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FOOD HABITS OF NESTING GOLDEN EAGLES IN THE COAST RANGES OF CALIFORNIA

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The present paper summarizes observations on the hunting methods and the prey of 17 pairs of Golden Eagles (*Aquila chrysaëtos*) studied on their nesting grounds in central California in the period from 1947 to 1952. Field work was conducted in that portion of the inner coastal ranges extending from Mt. Diablo in Contra Costa County south to the Pinnacles National Monument in San Benito County. In this region the Golden Eagle, for a raptorial species, is still a common resident. In one instance the nests of four pairs of eagles formed a trapezoid the largest side of which was not over two miles in length. Returns from seven of 33 young eagles banded in their nests indicate no extensive movement of the population. All recoveries were from the coast ranges in central California.

From 1947 to 1950 observations were made in conjunction with other work, resulting at best in only a few visits per nest per season. During 1951 and 1952, however, considerable field time was devoted to studying the food and feeding habits of this species in an attempt to follow systematically as many nests as possible through the entire nesting season.

Nests of 17 pairs of eagles were examined. Food items were recorded by the writer on 68 visits. In addition, data from nine visits made previously to some of the same nests by Dr. Harold M. Hill and Albert J. Wool are included in the present paper.

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TECHNIQUES

The principal method of study was to record periodically the food items found in and about the nests. During visits in the nesting seasons of 1947 to 1950 inclusive, no attempt was made to remove prey items to prevent recount at a later date. However, since visits were of such a sporadic nature during this period, the possible error appears negligible. During the final two seasons of the study (1951 and 1952), visits to closer nests were spaced from five to seven days apart, and to more distant nests from 12 to 14 days apart. To prevent later recount, all prey items were removed after being recorded with the usual exception of one fresh item which was left as food for the young. The item left behind was noted and marked distinctively by removing claws to insure later recognition.

Frequently prey items were only identifiable by legs or feet, especially in the case of jackrabbits and fawns. In such cases, the number of individuals listed as present was determined by the largest number of any one part.

On the initial visit to each nest an attempt was made to collect all weathered remains of prey from previous seasons to prevent possible error in later visits. Such prey was identified and has been entered in table 1 under a separate heading.

NESTING

The majority of the eagles studied (14 pairs) constructed their nests in tall trees (fig. 1). The remaining three pairs nested on cliffs ranging from 40 to 300 feet in height

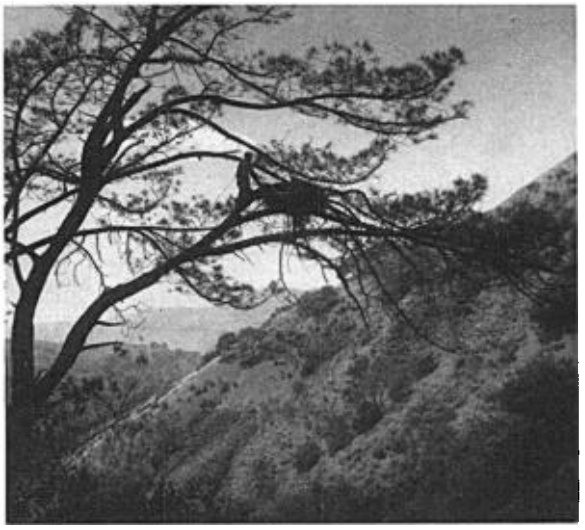

Fig. 1. The writer at a nest in northern Santa Clara County, California, May 8, 1951. Terrain visible in background is typical of that utilized by eagles in northern portion of study area. Photograph by A. Starker Leopold.

(fig. 2). Both tree and cliff nesting pairs often used alternate nests during different nesting seasons. Eggs, commonly two, were laid in late February or early March, hatching after an incubation period of 33 to 35 days. The young remained in the nest 65 to 70 days. It was during this period, in which the young were being fed in the nest by the adults, that the majority of the food habits information presented here was gathered.

