Golden Eagle Nesting Ecology in the Bighorn Basin:

Influence of Landscape Composition, Energy Development and other Human Activity on Golden Eagle Nesting Distribution, Success, Productivity, and Diet

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INTRODUCTION

Golden eagles (*Aquila chrysaetos*) are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d). The Act expressly prohibits "taking" of eagles, including injuring, killing, or disturbing eagles in a way that causes nest abandonment or reduced productivity. Even short-term loss of adults or reduced productivity is of particular concern because it takes several years for eagles to reach sexual maturity, they typically produce only one or two offspring per reproductive effort, and they do not necessarily reproduce every year after reaching sexual maturity (Kochert et al. 2002). Golden eagle populations are believed to be declining through at least a portion of the species' range in the contiguous United States (Harlow and Bloom 1989, Kochert and Steenhof 2002, Kochert et al. 2002, Preston and Leppart 2004, Good et al. 2007, Farmer et al. 2008) due to a variety of anthropogenic factors. Habitat degradation, collisions with human structures, such as wind turbines electrocutions, and human disturbance near nest sites are among the chief factors that negatively impact eagle populations.

Sagebrush-dominated ecosystems support most golden eagle nesting efforts in Wyoming. Loss or alteration of native sagebrush habitat due to invasion of exotic cheatgrass and associated large-scale fires (Kochert et al. 1999), residential and urban expansion (Boecker 1974, Scott 1985), and extensive agricultural development (Beecham and Kochert 1975, Craig et al. 1986) have negatively impacted eagle populations in intermountain basins and other lowlands through much of the West. Energy development, with its associated roads, well pads, wind turbines, and human activity, is another significant cause of sagebrush ecosystem alteration and potential impact on golden eagle populations, especially in Wyoming and adjacent states (Madders and Walker 2002, Smith et al. 2010, Rowland et al. 2011, Pagel et al. 2013),).

Golden eagles are also highly vulnerable to electrocution and collisions with utility lines associated with exurban expansion and energy development (Franson et al. 1995, Lehman et al. 2007, Lehman et al. 2010). Between 2007 and 2009, more than 200 golden eagles and scores of other raptors were killed after being accidently electrocuted in rural areas of Wyoming (T. Eicher, pers. comm.). Many of these incidents occurred along utility powerlines in or near oil fields and gas wells, including those in the Bighorn Basin, near Cody, Wyoming. Since 1991 there have been more than 1,000 documented eagle electrocutions across Wyoming, including at least 480 in the Bighorn Basin (T. Eicher, pers. comm.).

Recreational activity near golden eagle nests is another factor that can cause nest failure or reduced productivity (Scott 1985, Watson 1997, Watson 2010, Kochert et al. 2002). Disturbance can include repeated off-road biking or all-terrain vehicle use, hiking, rock-climbing, target shooting, as well as intentional approach toward nests. Abandonment is most likely during the early stages of nesting, depending on the type and duration of disturbance, but disturbance at any stage of nesting can negatively affect productivity.

Habitat loss and alteration, energy development, and motorized and non-motorized recreation are increasing in sagebrush-steppe ecosystems in the Rocky Mountain West and Intermountain Basins, especially in the Greater Yellowstone region (e.g., Preston 2006). Energy development is accelerating especially rapidly in Wyoming and adjacent states in response to demand and economic opportunity. Across Wyoming, the number of oil wells increased by 73%, and the number of gas wells increased by 318% between 2000 and 2006 (Oakleaf et al. 2010). The importance of gaining a better understanding of golden eagle ecology and conservation issues was underscored during the National Golden Eagle Colloquium recently convened for federal and state agencies and eagle scientists (Pagel et al. 2010). Discussions at this colloquium stressed the need for both broad, regional and statewide landscape surveys to determine current status and distribution of golden eagles and more intensive, local studies to examine nesting dynamics of golden eagles in response to a variety of factors, including landscape composition, human activity, and independent fluctuations of weather and prey availability. These data are critical to establish a baseline context for evaluating golden eagle status and trends in relation to human activities decades into the future.

