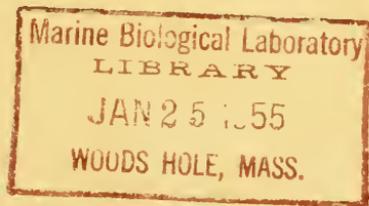


THE GOLDEN EAGLE

and its economic status



CIRCULAR 27

FISH AND WILDLIFE SERVICE

UNITED STATES DEPARTMENT OF THE INTERIOR

THE GOLDEN EAGLE

and its economic status

By LEE W. ARNOLD
Biologist

CIRCULAR 27

UNITED STATES DEPARTMENT OF THE INTERIOR, Douglas McKay, *Secretary*
FISH AND WILDLIFE SERVICE, John L. Farley, *Director*

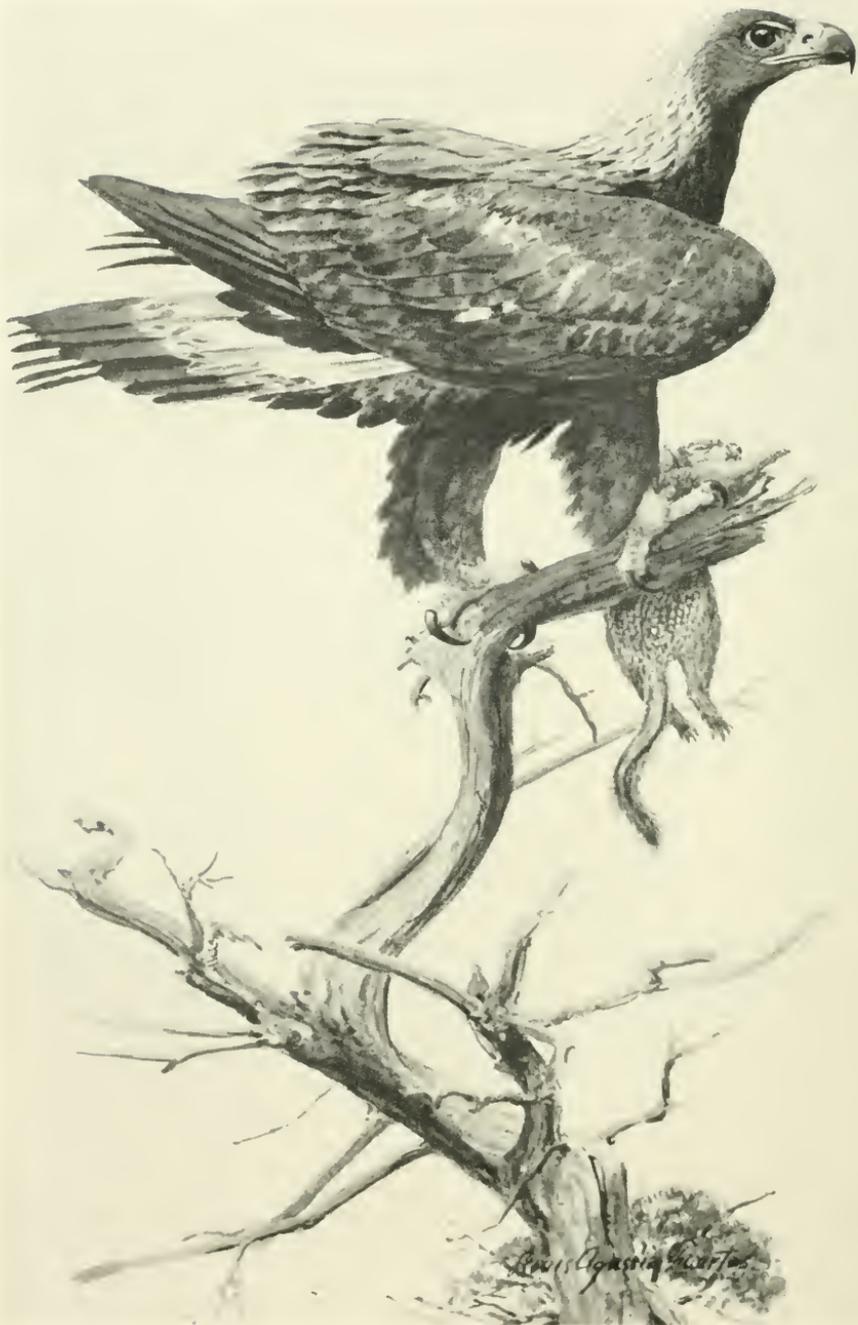


The investigational work on which this report is based was done while the author was a member of the staff of the Denver Wildlife Research Laboratory of the United States Fish and Wildlife Service. The report was submitted after the author had left the laboratory, and parts of it were condensed and revised by E. R. Kalmbach, then director of the laboratory.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1954

CONTENTS

	Page
RANGE	1
CHARACTERISTICS	2
LIFE HISTORY	4
Age	4
Courtship and nesting	4
Young	7
Territoriality	8
Migration	9
FOOD AND ECONOMICS	9
Food habits	10
Stomach analyses	11
Carrion as food	12
The golden eagle and its prey	13
Rabbits and rodents	13
Big game	15
Pronghorn antelope	15
Deer	18
Bighorn sheep	20
Game birds	22
Sharp-tailed grouse	22
Pheasant	22
Sage grouse	23
Wild turkey	23
Waterfowl	24
Other birds	26
Livestock	26
Sheep	26
Cattle	30
SUMMARY AND CONCLUSIONS	31
LITERATURE CITED	33



The golden eagle. From a Fish and Wildlife Service painting in color by Louis Agassiz Fuertes.

THE GOLDEN EAGLE

and its economic status

Arthur Cleveland Bent aptly summarized the present economic status of the golden eagle when he stated that it had "a powerful influence for either good or evil according to the conditions of its habitat." The present study has aimed at determining the nature of this influence under the varied conditions within the range of the species.

To approach this goal, significant life-history information was first assembled as a background for an understanding of the species. Data were then gathered to aid in an appraisal of the influence of the golden eagle on certain wild and domestic animals. Lastly, techniques useful in the bird's management were appraised.