HUNTING METHODS

During the normal course of field work, adult eagles frequently were seen hunting in the vicinity of the nests. During the latter phase of the study, six days were spent specifically observing the hunting methods of several pairs of eagles. Although some variation occurred, the hunting techniques utilized by all these birds were essentially the same. The basic hunting pattern consisted of soaring flight 100 to 300 feet above the ground, along the tops or upper faces of large open ridges in the vicinity of the nest, interspersed with low flights (± 25 ft.) coursing back and forth over patches of poison oak, small brushy draws, or rocky outcroppings. Eagles were observed making kills from both high soaring flights and low coursing flights.

The birds spent much time perching and preening on prominent rocky outcroppings or on bare trees affording good observation of the area about the nest. Perching did not appear to be a major means of watching for prey, as in some raptorial species. In one case, however, an adult female was observed to leave her perch on a rocky point two minutes after having settled there and fly across a wide canyon in a straight, unwavering flight to the top of the opposite ridge over a mile away where she killed and ate a striped skunk. It is my impression that the skunk was seen by the eagle before it left the perch, since the flight was directly to the prey.

Fig. 2. View from a cliff nest in northern San Benito County, California, May 30, 1952. Terrain is typical of that utilized by eagles in southern portion of study area.

As the nesting season progressed and the young required less parental care, there was an increased tendency for the adults to hunt together. Singly or together, however, the hunting pattern remained essentially the same except that when together one bird frequently would maintain the soaring flight while the other descended and coursed over localized areas.

It appears that hunting in pairs is a fairly common occurrence in the Golden Eagle, even to the point of combined efforts in making a kill. Albert J. Wool, a keen field observer who has lived in the study area for many years, describes the following specific instances. On the 31st of October, 1950, a pair of eagles was observed pursuing a Great Blue Heron down the bottom of a narrow canyon in northern Santa Clara County. The heron descended to the ground at the base of a thick clump of alders along the edge of the stream. One of the eagles moved downstream, circling over a clearing among the alders while the second gained several hundred feet in altitude and then dove toward the top of the tree beneath which the heron stood. The heron flew from the base of the alders and as it entered the clearing downstream the eagle circling there descended and grasped it, both birds falling into the shallow stream where they were joined by the

second eagle. With much struggling the eagles finally dragged the heron from the water. Apparently startled by Mr. Wool, both eagles left the heron and flew downstream. The heron was found to be stunned and bleeding but it was not dead. Two hours later, returning to the spot where he had left the heron, Mr. Wool heard a commotion about 100 yards up the steep, overgrown hillside and upon investigation both eagles were flushed and the partially eaten remains of the heron were found.

On June 6, 1937, a pair of eagles was observed killing a fawn on the slope of a steep ridge in northern Santa Clara County. The eagles were seen flying and calling over a patch of brush. As a doe and fawn left the patch the eagles swooped at the fawn, one hitting it and knocking it down the hillside; but it recovered and ran into a brushy draw. While one eagle alternately circled overhead and perched in a sycamore tree, the other alighted on the hillside and walked into the brush patch, following a cow trail. Locating the fawn, the eagle moved to its side and struck at it repeatedly with one wing, but made no attempt to use its beak or talons. The fawn screamed but did not leave the protection of the brush. Movement by Mr. Wool flushed both the fawn and the eagles. When the fawn had bounded some 50 yards down the hill both eagles swooped at it, the first knocking it off its feet and down the hillside and the second grasping it. As Mr. Wool approached, the eagle left the hillside carrying the fawn. The bird was 15 feet off the ground when it finally dropped the fawn and flew off. The fawn died a few minutes later. There were talon wounds behind the shoulders and in the abdomen.

In none of the observed kills were the adults ever seen to fly directly with the prey from the point of the kill to the nest, a circuitous route being used each time. Observations were not extensive enough to determine whether the same route was used each trip to bring prey to the nest.

Even among nesting pairs hunting close by one another under apparently identical conditions, differences existed in types and species of prey items brought to the nests. There appeared to be a degree of preference or specialization on the part of certain adults in obtaining particular types of prey. This was especially noticeable in the case of the four pairs mentioned previously which nested closely together. In two of these nests remains of fawns made up the greater part of the food items found, ground squirrel being a less common prey item. In the third nest, remains of both ground squirrels and fawns were common, while the fourth pair fed almost entirely on ground squirrels, no fawn remains being found.

