GOLDEN EAGLE POPULATION STUDIES IN THE SOUTHWEST

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In October 1962 the Bald Eagle Act of 1940 was amended to include protection for the Golden Eagle (*Aquila chrysaetos*). Under this regulation, authorization for control of Golden Eagles by ground shooting and trapping is granted by the Secretary of Interior on a county basis and within specified dates upon request by the governor of the state in which control is sought. Hunting of eagles with airplanes and the use of poison are both prohibited. Sheep and goat ranchers in the Southwest maintain that airplane hunting is the only effective method for controlling Golden Eagle populations and vigorously protest the regulation. They insist that this method of control must be restored or their means of livelihood will be placed in serious jeopardy. Conversely, conservation groups maintain that unrestricted control of Golden Eagles by airplane hunting would endanger the species and eventually doom it to extinction.

The population status of the Golden Eagle in North America is not well known. Kalmbach et al. (1964:2) note that, within the memory of man, this bird has been almost eliminated as a breeding species in the mountainous regions of eastern North America. Spofford (1964:4) estimated the continental population at 8000–10,000 birds, with up to 6000 wintering in the southwestern states and upland México each year. Factual information to confirm the accuracy of this estimate is lacking, and further study is clearly indicated.

This paper presents the 1964–69 results of a continuing study to (1) establish an index to the number of Golden Eagles wintering each year in the major control areas of New Mexico and western Texas and (2) to determine yearly nesting activity and productivity along the Front Range of the Rocky Mountains in New Mexico, Colorado, and Wyoming.

STUDY AREAS

The wintering habitat of the Golden Eagle in both New Mexico and Texas is typified by dry mountains and basins. A long history of severe cattle grazing over much of the region has resulted in the loss of grassland and in the invasion of various desert shrubs. These changes in forage production and species composition have brought about a gradual change in the ranching industry, and today sheep and goats have replaced cattle over much of the range.

In this study, winter eagle populations were sampled in a 10,000-square-mile area in east-central New Mexico and a 14,500-square-mile area in western Texas. The Texas study area was changed in 1966 because of the extremely low number of eagles found during the 1963–64 and 1964–65 wintering periods. The original area was abandoned, and three separate units containing a combined total of 12,000 square miles were established in areas where depredation complaints were the most persistent.

The nesting study was not confined to definite boundaries. It was conducted primarily along the Front Range of the Rocky Mountains in New Mexico, Colorado, and Wyoming, and in areas of broken terrain east of the Front Range. A limited number of nests were also observed west of the Continental Divide in Colorado.

METHODS

Upon completion of a reconnaissance study in the New Mexico and Texas depredation area in 1963, Baer et al. (unpubl. rept., U. S. Bur. Sport Fish. Wildl., 1963) concluded that useful Golden Eagle population data could not be obtained by ground observation methods because of the great area involved and the wide dispersion of the birds. Our wintering population study, therefore, was designed to use light aircraft.

Transects selected from a list of random numbers were located in a north-south direction across the study areas. The transects, divided into 50-mile segments to facilitate statistical treatment, were flown with a Cessna 180 aircraft at monthly intervals during the winter period except as noted in tables 1, 2, and 3. Flights were conducted at an altitude of 100–300 ft, depending on terrain features. The pilot and the observer recorded all eagles observed within ¼ mile of either side of the aircraft. Eagles were listed as adult, immature, or age unknown. (The criterion used for age classification was coloration: birds showing a significant amount of white at the base of the tail and in the wings were considered immature.) The New Mexico sample was 700 square miles (7 per cent) and the Texas sample, 600 square miles (5 per cent). The original 14,500-square-mile area in Texas contained a sample of 650 square miles (4.5 per cent).

Golden Eagle nests were located by literature review, by personal contact with falconers, ranchers, and other interested individuals, and by air and

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TABLE 1. Golden Eagles counted in a 10,000-square-mile study area in New Mexico, 1963–64 to 1968–69 (population estimates in parentheses).

