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Activity Patterns of Golden Eagles in San Benito County, CA

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Abstract

The golden eagle (*Aquila chrysaetos*) is a top predator of lagomorphs and ground squirrels in open, mountainous habitats in western North America. It is currently listed as a species of concern by the U.S Fish and Wildlife Service. Understanding the diel and seasonal use of water could enhance conservation of this important species. I quantified the visits (N=402) of golden eagles to 13 water sources using camera trap photo data obtained at the Ventana Ranch, San Benito County, California. Frequency of occurrence was analyzed by the Chi-square test to confirm diel and seasonal activity patterns. Golden eagle activity peaked between 10am and 5pm PST; there were no nocturnal visits to water sources. Bathing and drinking were noted at 32% and 14% of visits, respectively. Visits were rare during the Spring-breeding season and peaked in the hot months of July and August when both adults and juveniles were detected.

Introduction

Golden eagles (Aquila chrysaetos) are raptor found in mountainous regions (elevation 300-1000m) with sufficient open areas (Snow 1973, Whitfield et al. 2007, Watson 2010). It prefers remote, interior landscapes with minimal urban development (Whitfield et al. 2007).

Apex predators such as the golden eagle can strongly influence species in the lower trophic levels through direct predation or by modifying the behavior of other species (Roemer et al. 2002). Golden eagles are characterized by large territories and a low tolerance for human activity (Snow 1973). Due to these characteristics, golden eagles are considered a focal species and a "space-demanding habitat-quality indicator of the ecosystem" (Beazley and Cardinal 2004). Golden eagles are experiencing a decline in number due to loss of habitat, and are currently listed as a "species of concern" by the U.S. Fish and Wildlife Service under the Bald and Golden Eagle Protection Act.

The diel activity pattern of an animal is a fundamental aspect of their ecology, and it is influenced by both biotic and abiotic factors (Vieira et al. 2010). Ambient temperature affects the daily activity pattern of eagles and the warmer temperatures induce higher activity (Bozinovic et al. 2000, Vieira et al. 2010, Zalewski 2000). Raptors are affected by high temperature more than other birds (Schleucher 1993). Severe winter can hinder eagles' reproductive activity if prey availability decreases (Steenhof et al., 1997). Nonetheless, the temperature effects on the diel activity of the golden eagle have not been quantified.

Objective

In this study I quantified the effect of season, hour of the day and habitat on the activity of golden eagles at waterholes. I hypothesized that higher temperature will increase the need of water, thus increase the frequency of visits to the water sites. Therefore, I predicted that I would observe the highest number of visits at early afternoon in summer. Higher short vegetation coverage should increase the visibility for golden eagles to find prey from the sky, thus I also predicted that areas with the highest grassland coverage should have the maximum number of golden eagle visits.

Materials and Methods

Study Site

This study was part of a larger one designed to document the status of terrestrial vertebrates on the Ventana Ranch. The Ventana Ranch (VR) is privately owned range land in southern San Benito County with an area of 2,540 acres (36°22'20" North Latitude, 120°55'26" West Longitude). The elevation ranges from 550 to 1200m, and the area is characterized by rugged topography. The climate at VR is Mediterranean with cool, moist winters (November through March) and hot, dry summers (April through October). The VR is composed of three main vegetation types including grassland, chaparral, and oak woodlands. Livestock have been excluded for a decade to allow regeneration of native grasses (Voelker 2010).

Survey

The documentation of vertebrates started in 2006, and as of December, 2010, there were 13 camera trap sites continuously monitoring water sources (springs, ponds, troughs) on the Ventana Ranch. RECONYX camera traps (Models RM30, PM35T, and most recently Model PC900; http://www.reconyx.com) were mounted on trees or posts approximately 2m high. All cameras were set to "high sensitivity," "no delay," "continuous operation," and "one photo per trigger." These settings provided approximately one photo every other second while an animal was active at the water source. The more active the animal was at the site, the more photos were taken. Cameras were checked monthly and bait (~30lbs of Hog Grower Pellets 16% Protein) was provided in view of the camera at each check. Golden eagles showed no interest in the bait.