Such evidence of individual specialization is obscured when food habits data are lumped, as in the accompanying table.

PREY ITEMS RECORDED IN NESTS

Table 1 lists prey items found in the nests, by numbers of individuals of each species, percentage of total items recorded, and by date. In calculating percentages, no consideration of bulk difference was made, the percentage figures representing merely the number of prey items of each species in relation to the total number of prey items recorded. Figures in the column headed "Old remains (no date)" represent weathered bones that persisted in the nests from previous seasons. Remains of large animals would of course be more obvious than those of small prey. As a result these data are biased, but they constitute only a small part of the total record.

Mammals.—Two mammal species, the ground squirrel and jackrabbit, formed the majority of all prey items recorded. Within the study area there were notable local differences in the dominance of these species in the eagle diet, in some areas ground squirrels and in others jackrabbits prevailing. Generally speaking in the more northern portions of the study area the eagles nested in rugged, wooded areas (fig. 1), and hunt-

Table 1

Summary of Remains Found in Nests of 17 Pairs of Golden Eagles through Period of Study, 1947 to 1952

Prey species	March	April	May	June	Old remains (no date)	Total	Per cent
MAMMALS							
Jackrabbit (*Lepus californicus*)	2	52	71	7	12	144	28.6
Ground Squirrel (*Citellus beecheyi*)	1	70	59	2	1	133	26.4
Black-tailed Deer (*Odocoileus hemionus*)	....	6	34	9	15	64	12.7
Striped Skunk (*Mephitis mephitis*)	2	5	4	4	2	17	3.4
Gray Squirrel (*Sciurus californicus*)	....	6	1	....	....	7	1.4
Woodrat (*Neotoma fuscipes*)	....	....	4	....	....	4	.8
Domestic Cat (*Felis domesticus*)	....	1	2	....	1	4	.8
Pocket Gopher (*Thomomys bottae*)	1	2	....	....	....	3	.6
Weasel (*Mustela frenata*)	....	....	3	....	....	3	.6
Meadow Mouse (*Microtus californicus*)	....	....	3	....	....	3	.6
Opossum (*Didelphis virginiana*)	1	1	....	....	....	2	.4
Raccoon (*Procyon lotor*)	....	....	1	....	1	2	.4
Gray Fox (*Urocyon cinereoargenteus*)	....	1	....	....	....	1	.2
Mole (*Scapanus latimanus*)	....	....	1	....	....	1	.2
Cottontail Rabbit (*Sylvilagus audubonii*)	....	....	....	....	1	1	.2
						389	77.3
BIRDS							
Yellow-billed Magpie (*Pica nuttallii*)	....	3	25	2	....	30	5.9
Western Meadowlark (*Sturnella neglecta*)	....	3	3	2	....	8	1.6
Horned Owl (*Bubo virginianus*)	....	2	2	2	1	7	1.4
Valley Quail (*Lophortyx californica*)	....	1	3	....	....	4	.8
Crow (*Corvus brachyrhynchos*)	....	2	1	....	....	3	.6
Turkey Vulture (*Cathartes aura*)	....	....	....	2	1	3	.6
Roadrunner (*Geococcyx californicus*)	....	1	1	....	....	2	.4
Steller Jay (*Cyanocitta stelleri*)	....	....	....	2	....	2	.4
Mallard (*Anas platyrhynchos*)	....	....	....	1	1	2	.4
Scrub Jay (*Aphelocoma californica*)	....	....	....	1	....	1	.2
Sparrow Hawk (*Falco sparverius*)	....	....	....	1	....	1	.2
Red-shafted Flicker (*Colaptes cafer*)	....	....	1	....	....	1	.2
Barn Owl (*Tyto alba*)	....	....	1	....	....	1	.2
Lewis Woodpecker (*Asyndesmus lewis*)	....	1	....	....	....	1	.2
Red-tailed Hawk (*Buteo jamaicensis*)	....	....	....	....	1	1	.2
Great Blue Heron (*Ardea herodias*)	....	....	....	....	1	1	.2
						68	13.5
REPTILES							
Gopher Snake (*Pituophis catenifer*)	....	6	9	10	1	26	5.2
Pacific Rattlesnake (*Crotalus viridis*)	....	....	1	....	....	1	.2
Common King Snake (*Lampropeltis getulus*)	....	....	1	....	....	1	.2
						28	5.6
FISH							
Sacramento Perch (*Archoplites interruptus*)	....	17	....	....	....	17	3.4
Sacramento Sucker (*Catostomus occidentalis*)	....	....	....	....	1	1	.2
						18	3.6
Totals						503	100.0

