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HABITAT USE AND TIME BUDGETING BY WINTERING FERRUGINOUS HAWKS[1]

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Abstract: From 1992–1995 we studied the winter ecology of Ferruginous Hawks (*Buteo regalis*) in Colorado. Hawks spent 84% of the daylight interval perching. Time-budgets indicated that on average hawks perched 18 times day^{-1} (range 3–50), with perches averaging 30 min in duration. Diurnal perching was in trees, on poles, and on the ground. Utility poles and other human-made structures were used more than ground and deciduous tree perches. Tree perches were used for the longest mean duration. The mean daily Minimum Convex Polygon (MCP) home range of 36 hawks was 3.53 km^2. The black-tailed prairie dog (*Cynomys ludovicianus*) was the most important prey species, and extant prairie dog colonies characterized winter habitat for Ferruginous Hawks.

Key words: activity, black-tailed prairie dog, Buteo regalis, Cynomys ludovicianus, *Ferruginous Hawk, time budget.*

INTRODUCTION

Although much is known about the biology of Ferruginous Hawks (*Buteo regalis*) during the breeding season, little is known about the species during winter (Steenhof 1984). Banding studies have elucidated migration timing, routes, endpoints, and mortality of Ferruginous Hawks banded in Alberta (Schmutz and Fyfe 1987), Colorado (Harmata 1981), and North Dakota (Gilmer et al. 1985). Winter population estimates and geographic distribution have been derived from Christmas Bird Counts (Warkentin and James 1988). However, few published accounts have detailed habitat use, time-budgeting, or diets of Ferruginous Hawks in winter. Nesting Ferruginous Hawks are thought to be highly intolerant of human presence (Schmutz 1984, White and Thurow 1985). In contrast, wintering Ferruginous Hawks concentrate on prey-rich locations such as black-tailed prairie dog (*Cynomys ludovicianus*) colonies, regardless of human use of surrounding areas (Schmutz and Fyfe 1987, Plumpton and Andersen, unpubl. data). However, the future of such prey populations is in question (Miller et al. 1994), underscoring the importance of detailing species-specific requirements of Ferruginous Hawks during winter.

Successfully formulating management plans or understanding the biology of a species necessitates studying that species' requirements in all seasons. Our goal is to provide information on a well-studied raptor in a poorly-studied portion of its annual cycle.

METHODS

STUDY AREA

Fieldwork was conducted in portions of Adams, Denver, and Weld Counties, Colorado. In undeveloped areas, vegetation was characterized by shortgrass prairie. In locations where they had not been extirpated, black-tailed prairie dogs maintained vegetation at disclimax.

Hawks were captured for radio attachment using the Lockhart method (Harmata 1984) and with weakened and padded leg-hold traps baited with live mice and placed in sight of perched hawks along roadsides (Plumpton et al. 1995). Body mass was measured to the nearest 25 g using a spring scale. Visual identification legbands (VID) engraved with unique alphanumeric codes (Acraft Sign and Nameplate Co., Ltd., Edmonton, Alberta, Canada) were used to aid individual recognition

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within and among winters. Radio transmitters were attached to the rachis of the central rectrix or to two center rectrices with epoxy and cable ties.

Radio-tagged hawks were selected for observation at random without replacement. The selected hawk was located via telemetry before daylight and its behavior continuously recorded (Martin and Bateson 1986) throughout the daylight hours. Recording began when daylight permitted visual identification of the target hawk and ended when darkness precluded such discrimination. Triangulation was not used; we used telemetry only as needed to follow and maintain visual contact with study hawks. When hawks occupied a new perch, the time to the nearest minute and perch substrate were recorded, and location was estimated. At the termination of each perch, time again was recorded to allow calculation of perch duration. Hawks were observed from vehicles, from the farthest distance (about 1 km) that provided adequate viewing with a spotting scope. Daily Minimum Convex Polygon (MCP) home range areas were calculated using the program MCPAAL (Stuwe and Blohowiak 1985). The present analysis considers data from complete daily observations only. Upon successfully tracking all members of the radio-marked cohort for a complete day, and with each addition of an individual into the marked cohort, selection of hawks for observation again was randomized.

