environmental protection, economic growth, and community wellbeing can be inextricably linked, especially in areas that depend heavily on tourism and agriculture. Studies have found that the conservation and protection of natural resources can provide economic and community health benefits through what are referred to as ecosystem services (Hjerpe, 2014; Scarlett & Boyd, 2011; Stelk & Christie, 2014; Wratten et al, 2008). For instance, forest landscapes can purify drinking water and provide food supplies for communities, in addition to offering recreation and spiritual connections (Hjerpe, 2014), while wetlands provide erosion control, carbon storage and sequestration, and purification of storm water runoff (Stelk & Christie, 2014). Benefits from wildlife are also examined, such as bee pollination providing significant benefits to crop productivity and biodiversity (Wratten et al, 2008).

Other natural resources and processes provide services such as water storage, soil fertility, feed for herd agriculture, removal and prevention of invasive species, and scenic landscape and wildlife viewing (Scarlett & Boyd, 2011). While some of these services have benefits with clear financial returns (such as tourism), other non-market service benefits are harder to financially quantify, such as soil fertility and water purification, and therefore often result in undervaluation and a lack of protection during development and land use decisions (Scarlett & Boyd, 2011).

To promote and properly compensate landowners or land managers that protect environmental services, various programs have been developed for providing payments for ecosystem services (PES). PES programs are intended to make voluntary conservation efforts financially attractive for private landowners, and help provide a monetary value for land conservation that can be considered during federal and state land use decisions (Defenders of Wildlife, 2006; Casey, Vickerman, Humman, & Taylor, 2006; Wilcove & Lee, 2004). In Montana, where the majority of high quality habitat exists on private or state land, efforts to protect ecosystem services must aim to target preservation and wildlife-friendly management practices outside of federally owned properties.

The Nature Conservancy, JPMorgan Chase, EKO Asset Management Partners, the David and Lucile Packard Foundation, and the Gordon and Betty Moore Foundation recently conducted an analysis of the conservation economy, and found that impact investments and conservation practices can increase profitability and economic growth. This may account for why private investment in conservation has doubled between 2004-2008 and 2008-2013. The authors expect that this increase in conservation investment was encouraged through government subsidies for various land management practices that promote conservation, and the creation of conservation and mitigation banks to direct revenue streams to private landowners, among others (NatureVest & EKO Asset Managers Partners, 2014).

B. Summary of Habitat Conservation Mechanisms for Private Lands

To promote the protection of biodiversity on private agricultural lands, various government-backed programs, including market-based initiatives, have been utilized. For GSG specifically, Montana also utilizes the non-market Sage Grouse Conservation Initiative, which uses the Farm Bill to promote GSG habitat protection on ranchlands across the state (Natural Resources Conservation Service, 2015). There is a consensus that proscriptive regulations should be used to prevent damage, while incentives should be used to increase habitat size and function through activities such as restoration and connectivity improvement (Defenders of Wildlife, 2006).

Defenders of Wildlife (2006) conducted a literature review to develop a method of cataloging and assessing various conservation incentive mechanisms. They found seven major categories: Regulatory and Economic Disincentives, Legal/Statutory Innovations, Private Property Rights, Market Oriented Institutions, Financial Incentives, Public Tax Incentives, and Facilitative Incentives. Regulatory and economic disincentives include governmental regulations (such as the Endangered Species Act, Clean Water Act, and Clean Air Act), conservation compliance programs (such as the federal Farm Bill), and financial charges for habitat degradation (such as habitat conversion taxes, real estate fees, and taxes on pesticide and fertilizer use) (Defenders of Wildlife, 2006).

Legal/Statutory innovations describe mechanisms that allow habitat modification under certain circumstances. These include safe harbor agreements, conservation agreements, and regulatory relief such as exemptions from a legal requirement in return for an established long-term habitat management plan. To promote restoration and habitat expansion for federally listed endangered species, the USFWS developed safe harbor agreements, which are legally binding agreements between private property owners and the USFWS. The landowner is required to protect the current habitat of listed species, referred to as the “baseline requirement”, yet is not required to provide protection of any additional habitat restored on their property for that specific species after the agreement is made. This protects property owners from future regulations and potential penalties if they later decide to modify that restored land, even if that restored land becomes suitable or occupied by a listed species (Wilcove & Lee, 2004).

To promote conservation through private property rights, strategically placed conservation easements, covenants and deed restrictions, and stewardship exchange agreements have all been utilized. Financial incentives include the use of compensation programs, conservation stewardship incentives, and the provision of price-premiums in return for conservation and restoration efforts. For instance, Defenders of Wildlife’s Conservation Fund discourages livestock operators from harming wild predators by reimbursing operators for any livestock physically harmed. Financial incentives have also been paired with scientific assistance, such as in the Landowner Conservation Assistance Program from Environmental Defense. For this program, Environmental Defense agreed to conduct a confidential assessment of a landowner’s property to determine habitat and occupancy of two specific endangered species, develop a habitat restoration and management plan, and assist in negotiating a safe harbor agreement with USFWS for any restored parcels (Wilcove & Lee, 2004). An example of a price-premium is APR’s Blue Sky ranching program, which provides a price premium on beef raised with “wildlife friendly” ranching practices. Facilitative incentives refer more to educational and technical assistance programs, as well as recognition incentives.

Wambolt et al. (2002) conducted an analysis of various policy mechanisms to quickly maintain and increase GSG populations (within 5 years) on public lands in the Western United States by reviewing seasonal habitat needs and assessing threats. Policies assessed include population monitoring methods, translocation potential, prevention of development in core habitat areas and during breeding season, and prioritized restoration. Of 56 translocation efforts, only 3 were deemed to be relatively successful (birds survived but only established a small population). The study recommended that restoration efforts be prioritized in areas that neighbor high-quality habitat already occupied by GSG. It is important to note that there are several properties on APR with relatively poor quality habitat that neighbor GSG populations occupying high-quality habitat.

Wambolt et al. (2002) also found that different stakeholders, including "ranchers, farmers, hunters, environmentalists, energy and utility providers, real estate developers and small towns or rural communities," view management alternatives differently. For instance, fires are found to be harmful to GSG habitat, and many groups work to prevent fires from occurring in these areas. Yet surveys found that other stakeholders, such as livestock industry members, believe that fires increase the production of underbrush, such as forbs and grasses, which are beneficial to GSG. Other instances of disagreement include the role and need for predator control, and the level of coexistence and disturbance potential to GSG from livestock grazing (Wambolt et al, 2002). While all of these conservation mechanisms provide conservation benefits to targeted species and habitats, it has been recommended to broaden the benefits of these conservation efforts by focusing on habitats that benefit multiple species as an opposed to a "single species approach" (Defenders of Wildlife, 2006; Scarlett & Boyd, 2011). Our efforts focus mainly on the use of conservation easements and the market-oriented institution of conservation banking.

C. Introduction to and Legality of Compensatory Mitigation

The modern use of compensatory mitigation under the ESA arose from efforts to conserve wetlands under the Clean Water Act (CWA). Compensatory mitigation is a requirement to offset any degradation to habitat from development. Under the guidelines established under Section 10 of the Rivers and Harbors Act, as well as Section 404 of the CWA, impacts to wetlands are to be mitigated first by avoiding harm, if necessary by minimizing impacts, and as a last resort, by compensating for unavoidable impacts (USFWS, 2003). In a similar manner, conservation banking extends this protection for listed and threatened species under the ESA.

Although the ESA prohibits the "take" of species listed as endangered or threatened, the USFWS can issue permits which allow otherwise lawful activities to take these same species. This authority stems from the ESA Section 7 (a) (2) for 'takings' by federal entities, and Section 10 (a) (1) (B) for 'takings' private entities. Each "incidental take" permit issued by USFWS comes with the requirement that permittee must offset the damage to the species allowed by the permit. Permittees can implement their own mitigation program through onsite remediation or off-site conservation, pay into an in-lieu fee program, or purchase credits from an authorized conservation bank or exchange program (U.S. Dept. of Interior, 2012).

Authorized by Sections 7 and 10 of the ESA, conservation banks are further defined and authorized by USFWS guidance documents as "permanently protected lands that contain resource values, are conserved and permanently managed for species that are listed as endangered, threatened, candidates for listing as endangered or threatened, or are otherwise species-at-risk" (USFWS 2012).

D. Compensatory Mitigation Options

Regarding compensatory mitigation, conservation banking is just one of four commonly used market mechanisms, which also include habitat credit exchanges, in-lieu fee programs, and permittee-responsible mitigation (USFW, 2013; Pearman & Plawecki, 2015).

i. Habitat Credit Exchanges

Habitat credit exchanges are similar to conservation banks as they are conducted between the permittee (a willing buyer) and the credit sponsor (the landowner that owns habitat credits). The difference is that these credits are not certified by USFWS and land conservation easements are not required to be perpetual. These programs do, however, require a third-party administrator to ensure that performance measures are met and transactions can successfully occur. The administrator acts as the USFWS in this mechanism, as they determine the number of credits available on the sponsor's property, often based on quality and quantity of the habitat through an HQT. Since these exchanges are not approved by the USFWS, they are only valid for non-listed species (Pearman & Plawecki, 2015). Habitat exchange programs are currently in place for GSG in Colorado with the Colorado Habitat Exchange, Nevada through the Nevada Conservation Credit System, and Wyoming through the Wyoming Conservation Exchange.

ii. In-lieu Fee Programs

When there are no other mitigation options available for the specific species or habitat protection requirement, a permittee can contribute to a compensation fund that will eventually be used to conduct a mitigation project. The compensation fund must be approved by the USFWS, and the sponsor of that fund assumes all responsibility for successfully completing the necessary mitigation and permanent protection. The downfall of this type of mitigation approach is that there is a time lapse between the habitat damaged by the permittee and the habitat restored or protected by the mitigation fund, resulting in a temporary net loss of habitat. However, the mitigation efforts that eventually take place are often of a larger magnitude, since the funding for that restoration or protection effort can be substantial. Long-term performance measures must be achieved to insure compliance with these programs (USFWS, 2013).

iii. Permittee Responsible Mitigation

Permittee responsible mitigation refers to the permittee (the developer who must acquire a permit to degrade habitat) conducting their own onsite or offsite mitigation for habitat disturbances, and therefore assuming all responsibility for the successful completion of the mitigation projects. Mitigation often occurs at the same time of the degrading project, but it is not required to do so. The downfall of this approach is that it often results in a piecemeal protection of habitat. The projects are generally small in size, so instead of a large contiguous parcel of habitat, the restoration site may be separate from other preserved habitats or far from important connectivity areas. In addition, these projects often do not receive adequate monitoring of performance measures (USFWS, 2013).

iv. Conservation Banks

The USFWS defines a conservation bank as a "parcel of land containing natural resource values that are conserved and managed in perpetuity, through a conservation easement held by an entity responsible for enforcing the terms of the easement, for specified listed species and used to offset impacts occurring elsewhere to the same resource values on non-bank lands" (USFWS, 2003). The natural resource values of the bank property are then translated into credits. A typical credit price will include funding for the long-term management and protection of those values. Firms that are proposing developments within the habitat of a banked species can meet their mitigation requirements through the one-time purchase of credits from a bank, transferring all obligations of perpetual management and protection to the bank manager (USFWS, 2003).

Pearman and Plawecki at the Yale School of Forestry conducted the 2015 project "Assessing Compensatory Mitigation Options for Greater Sage-Grouse Conservation", which first conducted a study to determine each program's ability to effectively promote conservation based on additionality, durability, siting, scientific defensibility, metrics and methodology, stakeholder participation, and adaptive management. The students then conducted interviews in the energy industry, regulatory agencies, and conservation organizations. They found that conservation banks were best situated to provide maximum conservation benefits to GSG based on their seven criteria, followed first by habitat exchange programs, then in-lieu fee programs and lastly, permittee-responsible mitigation. The general preference of the energy industry was for in-lieu fee programs due to their generally simpler process, greater cost certainty, and high assurance that mitigation requirements were met and will continue to be met in the event of a future listing, while government agencies generally preferred conservation banks (Pearman & Plawecki, 2015).

Conservation banks are generally considered to be more economically and ecologically efficient at providing benefits to target species than permittee-responsible mitigation and in-lieu fee programs. This is because banks are generally larger tracts of intact habitat as opposed to the smaller piecemeal mitigation parcels from permittee-responsibility mitigation, and most banks don't contain the temporal lag between impact and habitat protection experienced by in-lieu fee programs (USFWS, 2013).

IV. Regulations for Perpetual Protection

A. Use of Conservation Easements as Perpetual Protection

The placing of a perpetual conservation easement on any privately-owned property legally ensures permanent protection. Conservation easements are voluntary but legally binding agreements between a landowner and a land trust, as only registered land trusts are eligible to hold conservation easements (Montana Assoc. of Land Trusts, 2015). Easements will permanently restrict development and future uses of the subject property to protect specific conservation values (Mont. Exec. Order 12-2015).

The monetary value of the easement is determined by a certified property assessor, and should include the value of all future developments foregone by the restrictions established by the easement (Plantinga & Miller, 2001). The landowner can seek public and private funds to compensate them for the easement, or can receive a tax break for donating the easement as a charitable deduction. When a landowner donates an easement to a land trust, the landowner can continue to own and manage the property in accordance with the set agreement, but gives up future development rights to the land (I.R.B, 2007). Continued land management practices could include producing crops, livestock, and timber, but need to be explicitly stated in the agreement. For conservation banking purposes, a potential credit supplier places the easement on the property with written stipulations prohibiting all activities that would endanger the species or its habitat. These activities generally include prohibitions against subdivision, conversion of habitat to crops, and other surface disruptions and structures (SB0261, 2015).

A potential pitfall of perpetual easements occurs when conditions drastically change and the original intent of the easement is no longer supported by language in the easement. Some argue that the requirement for an unwavering perpetual easement provides long-term security in conservation of habitat. Others argue that it fails to recognize that conservation needs change over time and that the easement may eventually lose any ecological benefit or even become detrimental (Mont. Exec.

Order 12-2015). Proponents of limiting ironclad perpetual protection point to forest management as an example of emerging science changing conservation practices. The importance of thinning techniques for forest health was not known when some easements were placed, and the easements do not allow for what now is known to be the best practice for the health and management of the forest ecosystem. Specific "dynamic" language is increasingly included in the terms of conservation easements to combat these concerns. Both state and federal courts, however, have been very cautious in allowing termination of perpetual easements to avoid weakening their intended protection and creating an opportunity for energy and mineral companies to unlock the economic benefits that are currently off limits (McLaughlin and Weeks 2010).

B. Montana Laws Regarding Conservation Easements and Perpetual Protection

Montana Code Sections 76-6-201 through 76-6-212 outline conservation easements in the state. To qualify as a conservation easement, the donated land must be managed in a way that accomplishes one of three conservation purposes: preservation of open space (including farmland, ranchland, or forestland), preservation of relatively natural habitat for fish, wildlife or plants, or preservation of lands for education or outdoor recreation for the general public (Mont. Assoc. of Land Trusts, 2015). The landowner also agrees to allow the land to be monitored annually by the land trust holding the easement. This monitoring helps the land trust enforce easement provisions. Federal law requires conservation easements to be held in perpetuity, formally defined as 999 years, to qualify for federal income and estate tax benefits (Mont. Assoc. of Land Trusts, 2015). While specific provisions may vary, land uses that are generally prohibited by a conservation easement include subdivision for residential or commercial activities, non-agricultural commercial activities or construction, surface mining, or dumping of non-compostable or toxic waste (Montana Land Reliance, 2015).

It is important to note that conservation easements are placed on the property title, which often does not include underground mineral rights. Landowners cannot receive a charitable deduction if they do not also own the subsurface mineral right, because at any time there may be a removal of those minerals by a surface mining method (Mont. Exec. Order 12-2015). This rule can be sidestepped if the probability of "extraction or removal of minerals by any surface mining methods is so remote as to be negligible" (26 USC Sec. 170 (h) (5)). During easement donations, the property owner retains the property title and all other associated property rights. If the landowner sells the property, the easement transfers with the deed of the property, and future owners must also adhere to easement rules.

Recent presidential executive orders have expanded the benefits landowners receive from donating a conservation easement. An individual can consider the "fair market value" of land placed under conservation easement as a charitable contribution, and deduct up to 50% of their adjusted gross income per year when filing federal taxes. The remaining amount of the original donation can roll over up to 15 years or until it has been completely deducted. If the landowner is a qualified farmer or rancher, they can deduct an additional 50% of their adjusted gross income, totaling 100%, when filing federal taxes (I.R.B 2007-25). It is important to note that the landowner remains responsible for paying property taxes, and that federal law requires a conservation easement to be held in perpetuity to qualify for income and estate tax benefits. These policies were made permanent at the end of 2015 with the Consolidated Appropriations Act, 2016. Currently, there are no state tax incentives in Montana for donating conservation easements (Mont. Assoc. of Land Trusts, 2015).

Ability of Conservation Banks to Provide Benefits to GSG

I. Best Operating Framework for Effective Conservation Banks

To determine the ability of conservation banks to provide benefits to their target species, we intended to review already established banks and track changes in the onsite populations and habitat functionalities. Unfortunately, few annual reports are made publicly available, and those that were available did not compare annual monitoring results against baseline conditions or provide the initial baseline report as a separate document. Several studies have assessed the quantity of banks established over time (Table 1), and their financial feasibility, credit transactions, and driving forces of establishment (DOI Office of Policy Analysis, 2013a; DOI Office of Policy Analysis, 2013b; Fox & Nino-Murcia, 2005; Maillet & Simon, 2007). None of these banks could track onsite ecological changes or their ability to meet stated management goals. Thus, there is little empirical evidence about the long-term efficacy of different approaches to conservation banking, especially regarding ecological outcomes. Therefore, our analysis of conservation banking is largely based on the theoretical literature.

Table 1. Summary of conservation bank statistics from 2007 (Maillet & Simon, 2007), 2013 (DOI Office of Policy Analysis, 2013a), and 2017 (RIBITS database search, 2017).

	Summary of US Conservation Bank Statistics		
	2007	2013	2017
Active USFW Approved Banks	78	93	123
Sold Out USFW Approved Banks	NA	12	23
Quantity of Species Covered	30	35	NA
Total Acres Covered	63,000	75,000	165,897
Range of Bank Sizes	12 - >10,000	8 - >4,000	5 - 29,082
Range of Credit Prices	NA	$15,000 - 400,000	NA

A. Market Size and Perception

There are two key economic requirements that are necessary for a functioning mitigation credit market: there must be enough participants, and participants must have a reasonable degree of certainty about the current and future state of the market. This second requirement includes, among other factors, information regarding the cost of credits, the legal and institutional requirements associated with the market, and the responsibilities of buyers and sellers (Teeffelen et al., 2014). The practice of conservation banks not making their credit prices or their methods for determining prices public is one common example of an information barrier that impedes efficient market activity.

Enough participants are necessary for conservation incentives to occur without undue or inefficient burden to developers. For example, if there is insufficient demand for new development, then investment by private landowners in restoration will not be rewarded, since they will be unable to sell the credits produced (Teeffelen et al., 2014). This would create a disincentive for other landowners to follow suit, since they would be giving up the economic benefit of an alternative, non-conservation land use, but are guaranteed nothing in return. This need for adequate demand has a huge impact on where conservation banking will be feasible, as well as on the size of any proposed bank. Successful banks have often been clustered in areas where rapid development is impacting the same type of habitat or species. Only banks that cover commonly impacted species or habitat will be able to sell enough credits to sustain themselves (Bunn et al. 2014). On the other hand, if there is an insufficient supply of credits, developers will not be able to purchase credits in a timely manner, likely imposing very costly delays on development projects and increasing stakeholder opposition to the exchange system (Teeffelen et al., 2014).

Given sufficient supply and demand for mitigation credits, the level of trading activity in the regional credit market still depends on several factors. First, the rate of land use change directly impacts the rate of market activity. Even with sufficient supply and demand in the long term, if the rate of land use change is very slow, it will result in low market activity. Second, the size of the area served by a bank changes the expected level of activity, as markets encompassing large areas tend to be more active. Market activity can be inhibited by strict requirements that reduce the versatility of credits, such as requirements that mandate close ecological similarity between restored and destroyed habitat. Similarly, high transaction costs, lengthy administrative processes, and a lack of information about potential buyers and sellers all negatively impact credit market activity (Teeffelen et al., 2014). Disallowing the practice of 'habitat borrowing' can add a significant time-delay, adding uncertainty about the future returns to current investments in restoration and decreasing market activity. 'Habitat borrowing' is the practice of awarding credits for restoration before the quality of habitat required by the credit system is achieved (Teeffelen et al., 2014), and will be discussed in more detail later.

In any market, a low level of trading activity increases the uncertainty for both producers and purchasers. It does not provide clear price signals, and may allow firms to accumulate sufficient market power to no longer be considered price-takers (Teeffelen et al., 2014). Conversely, if there is high trading activity then buyers and sellers receive frequent, reliable price signals and are better able to predict and make assumptions about the future price and availability of credits. Thus, if there is sufficient supply, demand, and market activity, then the economic preconditions for successful mitigation credit markets are met (Teeffelen et al., 2014).