In 2009, the Draper Natural History Museum initiated a multi-year study to determine golden eagle nest occurrence and distribution, annual nesting occupancy, activity, success, and productivity in a multiple land-use study site in Wyoming's Bighorn Basin. Our overarching goals are to establish a strong foundation to evaluate future golden eagle status in the study area in relation to environmental change and provide information and insights to help guide golden eagle management decisions in multiple-use landscapes across western North America. The study is being conducted over multiple years to help identify and partition the confounding effects of annual fluctuations in weather and prey availability and gain an understanding of human land-use patterns and trends. We are also integrating our scientific research with a diverse suite of educational programs to engage and inform the public regarding conservation of raptors and other wildlife. This report summarizes our efforts and results related to golden eagle nest area distribution, occupancy, activity, success, and productivity, nesting season diet, and relative lagomorph abundance through the 2013 summer field season. Analyses of eagle nesting parameters in relation to weather, landscape composition, and human activity are not yet complete, and all aspects of the study are ongoing.

STUDY AREA

The Bighorn Basin lies at the eastern edge of the Greater Yellowstone Ecosystem, in northwestern Wyoming. It is a multiple use landscape of approximately 750,000 ha that contains large, virtually intact tracts of native sagebrush-steppe interspersed with diverse human-dominated tracts. Except for a narrow gap to the northwest, the Basin is surrounded by high elevation ecosystems of the Beartooth and Pryor Mountains to the north, Bighorn Mountains to the east, Owl Creek Mountains to the south, and Absaroka Mountains to the west. Elevation varies from 1,100 – 1,800 m, and precipitation averages between 12 and 23 cm (USFS 2013). There are typically 90 – 120 frost-free days per year (Young et al. 1999). Flat and rolling terrain is broken sharply by sandstone outcroppings, cliffs, and ravines. Depending on local soil characteristics and topography, native vegetation is dominated by a complex of shrubs, e.g., big sagebrush (*Artemisia tridentata*), greasewood (*Sarcobatus vermiculatus*), saltbush (*Atriplex* spp.) and rabbitbrush (*Chrysothamnus* spp.), grasses, e.g., bluebunch wheatgrass (*Pseudoroegneria spicata*), prairie junegrass (*Koelaria macrantha*), and needle-and-thread (*Hesperostipa comata*), and forbs, e.g., scarlet globemallow (*Sphaeralcea coccinea*) and penstemon (*Penstemon* spp.), western yarrow (*Achillea millefolium*), and milkvetch (*Astragalus* spp.). Plains cottonwood (*Populus deltoids*) and willows (*Salix* spp.) occupy wetter drainages. Invasive species include cheatgrass (*Bromus tectorum*), knapweed (*Centaurea* spp.), tamarisk (*Tamarix* spp.), and Russian olive (*Elaeagnus angustifolia*).

The large, relatively unbroken swath of sagebrush-steppe habitat in the Bighorn Basin provides important seasonal or year-round sustenance for wildlife native to the Greater Yellowstone Ecosystem. Prominent mammals using the Basin either year-round or seasonally include pronghorn (*Antilocapra americana*), mule (*Odocoileus hemionus*) and white-tailed deer (*O. virginianus*), elk (*Cervus elaphus*), bighorn sheep (*Ovis canadensis*), free-ranging horse (*Equus ferrus*), white-tailed prairie dog (*Cynomys ludovicianus)*, white-tailed jackrabbit (*Lepus townsendii*), desert cottontail (*Sylvilagus audubonii*), black bear (*Ursus americanus*), badger (*Taxidea taxus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), and bobcat (*Felis rufus*). Occasionally, grizzly bears (*Ursus arctos*) wander into the Basin, and cougars (*Puma concolor*) occur persistently in the area. Gray wolves (*Canis lupus*) range around and within the area, especially near livestock operations.