ing was primarily conducted over the open tops of prominent ridges. There ground squirrels were the principal prey. To the south, terrain was more open and rolling (fig. 2), with wide ridge tops and fields comprising the hunting areas, and there jackrabbits predominated in the eagle diet.

Similarly, the terrain appeared to be an important factor governing the utilization of black-tailed deer as a prey species. Remains of this species in nests were considerably more numerous in areas where the adults hunted over abrupt ridges and mountainous terrain. Remains were almost entirely of fawns, although on one occasion (May 8, 1951) a complete left forequarter of an adult deer was found in a nest (fig. 4). Remains of two stillborn fawns also were found, indicating scavenging. It is well known that Golden Eagles will utilize already dead prey, but to what extent carrion was represented in the materials of my study is impossible to say.

Fig. 3. Newly hatched young and egg of Golden Eagle, April 17, 1951. Visible food remains include one ground squirrel and one horned owl.

The occurrence of deer remains in nests raises the question of how much weight an eagle can lift. According to Richard D. Taber, weights of black-tail fawns during the period of predation by nesting eagles would be between 6 and 17 pounds. Although most of the fawns found were quite young, and consequently small, some larger ones were brought to the nests late in the nesting period (figs. 4 and 5). Delivery would be facilitated by the fact that the ridge tops hunted by the eagles frequently were above the nest sites, and a fawn might be taken to a nest by a glide rather than by actual lifting of prey and flying up to a nest. Further, there is some evidence that at least in the cases of larger prey species, portions are eaten by the adults before the item is brought to the nest. In observed kills adults spent much time with the prey before taking it to the nest. Large prey species were most frequently represented in the nest by hindquarters rather than by remains of entire carcasses.

Of the remaining larger mammals, the four domestic cats recorded were apparently

all full grown when taken, but the gray fox and the two raccoons were young individuals. Remains of both adult and young skunks and opossums were found.

Birds.—Of the 30 Yellow-billed Magpies found in the nests, the majority were young birds, apparently just fledged. In at least two instances, however, remains were found of young magpies that were too young to have left the nest. Two groups of six and eight unfledged young were found in two eagle nests in northern Santa Clara County on

Fig. 4. Young approximately 28 days old, May 8, 1951. Food remains include one jackrabbit, parts of five fawns, and left foreleg of adult deer (left center).

May 8 and 12, 1951, respectively (fig. 5). Individuals of each group were in graduated stages of development.

The majority of the remains of seven Horned Owls were of adults (fig. 3). However, two half-eaten, downy young were found in one eagle nest on June 2, 1951.

Remains of two of the three Turkey Vultures recorded were from adult birds. The third was identified only from skeletal material and age was not determined.

Mallards nest regularly near both nests in which remains of this species were found. One of the two Mallards recorded was a female while the sex of the other was not determined (identification was made only from fragmentary skeletal remains).

Reptiles.—Twenty-six gopher snakes formed the bulk of the reptile remains. Most of these were adults. In a majority of cases the remains were of almost the entire snake, few being more than a third eaten. On one occasion late in a nesting season (June 14, 1951), seven untouched gopher snakes, only one of which was less than three feet in length, were found in one nest (see fig. 6).

Fig. 5. Young approximately 40 days old, May 8, 1951. Food remains include six young magpies (lower center), one rattlesnake (lower right), and parts of four fawns (right center).

The remains of the one Pacific rattlesnake recorded seemed to be from an individual approximately three feet in length, the anterior third of which was missing and presumably had been eaten (fig. 5). Only a small section of the one king snake, estimated to be two feet in length, was found.