Diurnal time budgets were reconstructed for each hawk, for each complete day of data collection. Time budgets and daily MCPs incorporated perched locations only, because flight represented a small portion of the daily time budget during winter. Additionally, locations of flying hawks could not be accurately estimated nor attributed to a particular behavior with certainty. Feeding behavior of radio-tagged hawks was monitored to the extent possible, concurrent with continuous observations.

DATA ANALYSIS

General linear models were used (PROC GLM; SAS Institute 1988) to test for differences among years. The Shapiro/Wilk test was used to test for normality of the data. Homogeneity of error variances was evaluated with a folded-form F-statistic (PROC TTEST).

When data satisfied parametric statistical assumptions, t-tests and product-moment correlations were used. When data failed to satisfy the assumption of normal distribution, logarithmic transformations or nonparametric equivalents were used. Count data were tested using frequency-table analysis. Repeated measures from an individual hawk were averaged (Martin and Bateson 1986); thus, sample sizes (n) are based on the number of hawks from which data were collected unless otherwise indicated. All statistical tests were conducted at $\alpha = 0.05$. Values presented are means $\pm$ SE. Ranges presented are extremes of daily observations, and are not the range in observed means.

RESULTS

Seventy-one Ferruginous Hawks were trapped 84 times from 1 October 1992 through 19 February 1995. Thirty-six hawks were equipped with telemetry transmitters and observed for 1,325 hr, during 148 complete winter days.

TIME BUDGETING

Wintering hawks predominantly perched, and little of each day was devoted to active flight or soaring. On average, hawks perched for 84 $\pm$ 1% of the daylight interval (range: 45–99%) and flew or soared for 16 $\pm$ 1% of the day (range: 0–55%).

The mean number of perches occupied daily was 18 (range: 3–50), and the mean duration of individual perch events was 30 $\pm$ 0.8 min (range: 1–482 min). Ferruginous Hawks used 2,603 diurnal perches in 3 categories of substrate: (1) deciduous trees (n = 777), (2) utility poles, fenceposts, and other human-made objects (n = 1,042), and (3) bare ground (n = 781). Three perches were undetermined because the hawks were in view-obstructed habitats, and perch was indicated by a stationary transmitter signal. One-way frequency table analysis indicated that perch substrates were not used equally ($\chi^2_2 = 53.2$, $P < 0.001$). The mean duration of perches also differed ($P < 0.001$) by substrate (ground mean = 24.5 $\pm$ 1.1 min, pole mean = 25.8 $\pm$ 1.1 min, tree mean = 42.8 $\pm$ 2.0 min). Of the time devoted to diurnal perching, 33 $\pm$ 2% was spent on poles, 25 $\pm$ 2% on ground perches, and 42 $\pm$ 3% in deciduous trees.

HOME RANGE

The mean daily MCP home range was 3.53 $\pm$ 0.44 km^2 (range: 0.01–40.0 km^2, n = 148).

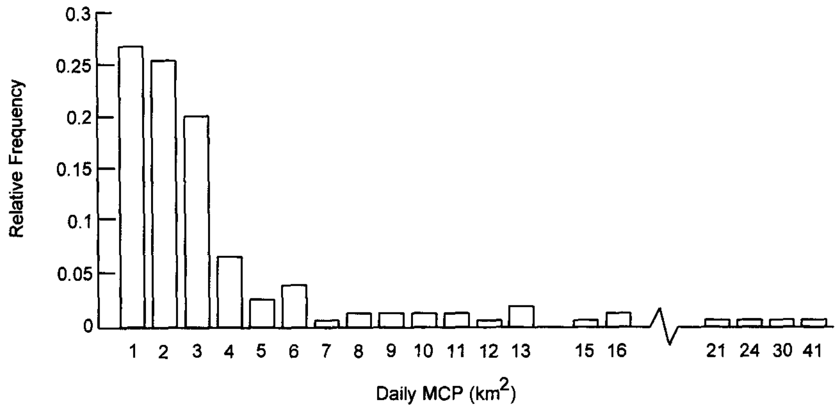

FIGURE 1. Daily Minimum Convex Polygon home range areas (n = 148 days) occupied by 36 radio-tagged Ferruginous Hawks wintering in Colorado, 1992–1995.