Month	Eagles recorded on aerial transects (7% sample)					
	1963–64	1964–65	1965–66	1966–67	1967–68	1968–69
Nov.	nf[a]	nf	nf	nf	64 (915)	51 (728)
Dec.	nf	49 (700)	nf	nf	58 (829)	67 (957)
Jan.	nf	40 (572)	48 (686)	63 (901)	62 (887)	nf
Feb.	27 (386)	45 (643)	60 (858)	55 (786)	nf	60 (858)
Mar.	25 (357)	52 (744)	18 (257)	31 (300)	nf	nf
Apr.	7 (100)	3 (43)	nf	nf	3 (43)	2 (28)

[a] nf = no flight.

ground search. The majority were found by scanning canyon walls and rock formations with a 20 × spotting scope. Nest locations were plotted on U. S. Geological Survey topographical maps in the field, and later transferred to aeronautical charts (scale, 1 inch:8 miles). Each nest was assigned an identification number and checked yearly to obtain comparative data. Beginning with the 1967 nesting season, an airplane was used successfully to determine nest status (Boeker 1970). Time saved by this method allowed ground crews to bypass inactive nests, concentrate on active nests for productivity and related data, and search for additional nests.

Productivity data were derived from a sample of nests where activity was monitored repeatedly during the nesting season. Food habits were determined from prey remains found in the nests. All remains not readily identified in the field were taken to the Denver Research Center for identification. Nestling eagles in nests visited by the ground crews were banded with Loktite bands, size number 9.

RESULTS AND DISCUSSION

WINTER POPULATIONS

Aerial transect data showed a striking difference between the size of winter populations of Golden Eagles in the New Mexico and Texas study areas. In New Mexico, the indicated population was much larger and increased each year during the six years of study (table 1). The birds began to arrive in October, reached peak numbers in December–February, and began to leave in March. By mid-April the only eagles remaining were a few believed to be local residents. We assumed that the highest monthly count within a winter season represented the maximum eagle population for that season. These high counts ranged from a low of 1.0 eagle per transect in February 1964 to 2.4 eagles per transect in December 1968, and tended to be increasing. To test the hypothesis that there was no difference in yearly maximum counts we compared the highest count for each of the six years by analysis of variance. This hypothesis was rejected ($P = 0.05$).

The numbers of eagles recorded on the Texas transects were extremely low in comparison with the New Mexico data. Only in Unit 1 (Marfa-Alpine), where the data indicated a relatively stable population, were eagles found consistently (tables 2 and 3).

A difference in the migration pattern of adult and immature Golden Eagles was suggested by age classification data obtained in New Mexico (table 4). Immature eagles made up 43 per cent of all November counts, 21 per cent of all February counts, and 46 per cent of all March counts. It may be presumed that more immature eagles move through the area at both the beginning and end of the wintering period, but actually winter in regions not known to us.

TABLE 2. Golden Eagles counted in a 14,500-square-mile study area in southwestern Texas, 1963–64 to 1965–66 (population estimates in parentheses).

Month	Eagles recorded on aerial transects (4.5% sample)		
	1963–64	1964–65	1965–66
Dec.	nf[a]	1 (22)	0 (0)
Jan.	nf	0 (0)	Discontinued
Feb.	3 (66)	1 (22)	—
Mar.	4 (88)	1 (22)	—
Apr.	1 (22)	nf	—

[a] nf = no flight.

NESTING

The breeding range of the Golden Eagle in North America extends from northern Alaska and northern Canada southward through the mountains to central México and western Texas. Smaller numbers formerly nesting in the eastern part of the North American continent (from Quebec southward to the mountains of Tennessee and North Carolina) have declined steadily and currently exist only as scattered pairs. Today most Golden Eagle nesting habitat is contained in the uplands of northern Canada and in the western states.

TABLE 3. Golden Eagles counted in three study units, Texas, 1966–1969 (population estimates in parentheses).

	Eagles recorded on aerial transects (5% sample)											
	Unit 1 (Marfa-Alpine) 4500 sq. miles				Unit 2 (Del Rio) 5000 sq. miles				Unit 3 (Kerrville) 2500 sq. miles			
Month	1966	1967	1968	1969	1966	1967	1968	1969	1966	1967	1968	1969
Jan.	2(40)	8(160)	nf	6(120)	0	0	0	nf	2(40)	0	nf	nf
Feb.	3(60)	5(100)	7(140)	8(160)	0	0	0	nf	1(20)	0	2(40)	nf
Mar.	5(100)	1(20)	5(100)	nf	0	0	0	nf	0	0	0	nf
Apr.	4(80)	2(40)	3(60)	2(40)	nf	nf	nf	nf	nf	nf	nf	nf

[a] nf = no flight.

The Front Range of the Rocky Mountains in New Mexico, Colorado, and Wyoming is undoubtedly a highly important segment of the nesting area. Equally important nesting populations are found in Montana, Idaho, Oregon, Utah, and California.