This study was first assigned to Ralph H. Imler, of the United States Fish and Wildlife Service, who conducted some of the earlier field work and examined numerous stomachs of these birds. Early in 1947 the writer conducted additional field research and reviewed the literature. Among others who contributed substantially to this presentation were members of several State game departments, including Frank W. Groves of Nevada, Robert R. Elliott of Colorado, and Paul V. Jones and O. F. Etheredge of Texas. Charles C. Sperry and numerous field personnel of the United States Fish and Wildlife Service also contributed.

RANGE

The golden eagle, *Aquila chrysaetos* in its various subspecies, has a circumpolar distribution in the Northern Hemisphere (Peters 1931). Despite barriers formed by oceans, mountain ranges, and great distances, only slight racial differences appear among golden eagles living in widely separated regions. The American race, *Aquila chrysaetos canadensis*, the only recognized subspecies on this continent, breeds from northern Alaska and Labrador southward into Mexico

and sparingly in the Appalachian Mountains to western North Carolina and eastern Tennessee. Its principal breeding range in the United States is in the area west of the 99th meridian. The writer has found it nesting from near sea level in southern California to near timberline in Colorado. During winter it ranges below sea level in some California valleys (Sumner 1929), and it wanders casually over the region east of the Rocky Mountains south to the Gulf Coast.

Fossil remains indicate that the golden eagle has been present in the Western Hemisphere for many thousands of years (Howard 1930). Deposits in caves of southern New Mexico (Howard and Miller 1933) show that this eagle lived during the Pleistocene period along with the California condor and sage hen, species that have long since disappeared from the area now known as southern New Mexico.

Consequently, it may be assumed that the golden eagle is a tolerant and resourceful species and is capable of adjusting itself to a variety of environmental and habitat conditions when not subject to undue interference by man. Yet, it is significant that within the memory of man this bird has been almost eliminated as a breeding species in the mountainous regions of Eastern North America.

CHARACTERISTICS

The golden eagle is a bird of many aliases. Common names for this species¹ include the American war bird, bird of Jupiter, brown eagle, calumet bird, calumet eagle, Canadian eagle, gray eagle, king of birds, ringtail, ring-tailed eagle, ringtail falcon, royal eagle, war bird, and white-tailed eagle. The same authority records the following folk names: American eagle, black eagle, black Mexican eagle, black Spanish eagle, dark eagle, grepe, Mexican eagle, mountain eagle, and war eagle. The names jackrabbit eagle and German eagle have also found usage.

Partly responsible for this variety of names is the fact that in its juvenile plumage the basal half of the tail of the golden eagle is white and white blotches are conspicuous on the under surfaces of the wings. With each molt during the first few years, these white markings become less extensive. When 4 or 5 years old, the adult has the appearance of a uniformly colored, dark-

brown or blackish bird (Jollie 1947). At close range, however, the ochreous cast to the feathers of the hind neck and the tarsus, feathered to the base of the toes, make identification of the adult simple.

The golden eagle is a large bird. The average weight of 13 Colorado individuals was 9.1 pounds, the largest bird weighing 12.25 pounds. The average wingspread of six eagles taken near Las Cruces, N. Mex., and measured by Cecil Kennedy, manager of the San Andres National Wildlife Refuge, was 6 feet 8½ inches. Other published accounts have indicated a wingspread of 7 feet and more. That the golden eagle is superbly adapted to soaring-gliding flight is emphasized by the fact that although it weighs approximately the same as the whistling swan it has almost double that bird's wing surface (Poole 1938).

The golden eagle's stomach capacity also is substantial. Although C. C. Sperry (laboratory notes) determined that the maximum weight

¹ W. L. McAtee, Dictionary of vernacular names of North American birds. MS.

of the crop and stomach contents of nine birds killed in the wild was 1.24 pounds, it is reasonable to assume that when the golden eagle is gorged, its crop and stomach capacity exceeds this amount. In captivity, a golden eagle will consume as much as 2 pounds of meat daily (Oberholser 1906).

The size of the burden carried in flight varies with the characteristics of the individual, its incentive, the altitude, wind conditions, speed at the moment, and possibly other factors. Once the momentum of its first thrust from the ground is lost, the golden eagle is dependent either on its own laboring flight or on the irregularities of air movements including thermals.

During the spring of 1937, C. C. Sperry (field notes) tested the weight-lifting ability of a wild bird caught in the vicinity of Fort Davis, Tex. He did this by fastening weights to its feet and then releasing it. The 11-pound bird with which he experimented could not raise itself from the ground with a 5¼-pound weight attached to its feet.

Walker and Walker (1940) conducted experiments with a captive bird in good condition near sea level in southern California. When released from a platform about 15 feet above the ground, the eagle, with a weight of 8 pounds attached, beat the air wildly and was able to fly only 10 to 14 yards before coming down to earth.

Cameron (1908) observed an eagle carrying a 7-pound jackrabbit. Under exceptionally favorable conditions greater weights might be

carried. Conversely, personal observations of the writer and various references in the literature show that under unfavorable conditions golden eagles with no more than a gorged crop are unable to "take off" in the absence of air movements. Dixon (1937) also observed that with a burden the size of a ground squirrel the eagle will often take a circuitous route to its nest to utilize the lifting power of air currents and thermals. It is fundamental to recognize, however, that the golden eagle will kill animals that it cannot carry away under any conditions.

In view of the apparent inability of the eagle to carry heavy objects, reports of eagles attempting to carry off children are worthy of comment. The writer has investigated the facts associated with three such alleged attacks. Two reported attacks occurred during August 1950 near Albuquerque, N. Mex. The first of these appeared to be based on the fact that a *Buteo* hawk did nothing more than circle 50 to a 100 feet over a suburban home. In the second case, a "huge bald eagle" was described by eye witnesses as being a pure-black bird with about a 3-foot wingspread which alighted in the yard of a suburban home only to be frightened away by a dog. The third alleged attack occurred in the vicinity of Carlsbad, N. Mex., during February 1948 (Arnold 1948) and was the only incident of the three in which a golden eagle even was involved. In this case the bird had been in captivity for some time and could not fly. The "attack" actually was occasioned by a

boy tossing the weakened bird on a smaller boy's head.

Despite the unlikelihood of a golden eagle carrying off even small children, instances of these birds attacking adult human beings are

on record. The noted ornithologist, Robert Ridgway once reported an attack by two golden eagles upon a friend who had flushed the birds from a nearby carcass on which they were feeding (Ridgway 1889).