Prominent birds (seasonal or year-round residents) inhabiting the Basin include, sage thrasher (*Oreoscoptes montanus*), Brewer's sparrow (*Spizella breweri*), vesper sparrow (*Pooecetes gramineus*), lark bunting (*Calamospiza melanocorys*), western meadowlark (*Sturnus neglecta*), long-billed curlew (*Numenius americanus*), mountain plover (*Charadrius montanus*), golden (*Aquila chrysaetos*) and American bald eagles (*Haliaeetus leucocephalus*), red-tailed (*Buteo jamaicensis*), rough-legged (*B. lagopus*), and Swainson's hawks (*B. swainsoni*), prairie falcon (*Falco mexicanus*), great-horned (*Bubo virginianus*), long-eared (*Asio otus*), short-eared (*Asio flammeus*), and burrowing owls (*Athene cunicularia*). Ferruginous hawks (*Buteo regalis*) are uncommon breeders in the Bighorn Basin, and also scarce during winter and migration periods. The Bighorn Basin is among the world's remaining strongholds for greater sage-grouse (*Centrocercus urophasianus*) populations (Harrell 2008).

Land ownership in the Bighorn Basin is divided among private and public hands, with the majority of public land administered by the Bureau of Land Management. Land use includes urban and exurban residential development, significant oil and gas development, livestock grazing, and extensive motorized and non-motorized recreation. The Basin is one of the largest agricultural production areas of Wyoming (Young et al. 1999). The area is traversed by a maze of paved and unpaved transportation corridors. It is also an increasingly popular area for hunting and other outdoor recreation. The Bighorn Basin is experiencing a period of rapid environmental change in response to weather fluctuations, increased recreational use, exurban residential sprawl, and significantly increased energy development, including the potential for wind energy development.

Our study area encompasses approximately 250,000 ha in the northwestern corner of the Bighorn Basin, near Cody, Wyoming. The area is bordered approximately by Powell and Lovell, Wyoming to the north, Meeteetse, Wyoming to the south, the western extent of the Buffalo Bill Reservoir to the west, and Greybull, Wyoming to the east. Vegetation, geomorphology, and human land use in our study area are representative of the Bighorn Basin as a whole.

METHODS

We conducted helicopter and fixed-wing aerial surveys in mid-March to early April each year to search for golden eagle nest areas and document whether the sites are occupied and any nests within an area are active (e.g., McIntyre 2002, McIntyre et al. 2006, Lehman et al. 1998). These surveys were repeated as necessary to confirm nest status. A nest area is defined as one or more alternate nests determined as being used or having been used by a single pair of eagles in a given year (Steenhof and Newton 2007). A nest area was determined to be occupied if two adult eagles were observed within the area during nesting season, or if there was evidence that one or more nests had been recently refurbished or used (i.e., fresh greenery or egg present). We only considered a nest area positively active if we observed an exchange of incubation bouts between adults, or if we confirmed the presence of egg(s), and/or nestling(s). We may have discounted some nests where eggs were laid and subsequently abandoned without any of the above in evidence. Because of our familiarity with nests and our practice of conducting repeated surveys, we believe that we have discounted very few such nests, but our calculation of active nest areas in a given year should be considered minimum number of active nest areas. We conducted aerial surveys again in late June – early July to determine nest success (at least one chick reaching average fledging age, i.e.., 51 days of age) and nest productivity (the number of chicks reaching fledging age). Between aerial surveys, we conducted extensive ground surveys and observations each year as needed to verify nest status. Between six and eight nests per season were selected (on basis of accessibility to observation point) for more intense monitoring. Each of these nests was monitored for at least six hours per week until fledging or nest failure. Volunteers contributed 361 hours and 2,364 travel miles to the project in 2013.