Photos taken in 2009 and 2010 were used in this report. Photos were downloaded with MapView 3.1, a software program provided by RECONYX. The photos were sorted by species, and all photos with golden eagles were separated by camera location. Then information on "bouts" of eagle activity (visits) was entered onto an Excel spreadsheet (http://microsoft.com). This information included: the location, ambient temperature, time (month, Julian date, and time of the day) of the bout, the duration of the bout, and the number of golden eagles observed at each bout. A bout was considered to be the duration of stay of one or more individuals of a species at a trap site. It starts when the first individual shows up at the site and ends when the last individual of a group leaves. A bout was considered ended when the last eagle appeared in a photo, or >15minutes elapsed between photos. All the photos with vague picture were removed from the analysis due to the difficulty of identification. The duration was determined to the nearest minute, and if there was just one photo for a bout, the duration was assumed to be one minute.

Statistical Analysis

The Excel spread-sheet was then converted into a CSV file to be analyzed using the R software platform (http://www.r-project.org/). A Chi-squared statistic was used test for independence between the frequency of bouts by time of day versus by month of the year. Patterns were similar between years so all data were pooled. The number of individuals captured in one photo was also recorded, and its seasonal variation was analyzed using a scatterplot. The vegetation cover of each site was determined by analyzing a satellite image of VR, and linear regression was used to analyze the relationship between eagle occurrence and grassland occupancy.

Results

After the removal of vague pictures, I recorded 402 bouts in which golden eagles visited one of the 13 camera trap locations from January 1, 2009 to December 31, 2010. The longest bout lasted 129 minutes. In this analysis, three individuals were identified, including an adult male, an adult female and a juvenile. The adults were hard to distinguish from each other, but the juvenile was easy to identify due to the white feathers in its tail. Bathing and drinking were noted at 32% and 14% of visits, respectively.

There was a clear diurnal pattern of bouts (chi-squared test: $\chi = 201.5$, $df = 13$, $p < 2.2e\text{-}16$), with 80% of detections occurring between 10am and 5pm PST. Only 4% of all bouts occurred between 7 and 9am, and only 1.6% of bouts occurred between 6 and 8pm. No bouts were observed between 9pm and 6am. (Figure1A)

There was a strong seasonality among months in the number of eagle visits to the camera sites (chi-squared test: $\chi = 280.3$, $df = 11$, $p < 2.2e\text{-}16$). The number of bouts peaked in July (21% of bouts), August (19%), and September (19%). Golden eagles were rarely detected in winter through early spring (December through April), and March had the lowest number of detections (0.77% of bouts). (Figure1B)

The largest number of golden eagles observed in one picture was three (an adult male, adult female, and juvenile), and it occurred only twice (in September). This number stayed low throughout winter and spring (January through June). (Figure 2)

A linear regression between the grassland occupancy and the logarithm of golden eagle occurrence showed the positive relationship ($y=0.238+4.313x$, $p=0.08$). (Figure 3) The coverage of grassland with largest number of bout observed was 60%.

