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NEST SITE CHARACTERISTICS OF A PREDOMINANTLY TREE-NESTING POPULATION OF GOLDEN EAGLES

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Abstract.—Habitats around 170 Golden Eagle nests found in northeastern Wyoming are described. This population of eagles is unusual in that 86% of the nests are found in trees. Deciduous trees and ponderosa pines with nests tend to be the larger trees in the stand and nests tend to be placed in the upper third of the tree. Ground nests occurred at significantly higher elevations than nests in deciduous trees or ponderosa pines.

CARACTERÍSTICAS DEL ÁREA DE ANIDAMIENTO DE UNA POBLACIÓN PREDOMINANTEMENTE ARBORÍCOLA DE *AQUILA CHRYSAETOS*

Sinopsis.—Se describe el habitat en los alrededores de 170 nidos de *Aquila chrysaetos* encontrados en el noreste de Wyoming. Esta población de águilas es muy particular ya que construyó el 86% de los nidos en árboles. La vegetación decidua y pinos ponderosa con nidos resultaron ser los árboles de mayor tamaño en el bosque. Los nidos fueron construidos en el tercio superior de esta vegetación. Se encontraron nidos en los suelos a alturas significativamente mayor que aquellos construidos en vegetación decidua o pinos.

Throughout North America, Golden Eagles (*Aquila chrysaetos*) nest primarily on cliffs (Bent 1937, McGahan 1968, Mosher and White 1976, Smith and Murphy 1982) infrequently using trees as nest substrates (McGahan 1968, Olendorff 1973). Recently, however, a population of predominantly tree-nesting Golden Eagles has been described in northeastern Wyoming (Menkens 1982, Phillips and Beske 1984). This paper describes habitat characteristics associated with three types of nest substrates used by this population.

STUDY AREA

The study area was located in northeastern Wyoming and was characterized by rolling, terrace-like plains with scattered hills and buttes (Fenneman 1931). Sagebrush (*Artemisia tridentata* and *A. cana*) dominates, with scattered pockets of greasewood (*Scarcobatus* spp.) and rabbitbrush (*Chrysothamnus* spp.), along with several species of grass. Cottonwood trees (*Populus* spp.) and willows (*Salix* spp.) are scattered along major drainages and draws, as well as in other moist sites. Pondersoa pine (*Pinus ponderosa*) and squawbush (*Rhus trilobata*) are found in the extreme eastern and northeastern portions.

METHODS AND MATERIALS

The U.S. Fish and Wildlife Service informed us of 170 eagle nest sites, 111 in deciduous trees, 36 in ponderosa pines, and 23 on the tops or sides of buttes or on river banks (ground nests). We described broad environmental features of the nest site (Table 1), quantified habitat fea-

TABLE 1. Descriptive statistics for environmental and habitat characteristics. Means (±1 SD) with different superscripts differ significantly at $P = 0.05$.

	Habitat			Environment	
Substrate	Cover[a] (%)	Density[b] (no./ha)	Height[c] (cm)	Relief[d] index	Elevation[e] (m)
Deciduous trees	0.04 (±0.05) $n = 65$	0.22 (±0.25) $n = 65$	0.37 (±0.13) $n = 65$	0.40[f] (±0.15) $n = 111$	1432[g] (±60.0) $n = 111$
Ponderosa pine	0.07 (±0.03) $n = 4$	0.46 (±0.24) $n = 4$	0.29 (±0.02) $n = 4$	0.35[f] (±0.11) $n = 36$	1425[g] (±60.0) $n = 36$
Ground				0.38[f] (±0.10) $n = 20$	1486[h] (±40.0) $n = 20$

[a] Cover = Percent cover by shrubs ≥20 cm tall.
[b] Density = Density of shrubs ≥20 cm tall.
[c] Height = Height of shrubs ≥20 cm tall.
[d] Compared using Mann-Whitney *U*-test.
[e] Compared using one-way ANOVA.
[f] Relief index not significantly different ($P > 0.05$).
[g] Elevation of tree nests not significantly different ($P > 0.05$).
[h] Ground nests significantly higher than tree nests ($P > 0.05$).

tures directly associated with the nest site, and quantified several specific characteristics of nest trees (Table 2). Habitat features were not collected at ground nests. Data on habitat features and nest trees were collected at 65 deciduous tree and 4 ponderosa pine nests. The small sample for ponderosa pines precludes statistical comparison with deciduous tree nest sites.