B. Institutional Structure and Currencies of Offset Credit Markets

Perhaps the most important variable impacting the success of an offset credit market is the environmental good or service that is being traded. How are ecosystem or conservation values being translated into credits, and what do the traded credits represent? Some writers have called offset credits "fictitious commodities," or the result of an "incomplete process of abstraction" (Boisvert, 2014). This question of currency is one of the most debated aspects of conservation banking, and of offset policies more generally. The choice of currency has huge and often opposing impacts on the economic viability of a policy and its environmental efficacy. On the one hand, all environmental markets must assume that the things being traded are roughly equivalent in environmental value, or there would be no guarantee that the desired outcome would be achieved (Salzman & Ruhl, 2000). On the other hand, requirements that mandate strict ecological similarity between restored and destroyed habitat drastically reduce the fungibility of credits, and thus limit market activity (Teffelen et al., 2014). Ecosystems are unique, both in terms of location and function, but representing them with a tradable currency can render them superficially comparable. The method of converting non-fungible ecosystems into a fungible currency is theorized to drive the structure, function, and level of participation in environmental markets (Salzman & Ruhl, 2000).

The ideal currency for any environmental market would be the social value of the environmental good being preserved or destroyed (Salzman & Ruhl, 2000). In the case of conservation banking for GSG, this ideal currency would be the value to society of the exact number of GSG, or potential for future GSG that would be preserved, restored or destroyed at a site. The uncertainties involved in any such ideal currency are huge, and so we must rely on proxy measures such as general habitat (Salzman & Ruhl, 2000). There is no consensus on exactly how such proxy measures should be calculated, however. In 2011, over 40 different methods were in use in the United States to assess and assign value to habitats (Boisvert, 2015). The question of which methodology to use is crucial, as it will determine whether the goal of environmental protection is reached. If the currencies cannot successfully incorporate the environmental values at stake, those values become external to the exchange, and market activity may degrade rather than protect them. However, more precise approaches to pricing—that is, approaches that most accurately capture true environmental values—increase transaction costs, and decrease market activity (Salzman & Ruhl, 2000). As Salzman and Ruhl (2000) point out, as the currency's precision increases, market efficiency is lost, and "thus the policy instrument's viability rests on a balance."

While the choice of currency may be the most important factor, there are other structural or institutional prerequisites for a successful offset credit market. Government agencies, or other entities with the authority to enforce decisions, generally play a large role in both the design and implementation phases of conservation banks. The basis on any offset market is a government entity prohibiting an activity, then permitting it under carefully controlled conditions (Salzman & Ruhl, 2000). Governments decide who is and is not eligible to participate, provide uniform methods of habitat evaluation and quantification, design the market, formulate trading rules, and design and approve legally binding obligations with respect to ecological outcomes, among other functions (Teeffelen et al., 2014). A trusted and responsible government entity is necessary to perform these myriad functions, and one of the more troubling critiques of offset policies is that, even when well-designed, they are extremely fallible in the face of regulatory failure (Moreno-Mateoset al., 2015).

C. Ecology of a Successful Conservation Bank

Since the goal of conservation banking is to avoid net loss of a species or habitat type, the ecological preconditions for conservation banking are as important as the economic or institutional ones. The key point is that all mitigation credit schemes take place in dynamic habitat networks. That is, they take place in landscapes where land use changes over time, and where different patches of habitat are destroyed and restored over time. Dynamic landscapes result in higher frequencies of local extinctions, leading to the necessity for more colonization than in more static habitat networks. To benefit the targeted species, landscape changes must be held to a rate that allows the species to track and populate patches of high quality habitat over time. (Teeffelen et al., 2014). A species' ability to persist in such a landscape depends on the characteristics of the habitat network as well as of the species itself. To address the ecological realities of a landscape, awarding of offset credits can take three forms: (1) the restoration of degraded habitat, (2) the creation of new habitat, or (3) the improved protection of existing but threatened habitat (Moreno-Mateos et al., 2015). Given the problems of time-delays, ecological bottlenecks, and restoration uncertainty, the most conservative approach seems to be to award credits for the improved protection of existing habitat, and for restored habitat only after restoration is successful. Teeffelen et al. (2014) argue that conservation banking is best-suited to large networks with high levels of connectivity between habitat patches, and to habitat types that are quick to regenerate after a development impact is removed.

High dispersal capacity along with high reproduction rates are a species' best defense in a dynamic system. This implies that conservation strategies that are based on habitat turnover may select against species with large area requirements, poor dispersal abilities, and low reproduction rates (Teeffelen et al. 2014). This selection effect can be mitigated, depending on how the quantification of habitat into credits is performed. Taking patch size into account (where value would rise along with size at a greater-than-linear rate), as well as connectivity, can align incentives toward the creation and maintenance of large, well-connected habitat networks and thus reduce the need for high dispersal and reproductive rates (Teeffelen et al., 2014).

D. Use of Habitat Restoration to Provide Additional Benefits

As mentioned, GSG require a large landscape and variety of habitats for survival (Connelly et al., 2010; Braun, 2006). This expansive habitat requirement makes the impact of sagebrush restoration efforts contingent upon the region-wide distribution and makeup of GHG habitat (Pyke et al., 2015). Pyke et al. (2015) therefore recommends a "landscape triage method", using spatial models to find the areas that can provide the most benefit from sagebrush restoration due to proximity to established high quality habitat and improvements to connectivity. Once priority areas are identified, the land can be managed to restore communities to an optimal balance of sagebrush, perennial bunchgrass, and forbs (NRCS, 2012).

Restoration can occur through both passive and active management. Some habitat is temporarily disturbed but can still support the overarching ecosystems. Passive management of intact habitat is important for the protection GSG. If the habitat is not resilient enough, or the impacts from previous uses or development are too severe, active management may be required to return to the previous ecosystem. In other words, if there is not a sufficient seed bank to allow the reestablishment of the 'natural' community, active restoration is needed. This is often dependent upon the level to which historical management of the sagebrush landscape treated sagebrush as a weed, which frequently occurred due its ability to "interfere with livestock forage production" (Pyke et al., 2015).

Passive management includes grazing modifications such as reduced stocking rate and rotation strategies, ensuring GSG access to natural streams, placing escape ramps in water troughs for GSG escapement (Braun, 2006; NRCS, 2010), removing or replacing fences with "wildlife friendly fences" (Braun 2006; Stevens et al., 2012), and placing salt near fence lines to keep extensive cattle grazing away from the center of pastures (Braun, 2006; Beck and Mitchell, 2000). Active management, described by Pyke et al (2015) as manipulating vegetation to increase the overall amount of habitat available to GSG, includes seeding for an optimal balance of forbs, grasses and sagebrush, and bushwhacking if sagebrush heights are too tall. For more information on the best management practices for restoration and management of sagebrush, see Appendix 3. Best Management Practices for Conservation Banking.

In conjunction with conservation banking, restoration can provide additional financial benefits either by increasing the value of previously established credits, or by generating new credits once agreed-upon thresholds are met. Sagebrush ecosystems are slow-growing (Booth et al., 1990), so credits should not be assigned until the created or restored vegetation meets established suitability requirements.

E. Importance of Timing for Restoration Credits

Allowing the practice of 'habitat borrowing' can severely reduce or eliminate these benefits (Teeffelen et al., 2014), because of the high degree of uncertainty inherent in habitat restoration and the prospect of resource bottlenecks. A meta-analysis of 108 ecological studies found that, depending on which metrics are used to determine success, restoration fails 29-58% of the time (Curran et al., 2014). In addition to the simple uncertainty of success in habitat restoration, there is a concern over creating a resource bottleneck. This is the idea that when there is a significant time-lag in habitat maturation, offsetting habitat destruction can lead to critically low levels of resource availability in the medium term, even if the resource does recover in the long-term (Maron et al., 2010). One study applied these ideas to model the long-term prospects of the endangered red-tailed black-cockatoo in Australia and the Buloke trees that they depend on for food. The study found that even in modeled scenarios where the trees recovered by the 150-year time horizon, there would be a resource bottleneck between 80 and 100 years, due to the inability of trees planted today to replace the habitat value of trees destroyed today. Such a bottleneck is likely to threaten the persistence of the species, despite the expected long-term success of habitat restoration (Maron et al., 2010).

II. Assessing the Market Potential for Conservation Credits

A key element in determining if an organization should establish a conservation bank is the existence of a market for credits (Jack et al, 2011; Fripp & Shantiko, 2014; Duke, Pocewicz & Jester, 2011; Kroeger & Casey, 2007; Teffelen et al. 2014). This includes an assessment of the expected number of credits to be generated at the proposed bank site (individual supply), amount to be generated elsewhere in the state (market supply), and amount to be demanded by future developers (market demand). If there is sufficient demand for the expected supply, the likelihood of a self-sustaining or profit-generating conservation bank is much higher (Pindilli & Casey, 2015), and therefore so is the bank's potential to provide lasting conservation benefits.

A. Identifying and Quantifying Potential Sellers: Estimating Market Supply

Although literature directly referencing market supply analysis specific to conservation banks is extremely limited, there is ample literature on estimating supply in other PES programs. Various mechanisms used to identify and quantify the market supply of credits in a PES program include the comparison of revenues from alternative land uses (Heimlich et al., 2013; Antle et al., 2010), a revealed preference approach using conservation contract auctions (Jack et al., 2008), a contingent valuation approach project participation in forest conservation practices (Kilgore et al., 2008; Lindhjem & Mitani, 2012) and a qualitative multi-year collaborative approach via focus groups and semi-structured interviews (Duke et al., 2011), among others.

Heimlich et al. (2013) estimated the supply of credits and derived a supply curve for a habitat conservation program for a similar species, the Lesser Prairie Chicken, in the five-state habitat range of Colorado, Kansas, New Mexico, Oklahoma and Texas. In this study, authors assessed the interest of landowners to participate in a habitat exchange program based on revenues from alternative land uses from cropland agriculture and ranching operations. Those parcels that had returns from current operations comparable to those from a habitat exchange program were determined likely to participate in a habitat exchange program, using the assumption that landowners would be indifferent between equivalent revenues (Antle et al. 2010). As a stated limitation, their analysis did not consider the fact that ranching can occur in company with a PES program, since the Lesser Prairie Chicken habitat can be managed on functioning ranchlands, as can GSG habitat. Also, the assumption of indifference between revenues from agriculture or conservation may be unrealistic, as unobservable risk and time preferences, cultural values, and subjective beliefs could be important predictors of a landowner's involvement (Parks, 1995).

In 2011, Jack et al. conducted a pilot study in Indonesia to derive a supply curve of hectares to enroll in an erosion conservation payment program on erosion-prone coffee farms via procurement auctions. Using a revealed preference approach, their study assessed landowners' willingness to accept (WTA) a conservation contract based on their bid for payment to install erosion control projects on farms. Under a fixed-budget approach, the researchers determined the number of hectares enrolled at given prices (or amounts awarded) for the conservation investment. Their method could also be used to select sites based on least cost, most cost-efficient, and specific eligibility requirements to promote the greatest conservation benefits per dollar awarded. This type of WTA study avoids the potential overestimation or bias generated from contingent valuation methods (Carson & Hanneman, 2005; Harrison, 2006), yet requires significant time, travel, and organization to conduct.

A method to qualitatively assess the potential market for a PES program was used by the Duke, Pocewicz and Jester (2011) feasibility study to implement a PES program in the Upper Green River Basin of Wyoming. This multiyear study used "semi-structured scoping interviews" and landowner focus groups to identify concerns and interests of the ranching community as potential sellers of credits, in addition to identifying concerns and interests of regional developers as potential buyers of credits. As a first step in assessing the overall market, this feasibility study did not attempt to estimate the actual supply curve of credits at various payment prices, but did provide insight into the likelihood of support and involvement under various PES project designs.

B. Identifying and Quantifying Potential Buyers: Estimating Market Demand

The presence of an adequate number of credit purchasers is essential for the success of any PES program, including conservation banks, and can have a significant impact on the cost and price credits (Kroeger & Casey, 2007; Hansen, Jakle, & Hogarty, 2013, Teffelen et al., 2014). Most the literature cites mechanisms for spatially identifying and quantifying expected demand for credits (Naugle et al., 2013; Rushford et al., 2015) yet few site the methodology for translating that information into a quantitative demand curve. Other analyses stress the factors that influence demand, such as the available mitigation options, cost of credits, and expectations of future regulations (Pearman & Plawecki, 2015).

Copeland et al. (2013) estimated the expected demand for credits in Wyoming by measuring different development and growth scenarios in the energy industry, including oil and gas extraction and the implementation of wind farms, as well as expected demand from developments for residential housing that would result in habitat destruction and fragmentation. Authors overlaid established core GSG habitat areas with "federal minerals estates", and areas authorized for energy exploration and development. They made predictions of the growth within 20 years, and a "long-term" measure by doubling wind and residential development and estimating a full production of oil and gas reserves. Using GIS data describing known GSG leks with a buffer of 5 miles, they predicted the impacts of these short and long term developments on GSG populations, estimating that cumulative long term development would cause 29% decline in GSG populations statewide (14% in short term), and 24% decline in GSG populations in core habitat. Assuming a successful implementation of Wyoming's Core Area Policy, no leks in core areas would be extirpated and there would only be a 9-15% statewide reduction in the long term, and 6-9% in core areas. It was noted that the Wyoming policy does not completely protect core areas, as residential development is not restricted. This mechanism is similar to that recommended by Defenders of Wildlife (2006), in that the government strategy to prevent further destruction, while targeted voluntary conservation easements can be used to improve or further mitigate impacts.

Rushford et al. (2015) developed a framework for strategic allocation of conservation funding in Wyoming by placing conservation easements in areas that are the most at-risk for development, in addition to being cost-effective and providing ecosystem benefits. The researchers estimated the probability of development based on the presence of current conservation easements, land protections, unprotected agricultural land, population growth rates, and comparison of developed residential parcels to undeveloped agricultural parcels. They also predicted stress from future residential development based on parcel proximity to towns, roads, forest, terrain roughness, and scenic views, among others factors. Areas that contain both quality habitat and high development risk were prioritized.

The Montana Department of Commerce worked with the Census and Economic Information Center and the Montana Department of Transportation (MDT) to create a population projection model for 16 counties of Eastern Montana, projecting the population from 2012 to 2035. Population projections were dependent on four major oil development scenarios: Low Oil; Med-Low Oil; Med-High Oil; and High Oil. MDT used analytic modeling methods to project that Low and Med-Low Oil development would result in moderate residential growth in the region, while Med-High and High Oil development would cause “drastic” residential population growth, and therefore a drastic increase in development needs (Ramler, 2013). This 16-county region, also known as District 4, happens to be where most the State’s core habitat for the GSG exists, meaning that population projections calculated in this study could provide insight into future demand for credits.

Taylor et al. (2013) analyzed the combined impacts of West Nile Virus and energy development on GSG lek counts in WAFWA Sage Grouse Management Zone I. By separating their study zone into five management zones, including Eastern Montana (where APR is located), and identifying and predicting oil and gas development, they, in a way, give insight into the amount of credits that could be demanded from various well densities near GSG leks (or, pending policy clarification, on GSG core habitat). Researchers identified oil and gas wells that were located within various radii around known leks (from 1 km to 20 km). Of the 1139 leks in the analysis, 60 percent had oil or gas wells within the 20 km radii. In Eastern Montana, specifically, 31 percent of leks were within 20 km of an oil or gas well. They then analyzed the impact of the upper legal limit of well densities (3.1 wells/km2) in Wyoming, and projected that the male GSG population would decrease by 61 percent compared to no oil and gas development, and that lek sizes are reduced immediately after high well density is developed. They found that a 3.2 km radius of protection around leks is not large enough, as many birds have nests roughly 15 km away from leks, exposing them to direct impacts from well development. The authors highlight that in addition to the protection of specific leks, protection of surrounding sagebrush habitat is crucial for GSG survival (Taylor et al., 2013).

III. Assessing the Efficacy and Benefits of Conservation Banks

As a relatively new policy tool, there is no consensus on the overall strengths and weaknesses of conservation banking. Boisvert (2015) suggests that as a market-based mechanism, conservation banking is “expected rather than demonstrated to be efficient, transparent…and to reduce transaction costs.” Others have referred to offset policies as a sort of defense mechanism that maintains an “illusion” that capitalism is the solution to the very problems that it creates (Moreno-Mateos et al., 2015). However, offset policies may provide a partial solution to the loss of habitat and biodiversity by providing a better mechanism for compensating and encouraging conservation (Quietier, 2015).

A. Methods for Assessing the Value of Conserving Threatened Species

The value of any conservation action is best understood as the difference in value to society between the scenario in which the conservation action is taken, and the alternate scenario, in which the conservation action is not taken (Maron et al., 2013). In assessing future actions, this will generally involve significant uncertainty, as the consequences of actions taken or not taken cannot be known with surety. However, if there are sound estimates of the changes to habitat and populations that can be expected under the conservation and alternative scenarios, there are credible methods for assessing the value of conservation.

The classic approach of valuing goods and services—that is, observing their prices in the free marketplace—does not capture most of the benefits of conserving landscapes or ecosystems. Most landscapes provide a variety of functions that are valuable to people, and are subject to many possible uses which may not all be traded explicitly (Groot, 2006). Groot (2006) also suggests that the first step in valuing a landscape or ecosystem is to translate ecological complexity into a limited number of ecosystem functions or services. These may include functions that regulate ecological or physical processes that impact humans, functions that produce goods of market value, functions of providing information to society, and others.

The second step in this process is to assign values to these functions. The types of value that might be considered include ecological value (measured as integrity, resilience, or some other measurable characteristic), socio-cultural value (such as equity, cultural identity, or spiritual values), and economic value (including use and nonuse values) (Groot, 2006). Since economic methods of valuation will ideally incorporate both ecological and socio-cultural values, this review focuses on economic valuation techniques.

Both market-based and non-market valuation techniques share two problems. First, they depend on the current distribution of income and resources, whether as reflected in actual economic activity or in stated willingness to take economic action. Second, if values are to reflect scarcity as economic theory demands that they do, perfect knowledge of future demand, the stock of a resource, and the available technology is required. Even with these limitations, valuation of goods and services, even non-market ones, can help society to make informed choices (Loomis, 2010). The values that are developed should reflect the sacrifices that individuals are willing and able to make to achieve some goal—in this case, conserving GSG and their habitat.

One type of methodology, known as “revealed preference,” elicits the value of non-market goods based on people’s observable behavior in the marketplace. Even though non-market goods are not traded explicitly, the preferences of society can often be revealed through an examination of economic decisions related to the non-market good in question (Damigos, 2006). “Stated preference” methods, on the other hand, attempt to derive a holistic metric that captures a range of possible types of value, including use value, option value, existence value and bequest value (Loomis & White, 1996). Stated preference methods utilize a survey-based approach, in which a simulated market is created, and within which citizens can place values on the benefits they receive from untraded goods or services in a process known as the contingent valuation method. Through this simulated market, the average willingness to pay (WTP) for untraded goods or services can be estimated (Loomis 2010).

A significant weakness of the stated preference approach is the fact that survey-based studies carry inherent bias. A review of 60 CVM studies found that study design was one of the most important elements in the resulting WTP . When participants were asked to pay to secure an ecological gain, WTP was on average more than double the WTP that was elicited when participants were asked to pay to avoid an ecological loss. This was, in turn, more than double the WTP of participants to 'plan for biodiversity conservation', with no stated loss or gain (Martín-López et al. 2008).

B. Assessing the Efficacy and Efficiency of Conservation Methods

To assess the success of a conservation program, a set of regulations and monitoring mechanisms must be established to ensure that a base level of service is provided, and to track the progress of markets against intended goals (Defenders of Wildlife, 2006; Casey et al., 2006; Kroeger & Casey, 2007). Defenders of Wildlife highlight that the two major elements determining a conservation program's economic efficiency are the cost-effectiveness and transaction costs. The main method to test the effectiveness and efficiency of incentive mechanisms, is to estimate the level of landowner participation in the program, the acreage enrolled, and the amount of funding allocated by agencies that support various management practices. With this information, the consumer surplus can be determined, based on "the surplus demand for a conservation program as measured by the backlog of qualified applications that exceed available funding" (Casey et al., 2006). Tracking the progress of these conservation efforts has not, however, given insight into direct biological improvements. As Casey et al. mention, "there have thus far been no direct measures of biological performance with respect to specific incentive mechanisms or programs" (Casey et al., 2006).

Kroeger and Casey (2007) identify major hurdles to the establishment of successful PES programs, which include the fact that ecosystem services are location-specific, require large amounts of highly specific information, and have high transaction costs—that is, they generally involve lengthy negotiation processes between buyers and sellers. They also assert that the "presence of large-scale government payments for ecosystem services could crowd out some private investment." This concern is applicable to Montana, where the state-run PES system may impact the success of a private conservation bank. Finally, the Kroeger and Casey (2007) suggested that the transaction costs of establishing and implementing incentive and conservation programs should and can be reduced, such as using an established ecosystem marketplace.

Another potential difficulty with such programs is that many ecosystem services are not private goods. In many cases ecosystem services are not exclusive, resulting in a lack of incentives to provide benefits above what is legally required. The highest level of efficiency and quality of the "product," in this case habitat conserved, is generally not achieved in this type of market system. This results in the need for extensive monitoring and enforcement to ensure that the required services are being provided. Or as summarized by Boyd and Banzaf (2006), "the buyer is concerned only about satisfying the regulator's definition of an adequate unit."