We initiated roadside surveys in 2010, and have continued these through 2013 to develop a relative index to abundance of lagomorphs (i.e., white-tailed jackrabbits *Lepus* *townsendii*, cottontails *Sylvilagus* spp.). We established five, 5-mile (8.0 km) secondary roadside transects throughout the study area. Each transect was surveyed during one full moon night in each of three stages of the eagle breeding season, i.e., incubation, nestling, and fledgling stages. The surveys began between 2100 and 2200 hours Mountain Daylight Time during nights without precipitation and low to moderate wind conditions. Each transect was surveyed two observers in a vehicle with headlights and a spotlight. Observers recorded each rabbit and hare observed within approximately 50 m of the road, and each survey lasted between 30 and 45 min. To assess nesting food habits, we collected prey remains and pellets from a sample of nests (determined by accessibility) after chicks fledged or nests were abandoned.

In partnership with Dr. John Campbell and his students at Northwest College, Powell, Wyoming, we have begun quantifying landscape composition (primarily percentage of shrub cover), amount of energy development (e.g., numbers/sizes of structures, roadways, etc. associated with energy development), and other human activity (e.g., recreational use, etc.) surrounding each nest area at 1.5 km intervals. These characterizations are ongoing, but will be completed and integrated into future analyses of relationship between eagle nest use and productivity and landscape composition and land use. We began capture/banding operations in 2010 to identify individual eagles and gain information on mortality and movements. We chose to mark birds with orange, anodized aluminum leg bands, each imprinted with a unique, white alphanumeric code.

RESULTS 2009-2013

Nest area distribution and reproduction — After our 2013 early season aerial surveys and ground surveys/nest visits, and a review of 2009 - 2012 data sheets, we refined earlier nest area designations. From additional nest-site visits and critical examination, we eliminated some nest areas as being redundant, belonging to other raptor species, or as not likely to have been occupied by eagles for several years. We are including 66 distinct golden eagle nest areas in this report. Among these, we've included 14 nest areas that are not known to have been active during the study, but are known to have been occupied or active within the last ten years. Nests areas are distributed unevenly through the study area, conforming to the distribution of prominent sandstone outcrops and other topographic relief. Using approximate polygons, density of nest areas across the study area was 42 km^2/nest area, with highest densities occurring in the Sheep Mountain Zone (23.4 km^2/nest area) and Oregon Basin Zone (28.6 km^2/nest area) (Figure 1). In preparation for publication, we will standardize estimates using minimum convex polygons to calculate nest densities.

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Figure 1. Distribution and activity of known nest areas within the study area.

Reproductive effort and productivity were highest in 2009, followed by declines during the next three years, and a moderate rebound in 2013 (Table 1). Occupied nest activity is the percentage of occupied nests that are active in a given year, varying from a high of 82% in 2009 to lows of 43% and 48% in 2011 and 2012, respectively, and rebounding to 61% in 2013. Occupied nest success — the percentage of occupied nests that produced at least one fledgling — exhibited a similar pattern, with the high (73%) occurring in 2009 dipping to lows of 32% in 2011, 31% 2012, and rebounding slightly to 36% in 2013. Similarly, Productivity, or the number of fledglings produced per occupied nest area, was highest (1.11) in 2009, dropped to 0.39 and 0.31 in 2011 and 2012, respectively, and rebounded slightly to 0.41 in 2013.

Year	**Occupied Nest Activity**	**Occupied Nest Success**	**Productivity**
2009	82%	73%	1.11
2010	64%	52%	0.79
2011	43%	32%	0.39
2012	48%	31%	.031
2013	61%	36%	.041

Table 1. Results of nest surveys 2009-2013.