Fish.—Remains of fish were found at only two of the nests. Beneath one of these were recovered the left operculum and right cleithrum of a Sacramento sucker approximately 15 inches in length. Identification was made by Dr. W. I. Follett, Curator of Fishes, California Academy of Sciences.

Remains of 17 Sacramento perch were found during a number of visits to the second nest. These remains were from fish averaging 10 inches in length and were for the most part only partially eaten.

The two nests where fish remains were found were only a few thousand yards apart and were located in the vicinity of a lake which evidently served as a source of such food items.

Other records of North American Golden Eagles utilizing fish as a food item are unknown to the writer.

FOOD OF THE ADULTS

During the period when the young eagles are in the nests, the food eaten by the adults appears to be of the same species, and very often the same individuals, as are brought to the young. The fact that adults often consume parts of large prey items before bringing the remains to the nest has been mentioned. In instances during which adults were observed feeding young, the adults freely ate from the carcass from which

they fed the young. Contents of adult pellets found in the nests before the young were large enough to produce comparable pellets did not differ materially from fresh prey remains found in the nests.

Twelve food items were found during eight visits to six nests before the eggs had hatched. Species of such food items were of the same species as were commonly found in the same nests during the first month after the eggs had hatched.

Fig. 6. Young approximately 65 days old, June 14, 1951. Food remains include seven gopher snakes.

DISCUSSION

The literature of North American ornithology contains numerous references to the food of the Golden Eagle. For the most part, however, these are in the form of brief notes on the contents of single nests or a few stomachs, or observation of an occasional kill. May (1935) and Bent (1937) summarize a number of these, together with several more extensive works, to present collective reviews of what had appeared in the literature up to the mid-1930's. More recently, E. P. Pister (MS, 1950) reviewed and summarized some 94 papers on the subject. Nearly all writers concur that Golden Eagles take a wide diversity of prey species, but in all localities the bulk of the diet consists of a few predominant mammalian species such as the ground squirrel, prairie dog, and/or jackrabbit. In some instances, such as in the present study, game species or livestock may form a significant portion of the diet. Woodgerd (1952) found pronghorn antelope remains in 15.7 per cent of 51 eagle stomachs obtained in Montana. At the same time,

however, he found jackrabbits in 56.9 per cent of these stomachs. Buechner (1950) noted predation on domestic sheep and antelope in the Trans-Pecos region of Texas.

At times some control measures may become necessary when the food habits of the eagle oppose the interests of man. However, predation upon a game species does not necessarily indicate detrimental repercussions in the game population nor does the mere presence of a population of eagles in the vicinity of game or livestock indicate that such are preyed upon by the eagles. Murie (1944) found eagles abundant in an area supporting a sizeable population of Dall sheep and yet the latter species was represented in only 2.4 per cent of 632 eagle pellets examined. Ground squirrels were found in 86 per cent of these pellets.

In the present study area, the black-tailed deer is very abundant despite predation by eagles and mammalian predators as well. In fact, hunting and predation seem to be removing less than the annual increase in the herds as judged from the periodic disease losses stemming from malnutrition and excessive competition (Longhurst *et al.*, 1951). Such removal of fawns as can be charged to the eagles is probably a distinct benefit to the deer.

SUMMARY

Observations of food remains found in the nests of 17 pairs of Golden Eagles in the interior central coast ranges of California, from 1947 to 1952, are summarized. In the area studied, the Golden Eagle is a fairly common raptorial species. Nests were visited sporadically at first, but in later stages of the study visits were made from five days to two weeks apart. Remains were removed from the nests to prevent possible recount.

During the nesting period, eagles in the region studied bring to their young a wide variety of food items, dominated, however, by ground squirrels and jackrabbits. Black-tailed deer, mostly fawns, were extensively utilized by some pairs. Mammals collectively made up 77.3 per cent of the diet. Among the birds, which constituted 13.5 per cent of the diet, the Yellow-billed Magpie was the principal prey. A few snakes and fish completed the list of items found in the nests.

Comparison of these findings with other observations recorded in the literature indicates that the normal diet of the Golden Eagle consists principally of mammals, mostly non-game species.

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