C. The Role of GSG as an Umbrella Species for More Effective Conservation

It is widely thought that providing protection for one species can indirectly benefit others as well. The concept of an 'umbrella species' is often used in conservation and land use planning. Seddon and Leech (2008) defined the 'umbrella strategy' as the protection of one species whose conservation confers protection to many naturally co-occurring species. The evidence regarding the efficacy of umbrella species is ambiguous. As with many aspects of conservation planning, the long-term success of umbrella species-based strategies is understudied, but the empirical evidence suggests that umbrella species protection only offers limited protection to co-occurring species (Seddon & Leech, 2008). The great challenge with using the umbrella species approach is that different species, although they may share ranges, require a wide variety of conservation approaches. These are dependent not just on range, but habitat type, life cycle, lifespan, mobility, dispersal ability, and other factors (Breckkheimer et al., 2014).

Due to these challenges, many different criteria are used for selecting species to serve the role of umbrella. The simplest criterion is the range that is covered by a species, with the assumption that a large range indicates a high frequency of co-occurrence with another species (Rowland et al., 2006). Many other criteria, and hierarchies of criteria, have been suggested. Some have pointed out that the criteria for evaluating umbrella species should depend on the policy goals of conservation. If the conservation strategy focuses on protecting the habitat types that are utilized by the potential umbrella species, then the criteria should reflect that specificity. It has been suggested that in this case, the criteria for umbrella species should focus on shared resource requirements, land cover associations, levels of sensitivity to human impact, and levels of protection that are deemed adequate between the potential umbrella species and co-occurring species (Seddon & Leech, 2008).

These criteria are often secondary to political will, which is often only present for charismatic species with large ranges. Conservation efforts are then assumed to provide an umbrella of protection for other, less charismatic species (Breckheimer et al., 2014). Put differently, "charismatic vertebrates tend to be chosen as candidate umbrellas with little *a priori* reference to any ecological criteria" (Seddon & Leech, 2008).

There have been several studies conducted specifically on the potential role that GSG might play as an umbrella species. GSG certainly fits the simple criteria for an umbrella species—it is very wide-ranging (Manier et al., 2013), and approximately 350 wildlife species rely on sagebrush for some portion of their life cycle (Copeland et al., 2014). It has been suggested that, in theory, GSG make a good candidate for the role of umbrella—they are closely associated with sagebrush communities across their range, and thus co-occur with many other shrub-land species. GSG are also sensitive to anthropogenic disturbance, are among the best-studied sagebrush species, and the bird currently enjoys public and political attention (Rowland et al., 2006). Rowland et al. (2006) examined the overlap in ranges between GSG and 39 other species in the Great Basin region. 46% of these species had ranges that were substantially associated with GSG habitat. However, only 26% shared more than a 50% overlap. The limitation seems to be that GSG are one of the few true sagebrush obligates. Most other shrubland species utilize other habitat types as well. Therefore, only other sagebrush obligates or near-obligates are likely to receive the full benefits from GSG protection (Rowland et al., 2006).

In 2011, Hanser & Knick found moderate to strong associations between 13 different bird species and GSG. However, a 2013 study in Wyoming found that, of 11 sagebrush-associated species studied, none saw more than 50% of their statewide ranges occurring inside designated GSG core areas. Most of them did see more than 30% overlap, though, indicating that some degree of protection would be conferred on other species from GSG-specific conservation (Carlisle & Chalfoun, 2013).

In 2014, Copeland et al. studied the role of GSG in providing an umbrella of protection for migratory species. Breckheimer et al. (2014) asserted that for dispersal pathways, areas of synergy between species do exist, since species with very different spatial patterns often use similar portions of the landscape for dispersal. In a study in western Wyoming, Copeland et al. found that conservation measures in general overlapped with migratory mule deer 66-70% of the time, with mule deer stopovers 74-75% of the time, and with mule deer wintering areas 52-91% of the time. Approximately half of the protection of migration corridors and stopovers were due to conservation measures focused on GSG, and nearly all the wintering area protection was due to measures focused on GSG (Copeland et al., 2014).

It is important to note that protecting overlapping habitat within GSG core areas does not necessarily guarantee a positive outcome for another species. There is the concern that intensive protection of GSG core habitat may encourage accelerated development outside of core areas, in habitat that may still be vitally important to the feeding, breeding or migration of another species (Copeland et al., 2014). In any case, whatever role GSG may be able to play as an umbrella for other sagebrush-dependent species will depend on the type and extent of conservation measures that are enacted for their benefit (Rowland et al., 2006).

IV. Case Study: The Environmental Trust

The Environmental Trust (TET) was a California 501(c)(3) non-profit private conservation bank established in 1990 by San Diego State University biology professor Don Hunsaker (Teresa, 2006). The goal of TET was to acquire environmentally sensitive lands and then manage them for the benefit of the species occupying them under Multiple Species Conservation Plans (MSCP), the Endangered Species Act (ESA), and mitigation and conservation banks. In July 2005, however, TET filed for Chapter 11 bankruptcy protection due to "underperformed obligations" exceeding $13 million (ibid). Prior to filing for bankruptcy, Hunsaker's organization had acquired 4,261 acres and only about four million dollars in endowment funds. These funds left TET wholly unable to fulfill its obligations to manage and monitor the lands it had collected. TET is the only known example of a land trust that has filed for bankruptcy in the United States and today serves as a cautionary tale for nonprofit organizations who plan to engage in conservation banking (Cameron, 2011).

A. Why did The Environmental Trust Fail?

According to Sherry Teresa, Executive Director of the Center of Natural Lands Management, TET failed for five primary reasons: (1) Failure to implement a realistic business plan; (2) A vague definition of what constituted best management practices for habitat stewardship; (3) Lack of state and federal monitoring of TET's financial and habitat management practices; (4) Few to no internal financial management controls; and (5) Unsound corporate governance decisions (Teresa, 2006).

The lack of a business plan was most likely the main culprit for TET's failure. Dr. Hunsaker failed to realize that conservation organizations that require large endowments should be run with the same scrutiny and expertise as a for-profit business. Important business decisions were made by TET that disregarded sound practices, including entering negotiations for perpetual maintenance of habitat lands prior to investigating the property and details of the business transaction (Teresa, 2006). Properties were acquired by TET without adequate consideration of the funding required to perform its contractual obligations, and key managers were accused of frequently disregarding internal staff recommendations about management and funding.

TET also mismanaged endowment funds, which directly led to its bankruptcy. When entering an agreement with a permittee, TET agreed to record conservation easements and deposit 100% of endowment funds from the permittee into a permanent account intended to fund management, monitoring and maintenance of the property in perpetuity (McClure, 2005). Per their bankruptcy proceedings, however, TET failed to record many of the conservation easements and had a practice of only depositing 80% of the earmarked endowment funds into the endowment account. The other 20% was generally used to cover shortfalls in funding due to this same practice used in earlier agreements (Case # 05-023210LA101). Using new income to partially cover previous funding gaps kept TET in a constant race to acquire more properties to keep up with its expenses. This led to a practice of underbidding for new properties to secure agreements and thus increasing the shortfall to be covered by future agreements. According to Ms. Teresa, TET adopted a “We’ll make it up on the next deal” approach, which unsurprisingly ended in their bankruptcy (Teresa, 2006).

Another issue facing TET was the lack of a clear model for land stewardship. Most banking contracts and agreements will clearly state the goals or intent of the management “work” required of the bank owner, but they rarely detail how those goals are to be achieved. In TET’s case, Dr. Hunsaker defined stewardship as maintaining fences, picking up trash, and conducting drive-by monitoring visits. There was rarely enough funding to maintain fencing or pay staff to pick up garbage, and drive-by monitoring is insufficient to report on the proper management of 4,000 acres. It was a failure on the part of both TET and natural resource agencies that these practices were proposed and authorized (Teresa, 2006). TET’s approach also ignored the critically important concept of adaptive management. The legal requirement to manage a property in perpetuity requires planning for unforeseen events and unspecified obligations. Proper stewardship includes planning—and funding—for activities like the control of invasive plants and animals, public use and trespass/dumping issues, monitoring habitat and biology, maintaining infrastructure, public outreach and education, dealing with fire danger and fuels management as well as other unforeseen events. These tasks were not planned for, and TET did not consider them in their financial calculations (McClure, 2005; Teresa, 2006).

Natural resource agencies also played a critical role in the failure of The Environmental Trust by failing to act when it was clear TET couldn’t meet its obligations. In 2003, The California Department of Fish and Game (CDFG), along with USFWS, sent a letter to TET that identified stewardship deficiencies and what the departments jointly required TET to do to fulfill its obligations (Teresa, 2006). This letter and many others received no response from TET. When their requests were ignored, neither agency acted against TET, highlighting the lack of meaningful oversight of conservation banks in 2003 (McClure, 2005). While it can be assumed that agency personnel are better trained today due to increased exposure to banking agreements, there exists a clear possibility that the issue may remain. Where conservation banking is new, as it will be in Montana, the lack of trained agency personnel can be a critical source of both financial and ecological failure for conservation banks.

B. What can be learned from TET?

The experience of The Environmental Trust provides a cautionary tale for both regulatory agencies and future bank owners. The need for clear language outlining the management responsibilities of bank owners is vitally important for all parties involved. Without direct knowledge of the actual costs of USFWS requirements, bank owners cannot accurately plan for the financial needs of their endowment. As seen in the TET case, underfunding an endowment can lead directly to bank failure, harming the species, and putting the efficacy of habitat exchange systems into question. TET’s problems didn’t stem solely from vague management requirements, though. Misappropriating endowment funds to cover operating costs appears to be the most direct cause of their failure. It cannot be overstated how important it is to adopt and follow strict and prudent financial management prior to creation and while operating a conservation bank. While TET failed as a conservation bank, the lessons learned from their issues have permeated throughout conservation circles and, hopefully, will allow both regulators and land trusts to avoid similar missteps in the future.

Part 2. Developing the Habitat Quantification Tool and Determining Market Supply of Credits

I. White Rock Property as Model Bank

APR currently manages a total 353,000 acres in Northwest Montana, most of which are BLM or State-owned public lands, yet 86,586 acres are deeded properties privately owned as well as managed by APR (APR, 2017). Two properties contain conservation easements providing habitat protection in perpetuity, yet the rest of the deeded properties are only protected if APR retains ownership. Deeded properties were purchased from willing private landowners, and mainly consist of retired cattle ranchlands. Currently, APR manages their deeded and leased lands as six separate properties, yet annual lek surveys and counts only occur on four properties (Table 2).

Table 2. Total Greater sage-grouse populations on APR property (includes property both deeded to and leased by APR). Population counts are indicated by the highest value of three separate lek attendance counts, including both male and female birds. Numbers in parenthesis represent the quantity of active leks.

	Total GSG Population and (Quantity of Active Leks)			
	White Rock	Timber Creek	Sun Prairie North	Sun Prairie**
2002	127 (4)	103 (5)	12 (1)	86 (2)
2003		119 (4)		85 (2)
2004	36 (2)	98 (4)	43 (1)	129 (3)
2005	110 (4)	87 (4)	46 (1)	119 (3)
2006	123 (4)	153 (4)	41 (1)	91 (3)
2007	46 (2)	153 (4)		
2008		128 (4)		71 (3)
2009		127 (4)		44 (2)
2012	59 (2)	76 (3)	52 (2)	84 (3)
2013	14 (2)	36 (3)	31 (2)	14 (1)
2014	8 (1)	0 (0)	31 (2)	50 (3)
2015	80 (5)	134 (5)	31 (2)	69 (4)
2016	158 (5)	331 (6)	51 (2)	250 (5)

**Two new leks are starting to experience male attendance but are still considered inactive

During the summer of 2016, efforts were taken to survey and interview local ranchers in Phillips County to gauge their interest in participating in a conservation bank or habitat exchange system for GSG. APR's stated intent was to leverage banking to provide financial benefits to the community while increasing the amount of protected land in the area. The surveys and interviews were intended to measure awareness of previous sage-grouse conservation efforts, the establishment of MSGOT and conservation banking, and general willingness to participate in such a program. Since the role of APR was undefined in this hypothetical situation, respondents were notified that APR helped fund the research however survey results and interview responses were completely anonymous and catalogued by member of the research team without any oversight from APR or its employees. A total of nine people were interviewed either in person or via recorded phone call, and two additional people responded to the online survey published in the local newspaper. While the sample size was too small for thorough statistical analysis of responses, the consensus was that landowners have a deep appreciation for all wildlife and would be willing to take some action that would measurably benefit sage-grouse. A common concern among respondents was fear of losing management and control over ranching practices, especially in the event of fire and drought. There was also a general mistrust of partnering with environmentally-focused organizations (as opposed to a land trust or ranching association) and APR specifically. While the reasons behind these sentiments are beyond the scope of this project, it seems reasonable to assume that environmental groups that purchase properties and retire them from grazing and agriculture practices are a direct competitor to the ranching community. This highlights the importance of APR's continued efforts to engage local ranchers and create an honest dialogue to build working partnerships in Phillips County. For the purposes of this project and due to a lack of interest from private entities, a property owned and managed by APR was then chosen to perform further analyses as a model bank.

Two properties, Sun Prairie and Sun Prairie North, are inhabited by introduced yet genetically-native wild bison. Since bison cannot be managed and controlled in the same way as domestic grazers, it is unknown whether the state would permit their presence on a GSG conservation bank. Although ongoing research suggests a native bison herd will naturally graze in a manner beneficial to grouse, there are no published studies clearly defining the uppermost carrying capacity of such an endeavor. To avoid the uncertainty of state decisions regarding bison, we identified the 8,803 deeded acres on the White Rock property for our model bank. White Rock abuts large segments of public land, which will be managed at least partially for GSG conservation, as well as private ranchland. As an indication of White Rock's GSG habitat functionality, the most recent lek surveys identify three active GSG leks onsite, 10 within four miles, and 32 within 12 miles. Although White Rock is largely made up of very high quality GSG habitat, it also contains some parcels of unrestored cropland, currently farmed hayfields, and cattle grazing (Appendix 1, Table 4). To note, current grazing practices follow NRCS SGI protocols, yet the exact rest-rotation strategy was not provided (APR, 2017). This mix of high quality habitat for conservation along with opportunities for restoration presents an interesting site for a conservation bank, and will be the subject of the analysis presented here.

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II. Development of a Simplified Habitat Quantification Tool

To conduct an economic analysis, we needed to project the location and quantity of credits, as well as demand for credits. This required a consistent quantification mechanism to project the number of credits that could be generated in different areas. Some conservation banking systems assign credit value based on the acreage of a specific habitat type required to support a breeding pair (Carroll et al. 2009), while others use a formalized, site-specific methodology to translate the quality and extent of habitat into a currency of credits. For GSG, other states have employed a "functional acre" approach, where each acre is assigned a "percent functionality" based on its utility to GSG, and one "functional acre" corresponds to one credit (Nevada Natural Heritage Program and the Sagebrush Ecosystem Technical Team, 2014; Wyoming Conservation Exchange, 2016). For example, one credit is assigned to each 100 percent functional acre, but one credit would also be assigned to two acres of 50 percent functionality. The formalized methodology used to translate habitat quality into a currency of credits is called a Habitat Quantification Tool (or HQT). HQTs differ by state, and are developed specifically to account for the habitats and ecosystems of each landscape that has a GSG conservation strategy and credit market.

To estimate the potential supply and demand of credits in Montana, we converted spatial data into approximate functional acres. Since the Montana Sage Grouse Oversight Team (MSGOT) is still in the process of developing a habitat quantification tool (HQT) designed specifically for Montana, we turned to two proxies that could give us a range of possible credit quantities. HQTs provide a consistent metric for rating the function of both the habitat being protected (generating credits) and the habitat being affected by development (requiring offset credits). Exactly how to quantify the "function" of habitat for GSG varies between states and regions.

Though scoring varies, the metrics used to calculate function are similar across HQT's. They all include sagebrush density, height, shape, as well as grass and forb cover density, height, and availability during summer and brood-rearing seasons. Due to grouse sensitivity to noise and increased predation from anthropogenic structures, disturbances extend outward from surface features, and are represented in GIS analysis by spatial buffers.

The first proxy is the HQT currently in use by the Wyoming Conservation Exchange, a nonprofit entity created through a partnership between landowners, Sublette County Conservation District, The Wyoming Chapter of the Nature Conservancy, Environmental Defense Fund, and the University of Wyoming. This HQT has well-defined metrics for scoring habitat attributes and disturbances based on peer-reviewed literature and site-level data throughout the Green River Basin. Since the habitat functionality scores and distance decay from disturbances they use are based on site-level data, and resulted from a local political process, it was appropriate to also use a more generalized set of metrics to score habitat and define disturbance distances. The second proxy came from the U.S. Geological Survey Disturbance Buffer Estimates and Montana Fish Wildlife and Parks definition of land cover types where GSG are typically found (Manier et al., 2014; Montana Fish Wildlife and Parks). Using a synthesis of pertinent literature, the USGS synthesis presents the upper and lower distance range of observed effects of different features and activities, as well as upper and lower suggested buffer distances to best benefit the grouse (Manier et al., 2014). The Montana FWP field guide on GSG lists land cover types where the bird is commonly associated (n=9), occasionally associated (n=4) and, by exclusion, all other land cover types are considered "not associated" with GSG (Montana Fish Wildlife and Parks).

For all analyses, the spatial data were first projected into Montana FIPS 2500 state plane coordinate system and non-Montana specific data clipped to state boundaries. Using both suggested buffer distances (from the Wyoming HQT and USGS synthesis) the Euclidean distance tool was used to create distance buffers which were then classified to break into two groups at the suggested buffer distance. Active oil wells, for example, have an interpreted lower range of 5km in the USGS synthesis and each active oil well point feature received a buffer that extends to the edge of the state and was classified as 0-5km and 5,001m - state boundary. This buffer was then reclassified into a disturbance score, in most cases 0 or 1. Since the noise and activity involved in an active oil well are determined to be completely detrimental to the functionality of GSG habitat, the distances were reclassified from 0-5km to "0," and from 5km and greater to "1". At this point the buffer layer extends out from each feature to the edge of the state and gives all grouse habitat that falls within 5km a score of zero. This process was repeated for each surface feature with both Wyoming HQT and USGS buffer distances. When all buffers were reclassified, they were combined into a single disturbance raster using the ArcGIS weighted sum tool. See Appendix 1, Table 1 for a summary of the differences between the buffer distances for these two methods.

Surface features and anthropogenic activities are not the only concern in estimating potential habitat functionality, though. Even if a patch of land is outside of the influence of all potential disturbances, there is no guarantee that it would be habitable by grouse. Wisdom et al. (2003) suggest that linking species requirements to a vegetation classification system is a crucial step in any regional habitat assessment. The authors recommend identifying the vegetation coverage data to be used, and associating each cover type with its utility to the species based on expert opinion or a review of the scientific literature (Wisdom et al., 2003). To this end we used the 2016 USGS Gap Analysis Land Cover spatial layer to assign "suitability" scores to different land cover types based on the Montana FWP Field Guide. Land covers where grouse are commonly associated received a habitat value of "1", areas they are occasionally associated with "0.5" and all other types were given a score of "0". While these numbers provide an upper estimate of habitat suitability, the results were only used to estimate the total market of suitable acres, and site-level analyses would be necessary for any actual credit generation. Site-level transects across all properties returned vegetation metrics that agree with the USGS general land cover type description (n=45, 72% agree for Big Sagebrush Steppe and n=27, 93% agree for Great Plains Mixed Grass Prairie), which provides some confidence in the accuracy of the land cover types as a proxy for actual habitat condition (Appendix 1, Table 2.). USGS has published spatial data in their SageMap program which uses a four-tier ranking system for sage-grouse habitat. The entirety of White Rock and the clear majority of other APR properties are ranked as "occupied by sage-grouse sometime during the year and considered important for the existence of grouse". The SageMap rankings are based on expert biologist opinions and would provide a higher estimate of suitable acres than our system based on FWP land cover associations.

Within APR properties and Phillips County, three land cover types were defined in more detail using the habitat metrics measured from site-level transects to, as closely as possible, replicate the vegetation standards of the Wyoming HQT. Only these three cover types received this level of detail due to lack of adequate sample sizes to make credible estimates about other land cover types. The sample-sufficient cover types were big sagebrush steppe, cultivated crops and Great Plains mixed grass prairie (Table 2 below). The result was two sets of surface feature buffers (one based on the Wyoming HQT, and one based on the USGS synthesis) and two sets of land cover scores (a "suitability" score based on the Montana FWP Field Guide, and a "functionality" score compiled from site-level transect survey scores for the three land cover types mentioned above, and the Montana FWP Field Guide-based values for all other land cover types). These datasets cover the entirety of GSG core area within Montana to provide support for a range of possible credit supply and demand scenarios.

Table 2. Average vegetation functionality scores (Total Score) for land cover types sampled in July 2016 on APR deeded properties. We applied WY HQT breeding season metrics to quantify functionality based on vegetation height and percent cover. Breeding values were used instead of summer values due to the relatively moist conditions.