LIFE HISTORY

The following synopsis of the life history of the golden eagle sets forth only those aspects considered essential for appraising its economic status.

AGE

The maximum age of the golden eagle in the wild state is unknown, although Dixon (1937) presents fairly conclusive evidence that one bird he studied lived at least 30 years under natural conditions. Cameron (1908) records an eagle that lived at least 23 years, while other writers indicate an even greater life span in captive birds.

COURTSHIP AND NESTING

The time of courtship varies both with altitude and latitude. In the Mount McKinley, Alaska, area, Sheldon (1908) stated the birds arrived in April and immediately started nesting activities. In more southerly areas, where the birds may remain in the vicinity of the nesting territory throughout the year, courtship may begin considerably earlier with egg laying taking place in January and February.

Courtship, including displays of aerial gymnastics, is participated in by both sexes and may be continued throughout the nesting season

(Bent 1938). During this period as well as the nesting season, the selected territory is defended against other golden eagles.

There may be great variation in nest sites. One active nest observed by the writer near Hereford, Colo., was constructed in a crevice on a cliff above a sheer drop of some 100 feet. Another nest, in the vicinity of Middletown, Tex., was placed about 15 feet from the ground on a horizontal limb of a lone cottonwood. Several nests on cliffs were so located that a rock overhang gave protection from the elements; other successful nests were afforded little or no protection. In some localities favorable to nest building, a pair may construct several "dummy" nests; in other areas, where apparently there is only one satisfactory nesting site, nest building may be confined to it.

During this study, no consistency has been found with regard to the direction of exposure of the nests. Dixon (1937) noted a tendency for the birds to place their nests so that they could keep a watchful eye on golden eagles in adjoining territories.

Nests actually used by the golden eagle may vary in size from structures some 3 feet across, and of equal or greater depth, to platforms



FIGURE 1.—Nest of a golden eagle. (Photograph by Lee W. Arnold.)

5 feet across and little more than a foot thick. Basic nest materials consist of sticks variable in size. The lining may include the ends of pine branches, soapweed, shredded bark, oak moss, burlap bags, newspaper, matted cattle hair, or, as observed in one nest in Utah, a silk stocking. This latter article is of interest in view of a somewhat legendary case in which the discovery of a part of the clothing of a small boy in an eagle's nest led to the deduction that the eagle had killed the boy.

The date of egg laying varies greatly in the southern and northern parts of the golden eagle's range. Laying as recorded by Bent (1938) is as follows: Arctic America (5 records) May 27 to June 29; California to Texas (272 records) February 9 to May 18. Thus, there is about a 3 months' spread in the dates on which the first eggs are laid in the extremes of the golden eagle's range. The usual set is two eggs. Sets of one egg are common and of three rather rare; at least one set of four has been taken, according to Bent.

According to Dixon (1937), both sexes share in the incubation of the eggs. Although this point is debated by some observers, all agree that the male does help brood the young. According to Bent, the period of incubation is about 35 days. Although a female may desert her eggs if the nest is bothered by man, she will rarely desert the young. Dixon found that the eggs of various females show great individuality and, one might say, a family resemblance as to shape and color.

This characteristic appearance of the eggs can be used in determining the tenure of a nesting female in a given locality.

Adult eagles are usually extremely wary when a person comes near the nest. Unless special precautions are taken, an observer may at best catch merely a glimpse of one or both adults as they leave the vicinity. His next view of the birds may be when they reappear in the distance on some vantage point or as casually circling specks high in the sky. Without adequate observations it may even be difficult to determine which of several nests in the vicinity is the one occupied at the time.

The exceptional wariness that adult eagles display when humans are in the vicinity of their nests no doubt plays an important part in their ability to survive. It is the basis for Dixon's (1937) comment that in southern California the golden eagle is better able to survive than most predatory birds, and for Pierce's (1927) statement that the golden eagle is holding its own in southern California far better than is perhaps to be expected.

Extreme wariness is such a universal trait in the golden eagle that one may even speculate as to the effect the unrelenting pressure exerted on the "war eagle" by generations of North American Indians may have had in forming or strengthening this behavior.²

²Tail feathers of the immature birds, with their broad, white bases were especially sought and, to assure uniformity, the two central feathers were selected. Golden eagles were even kept in captivity so that these feathers might be plucked when they grew out.

YOUNG

Accounts of the growth and development of the young of the golden eagle have been recorded by several observers (Cameron 1905, Summer 1929a, Bent 1938, and Jollie³). At about 9 or 10 weeks of age the young are fully feathered and ready for their first flight in the vicinity of the nest (fig. 2). Bent reports, and the writer's observations verify the conclusion, that young eagles frequently remain in the vicinity for some time after they leave the nest. They are approximately 3 months old before they gain the full power of flight. On first leaving the nest they hunt

with their parents, who normally watch and guard them until they learn to take care of themselves. In northern Colorado, young and old birds were observed together until the last part of October.

An increase in the number of eagles seen in early fall in certain localities may be the result of the appearance on the wing of the young of the year and should not be confused with winter aggregations of migratory birds from other areas. The young are, for the most part, more fearless of man than the adults and consequently more conspicuous.

³Malcolm T. Jollie, *The golden eagle—its life history, behavior, and ecology*. Unpublished thesis, University of Colorado, 1943.



FIGURE 2.—Nestling golden eagles on Colorado State Antelope Refuge. (Photograph by Lee W. Arnold.)

The juvenile plumage of the golden eagle is retained for 1 year, the only change being a wearing away of tips of the feathers. From the postjuvenile molt on, progressive changes take place through annual molts, each bringing the bird a step closer to mature plumage. At times, one or the other of a nesting pair may not have acquired its full adult plumage. The fully adult plumage is acquired at the age of 3½ years, or more (Jollie 1947).

There is evidence that the golden eagle, contrary to common belief, does not mate for life but that, in the jockeying of birds for better territories or for more virile mates, new matings are not uncommon (Dixon 1937).

TERRITORIALITY

In northern Colorado, the writer observed that each pair of golden eagles occupied a specific territory. Territory referable to the six nests studied there embraced about six townships. Feeding, roosting, and soaring-playing areas were all found within each pair's territory, and the size of these areas varied with availability of food, nest sites, and suitable terrain.