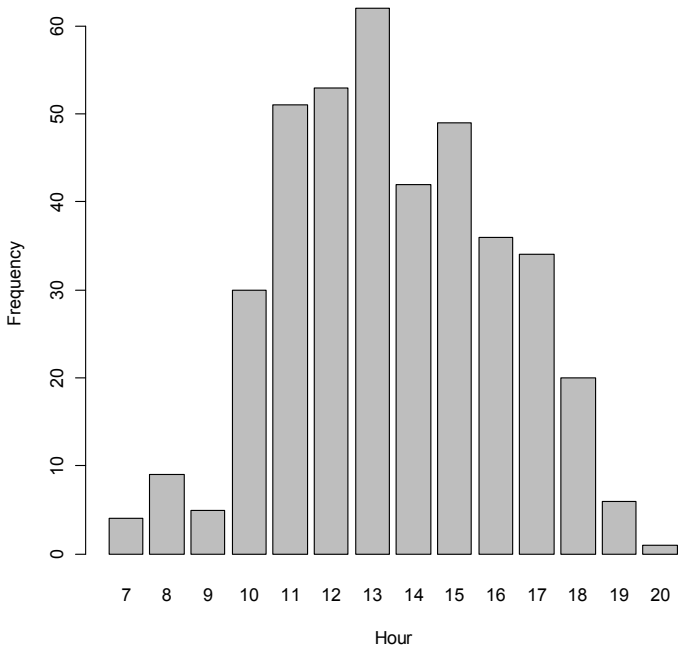

Figure 1A: Diel activity pattern of the golden eagle at 13 water sources with camera traps at the Ventana Ranch, San Benito County, California, 2009-2010. N = 402.

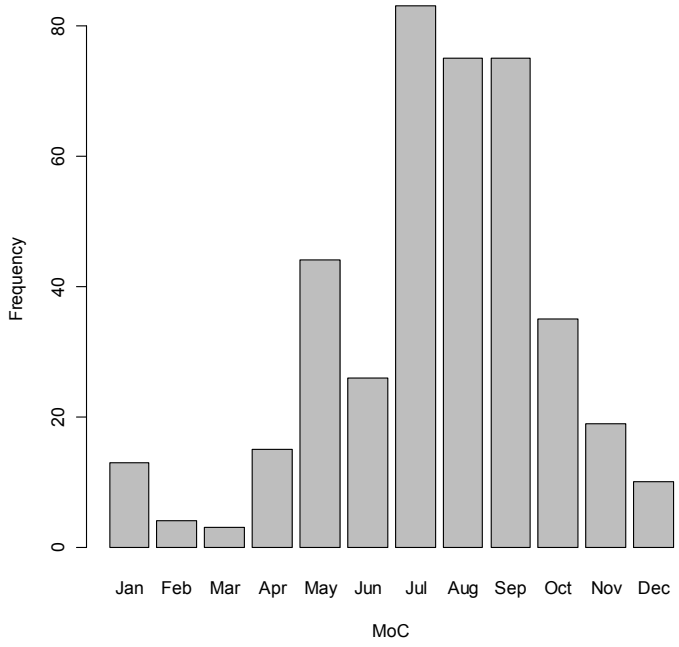

Figure 1B: Seasonal activity pattern of the golden eagle at 13 water sources with camera traps at the Ventana Ranch, San Benito County, California, 2009-2010. N = 402.

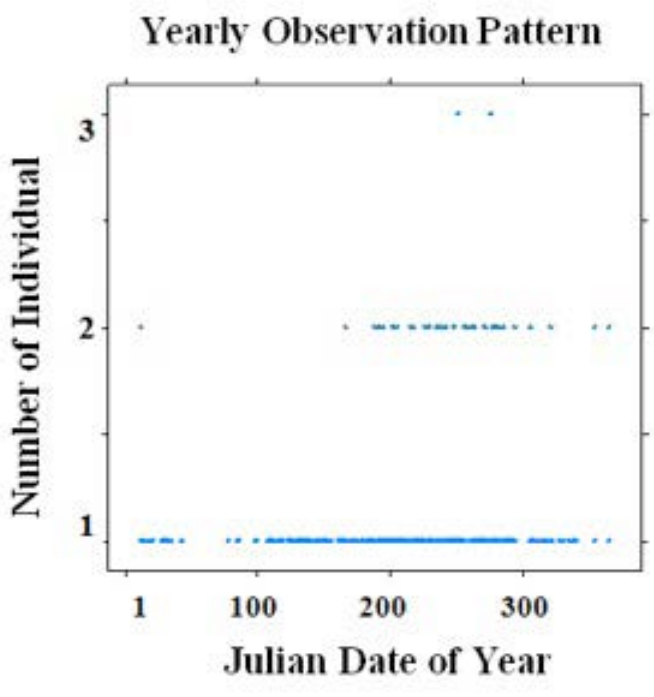

Figure 2: The number of individual eagles detected in one picture. Each dot represents the bout at one of 13 water sources with camera traps at the Ventana Ranch, San Benito County, California, 2009-2010. N = 402.