Food Habits — We examined 2013 prey remains at the conclusion of the 2013 field season and integrated these results with those from previous years of the study. Table 2 lists the minimum number of individuals identified in each species or category, i.e., if we identified three hind feet as cottontail, the minimum number of cottontails in this sample was two. In some cases, a bird species was represented by a single feather, i.e., one individual, in a sample. Even if several feathers of a species were present, we counted this as one individual unless two skulls, three wings, etc. were present. Thus far, we have identified a minimum of 693 individuals from the remains of 18 different nests — some nests have contributed remains in two or more years. Cottontails were the most frequently occurring prey species in each year of the study thus far, representing 71% of all prey remains identified. The diet was much more varied in 2011-2013 than in 2009 and 2010 however, with percentages of pronghorn fawns, white-tailed jackrabbit, and "other" increasing in the latter years. Species counted as "other" in Table 2 include a variety of ground squirrels and other rodents, snakes, and small to medium-sized birds, including common raven (*Corvus corax*), northern flicker (*Colaptes auratus*), and black-billed magpie (*Pica pica*), among others. The remains of other raptors, including Great Horned Owl (*Bubo virginianus*), were found in some nests. Several small bones have not yet been identified with certainty.

Year	Cottontail spp.	White-tailed Jackrabbit	Pronghorn	Greater Sage-grouse	Other	Total
2009	121	2	3	1	14	141
2010	134	4	5	1	19	163
2011	100	5	12	3	32	152
2012	43	16	13	6	11	89
2013	91	15	5	1	36	148
Total	489	42	38	12	112	693

Table 2. Prey remains (minimum number of individuals) from eagle nests sampled 2009-2013.

Lagomorph surveys — We initiated lagomorph surveys in 2010, after it became clear from our 2009 food habits investigations that rabbits and hares comprised an overwhelming proportion of the eagle diet in our study area. The pooled transect results (Table 3) show a dramatic decline in cottontails and jackrabbits through the first three years of our surveys. Jackrabbit indices were lower and typically more variable within a season than cottontail indices, but rose dramatically in 2013, nearly equaling cottontail numbers.

Year	Pooled Cottontails across routes and periods of nesting season	Pooled White-tailed Jackrabbits across routes and periods of nesting season	Total Lagomorphs
2010	176	67	243
2011	57	27	84
2012	58	22	80
2013	55	45	100

Table 3. Lagomorphs detected during surveys 2010-2013.

Relationship between golden eagle productivity and relative lagomorph abundance — Variations in golden eagle productivity (Table 1) and total lagomorph abundance (Table 3) were remarkably parallel in years 2010 through 2013 (Figure 2). As lagomorphs declined in our study area, so did golden eagle productivity. Unfortunately, we did not conduct lagomorph surveys in 2009, and thus cannot compare eagle productivity with lagomorph abundance in the most productive year for eagles.

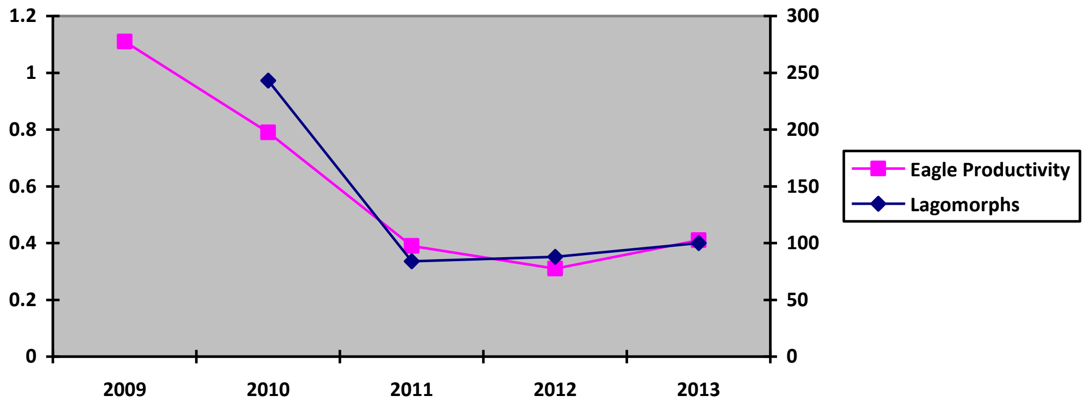

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Figure 2. Relationship between relative lagomorph abundance and golden eagle productivity.

