California-Nevada Golden Eagle Working Group
Mini Symposium

MONITORING TERMINOLOGY AND ECOLOGY OF GOLDEN EAGLE PREY

November 4, 11:10 - 4:50

Symposium Organizers: Jeff Smith, Mike Collopy, Adam Duerr, Carie Battistone, Heather Beeler

Symposium Moderator: Jeff Smith

Time	Presenters	Topic
11:10 -11:15	Jeff Smith	Introduction to Symposium
11:15-11:45	Karen Steenhof	Coming to Terms: Why We Need to Use Consistent Terms to Describe Territory Occupancy and Breeding Activities
11:45-12:15		Questions and Discussion
12:15-1:30	Lunch	
1:30-2:00	Geoff Bedrosian	A Review of Spatial and Temporal Patterns in Golden Eagle Diets in the Western United States, with Implications for Conservation Planning
2:00-2:30	Todd Esque	Hare Today, Gone Tomorrow? Analyses of Lagomorph Populations in the Western United States
2:30-3:00	Leo Salas	Suitability of Ground Squirrels as Prey for Golden Eagles in a Changing Climate
3:00-3:20	Break	
3:20-3:50	Daniel Driscoll	Protocol for Golden Eagle Occupancy, Reproduction, and Prey Population Assessment
3:50-4:50		Panel Discussion – Ecology of Prey Populations

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Abstracts (in order of presentations)

Coming to Terms: Why We Need to Use Consistent Terms to Describe Territory Occupancy and Breeding Activities

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Inconsistent and ambiguous terminology can make it difficult to interpret and compare scientific results. Inconsistent use of the term "active" in the raptor literature may lead to confusion, particularly about long-lived raptor species that occupy nesting territories but do not lay eggs every year. Sergej Postupalsky defined the term "active" in 1974 to refer to raptor nests or territories that contained eggs or young. Unfortunately, nearly 40 years after his recommendations, many raptor researchers still use the term "active" in different contexts, and many fail to define terms used to describe territory occupancy and breeding activities. We reviewed articles in the *Journal of Raptor Research* from 1973 through 2013 and found 102 that used the term "active" to describe nests, territories, or breeding areas. We also found 16 articles published from 2010 to 2013 in other wildlife journals that used the term. Only 41 (35%) of these 118 articles defined the term "active" in their papers. Of these 41, only 26 (63%) defined it consistently with Postupalsky's definition. Other definitions expanded the concept of "active" to include the presence of adults or a refurbished nest: evidence usually used to confirm an "occupied" nest or territory. As Postupalsky noted 40 years ago, this lack of standardization often makes meaningful comparison of data from different studies all but impossible. We recommend avoiding the term "active" unless it is clearly and carefully defined, and we recommend using terminology recommended by Steenhof and Newton (2007) instead.

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A Review of Spatial and Temporal Patterns in Golden Eagle Diets in the Western United States, with Implications for Conservation Planning

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Food habits of Golden Eagles (*Aquila chrysaetos*) are of increasing interest to wildlife managers seeking to mitigate the impacts of energy development across the western United States. We compiled a geodatabase of published and unpublished Golden Eagle prey data in order to characterize spatial and temporal patterns in prey use, investigate ecological relationships between Golden Eagles and prey communities, and inform conservation planning. We analyzed 30 studies identifying 42,841 individual prey during the breeding season from 1954–2015 and found principal prey groups differed among western ecosystems. Dietary breadth varied from 1.36 to 12.27, with lower breadth associated with desert and shrub-steppe ecosystems and higher with mountain ranges and the Columbia Plateau. Diets in the Great Basin were characterized by high frequencies of leporids and in California sciurids were most frequently observed. Analysis of long-term data from southwest Idaho indicated prey switching from leporid to sciurid species in response to habitat change caused by wildfire and cheatgrass (*Bromus tectorum*) invasion. Similarly, Golden Eagles in Central Utah fed more frequently on rock squirrel (*Otospermophilus variegatus*) in years with decreased use of jackrabbits (*Lepus* spp.) and cottontails (*Sylvilagus* spp.). These results support the conclusion that Golden Eagles are opportunistic generalist predators that specialize on locally available prey species. Spatial and temporal variations in Golden Eagle diet likely reflect changes in prey community structure in response to environmental factors, such as drought and invasive species, that affect prey species abundance, distribution, and availability. A diverse prey base could be important for allowing Golden Eagles to shift among alternative prey in response to changing conditions. Land management practices that support or restore shrub-steppe ecosystem diversity should therefore benefit Golden Eagles. More information is needed on diet during the nonbreeding season to determine what food resources, such as carrion, are important for over-winter survival.