Dixon, in studying 27 pairs of golden eagles, mapped their territories and kept records of their activities. He found a direct relation between the amount of actual hunting area available to a pair and the overall size of the territory occupied. As a rule, a pair of eagles in a wilderness area with ample food supplies occupied a smaller territory than one whose territory

was planted to crops. Therefore, it can be expected, if other things are equal, that the geographical area occupied by a pair of eagles in hilly country will be smaller than in flat, open country. The minimum area studied encompassed 19 square miles, the maximum 59 square miles, and the average for the 27 pairs was about 36 square miles, the equivalent of a township.

Dixon (1937) noted that the boundaries of the territory claimed by a pair of birds were definite and the area was handed down from generation to generation. The death of one bird of a pair soon led to the choice of a new mate, and did not affect the status of the area involved. If both birds were destroyed at the same time the area became open territory but did not seem to remain so for long. This was substantiated by the observation that although the female of one pair was killed in December, the male had a new mate and a set of eggs was laid by February 20.

In describing nesting territories of golden eagles, Baird, Brewer, and Ridgway (1874) reported that in southern Oregon each pair of eagles seemed to confine itself to a certain district, the nests being about 20 miles apart. W. Steinbeck of Hollister, Calif., also observed that each pair had its own range and would drive any outsider away (Bendire 1892). These ranges were usually from 2 to 6 miles wide, and the birds became so attached to them that it seemed impossible to drive them away. In one case, where he took three sets of eggs in successive years and killed the female, the male

procured another mate and occupied the same nest the next season.

Adolph Murie (1944) stated that in Mount McKinley National Park individual pairs of golden eagles confined their activities to areas less than 10 miles in diameter, but he suspected that at times they cruised considerably farther afield, especially when carrion was available.

MIGRATION

There is evidence that the golden eagle's movements in fall and winter may be a somewhat more orderly migration than was commonly supposed (Broun 1939). That migration may not influence the entire population is emphasized by the fact that in some areas golden eagles remain in their nesting territories

throughout the year and that in other areas winter concentrations may vary from year to year or even from day to day. The available food supply is probably a governing factor in this respect. Weather conditions are evidently of secondary importance, as the birds are quite capable of surviving subzero temperatures satisfactorily when food is obtainable.

Concentrations and movements during fall and winter have an important bearing on the economic status of the golden eagle in a given locality. Knowledge of these traits and an understanding of the tendency toward territoriality during the breeding season is essential in any contemplated program of eagle management.

FOOD AND ECONOMICS

There is no easy way to determine the general economic influence of the golden eagle, and, although there are several methods of approach, each has advantages as well as disadvantages. These methods are discussed in the following paragraphs in advance of the presentation of testimony used in arriving at an appraisal. In the final analysis, conclusions must be drawn from a summation of all evidence and the weight to be given each will rest largely on the analyst's familiarity with local conditions.

Interviews with outdoorsmen yielded evidence regarding the golden eagle that ranged from high praise to outright condemnation and, whereas the author has en-

deavored to present all shades of valid testimony, including that in published form, data unduly affected by personal bias was discarded or appropriately evaluated.

Careful analysis of crop and stomach contents is probably the most reliable source of information concerning the food eaten, but even this has its limitations. The inability to differentiate carrion from captured prey has long plagued the food analyst. Also, after large numbers of eagles are removed for their stomachs, the relation between the residual population and its prey is different from that at the outset. The examination of regurgitated pellets of undigested food likewise has advantages and disadvantages

(Errington 1930; Glading, Tillotson, and Selleck 1943). It has merit in that it permits detection of seasonal fluctuations in the food of the same group of birds with no individuals being removed from the environmental complex. On the other hand, the examination of pellets, even more so than that of stomachs, fails to reveal those items that are readily obliterated in the digestive process; and also, when flesh, devoid of hair, fur, or bones, is being ingested, pellets may not be formed. This may happen when the eagle is feeding on large carcasses, yet Murie (1944) found in Mount McKinley National Park, that pellets ejected by golden eagles frequently revealed evidence of the birds having fed on the bodies of caribou calves and Dall sheep—construed to have been carrion.

Still another method of food appraisal of the golden eagle involves the inspection of food remnants found in or under nests or in the vicinity of perches frequently used by the birds. Through frequent collecting of freshly deposited material, a picture of seasonal fluctuation in food may be obtained by this method. On the other hand, accumulations of food debris over a period of years may have the picture confused by the fact that other creatures, particularly packrats (*Neotoma*) may add to or detract from the accumulation.

The foregoing recital sets forth some of the problems faced by the student of the economy of wild creatures. The science is fraught with many difficulties; it also has many reassuring and convincing

characteristics, not the least of which is an adequate and intimate field acquaintance with the creature being appraised. In his analysis, the author has endeavored to make use of all approaches available to him.

FOOD HABITS

The American golden eagle is both a predator and a carrion eater, and at times it takes carrion even though live food is available. Like most widely ranging species its food varies from place to place depending on availability.

Indicative of the golden eagle's adaptability are the following items which have been reported eaten by this species. These lists were compiled from the literature and from field records of the United States Fish and Wildlife Service.

Among the birds taken are herons, swans, geese, ducks, turkey vultures, accipitrine hawks, *Buteo* hawks, marsh hawks, falcons, grouse, ptarmigan, European partridge, quail, pheasants, wild turkeys, coots, plovers, curlews, band-tailed pigeons, owls, kingfishers, magpies, ravens, crows, and various smaller perching birds.

Mammals listed as taken by the golden eagle include opossums, moles, raccoons, ring-tailed cats, martens, weasels, minks, skunks, foxes, coyotes, bobcats, woodchucks, ground squirrels, prairie dogs, arboreal squirrels, pocket gophers, native rats and mice, muskrats, porcupines, pikas, varying hares, jack-rabbits, cottontails, deer, elk, caribou, pronghorn antelope, mountain sheep, and mountain goats.

Among the reptiles reported taken by the golden eagles are rattlesnakes, various nonpoisonous snakes, terrapins, chuckwallas, and other iguanas. There are also two references in the literature and one in the field notes of golden eagles eating frogs.

Domestic animals among the eagle's prey include cattle, sheep, goats, pigs, dogs, and cats, while domestic fowl eaten include ducks, geese, chickens, and turkeys.