	WY HQT Percent Functionality for Land Cover Types						
Land Cover Types	Sagebrush Density *(0.25)*	Forb Cover *(0.17)*	Grass Cover *(0.17)*	Sagebrush Height *(0.1)*	Forb/Grass Height *(0.17)*	Total Score	Sample Size
Big Sagebrush Steppe	69.5%	86.7%	97.8%	52.2%	77.2%	82.9%	45
Cultivated Crops	8.3%	75.0%	100.0%	11.1%	82.8%	62.9%	12
Great Plains Mixed Grass Prairie	59.1%	94.4%	100.0%	61.3%	75.6%	82.6%	27

Land cover suitability scores were then multiplied by the disturbance raster using ArcGIS raster calculator to create a final suitability score raster that incorporates both land cover type and distance to known disturbances. The statistics were then compiled using the zonal statistics tool for Montana core areas and individual APR properties with both sets of disturbance distances (Wyoming HQT and USGS synthesis) and land cover scores (MT FWP associations and site-level transect data fed into the Wyoming HQT). The individual contribution of each disturbance layer on APR properties was also calculated to highlight potential areas for APR to target habitat restoration and provide uplift for GSG.

A. *Results from Simplified Habitat Quantification Tool*

The simplified HQT described above provided our analysis with a mechanism for translating any property or group of properties within GSG core area into a currency of mitigation credits. This simplified HQT was then applied to APR properties, to recipients of MSGOT grant funding for conservation easements, and to oil and gas fields to project both APR supply, statewide supply and statewide demand for mitigation credits. Our initial assessment used the results from Wyoming HQT buffers and land cover "functionality" scores, and other combinations of disturbance buffers and land cover classifications provided figures for alternative scenario analyses. See Table 3, below, for the average percent functionality and suitability of deeded APR properties under the four different HQT scenarios studied, and Table 4 for the number of credits generated.

Table 3. Functionality of five deeded APR properties for different combinations of disturbance buffers and land cover classifications.

	Results of APR Property Functionality				
	White Rock	Dry Fork	Sun Prairie North	Sun Prairie	Antelope Creek
WY HQT Vegetation Functionality	81.0%	81.0%	70.0%	84.0%	81.0%
WY HQT Functionality Score	63.3%	72.7%	63.6%	73.6%	69.0%
WY HQT Suitability Score	73.2%	85.8%	60.5%	84.8%	83.1%
USGS Synthesis Functionality Score	54.9%	69.7%	58.1%	20.8%	11.0%
USGS Synthesis Suitability Score	63.1%	82.1%	55.3%	26.1%	85.2%

Table 4. Total number of credits that would be generated on APR properties under the four different HQT scenarios

	Expected Credits Available on APR Properties				
	White Rock	Dry Fork	Sun Prairie North	Sun Prairie	Antelope Creek
Total Deeded Acreage	8,804	5,801	7,058	8,913	2,050
WY HQT Functionality Score	5,573	4,217	4,489	6,560	1,415
WY HQT Suitability Score	6,445	4,977	4,270	7,558	1,704
USGS Synthesis Functionality Score	4,833	4,043	4,101	1,854	226
USGS Synthesis Suitability Score	5,555	4,763	3,903	2,326	1,747

Additionally, the surface feature disturbances impacting credit generation on each property were identified and ranked by influence, as shown in Appendix 1, Table 5. It is hoped that this information may allow APR to target management activities for credit maximization.

III. *Estimating the Statewide Demand for Credits*

To estimate the statewide demand for credits, we considered only the impacts to GSG core habitat that are likely to occur from the development of new oil and gas wells in Montana. We did not include residential development, since it is largely exempted from mitigation requirements. In addition, we did not include the conversion of prairie into cropland. This largely because the proposed state regulations are still ambiguous as to what mitigation, if any, cultivated cropland will require. Finally, we did not include the impact from road development in our main analysis due to more uncertainty associated with our estimates for road-building than for oil and gas development. As discussed below, though, we did include an analysis of demand from roads associated with oil and gas development as one of our alternative scenarios. Oil and gas development is expected to be the largest single threat to GSG in the near future (Manier et al., 2013), and so our analysis focuses on that. By not including other potential sources of credit demand, we may underestimate statewide demand. However, that just provides a more conservative projection of demand, which is of more use to American Prairie Reserve than overly-optimistic projections.

To calculate the future demand for oil and gas wells in core GSG habitat, drilling data from the Montana Board of Oil and Natural Gas was gathered for every county in Montana. These data were then compiled into a single spreadsheet, which included the date that the well was drilled, the type of well (oil, natural gas, dry well, etc.), a unique well identification number, as well as other information. The historical data for wells drilled went all the way back to the year 1890, but only data from 1980 to present was used for this analysis as there were gaps in the dataset before this timeframe, and the analysis required monthly well data. Wells were plotted based on the date that drilling commenced; by doing this the slope of the resultant curve would represent the rate of new well creation. Monthly well data was in the form of new wells drilled each month.

The combined oil and gas wells were plotted over time from 1980 to present in Figure 1 below. A linear regression was performed on this data set, and the result showed that the number of oil plus gas wells increased by 34.76, on average, for the entire state of Montana. The regression explained 97.5 percent of the variation in the number of new wells. A second regression was performed on the data from the year 2010 to present, since the trend during this time seemed to be much slower than the overall historical trend of well growth (Figure 1). The more recent trend was found to be growing around 7.43 wells per month for the entire state.

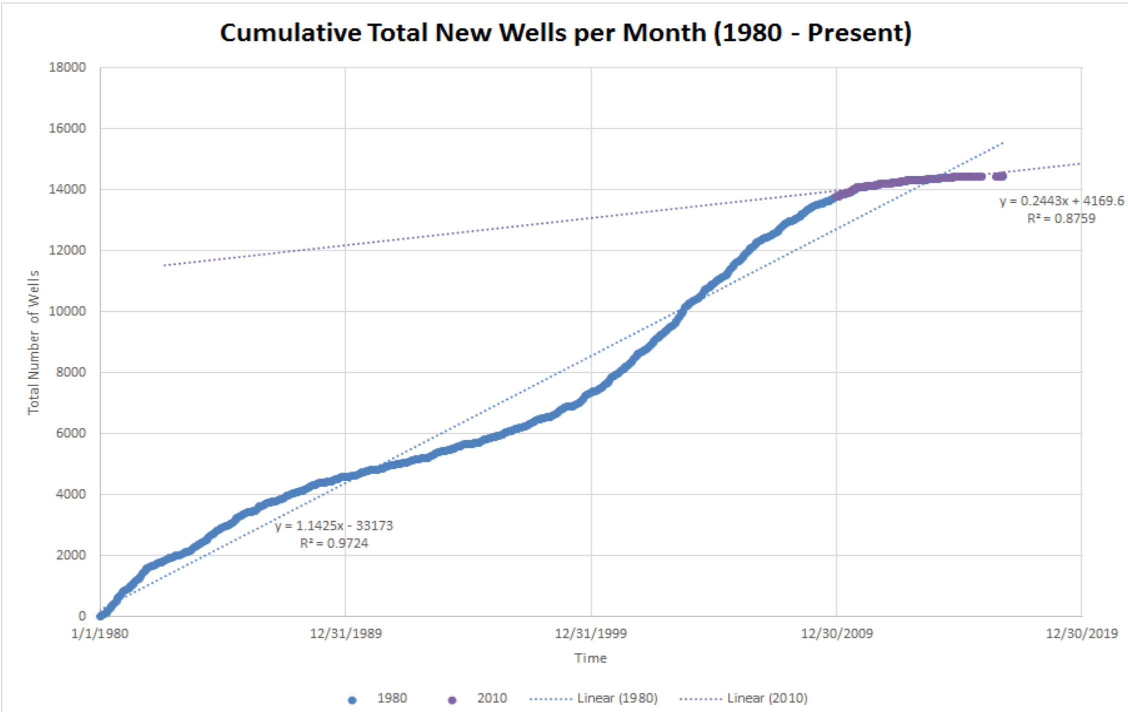

Figure 1. Cumulative total of new oil and gas wells drilled in the state of Montana each month, 1980 - present. Source: Montana Board of Oil and Gas Conservation.

Next, a GIS analysis was conducted to overlay all historical wells in Montana with Core GSG Habitat. We found that 7.58 percent of oil and gas wells (4,640 in total) occurred in areas that have been designated as Core GSG Habitat. Based on this core percentage, we predicted that about 7 wells (6.7) would be drilled in these areas each year (using the more conservative estimate of new wells). We assumed that the future percentage of wells in Core area would be the same as the historical rate in part because there was no way to predict the exact location of a future oil well. There is a very high statistical correlation between oil and gas wells and delineated hydrocarbon "reserves", and these reserves overlay similar percentages of GSG habitat as the actual wells do.

To calculate the actual disturbance, and thus mitigation required for each new well, a literature search was conducted. This search resulted in a range of 2-20 km radius of disturbance around each well (Taylor, 2013). Ultimately, a disturbance radius of 2.1 km was used since this value is used in the Wyoming HQT. According to this HQT, GSG habitat is reduced to zero inside this range. Using this disturbance value, each new well would result in 3,423.5 acres of habitat degradation. Applying the simplified HQT to oil and gas fields in core sage grouse habitat found an average habitat functionality of 72%, predicting 2,458 credits demanded per well. This results in a demand of 16,615 credits per year, not accounting for any new roads leading to and from these wells in core habitat.

A. *Alternative Scenario Analysis: Impact from Roads During Oil and Gas Development*

To examine the disturbance associated with new minor roads in core GSG habitat, a GIS layer containing all "minor roads" in the State of Montana was extracted from the Montana GAP Analysis

Land Cover Data (Montana Natural Heritage Program et al., 2016). This was overlaid onto the previously discussed analysis and was clipped by the core area layer (Montana Transportation Framework). The “near” function was used to find the shortest linear distance from each well in core habitat to a minor road; the average “shortest distance to road” when examining all wells in core area was 2.1007 km. This value was surprisingly close to the 2.1 km disturbance radius that would be applied to each newly constructed well in core sage-grouse habitat. Next, the wells that were located greater than 2.1 km from a minor road were examined in more detail; a new well this distance or further away from a current road would require additional mitigation in addition to the disturbance from the actual well itself. Wells greater than 2.1 km away from minor roads accounted for 33.21% of the total historical oil and gas wells in core sage-grouse habitat. Additionally, the average “shortest distance to road” for these wells was 4.75 km.

It is unclear whether new wells constructed in core area would be located closer or further away than 2.1 km from existing roads. Since the locations of future wells constructed in Montana are uncertain, we must again use the assumption that the future well distribution will match the historical distribution in the state. For consistency, we assumed that 33.21% of new wells constructed in core area were located greater than 2.1 km away from an existing road, and that the average distance from roads for these wells was 4.75 km. To calculate the additional disturbance these roads would create, the percentage of wells >2.1 km away from roads (33.21%) was multiplied by the projected number of new wells in core habitat each year (6.7) times the length of road not covered by the actual wells disturbance (4.75 - 2.1 km). The result was 5.89 km of new roads built each year that would not overlap with the disturbance caused by new wells in core area. Based on the Wyoming HQT, these stretches of roads would disturb 1.5 km on each side. Considering the 72% functionality of the habitat overlying oil and gas fields in core area, road construction related to these wells would require 3,138.46 additional mitigation credits per year.

This projection of road impacts associated with oil and gas development was not included in our main analysis because our estimates involve a very high degree of uncertainty. Oil and gas wells are each assigned an impact buffer of 2.1 kilometers regardless of specific location within core habitat, and so a simple estimate of the number of wells in core area is sufficient to estimate the impact from new wells. The impact from a road, on the other hand, depends on the length and shape of the road, which in turn depend on the topography of a particular well location and its proximity to existing roads. We do not seek to predict the exact locations of any future wells, and so in that respect our road impact analysis provides only a rough estimate. In addition, our analysis calculated the average distance from existing wells to minor roads, as they are defined in our dataset. There are small unpaved roads that could be used to access wells, but for which we do not have spatial data. These potential sources of error do not invalidate this analysis, but it should be used cautiously. Our main analysis, which only considers oil and gas wells, provides a more conservative estimate of credit demand.

IV. *Determining the Market Supply and Market Share of Credits*

There are currently no certified credits in Montana, yet the state organization responsible for promoting the Habitat Conservation Strategy, MSGOT, is planning to award credits to properties that received conservation easements through the Montana Grant Stewardship Fund (MSGOT, 2016). These grant-funded conservation easements will not establish conservation banks, which have management requirements in addition to the maintenance of an easement. These credit-generating properties will have more in common with traditional case-by-case mitigation projects than with a conservation bank. While these properties will generate mitigation credits, those credits will be owned by MSGOT, not the landowner. Landowners are still willing, however, to accept the costs of lost development potential and the associated reduced property value for several reasons. First, lower assessed property values mean lower property taxes. With a third party covering the costs of acquiring an easement, this alone may be worth it to some. For others, there is a cultural and sentimental benefit associated with ensuring that traditional rangeland remains undeveloped.

To date, four properties covering 34,692 acres are in the process of receiving conservation easements for the protection of GSG through this program. Since some of the easements were purchased with matching funds, we assume that only the acres purchased fully by MSGOT funds are eligible for credits, since under the grant program, MSGOT will be the owner of any resulting credits. The relevant properties total 16,823 acres. The property boundaries for MSGOT grant recipients were spatially identified via tax assessor parcel IDs, publicly available on the Montana Cadastral database. Once spatially identified, we applied the simplified HQT to estimate that the average habitat functionality of MSGOT credit suppliers is 79%.

A. *Results of Statewide Credit Market Assessment*

Based on our estimate for the total number of new wells drilled in core habitat per year, we determined that the market would demand 16,615 mitigation credits annually. The market supply of credits is estimated to be 17,836.6, with MSGOT supplying 12,263.8 credits. APR's market-share of total mitigation credits (number of APR credits divided by total potential credits in Montana) would therefore be 31.24 percent in 2017. Finally, assuming credit purchases were distributed equally among all credit sellers, APR would sell all its credits in less than 1.5 years.

Part 3. Financial Analysis of Establishment and Perpetual Management

I. Stakeholder Analysis

A. Beneficiaries

The direct financial benefits from the sale of habitat credits on APR property will be received by APR, however, it is worth noting that other parties can indirectly benefit from APR's actions. By providing credits to the Montana marketplace, APR will allow developers in core areas to further their business interests in a timely manner, protecting the ability for economic growth in the region. While not included in our analysis, there are financial repercussions from lengthening construction schedules to include creating offset credits for individual projects. Having a ready supply of credits will facilitate state approval of necessary projects in core areas, shorten the project planning phase, and may prevent potential developers from moving out of state to avoid the burden of in-house credit creation.

By creating and selling credits, APR may also benefit GSG recovery. Ecological evidence has shown that large, unfragmented parcels of habitat are more beneficial to the bird than the same net area broken into smaller pieces (Stiver et al., 2015). By placing lands under permanent conservation easements, APR would ensure the continued legal protection of GSG in the event any properties are sold. If APR is profitable, neighboring private landowners may be inclined to follow suite, and develop a conservation bank on their own property, thus spreading the overall acreage under perpetual protection and targeted management. While difficult to quantify financially, it is clear there is an ecological benefit from protecting and managing large parcels of land for GSG.

B. ***Cost Bearers***
The costs of establishing a conservation bank fall squarely on the property owner and the outside party that holds the conservation easement in trust. For APR, we assume that any GSG focused easements placed on their properties will be held by the Montana Land Reliance, a nonprofit land trust who holds a previous easement for APR. By statute, all properties enrolled in habitat credit creation must have their conservation easements held by a third party to guarantee continued management in the event the property owner can no longer enforce the easement terms (EO 12-2015). The land trust would be legally responsible to uphold the landowner's responsibilities under the easement.

Since both the property owner and the land trust are legally responsible, there can be negotiations between the parties to define their exact operational responsibilities. In APR's case, we envision the Montana Land Reliance as the holder of the easement to satisfy state requirements, however all operational, management, and maintenance costs to meet the easement terms will be borne by APR. This division allows APR to use its labor and expertise in prairie management to care for the credit properties in a more cost-effective manner than a land trust would. Oversight by the land trust provides a form of self-reinforcement ensuring that APR meets the requirements. Because of this assumed division of responsibilities, our financial assessment assigns the appropriate costs to each party.

A potential indirect cost of placing a bank on APR lands is the negative perception the action may bring from local ranchers and environmental groups. APR is working towards more amicable relations with the local community, and using conservation banking to fill their coffers may negate other outreach efforts. Because APR is a direct competitor for grazing lands in Phillips County, some ranchers perceive APR as a wealthy bully, and using conservation to increase its capital could increase tensions in the community (Lubove, 2013). APR is in danger of having a similar fallout with other environmental NGOs if they are seen as chasing profits through conservation. Due to APR's status as an environmental organization, there is a credible argument to be made that their property is already protected, even without conservation easements. If this is true, placing an easement and selling credits that allow habitat degradation from development would result in a net loss of GSG habitat statewide. The financial costs of decreased reputation in the eyes of local ranchers and other environmental groups are not apparent, however they should be strongly considered and accounted for if APR decides to start a conservation bank.

II. Quantification of Direct Costs

A. Costs of Reduction in Property Value from a Conservation Easement

The placing of a perpetual conservation easement on any privately-owned property legally ensures permanent protection, and is required for any conservation bank. Conservation easements are voluntary but legally binding agreements between a landowner and a land trust, as the land trust holds the easement, and the landowner continues to hold title to the land (Jay, 2010). By placing a conservation easement on private property, the property owner gives up all future development rights that could negatively impact the target species, in this case, GSG (Gattuso, 2008). This includes any developments that could negatively alter or disturb sage grouse habitat (grasslands and sagebrush), or the bird directly through increased noise levels or predation. Therefore, the value of the easement is determined by a certified property assessor, and should include the value of all future developments foregone by the restrictions established by the easement. To note, the landowner can continue to own and manage the property in accordance with the set agreement, which for APR will be cattle grazing. All other uses will be prohibited, including subdivision, conversion of habitat to crops, and other surface disruptions and structures (Gattuso, 2008).

To quantify the foregone future development value of the proposed conservation bank, the methodology from Plantinga and Miller's 2001 "Agricultural Land Values and the Value of Rights to Future Land Development" was used. Assuming constant grazing rates, the value of development rights (or VDR) is:

$$\mathbf{VDR} = \mathbf{P} - \frac{\mathbf{A}}{r}$$

Where P is the market price per acre of land under easement; A is the rental rate of the highest valued use of the land allowed after the easement is established; and *r* is the discount rate (Plantinga & Miller, 2001). For the proposed conservation bank on APR's White Rock property, the value per acre was quantified by taking the average of the tax assessed value of all 8,803 acres, which was $70 per acre (Montana State Library & Montana State Department of Revenue, 2016). Initially this was expected to be an underestimate of the actual market value in the area, yet a phone call with a property appraiser in Phillips County (the county where White Rock is located) said that the average market value per acre is $39.50, with a range of $31.25 to $212.50. This range is based on the acre's ability to support a 1,000-pound cow and her calf with vegetation for one month (a metric known as an Animal Unit Month (AUM)). The rental rate of the highest valued use of the land allowed after the easement is established is the private grazing fee. Cattle ranching will be permitted if the ranching practices apply best management practices to balance habitat for GSG (see Appendix 3 for recommended management practices).

The 2014-2016 monthly private grazing lease rate on the property was $18 per AUM (APR staff conversation, 2017). Total AUMs on the deeded White Rock property were calculated using the estimated AUM/acre table for Phillips County from the US Department of Agriculture's National Resources Conservation Service. A GIS layer of these values was available on this site as well, and data for MT641 - Phillips County was downloaded. The layer contained AUM values for all lands contained in Phillips County; this layer was clipped with the boundaries of different APR properties, including White Rock. Zonal Statistics was used to determine the average AUM for APR deeded lands on White Rock, and the property was found to have an average AUM of 0.24 per acre. The average grazing rate per acre is therefore $4.32. The grazing fee is then discounted as a perpetuity since the price per acre is expected to be the net present value of all future uses of the property (Plantinga & Miller, 2001). Interestingly, the foregone VDR was calculated to be -$651,474.84, indicating that the property price is underestimating the true per acre value. For this analysis, we therefore reflected the loss of future development value as $0.

B. *Legal Costs of a Conservation Easement*

After speaking with three different land-use attorneys in Montana, we decided to use an estimated legal cost of $5,000 for establishing a conservation easement. The estimates ranged from $2,000 to $10,000, depending on the number of hours involved. All three attorneys noted that the more expensive legal fees would occur if they were needed to write and negotiate the terms of the conservation easement, however MSGOT is in the process of developing easement guidelines to meet state requirements. These guidelines should lessen the legal fees somewhat; however, we expect there to be some negotiation to consider public access, fencing stipulations, and grazing requirements, especially if APR intends to allow wild bison on bank property. Based on these assumptions and to account for any unforeseen costs, we decided to use $5,000 as an appropriate estimate.