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Hare Today, Gone Tomorrow? Analyses of Lagomorph Populations in the Western United States

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When available, jackrabbits and other lagomorphs comprise a significant portion of golden eagle *(Aquila chrysaetos*) prey items in North America. It is thought that past land use conversions from untilled lands to agriculture coupled with predator management have influenced lagomorph populations resulting in large population fluctuations. Recent increases in renewable energy development, as well as potential climate change have raised questions about further changes in rabbit habitats, rabbit populations, and potential impacts to golden eagle populations. Within the western United States, lagomorph species in the diets of golden eagles vary locally and include the black-tailed (*Lepus californicus*), white-tailed jackrabbit (*Lepus townsendii*), and cottontail rabbit (*Sylvilagus* spp.). Jackrabbit abundance also influences reproductive success and population trends of other predators such as coyotes (*Canis latrans*), bobcats (*Lynx rufus*), and other raptors, increasing lagomorph importance in communities across western landscapes. To understand trends in lagomorph populations, we analyzed data pertaining to common lagomorph species dating from the mid 19th century to the present. Additionally, we summarize the results of annual hunter surveys (i.e. hunt success) and road surveys for jackrabbits and cottontails for across 15 western states dating back to the1950's, including 15 long-term hunt success surveys and 19 road surveys. Data from the majority of surveys indicate stable or declining trends with only one survey showing a significant upward trend. Both jackrabbit and cottontail species exhibited large inter-annual fluctuations in hunt success and road count indices, complicating interpretations of long-term trends. Although frequent and large in magnitude, these fluctuations were not clearly cyclic, with temporal autocorrelation coefficients generally indicating significant correlations at lags of only 1 year. Population trends were not strongly or consistently linked to precipitation events of current years, previous (lag) years, or Pacific Decadal Southern Oscillation. We speculate that these patterns are due to the synergistic nature of lagomorph populations in relation to other factors such as predator populations or disease. We also present the results of recently designed and implemented lagomorph surveys for the Mojave Desert Ecoregion. We found minor fluctuations in density and distribution surveys from the first two years of data. Densities of black-tailed jackrabbit were influenced by landscape roughness, vegetation parameters, and the distribution of desert washes. We will also discuss the benefits of coordinated landscape analyses to inform landscape management issues in the western United States.

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Suitability of Ground Squirrels as Prey for Golden Eagles in a Changing Climate

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The success of nesting golden eagles in providing adequate food for their young depends on the ability of the parents to consistently find large-bodied prey during the 10-week nestling period. Prey are also important for post-fledging for adults, and at all times for the "floater" population, mostly comprised of subadults. Thus, the prey species must be visible above ground in adequate local densities to assure a high probability of daily capture events. The purpose of this paper is to compare ground squirrel species from different genera with different life histories, habitat relationships, and patterns of dispersion, and highlight the factors that influence their availability to raptors. In order to explore the likely effects of predicted climate change on these ground squirrels we modeled the impact of climate change through a two-step approach, by fitting first an occupancy model, and then using the predicted occupancy values in a landscape-level model that included vegetation and climate covariates. For recent historical (20th century) climate data we used the 1km WorldClim data (http://www.worldclim.org/), aggregated to 2km resolution. For future climate data we used future climate projections by Conservation International (http://futureclimates.conservation.org/), which comprise outputs from five GCM's downscaled to 5km resolution, which we further re-sampled to 2km resolution. Results indicate that California Ground Squirrels will expand their range further north and east. This relatively large generalist terrestrial rodent may become a more significant prey in the diet of Golden Eagles in the future.

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Protocol for Golden Eagle Occupancy, Reproduction, and Prey Population Assessment

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Golden Eagles (*Aquila chrysaetos*) are long-lived, slowly-reproducing organisms that breed throughout much of the northern hemisphere. Human-related mortality factors that have emerged during the past century, along with considerable habitat degradation, have recently brought into question the issue of population health, particularly in the American West. Understanding the population ecology of Golden Eagles requires data compilation over vast regions, thus standardization of protocols for occupancy, reproduction, and prey population assessment are imperative to the comparison of data from various studies. Essential to this task are the avoidance of bias and error between and among surveys and projects. Survey protocols for Golden Eagles and their primary prey species in the Southwestern United States, potential sources of bias and error, and calculations used to estimate animal numbers are presented.