In this study, 93 per cent of the 150 nests found were on cliffs; the remainder were in trees or on earthen mounds. In Idaho, Hickman (unpubl. rept., U. S. Bur. Sport Fish. Wildl., 1966) reported 96.5 per cent of 117 nests on cliff sites and 3.5 per cent in live ponderosa pine (*Pinus ponderosa*) trees; and in Montana, McGahan (1966:12) found 62 per cent of 92 nests on cliffs and 36 per cent in trees. Nesting density varied greatly throughout the study areas and appeared directly related to the availability of nest sites and associated vegetative types. Cliffs overlooking open grasslands, where both prey populations and ease of hunting are optimum, were more heavily used than those overlooking closed forests.

Dixon (1937), Watson (1957), Lockie and Ratcliffe (1964), and McGahan (1966), all described the construction and use of alternate nests by Golden Eagles. Some workers have suggested that eagles use alternate nests in alternate years, others that they never use alternates, and still others that unsuccessful nesters of one year use an alternate nest the succeeding year. We were unable to recognize criteria for set patterns in the use of alternate nests. Our data also indicate that the habits of individual pairs of eagles differ widely. Several pairs produced young in the same nest during each of the six years of study, even though they repaired and regularly attended alternate nests until the eggs were laid. Other pairs used alternate nests in successive years, and some apparently nested only in alternate years. The number of alternate nests associated with a main nest site and the distance separating nests can probably be attributed to terrain features and the proximity of other nesting pairs.

TABLE 4. Age classification of Golden Eagles found on New Mexico aerial transects, 1964–1969.

		Adult		Immature		Unknown	
Month	Total	No.	%	No.	%	No.	%
Nov.	115	59	51	50	44	6	05
Dec.	174	102	59	53	30	19	11
Jan.	213	145	68	56	26	12	06
Feb.	241	169	70	50	21	22	09
Mar.	116	48	41	53	46	15	13
Apr.	14	7	50	7	50	0	0

Nesting and egg laying dates were generally dependent on the geographical location of the nests; nesting was earlier toward the south and at the lower elevations. In this study, nesting elevations ranged from 4000 to 10,000 ft and averaged 6300 ft. In New Mexico, incubating eagles were found as early as mid-February, while in Colorado and Wyoming, most egg laying took place in March.

Overall nesting activity, based on the ratio of active nests to total nests checked, averaged 45.5 per cent in 1964–69 for the tri-state area. Along the Front Range (not including nests located in North, Middle, and South Park in Colorado), nesting activity increased by 12 per cent between 1964 and 1967, but declined by the same amount in 1968 and 1969 (table 5). A sharp reduction occurred in the area between Denver, Colorado, and the New Mexico state line in 1969 when only 8 of 37 nests were found active as compared with 16 of 36 in 1968.

Productivity remained relatively constant throughout the study (table 6). The six-year average for eagles hatched per nest was 1.52, and, excluding 1969 when there were insufficient data for determining fledging success, 1.39 were successfully fledged per nest. McGahan (1966) reported an average of 1.80

TABLE 5. Activity of Golden Eagle nests checked along the Front Range in New Mexico, Colorado, and Wyoming, 1964–1969.

Year	New Mexico		Colo. Zone 1 (Denver-N. Mex.)		Colo. Zone 2 (Denver-Wyo.)		Wyoming		All nests[a]	
	No. checked	% active	No. checked	% active	No. checked	% active	No. checked	% active	No. checked	% active
1964	—	—	31	29	17	59	4	75	62	41
1965	22	55	32	37	28	61	8	38	107	49
1966	21	43	32	34	33	64	11	73	117	47
1967	25	56	35	37	38	63	16	63	129	44
1968	31	48	36	44	44	45	24	54	144	52
1969	19	47	37	22	49	47	20	60	147	41

[a] Also includes nests located in North, Middle, and South Park, Colorado.

birds hatched and 1.56 fledged per nest from the 45 nests studied in Montana in 1963 and 1964. In Idaho and Oregon, a sample of 18 nests in 1966 showed an average per nest of 1.40 hatched and 1.30 successfully fledged (Hickman, pers. comm., 1967).

Human disturbance accounted for at least 85 per cent of all known nest losses in this study. Other mortality factors noted included wind destruction of a tree nest containing young, two instances of young eagles falling from the nest, one eaglet infected with trichomoniasis, and the disappearance of several eggs and young from unknown causes.