C. *Annual Operating Costs*

The annual operating costs used in our analysis were based largely on those of the Sweetwater River Conservancy Conservation Bank in Wyoming (Table 1 of the Appendix). Annual operating costs for livestock management, fire management, noxious weed management, predator management, West Nile Virus prevention, and recreation management were reported as per-acre expenses, while GSG lek counts, 5-year aerial surveys, and annual ground habitat surveys were reported as total figures, based on the wages owed to employees and fees of contractors carrying out those functions (Sweetwater River Conservancy GSG Habitat Bank, LLC Management Plan, 2014). Where per-acre costs were given, we simply adjusted the total figure for White Rock's acreage. Where total figures were given, we made credible estimates of the length of time an action would take and the number of employees that would be needed if the action took place on the model bank, as well as a wage rate appropriate for the task in question. For instance, we estimate that it would take one full time biologist approximately one month to complete the annual lek survey, making a fair wage of $25 per hour. This results in an annual ground survey cost of $4,000. To estimate the cost of the 5-year aerial surveys, we contacted a drone operator in Montana who has worked on similar projects before. Based on that contact and a thorough internet search for aerial survey quotes, we estimate that it would take approximately 40 hours to survey the proposed conservation bank with an aerial drone, and the operator would charge approximately $150 per hour, resulting in a total cost of $6,000 every 5 years. For more information on the specific actions identified in each operating cost category, see Appendix 3 Best Management Practices.

While there are differences between the Sweetwater River Conservancy Conservation Bank and a hypothetical APR conservation bank, we believe that they are similar in key ways, which allow this transfer of costs. Sweetwater Conservation Bank was established to protect GSG, and it is in a very similar landscape to APR. Like White Rock, it is made up of a patchwork of high quality habitat and habitat in need of restoration. We are assuming that the regulatory system in Montana will be very similar to that of Wyoming, meaning APR's bank would be operating in the same regulatory environment as Sweetwater. Establishing an accurate idea of an APR conservation bank's annual operating expenses is critical, since they determine the size of the endowment that APR would have to establish under USFWS rules, which is the single largest cost of establishing a conservation bank.

D. *Establishing a Banking Agreement*

To enumerate the costs of establishing a conservation agreement, we first had to calculate the endowment fund required to back the proposal. The endowment is an interest generating account that is held in trust to ensure that the annual operating costs of managing the conservation bank will be available in perpetuity. Using our 3 percent interest rate, the size of the endowment would need to be $711,217 to generate the $21,336.52 that is required for annual maintenance and monitoring. In some banking agreements the landowner is allowed a certain period of time to establish the endowment fund, 20 years in the case of Sweetwater, but for simplicity in our analysis we required the endowment to be funded up-front. If we allowed the cost of the endowment fund to be established over a period of time, the overall cost would be discounted in the future and thus reduced. In this scenario the initial profits of credit sale would also be reduced as revenue was paid into the endowment, so it is uncertain how the BC ratio (BC ratio) of the project would be affected.

We estimate that the drafting a conservation banking agreement for a conservation bank on the

White Rock property will cost roughly $200,000. This number was based on the stated costs of the Sweetwater Banking agreement (SRB Management Plan); it included legal fees, permitting, initial surveying, and other consulting work needed to establish the conservation document. For our analysis, we are used the same value as Sweetwater since these fees are much less acreage-dependent. For the initial monitoring required to assess the quality of the sagebrush habitat on the property, LIDAR monitoring will be conducted via drones and the results would be verified with vegetation surveys and lek counting. Since these activities cost the Sweetwater Conservancy $40,000 for 55,595 acres, we estimate a cost of $6,962.90 for APR's White Rock property. Finally, the legal fees for drafting and placing a conservation easement on White Rock range between $2-10,000, so we have estimated the cost at $5,000 for the conservation easement.

III. Quantification of Direct Benefits

A. *Estimating the Price per Credit*

Now that the predicted demand, supply, and market share of statewide credits have been estimated, the only missing variable to quantify the expected financial benefits from establishing a conservation bank is the price of a credit. After an extensive review of the literature, and outreach to conservation banks in other states that target the same or similar species to GSG, it became clear that credit prices are proprietary and surprisingly secretive. The Nevada Habitat Exchange for GSG notes that credit prices are market driven, and are therefore negotiated by the purchaser and supplier during each credit sale (Nevada Natural Heritage Program and the Sagebrush Ecosystem Technical Team, 2014).

As such, to proxy a potential market credit price, we look back to the MSGOT Stewardship Grant Funding Program. As mentioned, MSGOT has expressed intent to award credits to properties that received grant money, to sell those credits as offsets and replenish the Stewardship Grant Funds 100 percent (MSGOT, 2016). MSGOT is not expected to be allowed to profit from the sale of those credits. Therefore, it can be assumed that an average price per credit is equal to the funds spent to date divided by the quantity of credits awarded.

$$Credit\ Price = \frac{MSGOTspent}{MSGOTacre\ x\ HabitatFunctionality}$$

This analysis calculated a functionality of 72.9% for all properties that received MSGOT funding, resulting in average credit price of $236.22. To note, this price only considers the amount directly awarded from MSGOT, not the additional costs that MSGOT may incur by placing and verifying credits on grantee properties. As mentioned, Montana has yet to publish their state-specific legal requirements for awarding and verifying habitat credits, but it is reasonable to assume costs are similar to those of establishing a conservation bank in Wyoming. Regardless, this analysis chose to use the low estimate of credit price as a conservative indication of expected revenues from credits sales.

B. Justification of Discount Rate

The topic of appropriate discount rates for environmental investments stirs much debate among environmental economists (Padilla 2002). In general terms, discounting future costs and benefits into present day monetary value is a way for economists to include pure time preference into their analyses. Since the benefits of selling credits from a conservation bank or habitat exchange are necessarily expected after the initial costs of certifying credits, the timing of expected benefits must be accounted for. Most discount rates are based on the U.S. Treasury 10-year bond interest rate, minus expected inflation (Whitehead 2005). As of December 1, 2016, the bond rate is 2.45 percent (U.S. Dept. of Treasury 2016), and inflation is 1.9 percent (OECD 2016). The United States Office of Management and Budget, however, suggests using a discount rate in the range from 3 to 7 percent (Circular A-4), and other environmental service CBAs often include a range of rates from 3-7 percent. The Clean Air Interstate Rule (CAIR) CBA was performed with both 3 and 7 percent discount rates (US EPA, 2005). The Nature Conservancy (TNC) used a 5 percent discount rate for its analysis of water supply benefits from forest restoration study (Podolack, 2015), while TNC also used a 3 percent discount rate when evaluating watershed conservation in Hawaii (Burnett, 2016). For this analysis we employed a 3 percent discount rate because it lies within established bounds (3-7 percent), but give a higher value to future benefits than a higher rate would. Because our client is an environmentally focused nonprofit organization, we feel safe in the assumption that they are more concerned with long-term environmental protection than with immediate monetary returns. It is also important to note that our calculations were built to update when variables are changed and if APR prefers a different discount rate in the future, our analysis is in a user-friendly format.

C. Results of Financial Assessment

Applying the results of the expected demand and price per credit, we applied the annual discount rate of 0.03 percent to determine expected revenue per year and overall benefit cost ratio. According to this analysis, establishing a conservation bank on the White Rock property would cost APR $1,000,625.48 and generate a direct benefit of $1,275,522.36 through the sale of mitigation credits. This assumes that all preparation could be completed in 2017, and credit sales would begin in January 2018. These costs and benefits result in a BC ratio of 1.27, suggesting that this project would be profitable. We calculated a “break even” credit price of $185.31 per functional acre, representing the minimum price that our client could sell mitigation credits for to maintain a BC ratio of 1.00. As stated previously, a price of $236.22 was used for this analysis. Complete results can be found in Appendix 1, Table 3.

D. Alternative Scenario Analysis

Due to the substantial assumptions made in this analysis, we tested the sensitivity of the financial analysis to other land cover classifications, disturbance buffer extents, and credit demand projections. In each scenario, our analysis projected a positive return to APR (Table 4 below). As described in the methodology section, the original analysis applied the average habitat “functionality” of land cover types, determined by field surveys, to the three cover types that occur most frequently on APR’s land, and less-precise scores, based on the Montana FWP Field Guide, to all other land cover types. We refer to the first approach as the “functionality” approach, and the second (combining functionality scores for three cover types with Montana FWP-based values for all others) as the “suitability” approach.

This multi-pronged approach was taken to account for possible errors in our assumptions. In some ways, the “functionality”-based results may reflect conditions on the ground more accurately. For example, cultivated cropland on APR property received a relatively high average functionality score (62.9%), since this cropland has been retired but not yet restored, but would be assigned a “suitability” score of 0. This is one example of a substantial disagreement between two methodologies for assigning values to cover types. On the other hand, there is substantial risk of error in applying specific field data from a particular location to the entire region. Functionality scores as measured on APR’s property may not be accurate in other areas, and we have no field data outside of APR with which to test this issue. Therefore, while the original analysis used the "functionality" scores, it was prudent to investigate how sensitive our results would be to a different land cover classification system. Applying this "suitability" land cover layer instead of the original "functionality" land cover layer to our simplified HQT, we estimated a slightly higher BC ratio of 1.28 with a break-even credit price of $160.83.

As mentioned, disturbance buffers used in the Wyoming HQT were relatively small compared to much of the literature regarding the actual impacts of surface feature disturbances on GSG. It is possible that this is the result of political pressure and negotiations during development and a desire to balance conservation goals with stakeholder acceptance. Whatever the reason, we assume that Montana will end up adopting a similar approach. However, this is far from certain, and Montana's eventual HQT may be more in line with the scientific literature. To determine the sensitivity of our analysis to surface feature buffer size, we used the "USGS synthesis" disturbance buffers (see Appendix 1, Table 1 for comparisons) with the functionality land cover layer (BC ratio 1.16, break even credit price $213.24) and the suitability land cover layer (BC ratio 1.16, break even credit price $185.53). While there was some variation in the results, either set of surface feature buffers results in a positive BC ratio.

The original demand projection only considered the construction of new wells in core habitat applying the "2010 growth" equation (approximately 7 new core area wells per year). If the next administration increases the rate of oil and natural gas production, the growth equation may be better represented by the 1980 trajectory of 32 new core area wells per year. This increase in demand projections results in APR selling out of credits within a single year (still assuming credits are purchased according to market share), providing a BC ratio of 1.28 when paired with vegetation functionality land cover types. The additional credits demanded from impacts due to the construction of roads to new oil and gas developments has the same impact, causing APR to sell out of credits within one year with a BC ratio of 1.28. As previously stated, the regulatory environment is highly uncertain. There are many possible regulatory tools that we would expect to result, similarly, in increased projected BC ratios and accelerated timelines, since this would just increase the amount of credits demanded per impact. These regulatory tools include required offset ratios greater than 1:1 and distance multipliers.

To test the sensitivity of our results to the timing of credit sales, we reduce APR market share from 31.24 to 10%, this causes APR to sell out in its fourth year of operation, still providing a BC ratio of 1.23. Market share seems to not be that significant a factor since the operating costs are all generated through the endowment establishment. This endowment provides protection from future fluctuations in the market, including changes and reductions in the market share of credits.

Table 4. Results of alternative scenario analyses comparing the original model (Wyoming Functionality) to six alternative quantification metrics.

Modeled Scenario	Summary of Alternative Scenario Analysis Results			
	Benefit-Cost Ratio	Credit Price (USD)	Supply of White Rock Credits	Years to Sell All Credits
Wyoming Functionality	1.27	$236.22	5,572.75	2
Wyoming Suitability	1.28	$205.25	6,444.32	2
USGS Synthesis Functionality	1.16	$247.78	4,833.24	1
USGS Synthesis Suitability	1.16	$185.25	5,555.14	1
High Oil and Gas Development Trajectory	1.28	$236.22	5,572.75	1
Energy-Related Road Construction Included in Demand Projection	1.28	$236.22	5,572.75	1
Reduced Market Share	1.23	$236.22	5,572.75	4

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Discussion

As stated, this analysis finds that the establishment and perpetual management of a conservation bank would be financially profitable for APR (1.24 BC ratio), based on expected demand from the oil and gas industry and an estimated credit price of $236. The upfront cost of bank establishment is substantial, $1,000,625.48, mainly due to the endowment necessary to earn annual interest equal to operating costs (71% of upfront costs). Though funding for the initial endowment may be a prohibiting factor for bank establishment, it is crucial to assure that perpetual management practices can be funded with or without credit sales. Revenues from credit sales will only be necessary to recover the initial cost of the endowment, while operating costs will be funded by endowment interest. The estimated credit market only considers current grantees of Montana Grant Stewardship Fund and the APR conservation bank. It is probable that other private landowners will either establish their own conservation bank or apply for MSGOT funding, resulting in increased total market supply of credits and reducing APR's estimated market share. This scenario would lengthen the timeframe before the upfront endowment investment is paid for.

If APR is able to expend this large upfront sum of roughly $1,000,000 they must consider alternative uses of this funding that could provide greater benefits to GSG or promote other organizational goals. Alternative uses could include: purchasing and protecting other properties with high risk of cropland conversion, providing financial incentives for neighboring ranchers to implement management strategies that protect GSG (Appendix 3, Best Management Practices), or removing features that reduce functionality (such as tearing down tall structures, removing fences, and replacing current fencing with a wildlife friendly alternative). The fact that the financial analysis finds that APR will not only cover costs but actually generate a profit from bank investment ($274,896), may help when considering other investment options.

The Montana Grant Stewardship Fund provides grants for private landowners, potentially including APR, to fund conservation easements on their property to benefit sage-grouse. If Stewardship funds are granted, MSGOT will retroactively apply their HQT, when developed, to generate credits on the properties where they have funded easements. To be clear, this does not mean that conservation banks will be established through the Grant Stewardship Fund. As described in our literature review, conservation banks operate according to specific bank agreements, and incorporate long and short term management requirements in addition to the acquisition of a conservation easement. The generations of credits through MSGOT's grant program is more similar to traditional case-by-case credit generation projects than to true conservation banking.

While the dispersal of grant funding has yet to occur, statutory language suggests that credits generated in this manner will be owned by MSGOT and proceeds from their sale will be used to replenish the Stewardship Fund. While this option may seem like an attractive mechanism to offset the upfront costs of bank establishment, there are several possible negative implications that could occur from APR receiving grant funding. Grant funding is a rival good, meaning if APR receives funding from the grant program, there will be less funding available to other applicants. Other applicants may be landowners with higher development or cropland conversion risk, or located in key connectivity areas between core areas. It is possible that by applying for this funding, APR would prevent these higher-risk properties from receiving easements that could provide greater benefit to GSG. In this case, not only would GSG receive lower benefits than the counterfactual, but APR could worsen their reputation with the surrounding community and other environmental organizations.

The most concerning aspect of conservation banking is the ability to provide additional benefits to the target species and avoid the potential for unintended adverse selection. Adverse selection refers to the mechanism by which individuals or organizations that already comply with a program will select into an incentive program, reducing actual benefits accrued as a direct result of creating that program. This results from hidden information, in which the operator of the incentive program thinks that the applicant can or will only comply if the incentive is provided (Ferraro, 2008). For instance, APR properties already contain high quality habitat, yet there is still room for habitat uplift through targeted management practices and removal of features that threaten grouse survival. If habitat improvements are unlikely with current funding sources, then the establishment of a conservation bank that provides targeted management would provide additional benefits to GSG populations on and near the White Rock property. Alternatively, if APR were already able to provide habitat uplift without the need for conservation bank funds, then creating a conservation bank would not only not provide any additional benefits, but would allow for habitat disturbance to occur elsewhere in the state, causing a de facto net loss in GSG habitat.

Region and statewide benefits from the use of conservation banking however, will be heavily dependent on the regulatory framework developed by the State of Montana. Through a literature review, we infer that benefits to the species from conservation banks are highest when credits have long-term certainty, low transaction costs during quantification and price negotiation, and provide equivalent or better habitat value in comparison to the habitat disturbed (debits). The fundamental order of operations mandated by MSGOT- avoid, minimize, and then offset impacts through mitigation- is still essential for habitat protection and will, by itself, reduce development pressure on GSG habitat.

To provide additional habitat benefits on a credit-by-credit basis, there are several regulatory tools the state could use. One regulatory tool is an 'offset ratio,' which determines how many credits are required to mitigate each debit. For instance, the state should use offset ratios larger than 1:1 (debit:credit) to account for long-term uncertainty in GSG population movements, since preserving habitat does not necessarily mean that habitat will be colonized by GSG. An even larger offset ratio could be used for credits generated through restoration, to account for the long-term uncertainty of restoration success, as well as the likely time delay between habitat restoration and colonization by GSG. Another regulatory tool that can be employed is a 'distance multiplier,' which effectively means the farther away from a habitat impact that mitigation occurs, the more credits will be required. This encourages mitigation closer to impacted habitat, and provides some protection for individual grouse populations. An alternative to distance multipliers, intended to accomplish the same purpose, is for the regulator to define service areas, where habitat impacts and mitigation must occur within the same service area. Different regulatory systems have also treated habitat restoration and creation in different ways. We recommend that, due to the long maturation time of sagebrush habitat, restoration and habitat creation projects must only receive credits once the habitat has reached its intended state. Allowing credits to be awarded before habitat is functional may lead to critical resource shortages in the short term, even if restoration is successful in the long term. In no case should disturbances be offset by creation or restoration of habitat that is not functional for grouse at the time the disturbance occurs.

At present, it is not clear what regulations will be developed by MSGOT to govern Sage-grouse mitigation in Montana. It is likely that some combination of the regulatory tools explained above will be utilized, but MSGOT may use novel regulations as well. American Prairie Reserve should be wary as regulations are developed, and ensure before they participate in the system that regulations are conservative on the side of species protection rather than development, and account individual populations' ability to reach suitable habitat as well as general ecological uncertainty.

Potential to Provide Benefits to the Species

Although the placement of a bank on already protected property (APR deeded lands) threatens the potential for additionality to provide net benefits to the bird. Potential benefits are as follows

- The land is deeded but not perpetually protected through a conservation easement, so if APR were to go bankrupt in the future or sell the land, this area could be developed
- All targeted management practices aimed at benefiting GSG are not occurring currently (still allow hayfields), therefore the bank would change and intensify the amount to which these lands were managed to increase overall habitat functionality
- A profit generating bank would create funds that would be utilized by APR to incorporate the same management principles on their other deeded and leased lands
- A profit generating bank could entice neighboring private landowner to invest in a conservation bank, increasing the net amount of land under perpetual protection, especially if that land is experiencing development pressure for cropland conversion or intensive agriculture
- A profit generating bank could create funds that would be utilized by APR to remove identified features than reduce habitat functionality

Despite these potential benefits, key risks to additionality must be considered, including

- Currently low development risk of White Rock, meaning the conservation easement may not necessarily be necessary to protect the current habitat
- No requirement for habitat uplift is necessarily documented in the plan.
- Could be allowing habitat degradation without providing any additional benefits from what

is already occurring/protected (net loss in habitat)

Mitigation Regulations Expected to Increase Likelihood of Species Benefits

The literature frequently sites that conservation banking can achieve no net loss, or even a net gain, of species population levels and resilience. Conservation banking can help put a price on ecosystem values and thus incorporate an externality into the development market (Gibbons, 2014). However, these positive outcomes are subject to economic, ecological and institutional constraints. The following are core aspects of an operating framework that have been identified to increase the likelihood of a conservation bank that can meet management goals.

- Sufficient number of participants (suppliers and buyers)
- Certainty about the future of the market, including long-term viability of credits
- Sufficient amount of trading activity and frequency
- Low transaction costs including offset quantification and price negotiation
- Equivalency in habitat value between habitat disturbances and credits
- Trusted, responsible, and enforceable governing body
- Offset ratio results in additionality
- Offset ratio that incentivizes developments away from high quality habitat
- Restoration credits provided after ecological benchmarks reached (if applicable)
- Clearly stated “service areas” with explicit population and habitat objectives

There is minimal empirical data on how effective conservation banks have been at providing benefits to their target species. This is due to lack of transparency and public monitoring reports from baseline conditions. Fortunately, much literature has identified key themes that should theoretically result in self-sustaining, if not profitable, conservation banks, able to provide meaningful benefits to their species of concern.

- Establishment of a bank that provides connectivity of high quality habitats
- Protects and borders large expanses of high quality habitat
- Ecologically based performance standards: increased abundance (number of males per lek and density of active leks)
- Clearly stated management responsibilities
- Large enough to provide year-round support for onsite GSG population
- Accurate understanding of financial needs for establishment and operation
- Sufficient funds for perpetual operation and management
- Establishment of appropriate endowment fund
- Preparation for worst-case scenario (years of no sales)
- Provides added benefit to the habitat
- Protects areas with high likelihood of development or conversion to agriculture
- Creates or restores habitat to full functionality
- Actively manages vegetation to benefit GSG
- Actively manages, reduces, and prevents threats including fires, invasive plants, predation, wildlife overgrazing, roads and trails, livestock management, and habitat fragmentation
- Provides a thorough and publicly available annual report describing all management tasks conducted, and changes in lek counts and vegetation functionality from both the previous year and the initial year of the bank.

Recommendations

We would recommend establishing a conservation bank only if the regulatory setting created by MSGOT reflects the best operating framework outlined in Appendix 3. In addition, a bank should only be considered if APR feels that they cannot implement these BMP's for GSG without the profits or revenue that would be generated from credit sales after bank establishment. We have shown that the upfront investment required to establish a bank is substantial, over $1 million; APR would need to determine that this money would best help them meet their management goals compared to other investments and/or project opportunities. While all APR properties would be good candidates for the bank, we suggest that White Rock is the most suitable location, due to its current lack of bison and the fact that the presence of some unrestored former cropland provides opportunities for restoration and habitat uplift.