Ninety percent of daily MCPs were < 9 km^2 (Fig. 1).

DAILY MOVEMENT PATTERNS

We collected > 1 daily MCP for 30 of the 36 hawks. Individual hawks often exhibited daily (within-winter) and annual (among-winter) reuse of specific areas and habitats, resulting in spatial overlap within hawks and among successive days. Twenty-seven of 30 hawks (90%) had daily MCPs that spatially overlapped both within and among winters.

FORAGING

Ferruginous Hawks were observed eating cottontail rabbits (*Sylvilagus* spp.) or black-tailed jackrabbits (*Lepus californicus*) (n = 4), black-tailed prairie dogs (n = 11), and unidentified small rodents (n = 1). Hawks occasionally kleptoparasitized prey from other raptors (2%). However, hawks secured prey most often by scavenging an unattended carcass (36%, n = 16), but often had their scavenged prey items stolen (18%, n = 8). Hawks made few kills that they consumed undisturbed (5%, n = 2). All of the kills we witnessed were prairie dogs, and most of the kills made by Ferruginous Hawks (75%, n = 8) were stolen by Bald Eagles (*Haliaeetus leucocephalus*) or Golden Eagles (*Aquila chrysaetos*). Prey acquisitions often occurred with such speed that the source of prey was not determined with certainty (25%, n = 11). Most (95%) of the successful prey acquisitions of any type were initiated from a perch. Prey acquisition was initiated from pole perches 20 times (44%), ground perches 14 times (31%), and tree perches 9 times (20%). In only one instance (2%) was a prey item acquired following extended soaring.

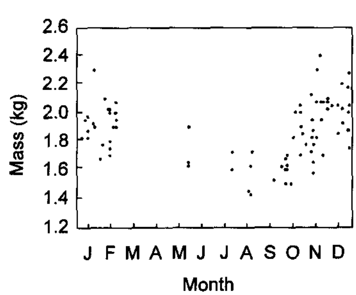

FIGURE 2. Body masses of Ferruginous Hawks trapped in Colorado (n = 84), 1992–1995.

CONDITION

Body masses of 71 hawks were taken at the time of original capture and remeasured for 9 hawks trapped twice and 2 hawks trapped three times. Mass averaged 1.88 ± 0.02 kg (n = 84). Mass varied through the year (Fig. 2) and was generally highest during mid-winter and lowest during late summer.

SITE FIDELITY

Two hawks were recaptured in all three winters and three were recaptured in two consecutive winters. We collected > 1 complete daily observation in consecutive winters for four of these five hawks. All four exhibited spatial overlap of daily MCPs, within and among winters. Most often hawks reused roost trees occupied in previous winters. One additional hawk was VID band-resighted, but not retrapped, in the area it had used and been captured in during the previous winter.

DISCUSSION

McAnnis (1990) reported that seven nesting male Ferruginous Hawks perched for 51% and flew for 49% of the diurnal time budget. Two males nesting in Idaho averaged 61% of the diurnal time budget perching and 39% flying (Wakeley 1978a). We observed that hawks were more sedentary during winter, and little soaring was attempted.

McAnnis (1990) estimated that seven male Ferruginous Hawks nesting in Idaho occupied a mean MCP nesting range of 9.9 km^2. Removing an outlier reduced the mean MCP to 7.6 km^2. Wakeley (1978b), observing for roughly the same time frame as McAnnis (1990), reported MCPs for two males nesting in Idaho of 17.2 and 21.7 km^2. Although the largest of the daily MCPs in our study exceeded those reported by McAnnis (1990) and Wakeley (1978b), the average MCPs for Ferruginous Hawks wintering in Colorado were smaller.

Bildstein (1978) discussed some of the problems in quantifying foraging behaviors (for example, what constitutes a foraging attempt?) and thus the difficulty of drawing reliable conclusions or relating findings to other studies. To minimize the effect that different possible interpretations of field behaviors would have on conclusions in the present study, we make no reference to attempted prey captures. Prey acquisition is the ultimate goal of foraging, but successfully acquiring prey could result from any number of methods including killing, kleptoparasitism, or scavenging unattended prey carcasses. Thus, the success rate of catching live prey is less relevant than is the rate at which any type of prey is secured.