DISCUSSION

The lands within and adjacent to Bureau of Land Management holdings in the northwestern portion of Wyoming's Bighorn Basin support a significant population of nesting golden eagles. The overall density of nest areas currently identified falls well within the density range reported in the peer-reviewed literature (Kochert et al. 2002), although results should be evaluated carefully due to variations in how densities are calculated and reported. Nest area densities in portions of our study area, specifically Sheep Mountain Zone and Oregon Basin Zone are among the highest densities reported in North America (Kochert et al. 2002), possibly due to the clumped distribution of nesting substrates (i.e., sandstone outcrops) and relatively high lagomorph abundance. However, we must exercise caution in comparing nest area density among highly variable study areas across western North America and using varied calculation methods, and we will continue to refine our results as we extend and refine our analyses. As we have become more familiar with the study area, we have discovered additional nest areas each year, even after adjusting for redundancies. This argues for the importance of long-term studies and caution in drawing inferences from short-term data. Some golden eagle nest areas are difficult to locate in remote, varied terrain.

While nesting activity, success, and productivity were similar in 2009 and 2010, we detected a marked decline in these parameters in 2011 and 2012, before detecting a rebound in 2013. Again, this underscores the importance of long-term, geographically-focused studies to help understand golden eagle ecology and population dynamics and to create an appropriate baseline range for golden eagle breeding populations in a given area. The nesting declines in 2011 and 2012, and the rebound detected in 2013 coincided with the decline and rebound in numbers of lagomorphs detected in our surveys initiated in 2010. Lagomorphs, especially cottontails, have been by far the most important eagle prey items identified from nest remains. Though clear interpretations or cause-and-effect relationships are premature with the data currently in hand, these results are suggestive that lagomorph availability strongly drives golden eagle nesting activity and success, and may thus exert a profound influence on golden eagle population dynamics in the Bighorn Basin. If this is true, energy development and other human activities in the Basin that influence lagomorph abundance and availability could exert an important indirect influence on the golden eagle population, even when they don't impact eagle nesting sites directly. Anecdotal observations indicate that human recreational activity, especially, off-road vehicle use, has increased since the beginning of our study. We are continuing to quantify human activity and examine its relationship to golden eagle nesting productivity for future reports and publications. We have observed at least three apparent nest area abandonments after increased off-road recreation near those nest areas. In one case, eagles stayed and fledged young after target-shooting occurred under the active nest. However, this nest area, known to be active and productive during the previous two years, has not been occupied in the three years subsequent to the onset of sporadic target shooting. Two other nest areas, productive in prior years, were abandoned during years with off-road vehicle use near active nests and have not been occupied since we first observed off-road vehicle traffic at these sites. We will continue to document recreational and other human activity near nests to eventually provide a quantitative analysis of the relationship between nest area occupation/activity/success/productivity and increased human foot traffic, off-road vehicle use, and other activity. The results of the next 2-3 years should be enlightening regarding the relationship between lagomorph abundance and eagle reproduction, particularly if lagomorph abundance continues to rebound and approaches 2010 numbers.