STOMACH ANALYSES

The stomachs and/or crops of 102 golden eagles have been examined in the laboratories of the United States Fish and Wildlife Service and the former Biological Survey. This material was collected under diverse conditions in numerous States and in Alaska over a series of years (table 1). In general, it reflects relatively modern conditions, 81 of the stomachs having been collected since 1920. Although a bird with such diversified

food habits as the golden eagle cannot be judged adequately by a mathematical presentation of data from such a limited series, a digest of findings is presented in the appended tables. Table 1 sets forth the areas in which the stomach material was taken and table 2 gives the results of the examinations.

Carrion, eaten largely during the colder months, had its origin mainly in the carcasses of larger mammals, both wild and domestic. The interpretation of carrion was made largely on the basis of the circumstances observed at the time the stomachs were collected. Observations made at that time often indicated that the birds were shot while feeding on a carcass, or were trapped by carrion used as a lure. The carrion nature of flesh cannot as a rule be determined by laboratory examination and reliance must therefore be placed on observations made in the field.

There will be doubtful cases in which the evidence is not clear and

TABLE 1.—Locations and months in which 102 stomachs and crops of golden eagles were collected

State	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Alaska.....				1	3				1		1		6
Arkansas.....				1						1			2
California.....				1									1
Canada.....								1					1
Colorado.....	1			1		1							2
Idaho.....					1								1
Illinois.....											1	1	2
Iowa.....	1												1
Maryland.....												1	1
Minnesota.....											1		1
Montana.....		2								1			3
Nebraska.....	2	6	1									4	13
Nevada.....			1										1
New Mexico.....	2	12	5		3				1			2	25
North Dakota.....	1	12											22
South Dakota.....											1		1
Texas.....	1	4	2	2						1	2		12
Virginia.....												1	1
Wyoming.....		2	1	1	1			1					6
Total.....	8	47	10	6	8	1		2	2	3	6	9	102

¹ Collected during the periods Jan. 1–Mar. 15 in 1940 and 1941 at a game farm in North Dakota.

TABLE 2.—Occurrence of food items in 102 stomachs and crops of golden eagles

Month	Number of specimens collected	Rabbits ¹	Rodents ²	Deer	Other wild mammals ³	Up-land game birds ⁴	Water-fowl ⁵	Other wild birds ⁶	Sheep and goats	Poultry ⁷	Carrion ⁸	Total food items
January	8	4		1			1				1	7
February	47	21			1	19		1	2		10	54
March	10	4	1		2			1	3		1	12
April	6	1	1		1				1		3	7
May	8	4									4	8
June	1	1										1
July	0											0
August	2		1			1						2
September	2		1	1				1				3
October	3		2								1	3
November	6	2	2						1		2	7
December	9	6							1	1	3	11
Total	102	43	8	2	4	20	1	3	8	1	25	115

¹ Jackrabbits (*Lepus*) and cottontails (*Sylvilagus*).

² Ground squirrels (*Citellus*), marmots (*Marmota*), and fox and grey squirrels (*Sciurus*).

³ Skunks (*Mephitis*) and reindeer (*Pangifer*).

⁴ Sage grouse (*Centrocercus*) and game-farm pheasants (*Phasianus*).

⁵ Pintail duck (*Anas*).

⁶ Turkey vulture (*Cathartes*).

⁷ Chicken.

⁸ Carcasses of domestic sheep, cow, horse, deer (*Odocoileus*), reindeer (*Pangifer*), and jackrabbits (*Lepus*).

⁹ 17 collected at a game farm in North Dakota.

those situations will have to be charged to the inefficiency of the procedures at hand. This may have occurred in the case of the pintail duck eaten by an eagle in January. Whether this duck was an overlooked victim of a hunt or the prey of the eagle cannot be determined from the stomach contents. Likewise, under modern conditions, there may be honest doubts as to whether the remains of a jackrabbit is indicative of eagle predation or of highway hazards. Generally, it is safe to assume, from the known predilections of the golden eagle, that the great majority of the rabbits and rodents were taken alive.

Mention should be made of the 19 instances of pheasants eaten in the month of February. Circumstances connected with their collecting are discussed under Pheasant on pages 22 and 23.

CARRION AS FOOD

It has been a popular conception for many years that the bald eagle is principally a scavenger, but that the golden eagle takes carrion only when compelled by necessity. Data assembled in this study indicate that carrion is frequently taken by the golden eagle even when living prey is available. Substantiating this contention are the following recorded incidents.

J. Stokley Ligon, in Socorro County, N. Mex., March 1915, noted that golden eagles fed on the carcasses of stock killed by wolves and thought that "no doubt the destruction of the gray wolves will increase the usefulness of the eagles by forcing them to kill more of their meat . . . rabbits." (Bailey 1928.) Murie (1944) observed in Mount McKinley National Park that golden eagles assembled at any car-

tion they could find although ground squirrels were available most of the time.

An experiment conducted by C. C. Sperry (field notes) in the vicinity of Fort Davis, Tex., proved that the carcass of a jackrabbit or of a lamb which had been dead for 2 days or more was preferred even though live lambs of all ages were in the immediate vicinity. As late as April 12, when sheep carrion was abundant and eagles scarce, Sperry trapped an eagle at the carcass of a stillborn lamb that had been dead 48 hours. This is common procedure among stockmen in the Southwest in their attempts to trap or poison golden eagles. A number of ranchers interviewed during this study remarked that when fresh carrion is available, golden eagles devour it instead of catching live animals.

One also observes, in areas of rabbit concentration in the West, a substantial number of golden eagles destroyed along highways to which these birds have been attracted by rabbits killed by automobiles. Also, their predilection for carrion is revealed in their own misfortune when they die from eating rodents that have been killed by poisoned grain used in rodent control.

One might even surmise that similar carrion-feeding habits are reflected by the evidence found at the prehistoric tar pools of LaBrea, Calif. Howard (1930) determined that in these deposits remains of the golden eagle exceeded those of all other hawklike birds, including the carrion-eating vultures. That these birds were attracted to the area by

the animals which died as a result of miring down in the pools of tar is a logical assumption.

Thus, the conclusion is drawn that the interrelation of the eagle and game or domestic animals is affected by the presence or absence of carrion as emphatically as by the relative populations of live buffer or prey species.

THE GOLDEN EAGLE AND ITS PREY

RABBITS AND RODENTS

Based on the findings of qualified wildlife technicians in nine western States, Canada, and Alaska, rabbits and rodents are the dominant food of the golden eagle over its wide range in North America. In a study of eagle food preferences in June 1943 in Colorado and Wyoming, R. H. Imler found that at nine active nests approximately 77 percent of the food items came from these sources (table 3).