Revenue generated from credit sales could be applied toward a variety of beneficial goals. Among others, options include increasing restoration efforts, accelerating the removal of interior fences, the acquisition of land at risk for cropland conversion or other development, establishment of conservation easements on land not currently under permanent protection, and targeted outreach to local landowners to promote ecologically sound land management practices and provide consultation and assistance for beneficial projects. If the White Rock conservation bank is as financially successful as our analysis suggests, it may encourage other landowners to consider establishing banks as well. In that case, the bank's revenue could help APR play an advisory role, helping partners to navigate the regulatory environment and establish sound bank management. Whatever purpose the revenue is put toward, it is crucial that bank's earnings be used for the benefit of GSG. Each credit sold by the bank will allow habitat degradation to occur elsewhere. If the revenue from credits is not used to provide additional benefits to GSG beyond APR's standard management practices, then the bank will result in a net loss of GSG habitat.

Our research has highlighted several other areas of bank management that we believe are important for APR to focus on as well. In terms of day-to-day land management, we highlight recommended practices in Appendix 3. There are other concerns, however, in addition to land management practices. Established conservation banks are generally not transparent in terms of their management practices, credit prices, or sales history. While this may serve the business interests of some individual banks, the lack of clarity, especially with respect to credit prices, may harm the public perception of conservation banks in general and discourage new entrants to the market. We believe that APR should be a model of transparency, publishing regular updates of credit supply, pricing, and sales history on the RIBITS public database (https://ribits.usace.army.mil/). Another common problem with conservation banks, and conservation projects generally, is the lack of adequate long-term monitoring. While we believe that a bank established by APR could benefit GSG, there is a lack of empirical evidence regarding the long term ecological impacts of conservation banking. By making a commitment to substantial and consistent monitoring of GSG population changes compared to baseline conditions, APR can help to establish a body of evidence that will assist planners, government officials and private landowners to make the most effective and efficient conservation policy choices in the future.

Limitations

While our analysis should provide valuable insight to APR, it is limited in several ways. First, our approach examined a 'model bank,' to be implemented on a specific property. The resulting costs and benefits would change somewhat if a different location were chosen. However, our spreadsheet-based cost-benefit analysis is designed to update costs and benefits based solely on acreage and habitat functionality, and so transferring it to a new property would be relatively straightforward.

In addition, several aspects of this proposed project involve a high degree of uncertainty. First, our projected demand is based on predicted new oil and gas wells, and there is long-term uncertainty in the rate of energy development. Our analysis provides a high and a low estimated trajectory for new oil and gas well creation, based on conditions in the past 36 years. However, with the rate of technological change and the increasing prominence of renewable energy sources, as well as the influence of international relations on oil and gas markets, we cannot say with total confidence that those conditions will continue to exist.

Our projected demand also does not include any sort of offset ratio or multiplier effect that may be imposed by state regulations, and which have been employed in other habitat exchange contexts. An offset ratio or multiplier would require that more than one unit of habitat be conserved for each unit of habitat that is disturbed. Not including an offset ratio probably results in an artificially low estimate of demand, since we expect the final state regulations to include something of that sort. In addition, our demand estimates only include mitigation credits required by new oil and gas wells. It does not consider road building, residential expansion, cropland conversion, or other sources of habitat disturbance. We expect that oil and gas development will be the primary driver of demand, but these other factors may be significant as well. In any case, not including these factors also results in a likely underestimation of the demand for credits. Overall, our projected credit demand is a very conservative figure.

On the supply side of our projected credit market, there is also significant uncertainty. Montana has not yet developed an HQT for determining how many credits would be generated for different levels of habitat quality. For our analysis, we created a GIS tool that is meant to be a simplified version of the Wyoming HQT, and applied it to APR's White Rock property to estimate how many credits APR could produce. If the final HQT approved in Montana is significantly different from the framework we used, it could substantially change APR's predicted supply of credits. We also estimated market-wide supply of credits based on grant funding that MSGOT has already distributed for the creation of credits. MSGOT has not spent all the available funding for this purpose, and has not decided when or how they will distribute the remainder. It would be possible for MSGOT to flood the credit market, greatly reducing the potential benefits to APR.

In addition to these specific limitations, there is a high degree of general uncertainty over how the state mitigation program will be structured, since regulations are still being developed. There are many possible regulatory changes which could impact this analysis. Just to name a few examples, the credit market could be statewide or split into multiple service areas, the impact estimates from development could be significantly different than those we used, or the state could allow the practice of awarding credits for restoration before restoration targets are achieved. We are if Montana will follow USFWS guidelines, and the example of Wyoming's compensatory mitigation credit trading system. While this is a large assumption we believe it is justified, in part because if

Montana departs too much from USFWS guidelines, our recommendation would be not to participate in the exchange for ecological reasons, even if it were profitable.

Ideally we would quantify the benefits to GSG by determining the time frame and cost necessary to provide 100 percent functionality, and the increase in the amount of birds or change in survival rates as a direct result of that habitat uplift. For instance, one could compare the quantity of leks and male attendance to each lek on areas with different habitat functionality as determined by the WY HQT, and use that as a proxy to quantify expected population or survival benefits because of that habitat uplift. Unfortunately, we were not able to acquire time series habitat functionality data necessary to compare any changes in lek attendance or quantities. Instead we rely on the assumption that increasing the habitat functionality, both vegetation thresholds and reduction of anthropogenic disturbances, will help increase survival and therefore population growth. Although we are unable to measure specific benefits to GSG through the establishment of a bank, future studies could track the habitat functionality changes as the best management practices are implemented.

Conclusion and Next Steps

If our assumptions about the future structure of Montana's compensatory mitigation market hold true, this analysis shows that APR could profit financially from establishing a private conservation bank on its White Rock property. With our projected credit price, the financial direct benefits would outweigh the costs of such a project with a healthy margin of error under multiple scenarios, resulting in BC ratios between 1.14 and 1.36. Based on unofficial conversations with individuals involved in Wyoming's compensatory mitigation market, we believe that our estimated credit price of $236 is likely much lower than the actual market credit price could be. While our methods of estimating the potential credit supply both at White Rock (5,573 credits) and the future Montana credit exchange (12,264 credits) are limited, they provide a credible estimate to evaluate the feasibility of creating a conservation bank. While APR is under financial constraints like any nonprofit organization, its stated primary goals are based on ecology and wildlife protection, not profits. The environmental efficacy of conservation banking is a hotly debated topic, with little empirical evidence regarding long-term outcomes. Our recommendations can be applicable to any private landowner considering the development of a conservation bank or mitigation program. For individuals or organizations that are planning to join or establish a mitigation program, we highly recommend that annual reports compare habitat quality and target species populations to baseline conditions as a method to track onsite additionality. It would be beneficial to the overarching PES community to make this information publicly available so more thorough analyses on the true effectiveness of conservation banks and mitigation programs can occur in the future.

Potential next steps are contingent on Montana's creation and USFWS approval of their HQT, in addition to the development of Montana's greater regulatory framework for a GSG offset program. Once this tool and future regulations have been created, APR can update our analyses with the exact buffer distances and values that will be used by the state to determine mitigation credits and debits. This would lead to an exact measurement of the credits at White Rock and other properties that would be available if a conservation bank were to be established. We also provide APR with a list of recommended regulations for effective conservation banks that can be compared against actual regulations once developed by the state, to aid in the decision for investing in a conservation bank. Though oil and gas transportation was not included in this analysis, we recommend that APR closely follow developments with oil and gas pipeline development, notably the Keystone XL

Pipeline. As currently planned, the Keystone XL Pipeline would cross through leased areas of APR's Timber Creek property. This could cause significant reductions to habitat functionality in the area, yet could also increase the demand for habitat offsets in the area.

If APR chooses to proceed with establishing a bank, it is important that the funds generated by credit sales are used either for continued improvement of sage-grouse habitat that would provide direct measurable benefits to the bird or to serve as a mode for community outreach to neighboring ranchers. The legal requirements, financial costs, and ecological complexity of establishing a conservation bank may also dissuade private persons from attempting to participate in banking. A conservation bank on APR property could serve as a model or template for neighboring ranchers that may otherwise feel overwhelmed and uncertain about the bank establishment process, in which case APR could provide technical guidance regarding easement drafting and bank establishment. This would serve APR's goal of increasing protected Sage-grouse habitat in the area around the reserve, as well as strengthen relationships with the local ranching community.

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Appendix 1. Tables

Table 1. Disturbance buffers (km) for various features identified in the Wyoming Habitat Quantification Tool (WY HQT). Buffer distance estimates for both the WY HQT and the more conservative USGS literature review disturbance thresholds are provided. **Source:** Wyoming Conservation Exchange. 2016. Greater Sage-Grouse Habitat Quantification Tool, Version 3. http://www.wyomingconservationexchange.org/wp-content/uploads/2014/08/WY_Sage_Grouse_HQT_May01_2015.pdf

	USGS Literature Review Buffer Distance Estimates (km)		
Category	Buffer (km)	Score Within Buffer	Score Outside Buffer
Lek Locations	8	1	0
Minor Roads	NA	NA	NA
Major Highway	5	0	1
High Intensity Residential	5	0	1
Low Intensity Residential	2	0	1
Active Oil Wells	5	0	1
Wind Turbines	3	0	1
Communication Towers	3	0	1

	Wyoming HQT Buffer Distance Estimates (km)		
Category	Buffer (km)	Score Within Buffer	Score Outside Buffer
Lek Locations	2.1	1	0.01
Minor Roads	1.5	0.5	1
Major Highway	4.2	0	1
High Intensity Residential	4.2	0	1
Low Intensity Residential	1.5	0.25	1
Active Oil Wells	2.1	0	1
Wind Turbines	3	0	1
Communication Towers	0	0.5	1

Table 2. Ground-truthing of land cover types with onsite transect data collected from vegetation surveys sampled in July 2016. Comparisons were only conducted for land cover types that had large enough sample sizes (n>10).

	Accuracy Analysis of Land Cover Type Data Layer		
Land Cover Types	Landcover Description	% Transects that Meet Description	Sample Size
Big Sagebrush Steppe	Artemesia shrub 10-40% cover, trees < 25% cover	71.7%	45
Cultivated Crops	No specifics identified		12
Greasewood Flat	No specifics identified		1
Great Plains Mixedgrass Prairie	Grass and forb > 25% cover, trees and shrubs < 25% cover	92.7%	27
Great Plains Ponderosa Pines Woodland and Savanna	No specifics identified		1
Great Plains Riparian	Narrow zone directly associated with streamsides or lakeshores		3
Great Plains Sand Prairie	No specifics identified		1
Introduced Upland Vegetation	Dominated by invasive alien vegetation		3
Mat Saltbrush Shrubland	No specifics identified		1
Recently burned grassland	Recently burned grassland ecosystem		1

*https://mslservices.mt.gov/Geographic_Information/Data/DataList/datalist_MetadataDetail.aspx?did=%7B1C91607B-A788-4B23-B1BA-53EED2842D03%7D

Table 3. Results of the cost benefit analysis including all direct costs and benefits for a proposed conservation bank on the White Rock property of American Prairie Reserve. Onsite and market credit values were calculated using the functionality value land cover types and WY HQT disturbance buffers.

Financial Analysis				
Direct Costs				*Time Frame*
Conservation Easement		$	27,005.24	*Year 0*
	Legal Fees	$	5,000.00	
	Administration	$	22,005.24	*10 hours/week from Year 0 - End of Credit sales*
	Loss of Future Development	$	-	
	Surveying	$	-	
Establishing Bank Agreement		$	918,180.24	*Year 0*
	Consulting & Legal Drafting	$	200,000.00	
	Initial Assessment	$	6,962.90	
	Endowment Establishment	$	711,217.34	
Annual Operating Costs		$	21,336.52	*Year 1 - perpetual*
	Livestock management	$	3,829.59	
	Fire management	$	644.07	
	Noxious weeds management	$	3,829.59	
	Predator management	$	696.29	
	West Nile Virus prevention	$	696.29	
	Recreation	$	765.92	
	Sage-grouse lek counts	$	4,000.00	
	5 year aerial	$	1,200.00	
	Habitat surveys	$	5,674.76	
Pre-Bank Restoration		$	55,440.00	*Year 0*
	Internal fence removal	$	55,440.00	
Total Direct Costs		$	1,000,625.48	
Direct Benefits				
Conservation Credits Sold				
	Onsite Credits		5572.75	
	Demand for Credits (year 1)		5190.85	*Year 1*
	Demand for Credits (year 2)		381.90	*Year 2*
	Price per Credit (low)	$	236.22	
Total Direct Benefits		$	1,275,522.36	
Break Even Credit Price		**$**	**185.31**	
BC Ratio			**1.27**	

Table 4. Percent land cover types on sampled APR deeded properties. Onsite vegetation surveys were conducted in July, 2016. Land cover data from Montana Land Cover Framework, 2016

	Percent Land Cover Types on Sampled APR Deeded Properties					
Land Cover Types	All 5 Properties	White Rock	Dry Fork	Sun Prairie North	Sun Prairie	Antelope Creek
Big Sagebrush Steppe	41.4%	36.2%	36.2%	31.3%	56.8%	76.4%
Great Plains Mixedgrass Prairie	27.9%	31.0%	45.1%	11.3%	19.9%	19.2%
Mat Saltbush Shrubland	5.8%	3.8%	2.4%	18.0%	2.6%	0.0%
Pasture/Hay	5.5%	11.7%	3.0%	7.8%	1.5%	0.0%
Great Plains Riparian	4.9%	5.3%	4.5%	1.0%	6.2%	0.5%
Cultivated Crops	4.7%	1.8%	0.0%	18.4%	1.9%	0.0%
Greasewood Flat	2.7%	1.9%	3.5%	0.5%	5.7%	0.6%
Introduced Upland Vegetation - Annual and Biennial Forbland	2.1%	1.7%	0.1%	6.5%	1.4%	0.0%
Open Water	1.8%	3.3%	0.8%	2.8%	0.8%	0.3%

Table 5. Average influence of features per APR deeded property in Core Habitat. A value of 1 indicates no influence (and therefore no disturbance to GSG habitat) and value of 0 indicates complete loss in habitat functionality (severe disturbance to habitat functionality)

	Average Influence of Features per Property (1= No Influence) USGS Surface Feature Buffers						
Property	Dry Fork	Sun Prairie	Sun Prairie North	Antelope Creek	Timber Creek	White Rock	Burnt Lodge
Low Intensity Residential Development	0.63	0.63	0.61	1	1	0.73	1
High Intensity Residential Development	1	1	1	1	1	1	1
Major Roads	1	1	1	0	1	0.96	1
Communication Tower	1	1	1	1	1	1	1
Active Oil and Gas Wells	1	1	1	1	1	0.47	1
Wind Turbines	1	1	1	1	1	1	1

	Average Influence of Features per Property (1= No Influence) WY HQT Buffers						
Property	Dry Fork	Sun Prairie	Sun Prairie North	Antelope Creek	Timber Creek	White Rock	Burnt Lodge
Minor Roads	0.71	0.66	0.82	0.83	0.76	0.75	0.73
Low Intensity Residential Development	0.78	0.81	0.76	1	1	0.85	1
High Intensity Residential Development	1	1	1	1	1	1	1
Major Roads	1	1	1	0	1	0.96	1
Communication Tower	1	1	1	1	1	1	1
Active Oil and Gas Wells	1	1	1	1	1	0.87	1
Wind Turbines	1	1	1	1	1	1	1

Appendix 2. Figures

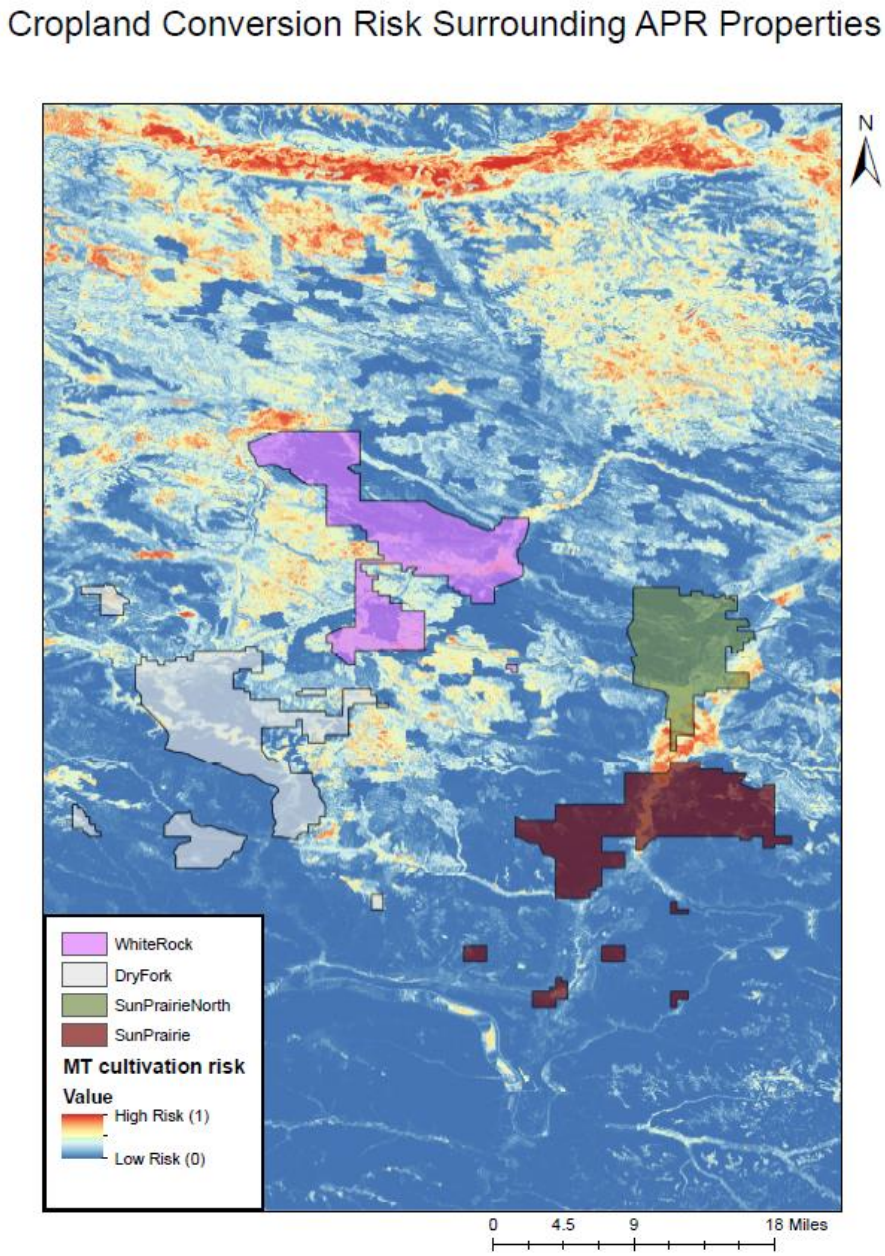

Figure 1. Cropland conversion risk surrounding APR leased and deeded properties. Data source: NRCS Sage Grouse Initiative.

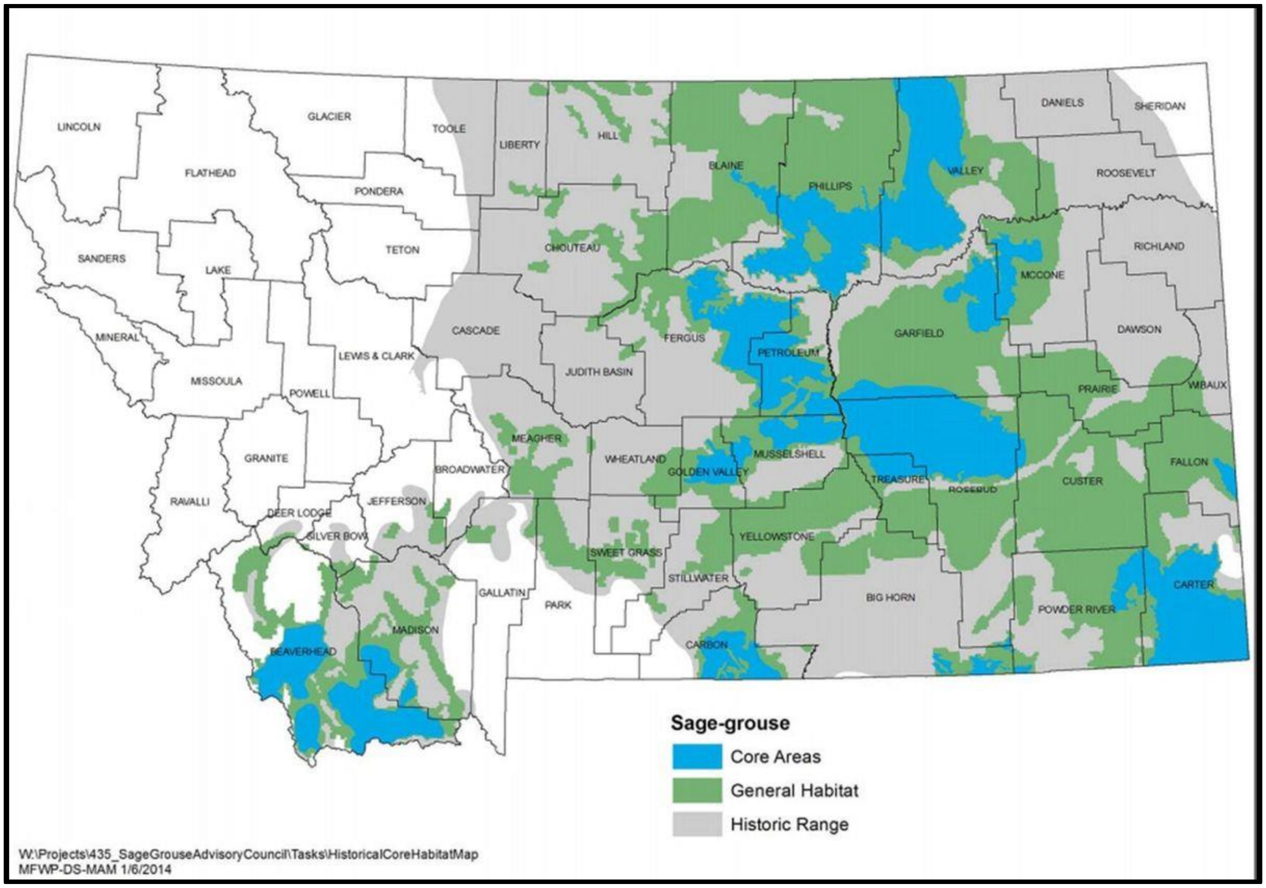

Figure 2. Core areas (blue), general habitat (green), and historic range (gray) of Greater Sage Grouse in Montana. Map designed by the Montana Sage Grouse Advisory Council.