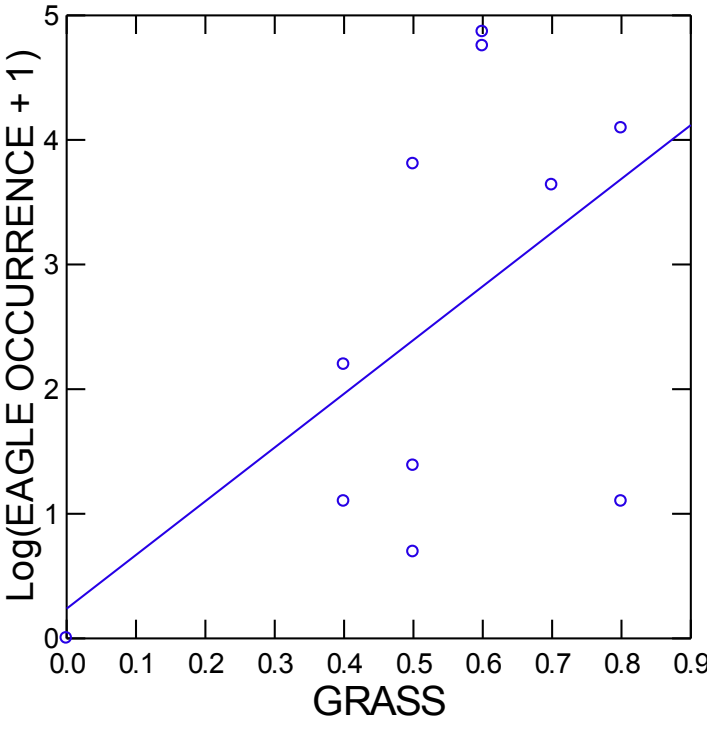

Figure 3: A linear regression shows eagle occurrence is more likely in habitat dominated by grassland versus forest or shrubland,

Discussion

Diel Pattern

The absence of visits to water by golden eagles between dusk to dawn is consistent with the fact that most birds roost throughout the night. This is related to their foraging behavior, which relies on their highly advanced eyesight and flying ability (Watson 2010). The frequent drinking and bathing activities, especially in the hot summer months, indicate that the camera trap sites were used as water source. This result contradicts the current notion that assumes large birds of prey can acquire their necessary water from their food sources (Watson 2010). Birds of prey, including golden eagles, are vulnerable to high temperatures (Bozinovic et al. 2000), and the frequency of energy consuming activities such as foraging should decrease as ambient temperature increases (Schleucher 1993). Bathing and drinking have cooling effects. Moreover, high temperatures will induce golden eagles' thermoregulatory behavior including panting, which induces water loss by evaporation (Prinzinger 1976). Therefore, the demand for water should noticeably increase when the ambient temperature exceeds a threshold. This may contribute to the result of high bout frequency in the middle of the day and low in the early morning and late afternoon.

Seasonal Pattern

In this study, there was one juvenile observed, so it is likely that at least one of two years had a successful breeding season. In the golden eagles' breeding season, early spring is usually spent on nest building, egg-lying, and incubation activities (Watson 2010), the latter lasting up to 40 days (Snow 1973). During this time, the incubation period hinders female eagles from hunting, so their activities are predicted to be low outside the nest. This notion is supported by this study, which showed a low frequency of bouts (of only one individual) in February through March. In contrast, after juveniles fledge from the nest (July), parents require more foraging activity to feed their offspring (Tjernberg 1981). This idea is also supported by my results in which both frequency and number of individual per bout increased after spring reaching a maximum in July. The bouts with three individuals observed in September indicate that the juvenile is still in its parents' territory, which is common for several year after fledging (Watson, 2010).

Habitat Preference

A linear regression (Fig 4) suggested a positive relationship between eagle visit frequency and the amount of grassland around the water source ($p<0.1$). This trend may be resulted by their foraging activities, in which favored open spaces due to the high visibility. However, woody vegetation provides the protection against ground predators, and they provide nesting sites (Watson 2010). Moreover, the increased duration and frequency of bouts in summer suggest that the potential threat of excess heat to golden eagles, and it may suggests the benefit of having shade-creating vegetation in a territory.