On two study areas established in northern Colorado by the author in 1947 (pp. 17, 18) to determine food preferences of the golden eagle, many kinds of acceptable prey were available to the nesting eagles, yet most of the animals eaten by them in that region were rodents or rabbits (fig. 3). Of 138 such animals recorded, 103, or 74.6 percent, were rabbits, 32, or 23.2 percent were prairie dogs, and 3, or 2.2 percent, were rats and mice. No ground squirrels or pocket gophers were found.

Although these studies show that the golden eagle feeds extensively on rabbits and rodents, it does not

TABLE 3.—*Food items found near 9 golden-eagle nests in Colorado and Wyoming, 1948*

Location of nest	Date observed	Age of young in nest (weeks)	Jack-rabbit	Cottontail	Ground squirrel	Wood rat	Sheep (bones)	Sage hen	Water-fowl	Unidentified
Colorado:										
Loveland	June 5	2-7	1	2					1	
Pawnee Butte	do	"Large"		6						
Grover	June 6	1-8	1							
Wyoming:										
Wolcott	June 10	2-3		9			3	1		
Do	June 19	(Same nest)		2	2					
Point of Rock	June 10	No data	1	9	4					8
Do	June 11	2-3		11	1	1				2
Farson	June 13	1-7	1	6	1			2		
Do	June 19	(Same nest)	3	2				3		
Do	June 18	No data	10	2	3			4	1	2
Rock Springs	June 15	1-7	9	4		1	1	11		
Total			26	53	11	2	4	21	2	12

give the ultimate answer to the economic considerations involved. The simple fact that rabbits and/or squirrels are considered desirable game species in some areas and in other localities pests, pointedly sets forth the complexity of the problem. In the West, where the golden eagle is resident, rabbits and rodents often are considered economic liabilities; consequently, the pressure exerted on their populations by the golden eagle is favorable to livestock, game, and forest management.

Rabbits were not abundant on the two study areas established in northern Colorado during the spring and summer of 1947. On September 3 and 4, 1947, during a 60-mile automobile census on both areas, one cottontail but no live jackrabbits were observed. The fact that the only jackrabbit seen was being eaten by two eagles may be indicative of food preference despite the relative scarcity of rabbits at the time.

Corroborating this apparent preference of the golden eagle for rabbits was the finding at a nest on

one of the study areas of the remains of 60 rabbits as compared with 28 prairie dogs, even though there was a colony of prairie dogs within 500 yards of the nest site. The fact that during the first part of the period, when young were present in another nest, cottontail rabbits predominated as food and later more jackrabbit remains were found there, may be indicative of varying food selectivity as the young eagles mature. Coney (1944) in Montana and others elsewhere have made similar observations.

Since mammalian predators had been drastically controlled in the Colorado study areas, the influence of eagles on the rabbit population may have been substantial. Evidence indicated that the eagles had to hunt the rabbits they captured, and that the rabbits taken were "seed stock" and not part of a surplus population crowded out into a precarious, marginal existence.

Despite the frequency with which the golden eagle preys on rabbits and rodents there are few references in the literature describing

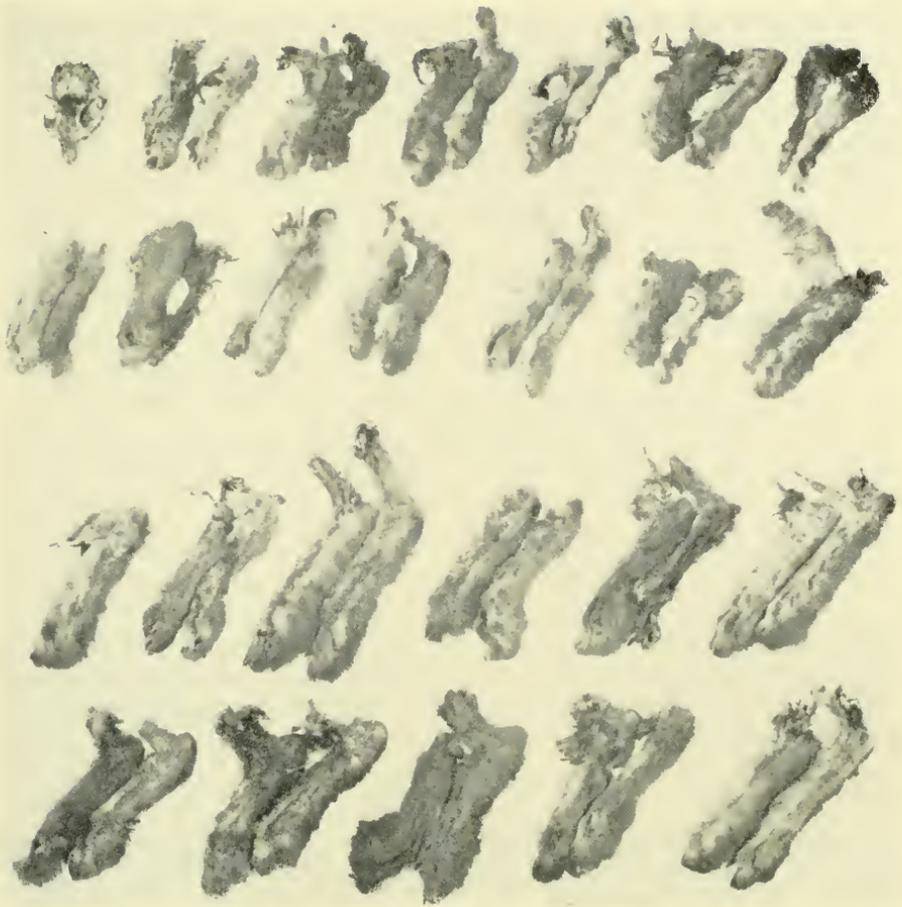


FIGURE 3.—Food remains found at nest of golden eagle on Colorado State Antelope Refuge in 1947. They include the skull of a prairie dog, 26 hind feet of cottontails, and 21 hind feet of jackrabbits. (Photograph by E. R. Kalmbach.)

the act. H. N. Elliott, a hunter for the former Bureau of Biological Survey cited the following incident that occurred in May 1936 in Jeff Davis County, Tex.:

The eagle was seen flying at a height of approximately 200 feet. At a certain point the bird folded its wings and went into a dive. When about 20 feet from the ground it spread its wings and continued toward the ground. When within a few inches of the surface its feet were lowered just enough to strike a prairie dog that was feeding some 10 feet from

its hole. The eagle then circled and returned to the point where the prairie dog had been struck and its back broken.