Wakeley (1978c) identified four hunting methods used by nesting male Ferruginous Hawks: (1) from a perch, (2) from the ground, (3) from low-altitude, active flight, and (4) from high-altitude, soaring flight. Wakeley (1978c) found that nesting male Ferruginous Hawks often used wooden fence posts as hunting perches, and one occasionally used wooden utility poles. He reported that hunting from elevated perches was among the least successful techniques of nesting male Ferruginous Hawks, but one of the most used in terms of time budgeting and in the frequency of captures attempted. Likewise, the majority of perches that preceded both passive prey acquisition (kleptoparasitism and scavenging) and active prey acquisition (killing directly) in our study were utility poles. However, Wakeley made no mention of scavenging. It is likely that territorial, nesting hawks existing at low density have little opportunity to scavenge or kleptoparasitize kills made by other raptors, whether conspecific or heterospecific, as is clearly the case with nonterritorial wintering Ferruginous Hawks, existing at much higher density.

Black-tailed prairie dogs constituted only 1% of the number of prey items taken by nesting Ferruginous Hawks in South Dakota (Blair and Schitoskey 1982). In our study, prairie dogs were the only prey species that we observed Ferruginous Hawks killing directly, and the species most often scavenged and kleptoparasitized. Winter habitat for Ferruginous Hawks in our study area was characterized by active black-tailed prairie dog colonies.

Breeding adult European Kestrels (*Falco tinnunculus*) depleted body reserves as they provisioned young, expending energy catching food they did not eat, and losing mass (Village 1990). Postfledging juveniles depleted reserves quickly in the first few weeks of independence from adults. In the winter, activity of kestrels of both age classes decreased, and captured food was consumed, rather than provided to young, and energy intake exceeded energy outputs, so mass increased. We observed a similar annual pattern of mass gain and loss in Ferruginous Hawks. However, we cannot eliminate the alternative that mass differences may have represented distinct populations using our area at different times of the year. However, wintering hawks in this study occupied smaller ranges and remained sedentary more than did nesting hawks studied elsewhere; this energy savings could result in a mass gain as described by Village (1990) for European Kestrels.

Ferruginous Hawks can exhibit a high rate of philopatry to wintering areas. All of the hawks recaptured (n = 5) or band-resighted from previous years (n = 1) were observed in areas occupied in a previous winter or multiple previous winters. Our study was not designed, however, to follow the fates of Ferruginous Hawks among multiple winters. Thus, philopatry may have been much higher than we demonstrate from fortuitous recaptures alone. Harmata and Stahlecker (1993) report about 30% of inter-annual site fidelity by wintering Bald Eagles. Rough-legged Hawks (*B. lagopus*) also overwinter in previously used areas (Garrison and Bloom 1993).

Ferruginous Hawks are restricted to grassland and shrub-steppe habitats, and conversion of prairie to agriculture is considered a major cause of declines in nesting populations (Houston and Bechard 1984, Schmutz 1984, 1987). However, in winter, these hawks are behaviorally plastic and tolerant of human disturbance and alteration of landscapes, provided that adequate populations of prairie dogs remain (Plumpton and Andersen, unpubl. data). Clearly, wintering Ferruginous Hawks: (1) can remain sedentary for long intervals, and occupy small daily and seasonal home ranges, (2) will reoccupy geographic areas and specific habitats for long intervals within a winter, and may reoccupy former ranges in successive years, (3) rely on a narrow spectrum of prey species, chiefly black-tailed prairie dogs, and occur in greatest density where such colonial prey occur, and (4) will acquire prey by killing directly, kleptoparasitizing from conspecifics and heterospecifics, and scavenging. If survival of overwintering Ferruginous Hawks is jeopardized by loss of wintering habitats or prey populations, identification and preservation of suitable habitats and prey sources within the winter range emerges as an important conservation issue for Ferruginous Hawks.

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