Prey remains found in 34 nests in 1965 showed that jackrabbits (*Lepus* spp.) and cottontail rabbits (*Sylvilagus* spp.) provided more than three-fourths of the eagles' total diet. Other mammals, in the order of their importance, included prairie dogs (*Cynomys* spp.), striped skunks (*Mephitis mephitis*), ground squirrels (*Citellus* spp.), marmots (*Marmota* spp.), mule deer (*Odocoileus hemionus*), and, in two nests, traces of domestic sheep and goats. Avian forms were represented by Great Horned Owls (*Bubo virginianus*), Magpies (*Pica pica*), Ring-necked Pheasants (*Phasianus colchicus*), Mourning Doves (*Zenaidura macroura*), Mallard Ducks (*Anas platyrhynchos*), Chukar Partridges (*Alectoris chukar*), and feral Domestic Pigeons (*Columba livia*). Remains of a prairie rattlesnake (*Crotalus viridis*) and of a bull snake (*Pituophis catenifer*) were found in two nests. Craighead et al. (1967) showed strikingly similar results in a Montana study where prey remains from 38 nests were examined. White-tailed jackrabbits (*L. townsendii*) and cottontail rabbits made up 70 per cent of the diet, various species of birds accounted for 12 per cent, and the remaining 18 per cent was composed of other mammals and miscellaneous items. The above data show domestic livestock to be only a trace item in the diet of Golden Eagles nesting within the study areas.

TABLE 6. Summary of Golden Eagle productivity in New Mexico, Colorado, and Wyoming, 1964–1969.

Year	No. nests sampled	No. birds/nest		% fledged
		hatched	fledged	
1964	27	1.6	1.3	85.7
1965	34	1.4	1.2	82.1
1966	41	1.5	1.4	95.2
1967	57	1.6	1.5	96.3
1968	54	1.5	1.4	94.7
1969	51	1.5[a]	—	—

[a] This figure represents a minimum number hatched. Data on early nest losses in 1969 were insufficient to calculate fledgling success.

In an effort to gain information relating to mortality and movement patterns after the fledglings leave the home nest site, 170 nestling eagles were banded during the course of this study. Band recoveries reported to date (table 7) suggest that young eagles in the Front Range area do not wander far from the nest site and may, in fact, remain in the vicinity throughout the year. More returns are needed, however, before definite conclusions are possible. Four of the five eagles representing band returns were reported shot; they are added evidence that man is responsible for most Golden Eagle mortality.

The few band recoveries suggest that the Golden Eagles nesting along the Front Range in Colorado and Wyoming are a population separate from those wintering in eastern New Mexico and western Texas. This supposition is also supported by the observation that considerable numbers of wintering birds still remain in New Mexico in March after egg laying is well under way in Colorado and Wyoming. The New Mexico wintering birds must

TABLE 7. Summary of Golden Eagle band recoveries from the New Mexico, Colorado, and Wyoming nesting study, 1964–1969.

No.	Banding		Recovery	
	Site	Date	Site	Date
1	Trinidad, Colo.	14 May 1965	Las Animas, Colo.	30 Nov. 1966
2	Peetz, Colo.	12 June 1966	Kimball, Nebr.	17 Oct. 1966
3	Golden, Colo.	23 May 1966	Ft. Collins, Colo.	20 Feb. 1967
4	Glendo, Wyo.	24 June 1964	Medicine Bow, Wyo.	7 July 1967
5	Livermore, Colo.	27 May 1967	Nunn, Colo.	20 Dec. 1967

begin their egg laying later, probably in Subarctic or Arctic regions.

SUMMARY

Monthly flights over randomly located transects in a 10,000-square-mile area in east-central New Mexico during the wintering periods of 1964–69 showed a steadily increasing population of Golden Eagles. Similar flights conducted in western Texas study areas during the same period indicated smaller and more stable populations.

A nesting study along the Front Range of the Rocky Mountains in New Mexico, Colorado, and Wyoming in 1964–69 also indicated a relatively stable Golden Eagle population. Human disturbance accounted for most nest failures and losses. At least 75 per cent of all prey items found in the eyries were jackrabbits and cottontail rabbits. In 1969, five band recoveries had been received from a total of 170 eaglets banded during the study. Because the Golden Eagle is so thinly dispersed over such a vast area, it is extremely difficult to detect changes in its population status. We believe that the results of this study demonstrate the feasibility of obtaining reliable indicators to Golden Eagle population trends within all critical portions of winter and nesting habitats. However, the sampling procedures must be expanded, particularly in other wintering areas, before a reasonable estimate of the continental population is possible.

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