BIG GAME

Pronghorn Antelope.—Golden eagles have been known to kill both young and adult antelope. Attacks on adult antelope occur usually in severe winter weather or during periods of food scarcity or distress for the antelope, the eagles, or both. Such incidents have been reported

more frequently than those of eagles attacking antelope kids.

E. S. Cameron (1908) has given this graphic account of the attack of several golden eagles on an adult antelope in Montana:

The eagles had obviously stampeded a bunch of antelope and then cut out a victim by a combined attack. Altogether the antelope could barely have covered three hundred yards after the first attack by the eagles.

The following observation was made by Willard W. Lahnum, biologist, United States Fish and Wildlife Service, on the Garcia Ranch near Magdalena, N. Mex., on June 19, 1943:

Milton H. Webster and I jumped an antelope and two kids this morning, and on the way back we passed over the same road. In the wheel track was a dead antelope kid with an adult golden eagle feeding on the carcass. About one-quarter mile from where the carcass of the

kid and the eagle were seen, were a female antelope and one kid. Not over one-half hour had passed since we had previously seen the female and the two kids.

Figure 4 pictures the victim of this episode.

Despite the authenticity of such reports, determining the importance of eagle predation in antelope survival is not easy. This becomes obvious if one considers that competent observers (Williams and Matteson 1948) believe there is a greater abundance of breeding golden eagles in Wyoming on the basis of comparable area, than in any other western State; yet, through various management practices which placed little or no weight on the influence of the golden eagle, a remnant antelope population of fewer than 5,000 in 1900 was increased to a point where more than 41,000 were harvested in 1952.



FIGURE 4.—Remains of antelope kid killed by a golden eagle near Magdalena, N. Mex., June 19, 1943. (Photograph by W. W. Lahnum.)

To obtain quantitative data concerning the golden eagle-antelope relationship, two areas in north-central Colorado bounded on the north by the Wyoming boundary were selected as study areas in the spring of 1947. One was the Colorado State Antelope Refuge, of approximately 114 square miles, and the other an area of similar size some 14 miles to the east. Although the refuge was admittedly the more suitable for antelope, approximately one-half of the other area compared favorably with the refuge in forage, terrain, and lack of barriers that would inhibit antelope movement. Nest sites and hunting territories for eagles were about the same on both areas. The principal economic use of each area was grazing of sheep and/or cattle. The study on the refuge was conducted cooperatively by the United States Fish and Wildlife Service and the Colorado Game and Fish Department, represented by Biologist Robert R. Elliott, who was conducting fawning studies at the time.

Between June 6 and 18, 1947, four occupied eagle nests were found on the refuge and two on the area to the east. An aerial survey of the areas at a later date failed to disclose additional nests. The activities of the six pairs of eagles and their young were followed at intervals until October 16. During the following winter, Elliott maintained records and determined the year-round presence of eagles in the vicinity of certain nests on the refuge. In April 1948, the writer again visited each nesting territory to de-

termine occupancy during the 1948 nesting season.

Information supplied by the Colorado Game and Fish Department indicated that approximately 548 adult antelope were on the refuge during the 1947 eagle nesting period. The antelope population on the other area was estimated to be not more than 50. Relatively few white-tailed and black-tailed jackrabbits or cottontails were observed on either area. Two prairie-dog "towns" of several dozen burrows each were located within the radius of influence of one nest on the refuge area and another "town" was within a few hundred yards of one of the nests on the other area. There may have been other undiscovered towns on either or both areas. A scattered population of mule deer was present in suitable habitat on each area.

In addition to these potential prey species, each area supported numerous other acceptable food species including small rodents, small mammalian predators, and several species of birds. Scarcity of sign indicated low coyote and bobcat populations, due no doubt to intensive control for several years. Fresh carrion was found on one occasion on each of the areas during the 1947 nesting season. Eagles were observed feeding on it in the refuge. Although a carcass on the other area gave evidence of having been fed on, none of the large birds was observed feeding on it.

All golden-eagle nests under study on the two areas were located on rock ledges adjacent to open country inhabited by antelope. Two nests

were situated so as to afford a clear view of several square miles of antelope range. Although another nest had a more restricted view, a newly dropped fawn was observed by Elliott within sight of it. The fourth nest on the refuge was placed on the precipitous face of a small canyon. Although it was shut off from the open country, the rock ledge above the nest afforded a clear view of the open antelope range. In two of these four nests two young eaglets each were raised to flight stage; another nest was probably successful; and at the time of discovery on June 19, the fourth nest contained two recently dead eaglets approximately 6 weeks old.

Nest contents, animal remains, and pellets at these nests were analyzed for evidence of golden-eagle predation on antelope kids. Although a portion of one antelope kid found beneath a nest indicated possible predation by eagles, Elliott's field observations revealed little predation of any sort on young antelope during the 1947 kidding season. The two active eagle nests on the eastern area were inaccessible to the writer, but remains only of rabbits and prairie dogs were discovered below them.

According to Robert Niedrach of the Denver Museum of Natural History, the 1947 eagle population for the eastern area was approximately one-half of that present between 1930 and 1935. Ranchers in the vicinity stated the antelope population had shown no noticeable increase. In contrast, at the time of this study the refuge was believed to support close to the maximum

number of eagles for an area of its type, and according to the Colorado Game and Fish Department the antelope population had increased from 250 in 1939 to more than 500 in 1947. It would appear that the number of nesting golden eagles on these areas at kidding time had no appreciable effect on antelope populations.

Elliott reported three instances in which eagles may have caused the death of adult antelope during the winter of 1947-48. Lehti (1947) also reported one highly probable eagle kill on the refuge on February 21, 1947. Although from the spring of 1947 to the spring of 1948, golden eagles exerted some influence on the antelope, evidence indicates that this was detrimental only in a minor way. Under a four-phase utilization program involving sheep, cattle, antelope, and to a less degree deer, there was competition for forage. Therefore, in the overall analysis of the situation in 1947, it is believed that the destruction by the golden eagle of rabbits and prairie dogs which were in direct competition for forage with the four major species, outweighed whatever minor negative influence there might have been.