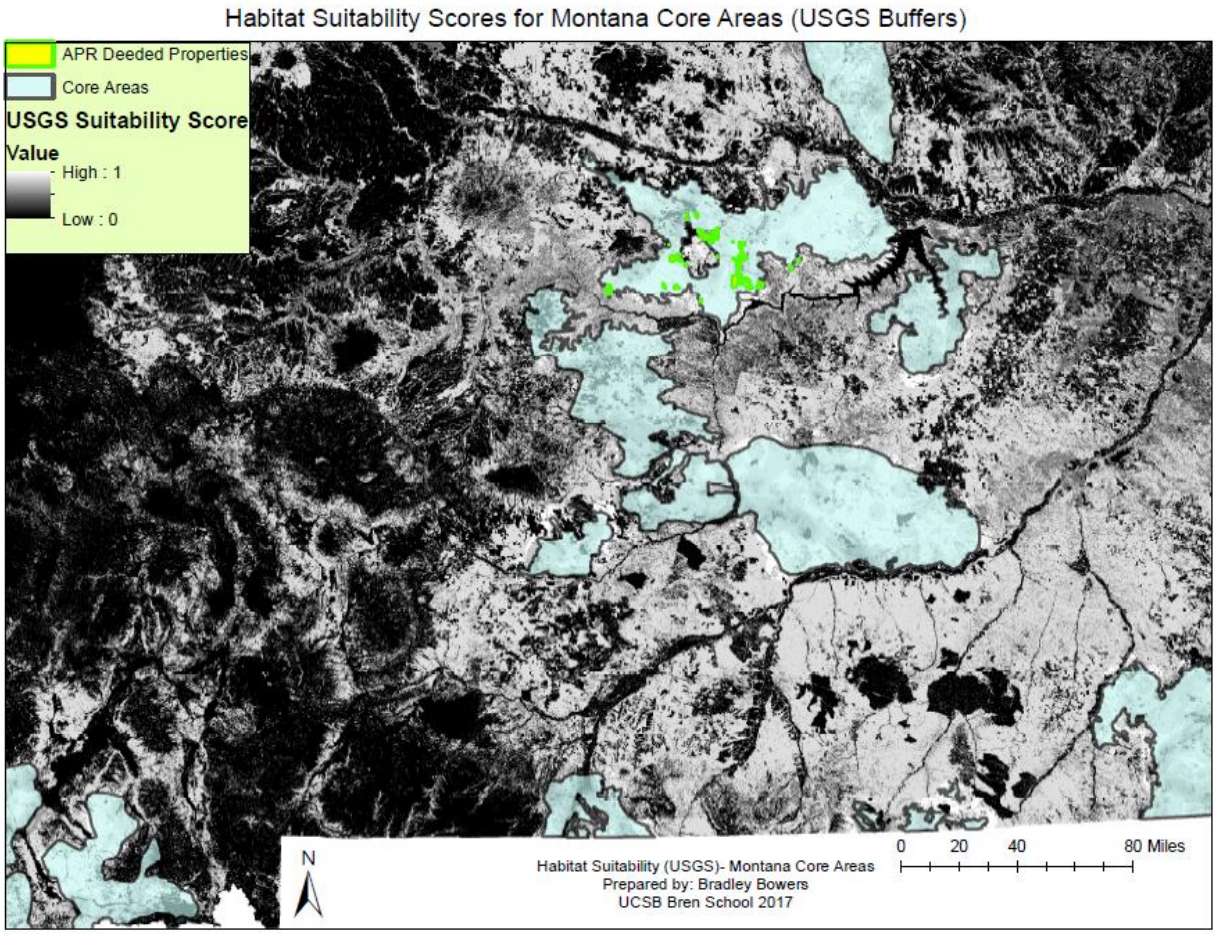

Figure 3. Habitat Functionality for Montana Core Areas. Habitat functionality determined by suitability land cover values and disturbance buffers from the USGS literature review.

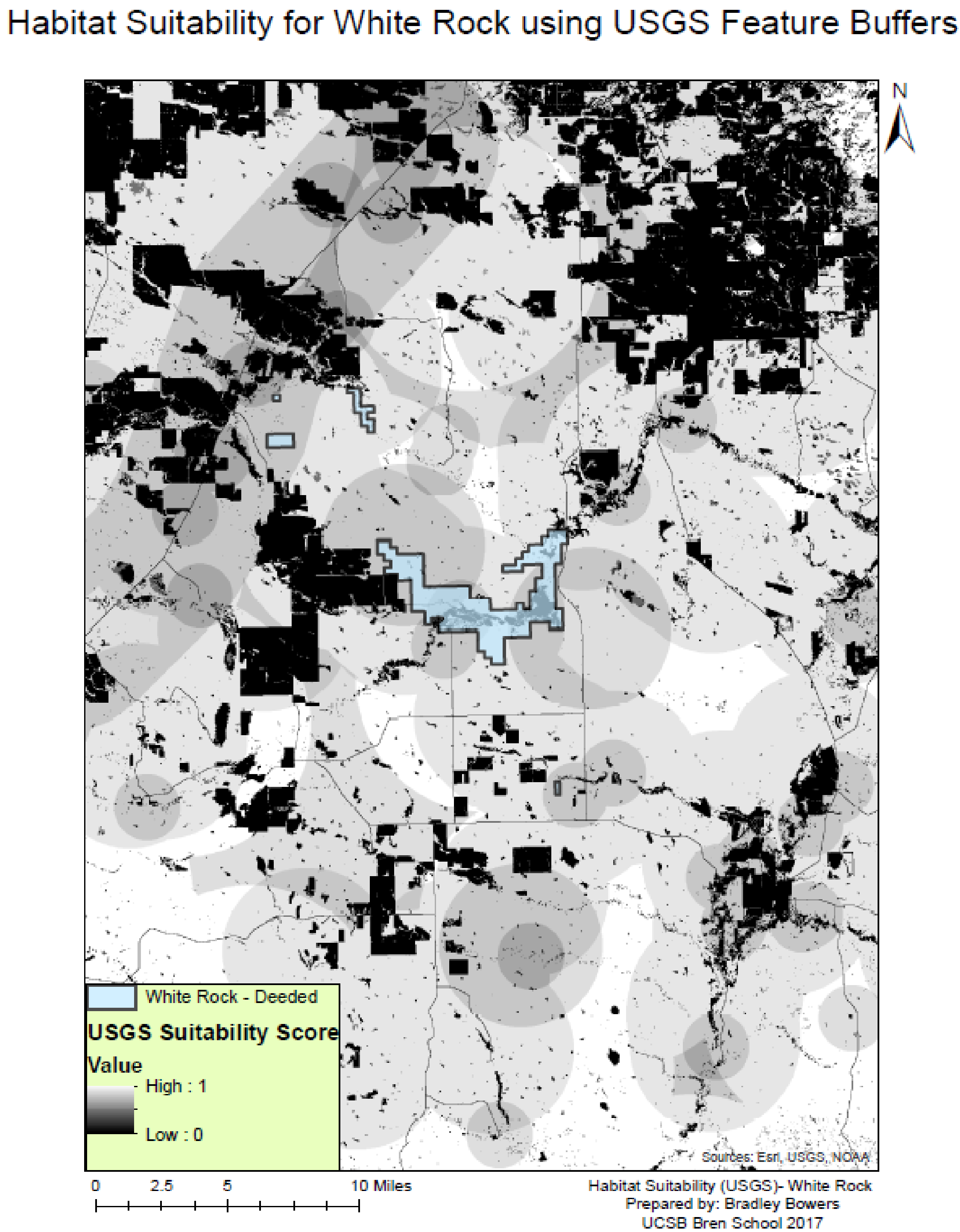

Figure 4. Habitat Functionality for APR's White Rock Property. Habitat functionality determined by suitability land cover values and disturbance buffers from the USGS literature review

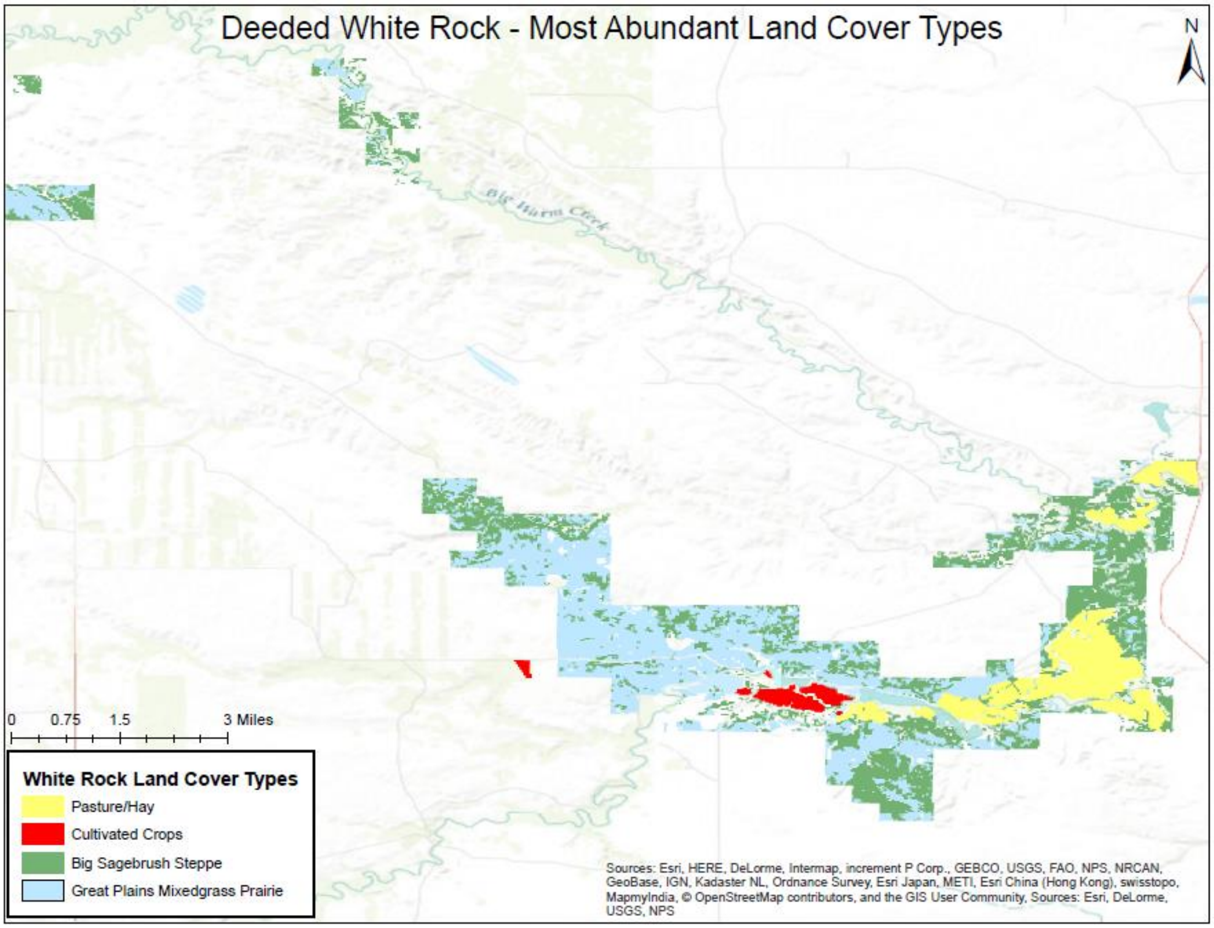

Figure 5. Abundant Land Cover Types on White Rock Deeded Lands. Most abundant land cover type is Big sagebrush steppe (green, 36.2%), followed by great plains mixed grass prairie (blue, 31.0%). Abundant lower valued land cover types include pasture/hayfields (yellow, 11.7%), and cultivated cropland (red, 1.8%).

Appendix 3. Best Management Practices for GSG Conservation Bank

I. Targeted Lek Attendance and Abundance

Braun (2006) recommends management goals of increased GSG abundance (number of active leks or number of males per discrete area over 3-5 years) and distribution, with abundance likely being a more easily accomplished goal. Focus is recommended to be primarily on currently occupied locations, and then areas surrounding those locations (Braun, 2006), as females return to predominantly the same areas for nesting year after year (Fischer et al, 1993; Lyon, 2000). A 2005 Montana Working Group published a population objective of 32 to 40 GSG males per lek, pending on FWP region, yet currently MSGOT aims for 7-15 males per lek. Therefore, properties should support at minimum 7 males per lek with goals to support 35 males per lek.

Two main population-monitoring techniques include lek counts, which determine the number of males per lek, and lek surveys, which determine the number of active, inactive, and new leks. The type of lek count varies pending if multiple leks are assumed to be used by the same population ("lek route") or if each lek is used by a separate population ("lek census"). Lek surveys are recommended to occur via aerial surveying every 3 to 5 years (Johnson & Rowland, 2007; Connelly et al., 2003). Lek counts are recommended to occur annually following the specific protocols outlined by Connelly et al. (2003) including "(1) from one-half hour before to one hour after sunrise; (2) during conditions of light (<15 km/hr) to no wind, in partly cloudy to clear conditions; (3) from early March to early May; (4) at least 3 times during a single visit, with 1-2 minutes between counts; and (5) with peak counts of males and females recorded separately."

To track brood size and survival (juvenile: hen ratios), Connelley et al. (2003) recommend the use of wing surveys over brood counts as they are less labor intensive. Regardless, all population estimations contain aspects of error as not all leks are known, counted, well defined, or are attended at all times during the breeding season. Another issue is that lek counts only count males, while the true indices of a population are the number of females, survival rate, and reproduction rates (Johnson & Rowland, 2007; Connelly et al., 2003). The approved Sweetwater Conservation Bank Management Plan includes annual lek counts and an aerial lek survey to occur every 5 years, both of which are budgeted in the annual operating costs for the model conservation bank on White Rock's property.

II. Habitat Fragmentation and Range

Braun (2006) recommends that unobstructed GSG habitat should be managed to be greater than a 1-mile block or "cadastral section", and ideally be greater than 20 square miles (or a group of 20 cadastral sections). Braun (2006) recommends that each township have a contiguous conserved "block" of 36 miles of sagebrush steppe. These blocks are also recommended to be connected through connectivity corridors of no less than 1 mile wide, and be free of any development, power lines, or fences. To note, some populations of GSG are migratory, traveling over a 1,000 square mile range annually (NRCS, 2012), yet the majority of populations in Montana are non-migratory. Connelly et al (2003) defined non-migratory populations as those that travel less than 10 km between seasonal ranges (one way).

III. Prescribed Fires and Wildfires

There is some controversy on the effect of prescribed burns, as some literature states that fires can benefit GSG by reducing conifer cover and sagebrush to quickly increase forb growth (essential for feeding) increasing nourishment for the late brooding season (Beck, Connelly & Reese, 2008). Yet fires can be detrimental to GSG (Connelly & Braun, 1997; Connelly et al., 2000) resulting in reduced sagebrush cover and therefore reduced protection during winter season and spring nesting (Beck, Connelly & Reese, 2008). Fires can also increase the potential for increased cover of faster growing annual grasses that outcompete more nutritional perennial grasses and forbs overtime (West & Hassan, 1985). Braun (2006) recommends the use of prescribed burns only when the specific need for increased brooding habitat is necessary. Braun recommends that fires should be no larger than 20 hectares, and not account for more than 20 percent of the property during a 30-year time interval. This prevents the potential of loss of important habitat and the need to reseed. Additionally, fires should not be used where cheatgrass is present or in low sagebrush habitat as cheatgrass can help with fire spreading (Braun, 2006). According to the broader literature however, it is recommended that APR refrain from participating in prescribed fires on the bank property to prevent the potential of unintended habitat degradation (Connelly & Braun 1997; Connelly et al. 2000; West & Hassan, 1985; Beck, Connelly & Reese, 2008).

The Sweetwater Conservancy Management Plan (2014) contains procedures for wildfire prevention and suppression, including all employees trained in fire rapid-response, an onsite fire truck, smoke detectors and fire extinguishers in all occupied buildings, prevention of parked cars in areas where catalytic converters could start fires, all ranch vehicles containing a shovel and fire extinguishers at all times, and no onsite fires including campfires or trash burning. The Management Plan (2014) will also keep and manage all secondary roads in the bank site as fire-breaks to prevent the need for additional construction of fire-breaks, except as needed during an active fire. The above Sweetwater procedures are all budgeted in the annual operating costs of the model bank at White Rock.

IV. Invasive Plants

Recent habitat surveys on APR deeded properties show minimal cover of invasive plants, yet to maintain and protect this quality GSG habitat, APR must continue to prevent invasive plants from being introduced to the area. Key invasive plants that cause threats to GSG include cheatgrass, pinyon pine, and juniper pine (Braun, 2006; Connelly et al., 2000). For cheatgrass-dominated sites, Braun (2006) suggests the reseeding of alfalfa and native bunchgrass in 20-meter strips. Ideal removal of pinyon and juniper pine is through the cutting down of each individual tree in order to protect understory and forbs. Crested wheatgrass, planted mainly for cattle grazing, can be used by GSG when young sagebrush seedlings are present. This habitat type only provides minimal nourishment as forb cover is often low. Braun (2006) recommends the disking and seeding of "dryland alfalfa, biennial sweetclover, native bunch grasses, and taller sagebrush" in crested wheatgrass sites that contain less than 5% sagebrush cover. He discourages disking of the entire site due to potential wind erosion and weed encroachment, and instead recommends disking and planting in 20-meter wide strips directed horizontal to the prevailing winds, every 100 meters.

The Sweetwater Management Plan (2014) stress the importance of Early Detection-Rapid Response (EDRR) protocols in preventing the spread of invasive plants, including extensive monitoring and prioritized removal once invasives are identified. Specific monitoring regimes were not clearly identified, yet prevention mechanisms include the frequent washing of ranch equipment and when possible, the use of certified weed-free seed. Sweetwater (2014) also mention the partnering with agencies and associations to stay up-to-date on the most effective weed control regimes, including the Wyoming Weed Management Association, Weed and Pest District Offices, and local sage-grouse working groups. The Sweetwater invasive plant management protocols (2014) were budgeted in the annual operating costs of the model back at White Rock on a per acre basis.

V. Predation and Fencing

Tall structures allow for the perching of various predators including raptors, ravens, corvids, and golden eagles. Braun (2006) recommends the removal of all unused power poles and power lines in sage grouse habitat, prioritizing those within 5.5 km of active leks and located near winter-use areas. The Sweetwater Management Plan (2014) prevents common raven predation by avoiding the outdoor piling of any carcasses or garbage. If “unacceptable” impacts to GSG nests are occurring from predation, Sweetwater (2014) plans to use chicken eggs treated with DRC-1339, but only after permitted by USFWS. Any more extensive predator control will be coordinated with USDA APHIS (Sweetwater Conservancy, 2014).

For fencing, Braun (2006) recommends that when necessary, use metal fence posts instead of wooden posts as raptors are less likely to perch on metal as opposed to wood. Fences should also be removed within 2 km of any active leks and contain no more than three wire strands. Strands should be barbless but if necessary, only the middle wire should contain barbs. Additionally, Stevens et al. (2012) found an approximate 83% reduction in grouse collision rates at marked fences relative to unmarked fences. This study also suggested marking efforts should be focused on areas with locally abundant grouse locations and fence segments <2 km from known leks. Collisions still occur greater than 500 m from large leks, and fence removal might be necessary in some areas to eliminate collisions (Stevens et al., 2012).

VI. Wildlife Overgrazing

Braun (2006) explains that wildlife such as elk, deer, pronghorn and hares are more prone to irregular grazing (or non-repetitive), meaning that they are unlikely to overgraze sagebrush steppe to a point that negatively impacts GSG. Braun (2006) also states that hunting allowances tend to keep any potential overgrazing from game animals unlikely. Braun (2006) recommends the removal of wild burros and horses from important yet deteriorating GSG habitat.