Although nesting eagles included more species in their diet in 2011 through 2013, compared with 2009 and 2010, cottontails remained the most frequently occurring species found in nest remains. These data should be interpreted with care due to some prey remains possibly being more easily detected than others. There is no indication, however, that another prey species can replace the critical importance of cottontails and jackrabbits in golden eagle diet in our study area. Prairie dogs and other ground squirrels are important primary or secondary prey in the diet of golden eagles in other regions (Kochert et al. 2002), but are relatively uncommon in the Bighorn Basin (pers. observation). Harrell and Marks (2009) reported a 71% decline in area occupied by prairie dogs between the mid-1980s and the early 2000s in the northern Bighorn Basin. Greater sage-grouse are rabbit-sized and fairly common in the study area, but have been detected only rarely in our prey remains. This may be due to the grouse effectively using the relatively dense sagebrush cover in our study area during summer (e.g., Dinkins et al. 2012, Greene 2013) or may indicate that grouse remains are somehow underrepresented in nest prey remains. Presumably, adult sage-grouse are most vulnerable to aerial attack during lekking bouts in relatively open sites. Golden eagles are often cited as predators on sage-grouse (Wiley 1973, Hartzler 1974, Bradbury et al. 1989, Gibson and Bachman 1992), and have even been cited as the principal diurnal predator of adult sage-grouse (Boyko et al. 2004), but observations of successful eagle predation are scarce, and sage-grouse remains are not typically reported as a significant component of golden eagle nesting diet by researchers studying golden eagle food habits (Kochert et al. 2002). The sage-grouse lekking period in our study area ends just after eagle nestlings appear, and therefore sage-grouse killed by eagles before very late sage-grouse courtship may not be brought back to the eagle nest for nestling consumption. The extent to which golden eagles successfully prey on greater sage-grouse merits further, directed study. Our study thus far provides no support for the tacit assumption that eagles are significant sage-grouse predators during the nesting season.

The increase in jackrabbit numbers detected in 2013 in our study may indicate a rebound in a jackrabbit population cycle. Little is known about lagomorph or other potential eagle prey cycles in the Bighorn Basin, but Fedy and Doherty (2011) reported what appears to be roughly an 8-year boom-and-bust population cycle for both cottontails and greater sage-grouse in Wyoming. Anecdotal reports from wildlife officials, local landowners and residents suggest that white-tailed jackrabbits also exhibit regular fluctuations, but on the order of a 10-12-year cycle. We hypothesize that eagle nest activity, success, and productivity will increase with increases in lagomorph numbers, barring any exceptional weather pattern or environmental disturbance. Additionally, we hypothesize that eagle diet breadth will shrink as lagomorphs become more available.

STATUS OF PROJECT AND FUTURE WORK

After five years, we believe we have detected virtually all recently occupied golden eagle nest areas in our study area, and our volunteer corps is well-trained and extremely helpful. We are currently analyzing the relationship between landscape composition, human activities, and eagle reproductive effort and output, and are preparing papers on eagle diet, relationships among eagle productivity, weather, and lagomorph abundance (e.g., Steenhof et al. 1997) for peer-review and publication. We will employ multivariate statistical techniques, such as MANOVA, discriminant function analysis, and logit analysis (Preston and Beane 1996) to tease apart the potential confounding effects of interrelationships among landscape composition, human activity, and eagle nest distribution, nesting activity, and productivity. Our public education programming has become very popular with local and even national audiences, and we anticipate expanding our audiences via our website and through K-12 ecological science curricula related to the eagle project.

Through at least 2015, we will continue golden eagle nesting surveys and monitoring and lagomorph surveys. Similarly, we will continue intensive monitoring of sample nests each year and complete analyses of nesting behavior observations in relation to relative lagomorph abundance, weather, and landscape composition and human activity. We will also continue collecting prey remains at nest sites and expand our knowledge of diet using remote nest cameras.

Our ongoing banding/marking operations will expand to include remote cameras placed at carcasses and are exploring the potential for deployment of GPS satellite transmitters on selected eagles in a continuing effort to help identify eagle individuals and determine site fidelity, mortality, and individual movements. We are continuing to explore a partnership with the University of Wyoming Berry Center for Conservation Biodiversity to analyze DNA from shed eagle feathers (e.g., Rudnick et al. 2005) to better understand demographics of our study population. In 2011 and 2012, we began a partnership with Yellowstone National Park and Craighead Beringia South to collaborate on a broad picture of golden eagle nesting ecology across a major portion of the Greater Yellowstone Ecosystem between the Bighorn Basin and Livingston, Montana.

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