At each nest site, habitat features were collected along four 50 m transects established in the cardinal directions (area = 0.75 ha). The vertical projection of the nest on the ground served as the center of the sampling plot. We estimated habitat characteristics in the sample plot using line intercept techniques (McDonald 1980).

Environmental features for all nest sites were collected within circular plots (1.5 km in radius) from topographic maps. *Relief Index,* a measure of total topographic variation, was derived by centering a star of 8 transects on the nest site radiating in N, NE, E, SE, S, SW, W, and NW directions. An area 0.1 km in diameter around the nest site was excluded to prevent duplication of habitat data. For each nest site, the mean number of contour lines (standardized to 20 ft intervals) crossed per transect and its standard deviation were calculated, and the associated coefficient of variation used as the index. The larger the index, the more heterogeneous the topography.

Nests in deciduous trees were categorized as active, failed, or inactive. Nests were assigned to a class for each year depending upon their status for that year. No significant differences between classes within or be-

TABLE 2. Nest tree specific characteristics. Comparisons between deciduous and pine trees were not performed because of the small sample of pines.

Substrate	DBH[a] (m)	NTREEH[b] (m)	PERNHT[c] (%)	TREE-DEN[d] (no./ha)	TREE-DBH[e] (m)	TREEHT[f] (m)
Deciduous trees	0.73 (±0.28) $n = 65$	13.4 (±2.5) $n = 65$	67 (±13) $n = 65$	11.7 (±17) $n = 47$	0.49 (±0.20) $n = 47$	11.9 (±2.4) $n = 47$
Ponderosa pine	0.64 (±0.06) $n = 4$	11.8 (±2.6) $n = 4$	75 (±8) $n = 4$	28 (±12) $n = 4$	[g]	10.6 (±1.3) $n = 4$

[a] DBH = Diameter at breast height of nest tree.
[b] NTREEH = Height of nest tree.
[c] PERNHT = Percent nest height, defined as the height of the nest in the tree divided by nest tree height multiplied by 100.
[d] TREEDEN = Number of trees greater then 8 m tall within the 0.75 ha sampling circle.
[e] TREEDBH = DBH of trees greater than 8 m tall surrounding the nest tree within the 0.75 ha sampling circle.
[f] TREEHT = Height of trees greater than 8 m tall surrounding the nest tree within 0.75 ha sampling circle.
[g] Not recorded.

tween years for any habitat variable existed. Thus, these data were pooled and the combined data set used in all of the following analyses. Nests in ponderosa pine and on the ground were too few to categorize. Data for individual nests were included only once in subsequent analyses.

RESULTS AND DISCUSSION

Habitat characteristics at both types of nest substrates were highly variable (Table 1) due to habitat heterogeneity (e.g., soil texture, and water holding capacity) between sites. Nest substrates do not appear to differ from each other in any habitat feature (Table 1).

Nests in deciduous trees and ponderosa pines were significantly lower in elevation than ground nests (Table 1): ground nests tend to be on the top of buttes, while tree nests are found close to water courses, which are lower in elevation. No significant differences were found between ponderosa pine, ground or deciduous tree nests for *Relief Index* (Table 1).

Deciduous trees used for nesting tended to be taller with larger DBH's (although not significantly, $P \geq 0.05$ for both comparisons) than trees surrounding the nest tree (Table 2). Only for eight of 47 (17%) nest sites with other trees surrounding the nest tree was the nest tree not the tallest in the stand. The number of trees surrounding the nest tree was highly variable (Table 2) ranging from zero to 50. However most deciduous tree nests were surrounded by 10 or fewer trees. These patterns are similar for ponderosa pine nest sites (Table 2). For both deciduous and pine trees, nests tended to be located in the upper third of the tree (Table 2) although percent nest height for both was highly variable (Table 2).

These results are similar to those of Tjernberg (1983) who studied the only other population of Golden Eagles nesting predominantly in trees. In both studies the number of trees surrounding the nest tree was highly variable, with eagles selecting the largest or one of the largest trees. Nests are also placed in the upper one-third of the selected tree. The use of larger trees may be a sampling artifact because nests may fall or blow out of smaller trees more easily, thus being more difficult to detect. However, we postulate that eagles select larger trees for their nests because of improved nest stability (and thus increased nest longevity), and also place their nests high in the substrate to improve their accessibility to adult eagles arriving at the nest.

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