VII. Roads and Recreation

The main detrimental effects of roads come from fragmentation of sagebrush habitat, noise from traffic and increased predation from associated infrastructure (power lines). Wisdom et al (2011) showed that when compared to extirpated leks, occupied leks had nearly twice the percent cover of sagebrush (46% versus 24%). Unfragmented sagebrush near leks covered almost ten times as much area as sagebrush not associated with leks (10,310 acres versus 1,190 acres). Due to the association of roads, noise, and infrastructure it proves difficult to tease out the effects of individual components. Hanser et. al found that roads closer to leks may have greater effects than roads located further away (2011). It also seems evident that due to variance in traffic and surrounding topography, not all roads have similar effects on leks. Lek trends show declining rates in different areas, Stiver et. al showed a negative effect of roads on attendance in Montana that were within a 6.2 mi radius of a major road, however in Wyoming the same study showed negative attendance rates on leks within a 3.1 mile radius of major roads (2006). Do to this disparity, we recommend a 3.1 mile buffer from active leks from new road construction, and suggest road closures from sunrise to sunset during breeding season (April-May). Braun (2006) recommends that any roads located within 5.5 km of active leks should first be avoided, and if unavoidable, closed during breeding season (March 1 to June 20).

Hiking trails within 5 km should also be closed during this breeding season (Braun, 2006), and sited to avoid known leks and nesting areas (Paige and Ritter, 1999). Camping on or near leks should be prohibited. For wildlife viewing recreation, Connelly et al (2000) recommends that only 1 to 3 lek locations be available for public viewing, and if necessary, protected with seasonal blinds. The Sage-grouse National Technical Team (2011) also warn against the negative impacts to GSG populations from repeated disturbances to leks, even from passive wildlife viewing. Motorized off-road recreation should be avoided in GSG habitat as they can fragment vegetation and assist in the spreading of exotic and invasive plants (Knick et al, 2011). The hunting of large game animals, including elk, mule-deer, and pronghorn will remain authorized in the Sweetwater Conservation Bank, according to the 2014 Management Plan, as a method to manage herds that feed on sagebrush. The proper amount of take per season will be determined with the Wyoming Game and Fish Department. If APR wishes to allow hunting on the bank site, APR should also consider working with the Montana Game and Fish Department and develop a method for tracking takes.

VIII. Livestock Management

A comprehensive literature review of management practices within and bordering the Wyoming Basin, Southern Rocky Mountain eco-basin provides key recommendations from dozens of sources. These include the use of smaller grazing herds or "stocking rate" (Braun, 2006) on a rest-rotation system (Desert Land Livestock Ranch; Braun, 2006), with an emphasis on the need for each pasture to rest for an entire growing season for sufficient growth of herbaceous cover (Woodward, 2006; Desert Land Livestock Ranch). It is currently unclear whether previously wild species such as bison should be considered as livestock at all, and there is some evidence that they can effectively self-regulate. Research is ongoing, and thus far inconclusive.

A. Stocking Rates

To allow areas that have suffered from overgrazing to restore, Braun (2006) recommends the grazing of no more than 25-30% of the property's herbaceous vegetation. This threshold is intended to leave enough forage (height and density) for successful GSG nesting. Braun's threshold is a more conservative recommendation as Holechek et al (1999) recommended a threshold of 30-35%, while the Natural Resources Conservation Service recommends 50%, commonly referred to as "take half leave half". Braun (2006) states that grazing should not occur on properties that produce less than 224 kg of dry herbaceous vegetation per year. He also warns that grazing on properties with less than 448 kg of dry herbaceous vegetation per hectare per year may also be detrimental to GSG. However, there is minimal research on the effect of cattle stocking rates on sagebrush grasslands (Braun, 2006; Holechek et al, 1999).

The Natural Resource Conservation Service (NRCS), a federal agency tasked with protecting environmental resources while providing assistance to agricultural operations, uses Animal Unit Months (AUM's) to calculate a stocking rate that prevents degradation of "future forage production". AUM's are defined as "the amount of forage required by one animal unit for one month" with an animal unit being one 1000-pound cow and her calf. To note, AUM's are not designed to maintain the ideal vegetation composition for GSG. NRCS estimates that cows eat between 1.5 to 3.5 percent of their body weight per day, with the industry average at 3 percent, resulting in 915 pounds of dry forage per AUM. It is also important to take into consideration that not all of the sagebrush landscape is palatable for cattle (Mosely, 2014). NRCS slightly accounts for this and the lost forage due to trampling, insects, and consumption by other wildlife, by applying a 25 percent grazing efficiency. NRCS AUM per acre is therefore calculated as annual forage production (dry weight) per acre multiplied by the 25 percent grazing efficiency, divided by 915 pounds per AUM (NRCS MT-32). This AUM calculation may overestimate the amount of palatable forage in sagebrush habitats, and it may be more conservative to use a lower grazing efficiency to ensure GSG protection. Vegetation surveys to quantify AUM's and track GSG vegetation thresholds should occur annually to ensure that proper stocking rates are utilized and vegetation quality is monitored and protected.

B. Timing

During the vegetation growing season, Braun (2006) recommends that grazing should only occur between June 20 and August 1 each year. During the Winter season, Braun (2006) recommends that grazing should not occur until the vegetation has stopped growing, around November 15 to March 1. This recommendation is supported by NRCS (2012) who recommend grazing rest periods from April 1 to June 15 to protect key nesting and brooding season.

Post wildfire, Braun (2006) recommends that no grazing occur on affected areas for at least 3 years, yet there has been insufficient research that has supported the effectiveness of this suspension duration. According to Beck (2000) grazing should not be allowed on seeded areas until sagebrush recruitment has occurred. This text also summarizes other work and concludes that longer periods of rest from grazing may be needed to ensure livestock trampling does not kill young sagebrush plants.

C. Grazing Plans

In order to protect GSG habitats and sagebrush ecosystems from overgrazing by maintaining minimum suitability thresholds (see Section IX) and following the timing and stocking rate recommendations above, several rotation strategies have been developed. Rest-rotation systems are when cattle or sheep are rotated to reduce feeding on pastures during those important vegetation-growing seasons (Spring and Fall), and to provide rest for an entire growing season for each pasture (Desert Land and Livestock Ranch, n.m.). The stocking rate in rest rotation systems is lower than other systems, as they are based on the forage produced by only the pastures being grazed that year (NRCS, 2012).

A full-deferred rotation of each pasture is recommended to occur at least once every 4 years (Braun, 2006) or once every three years (NRCS, 2012). Other grazing systems include alternate rotation (alternating rest and grazing between two pastures every 30 days if irrigated, or every year if non-irrigated rangeland) (NRCS, 2012), high intensity-low frequency grazing, and short duration grazing (NRCS, 1997). If fire risk is expected to remain low without grazing, it may be beneficial for some areas to have permanent retirement of grazing (Crawford et al. 2004).

D. Operations

Attracting livestock to vegetation near fences by adding water or salt to the fence line avoids impacts to the pasture center, which are more important to GSG due to the danger risk of fences (Braun, 2006; Beck and Mitchell, 2000). Ranchers are also encouraged to place ramps near water troughs to ensure that GSG are able to access water provided for livestock (Braun, 2006), yet must also contain an escape ramp to avoid GSG drowning (NRCS, 2010). In the Sweetwater Conservation Bank Management Plan, a GSG conservation bank in Wyoming, all new ranching facilities such as troughs, fences, and corral, will be sited a minimum of 0.6 km from known leks (Sweetwater River Conservancy, 2014). All grazing plans, operations, livestock quantity, and grazing timeframes should be developed and adjusted to ensure that the following seasonal vegetation suitability (height and percent cover) is acquired.

IX. Vegetation to Benefit GSG

A. Seasonal Variation

GSG are dependent upon sagebrush for their survival, but also require a mix of grasses, forbs, open space, and shrubs pending on seasonal needs. To note, the following highlight mesic vegetation requirements, as this is the main vegetation type near the American Prairie Reserve in Montana.

<u>i. Lekking Season</u>

Late February to May is lekking season, where open spaces are necessary for courtship displays and require sagebrush and young forbs within 0.6 miles for cover and feeding (Connelly et al., 2000).

<u>ii. Nesting Season</u>

April to June is nesting season, where vegetation requirements within 2 to 4 miles of a lek switch to perennial grasses and forbs with a minimum cover of 15 percent, and a 12-31 inch tall sagebrush canopy cover of roughly 15-25 percent (NRCS, 2012). Connelly et al (2000) recommends higher vegetation characteristics, with over 18 cm tall grass/forbs covering 25 percent (10% forb, 15% grass) and 40 to 80 cm tall sagebrush (same cover recommended as NRCS). Multiple studies have stressed the importance of “residual herbaceous cover” from previous years (Beck and Mitchell 2000; Aldridge and Brigham, 2003) with a minimum of 7 inch leaf height helping to ensure chick survival. If necessary, a minimum of 4 inches of leaf height can be suitable (NRCS, 2012).

<u>iii. Brood Rearing</u>

Brood rearing vegetation needs in mid-April to June, slightly differ from those needed during July to August, yet all need to occur within 1 mile of their nest. During early brooding, sagebrush becomes extremely important for protection from predators, while the necessary diet turns to insects such as ants and grasshoppers. Insects are found more in open spaces, described by NRCS as roughly 10-15 percent sagebrush canopy cover, and areas with herbaceous cover. Since late brooding season is often drier, GSG will move to moister habitat such as riparian areas or hay/alfalfa fields. Chic diet switches from insects to forbs, requiring roughly 15 percent forb/grass cover, and sagebrush cover between 10 and 25 percent (NRCS, 2012; Connelly et al, 2000).

<u>iv. Winter</u>

During the winter months of November to February, both GSG diet and protection are reliant on sagebrush. As such, NRCS recommends a canopy cover of 10 to 30 percent, with heights of at least 10 to 14 inches above the snow (NRCS, 2012). Connelly et al (2000) supports the sagebrush cover threshold, yet recommends a sagebrush height of 25 to 35 cm. For Montana specifically, higher sitings of GSG during winter occurred in areas with a sagebrush cover over 20 percent (Eng and Schladweiler, 1972; Wallestad ,1975)

B. Key Forb, Grass, and Sagebrush Species

Prime grass and forb species include perennial bunch grasses both medium-statured like big fgalletta, as well as short grasses (Sandberg bluegrass, blue grama). Forbs include alfalfa, largehead clover, mountain dandelion, purple coneflower, and trefoil, among others (Pyke et al, 2015). For more information, Montana State University’s Extension Service provides detailed information on each grass species with respect to grazing potential (Holzworth et al., 2003). Sagebrush species in the “floristic province” of the big sagebrush steppe land cover type surrounding APR include fringed sagebrush, silver sagebrush, Wyoming sagebrush, and sand sagebrush (Pyke et al, 2015).

A study comparing native and invasive forb growth found that the growth rate of native forbs ranged from 0.04 to 0.14 $g*g^{-1}*d^{-1}$ (James & Drenovsky, 2007). From seed sagebrush species can experience maximum growth rates ranging from 1.7 cm per week (Wyoming Sagebrush) to 4.02 cm per week (Basin Sagebrush). Overtime, growth rates reduced significantly. For instance, after 24 weeks Wyoming sagebrush growth rate was only 0.2 cm per week (Booth, Welch & Jacobson, 1990). To note, all growth rates listed above occurred in a greenhouse, so are likely overestimates of the natural growth rate.[JC2]

C. Riparian Areas

Connelly et al. (2000) stresses the importance of avoiding the development of springs for livestock water. If the water from a spring will be used in a pipeline or trough, the project should be designed to maintain free water and wet meadows at the spring.

Connelly et al. (2000) goes on to argue that capturing water from a spring using troughs and pipelines "may adversely affect wet meadows used by grouse for foraging". Braun (2006) also recommends guiding livestock away from natural surface water flow such as springs and seeps in order to ensure adequate access for GSG. Seasonal loss of herbaceous vegetation in summer months often encourages female GSG to move their broods to riparian areas. Donnelly et al. (2016) concluded that riparian areas may represent an important and potentially limiting component of GSG late brood rearing habitat (Donnelly et al., 2016).

D. Vegetation Monitoring

NRCS and MSGOT vegetation monitoring mechanisms, such as those used to calculate the amount of dry forage, in addition to those used to enumerate credits with the HQT, should occur annually (Sweetwater Conservancy, 2014; NRCS, 2012). The Sweetwater Conservancy Management Plan (2014) includes the establishment of monitoring sites based on NRCS soil mapping units, and photo points. The HQT for Montana is not yet developed, but as a proxy, the mechanisms used by Stiver or the Wyoming HQT could be utilized. It is possible that the NRCS vegetation method could meet the standards necessary to track GSG habitat cover and height, but should be cross-checked once the Montana HQT is developed. Additional literature providing habitat conservation and monitoring mechanisms includes the Greater Sage-Grouse Umbrella Candidate Conservation Agreement with Assurances for Wyoming Ranch Management (Wyoming Bureau of Land Management et al., 2012).

X. West Nile Virus

West Nile Virus has caused significant threats to GSG populations across the habitat range, amplifying other impacts such as oil and gas development (Taylor et al., 2013). A contained laboratory study found 100 percent mortality of West Nile VIrus infected GSG within 6 days of exposure (Clark et al., 2006). A study in Wyoming found that populations containing individuals infected with West Nile Virus had a survival rate 76% less than populations without infected individuals (Walker et al., 2004). West Nile Virus is transmitted through the mosquito species Culex tarsalis, which lays larvae in still water, yet can also be passed from bird-to-bird (Doherty, 2007).

As an added reason to prevent livestock from riparian areas, Doherty (2007) explains that the trampling of riparian vegetation and hoof prints in wetland sediment can promote breeding areas for Culex tarsalis, increasing the risk of exposure of West Nile Virus. Preventing breeding areas (shallow water) can also reduce the threat of West Nile Virus, either through maintaining a muddy shoreline where water levels are just below rooted plants (Doherty, 2007), making steep slopes near shoreline perimeters and maintaining a water depth of greater than 60 cm (Knight et al, 2003), and/or having vegetated inflow and outflow areas separated by open water (Walton and Workman, 1998). Inflow and outflow areas can also be strategically lined with crushed rock and inflows can be directly piped open water to further prevent shallow mosquito breeding areas (Doherty, 2007). The Sweetwater Management Plan (2014) included the direct pumping of inflow into water bodies as prevention mechanisms. The Management Plan (2014) also follows USFWS guidelines to collect all dead GSG and submit at a local veterinary laboratory. If West Nile Virus is present, options for removal include the use of chemicals such as *Bacillus thuringiensis* or the introduction of predatory minnows (Pimephales promelas) into infected water bodies (Sweetwater River Conservancy, 2014).

Appendix 4. Conservation Bank Establishment Guidelines

I. How Banks are created
There are multiple bank creation methods. The guidance document lists: acquisition of existing habitat, protection of existing habitat through conservation easements, restoration and enhancement of disturbed habitat, creation of new habitat in some situations, and prescriptive management of habitats for the specified biological circumstances. Banks are allowed to be created in response to, and for the purpose of, offsetting the impacts of a specific project, or prior to a project requiring the credits in anticipation of a future demand for credits. Due to the perpetual easement requirement for banking lands, each credit sold can factor into the future USFWS decisions on the risk to the species' endangerment. The stability of this system highlights the importance of the perpetual requirement, "regardless of the future status of the species for which the bank was initially established".

B. Authority
Conservation banking is intended to aid and streamline the processes under Sections 7 and 10 of the Endangered Species Act (1973). Under both sections, activities are authorized that would result in adverse effects to listed species and their habitats. Section 7 covers actions by federal agencies, while Section 10 applies to private (non-federal) actors. Both sections allow USFWS to authorize actions which would otherwise be legal, but result in the incidental taking of a listed species or its habitat under the ESA, as long as the actions do not jeopardize the continued existence of the species and designated critical habitat will not be destroyed or adversely modified. It is important to note that habitat and species are defined at the landscape and population levels, not the individual or localized habitat level. Adverse effects brought by government or private actors are minimized through consultation with USFWS as well as mandatory conservation measures that are required when their actions are authorized. Purchasing credits from an off-site conservation bank that guarantees the protection of the listed species and/or its habitat is considered adequate compensation.

C. Goals and Strategy
The overarching goal of a conservation bank is to provide an economically effective process that allows landowners to offset their adverse effects on listed species by producing conservation benefits for the species. Habitat loss and fragmentation are particular dangers to species, and siting a large conservation bank can be effective in combating these issues by protecting large swaths of land from development while instituting management plans that control invasive species and allow natural disturbance regimes. Conservation management plans are also developed to identify the threats and conservation needs in a given area.

D. Eligible Lands
Conservation banks are allowed to be established on local, private, State, or Tribal lands as long as the managing agency maintains the habitat. Federal lands used for banks are a small subset of banks, which are all approved on a case-by-case basis by the director of USFWS. No matter the source ownership, lands used to establish the bank may not be previously designated for conservation purposes unless designation as a conservation bank adds additional conservation benefits. Previous designations for conservation include parks, green spaces, and municipal watersheds, among others. However it is unclear how this would affect lands owned by a conservation-driven organization. The mere existence of conservation banks managed by nonprofit

environmental firms implies that land simply being owned or managed by a conservation-oriented entity would not preclude the formation of a bank. What is clear, however, is that lands that have already been permanently protected under Federal or state programs to benefit federally listed species are ineligible.

E. Site Selection

The USFWS approves specific bank locations after consideration of the location, size, configuration, and ecological suitability of the property and its surrounding areas. This includes determining the habitat quality within the bank as well as the character of the lands along its borders. Use of the land by the target species is also a critical factor in certification of the bank. Through these considerations, USFWS factors in the area of the bank versus its linear boundary size to minimize edge effects, placement of the bank as a corridor that bridges two or more other areas critical to the species, and the protection status of border properties that could aid in dispersion of the species. The overarching goal is to provide large, unbroken parcels of protected property with usable habitat for the species in question. The location of some APR properties, and Sun Prairie in particular, could provide added benefits due to its border with the Charles M. Russell wildlife refuge. Minimum size of potential banks is a concern of USFWS, but it varies with each individual species' requirements.

F. Role of Habitat Restoration

The USFWS certifies conservation banks that follow any, though usually a combination, of three strategies: preservation of existing habitat, restoration of degraded habitat, and creation of new habitat. Proper management to maintain the habitat is a critical component of all three routes. These different approaches can each be effective, however the credit awarding policy becomes crucial in the case of new and rehabilitated habitat. Since USFWS generally requires the offsetting habitat to exist prior to disruption of existing habitats, new and rebuilt habitats should meet benchmark criteria prior to generating credits for sale by the bank.

G. Long-Term Management and Monitoring

Proper management of conservation bank lands is key to their success and continued approval by USFWS. Active management programs often include "halting and removing illegal trash dumping, preventing trespassing that might include off-road vehicle use, and/or imitating natural disturbance regimes that might include prescribed burns". Management plans must also be adaptive to new conditions that may arise in order to safeguard the habitat for the benefit of the species. Responsibility for management falls on the bank sponsor, with oversight from USFWS.

Monitoring the protected habitat is also the responsibility of the bank sponsor. During the establishment of a conservation bank, clearly stated biological goals provide a framework for developing a monitoring program. As with management, monitoring systems must be adaptive and flexible to incorporate natural disturbances to the environment. Methods used to monitor the habitat must be based on sound science. However, the service does not prescribe mandatory intervals or protocols. These details are established during bank formation and are based on the biological framework used. If individual members of the species are the benchmark, for example, intervals and protocols must be geared to capture the correct data in a scientifically defensible way. Monitoring reports are generated by the bank sponsor and submitted to the overseeing agency as required, usually annually.

The banking agreement includes remedial actions and methods for conflict resolution in the event that the conservation bank fails to meet its obligations. This includes provisions that pass ownership of the bank to another entity able to provide perpetual operations. This is often the third party land trust which holds the conservation easement for the bank owner. Although every contingency cannot be planned for, the banking agreement must include contingencies that cover every prudent possibility of bank failure. This includes planning for natural disasters and other unexpected events such as fire and flood, especially for bank credits that have already been sold by the bank. Events that degrade habitat on bank property and occur prior to credit sales can be easily managed through suspension of specific credit sales, but special care must be taken to establish plans for events on previously-sold credits. An example of this occurs in the Nevada Habitat Exchange, where each credit sale included a partial credit donation to a fund which ensures extra habitat is protected to cover unforeseen events.

H. Funding Requirements

Funding for management, monitoring, and perpetual operation of the bank is required for USFWS approval. The amount of funding necessary for ongoing management of the bank has to be clearly articulated in all banking agreements. The costs of monitoring and managing activities are estimated through establishing the monitoring programs prior to bank creation. Funding of ongoing activities is often in the form of an endowment, which can cover costs through interest accrual. This endowment should be kept separate from funds used to create the bank and purchase properties, enhance habitat, pay property taxes, and cover legal and consultant fees. One way in which an endowment is established is by including the cost of management into the credit price. As credits are sold, a portion of the proceeds are deposited into a non-wasting endowment fund. In this way, the size of the endowment depends on the amount of habitat sold and management efforts needed for each credit. Endowments can also be funded by revenue generating activities like entrance or use fees on the property for hikers, bird watchers etc.