Limitation of the Experiment

Due to difficulty of the identification, the total number of individual golden eagle caught by camera trap was unknown. Thus the experimental results were likely to be based on pseudo-replication, defined by Hurlbert (1984). If it is the case, the trend is derived by the experimental results which might be biased by small number of individuals. This caveat is common especially among studies on rare species (Hurlbert, 1984), and it is not feasible to collect behavioral data from large number of golden eagles in an experimental field with a limited scale. Therefore, I suggest the necessity of similar experiments on different groups of golden eagle to test the reliability of the findings generated by this study.

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Literature Cited

Beazley, K., N. Cardinal. 2004. A systematic approach for selecting focal species for conservation in the forests of Nova Scotia and Maine. Environmental Conservation 31:91-101.

Bozinovic, F., J. A. Lagos, R. A. Vasquez, and G. J. Kenagy. 2000. Time and energy use under thermoregulatory constraints in a diurnal rodent. Journal of Thermal Biology 25:251-256.

Hurlbert, S. H. 1984. PSEUDOREPLICATION AND THE DESIGN OF ECOLOGICAL FIELD EXPERIMENTS. Ecological Monographs 54:187-211.

Prinzinger, R. 1976. Temperature Regulation and Metabolism Regulation of the Jackdaw Corvus Monedula the Carrion Crow Corvus Corone and the Magpie Pica Corvidae. Anzeiger der Ornithologischen Gesellschaft in Bayern 15:1-47.

Roemer, G. W., C. J. Donlan, and F. Courchamp. 2002. Golden eagles, feral pigs, and insular carnivores: How exotic species turn native predators into

prey. Proceedings of the National Academy of Sciences of the United States of America 99:791-796.
Schleucher, E. 1993. Life in Extreme Dryness and Heat - a Telemetric Study of the Behavior of the Diamond Dove Geopelia cuneata in its Natural Habitat. Emu 93:251-258.
Snow, C. 1973. Habitat Management Series for Unique or Endangered Species: Report No. 7 Golden Eagle Aquila chrysaetos. Bureau of Land Management U.S. Department of the Interior. Publication No. T-N-239. Denver Service Center, Denver, Colorado, USA.
Steenhof, K., M. N. Kochert, and T. L. McDonald. 1997. Interactive effects of prey and weather on golden eagle reproduction. Journal of Animal Ecology 66:350-362.
Tjernberg, M. 1981. Diet of the Golden Eagle Aquila chrysaetos during the Breeding-Season in Sweden. Holarctic Ecology 4:12-19.
U.S. Fish and Wildlife Service. 1999. TITLE 16. CONSERVATION, CHAPTER 5A. PROTECTION AND CONSERVATION OF WILDLIFE, BALD AND GOLDEN EAGLE PROTECTION ACT <http://www.fws.gov/migratorybirds/mbpermits/regulations/BGEPA.PDF>
Vieira, E. M., L. C. Baumgarten, G. Paise, and R. G. Becker. 2010. Seasonal patterns and influence of temperature on the daily activity of the diurnal neotropical rodent Necromys lasiurus. Canadian Journal of Zoology-Revue Canadienne De Zoologie 88:259-265.
Voelker, W. B. 2010. Ventana Ranch Resource Management Plan. Thesis, University of California, Berkeley, California, USA.
Watson, J. 2010. The Golden Eagle. Yale University Press, New Haven, Connecticut, USA.
Whitfield, D. P., A. H. Fielding, M. J. P. Gregory, A. G. Gordon, D. R. A. McLeod, and P. F. Haworth. 2007. Complex effects of habitat loss on Golden Eagles Aquila chrysaetos. Ibis 149:26-36.
Zalewski, A. 2000. Factors affecting the duration of activity by pine martens (Martes martes) in the Bialowieza National Park, Poland. Journal of zoology 251:439-447.