This brief field study does not solve the eagle-antelope problem throughout the wide overlapping range of the two species. Under other conditions the situation as it existed during the 1947-48 season might be subject to different interpretation, even in northern Colorado.

Disc.—Under favorable conditions the golden eagle may kill

adult or young deer. Somewhat typical of the evidence concerning such activities is the following observation made in September 1939 in southeastern Arizona by Glen Taylor, a hunter for the former Bureau of Biological Survey. The animal under attack was a white-tailed fawn.

While hunting lions on the south end of the Galiuro Mountains, I was walking up a very rough canyon. As I neared the head I heard a noise like a baby crying in pain and looking up to the rim of the canyon, saw a Mexican (golden) eagle swoop down and then rise very fast. I then noticed an old doe deer standing on her hind legs and pawing at the eagle and a fawn was lying on the ground under the doe. After the eagle had swooped six times, the doe struck it on one wing, and it flew over in the top of a juniper, where I shot it. Upon returning to camp that evening I came back by the place where the fight took place and there lay the fawn nearly dead. It could not control its back legs. The eagle had injured its back and no doubt it died later.

In contrast, is an incident observed by Philip Wells of the Arizona Game and Fish Commission during the spring of 1945 in northern Arizona, in which a doe was able to protect twin fawns from eagle attack.

The following account from Adolph S. Hamm, Cheyenne, Wyo., is illustrative of eagle depredations on adult deer:

J. W. Verplancke, and his companion Arthur Vany, while running their trap lines in southern Carbon County in December 1938, were 300 to 400 yards from a small group of mule deer when suddenly a large golden eagle swooped down and attacked a five-point buck in this herd. The eagle caught the deer in the back with its talons and within a hundred yards in snow 2 feet deep brought

it to the ground. In a few seconds 7 more eagles swarmed on the deer and started ripping him open. It took the boys about fifteen minutes to work their way through the deep snow to where this deer was down and during that time the eagles had completely disemboweled the deer and, of course, he was dead. When the men returned 2 days later, the eagles had practically devoured the entire carcass as there were no signs of any other animals having fed upon it.

These records and others indicate that under certain conditions eagles may kill even adult deer. Here again, as in the case of the antelope, the importance of this factor is difficult for the game manager to ascertain. Often golden eagles swoop at a wide variety of animals ranging in size from ducks to grizzly bears (Murie 1944) merely to harass them. An example of this was reported in 1948 by Refuge Manager Greenwalt of the Wichita Mountain Wildlife Refuge in Oklahoma:

On the 8th Shrader saw an eagle feint three times at an adult doe deer within a distance of a half a mile while the animal was running for cover. He said the eagle did not strike the deer but came close each time.

The following account, narrated in a letter by Jack A. Parsell, Forest Service employee of the Nezperce National Forest in Idaho, indicates that at times these passes at prey may be of more serious intent. He stated:

On one occasion, in the spring of 1936 I personally observed an eagle in the act of separating a yearling mule deer from a band of fifteen others. The eagle, after thoroughly frightening the deer by swooping down and flagging the animal with its wings, proceeded to direct the course of the deer through an exceedingly precipitous area to the river some 1,000 or

1,500 feet below. There was no mistaking the intent of the eagle. It directed its efforts toward forcing the deer over the sheer bluffs, thereby either killing the deer or crippling it so badly that it could offer no further resistance to the attack of the eagle.

Sutton (1928) reports a similar case of a golden eagle pursuing a fawn until it was driven over a sharp declivity. The deer's leg was broken in the fall, whereupon it became easy prey for the large bird. Anderson (1940) also reports two instances where he thought golden eagles were intentionally trying to knock mountain goats from ledges. In one of these the eagle actually knocked a yearling goat off the ledge but the latter landed on a ledge 10 feet below with no apparent ill effects.

To what extent such observations portray the unusual or the commonplace is not possible to state. Pending the time when adequate field appraisal of the deer-eagle relationship can be made, available evidence indicates that the golden eagle has only a minor influence on deer. Although more than 100 years have elapsed since Audubon (1834) placed "young deer" at the top of the golden eagle's food list, there still is almost as much need for factual data on this specific trait as there was in 1834.

Bighorn Sheep.—In a study of the bighorn in Arizona, cooperatively conducted by the National Association of Audubon Societies, the Arizona Game and Fish Commission, and the University of Arizona in 1937, A. A. Nichol (correspondence) found that the three major factors operating to the detri-

ment of the species at that time were poaching, roads, and drought, and the greatest of these was poaching. No eagle depredations on bighorn sheep were observed during the investigation.

Since Nichol's survey, this species has been subjected to research in practically every State in the West. Bighorn-sheep refuges have been established, and technically trained wildlife managers have been assigned to them. Even with this increased emphasis on bighorn-sheep restoration, authentic information is still sketchy concerning the effect of golden eagles on bighorn sheep with which they often share the same range.

Great interest, however, was manifested when Allen (1939) in his account of the ecology and management of Nelson's bighorn, considered the eagle a serious threat to bighorns in southern Nevada. He expressed the opinion that golden eagles probably killed far more newborn lambs than did mammalian predators, and stated that he had personally observed 17 kills of bighorn lambs by eagles.

Refuge Manager Kennedy (1948) of the San Andres National Wildlife Refuge, N. Mex., recorded a highly probable case of a golden eagle's killing a desert bighorn lamb. In this instance the ewe was observed in the process of giving birth to the lamb, and she was seen with the lamb 2 days later. On the third day a golden eagle was observed feeding on the lamb, and circumstances attending the observation indicated that the eagle had killed the lamb. It may be signifi-

cant that although a study has been made by personnel of the San Andres Refuge of six golden eagle nests, no further evidence of predation on bighorn sheep by eagles has been encountered.

C. C. Spencer (1943), in his study of bighorns in the Tarryall Mountains of Colorado, failed to observe eagles attack or molest the sheep in any manner. He did note that the sheep were not alarmed when eagles came near, although the ewes were alert even when a raven came close to the lambing grounds. As a result of his studies he felt that although his observations were not conclusive, they were at least indicative that in the Tarryall Mountains the eagle is a minor factor in the well-being of the bighorn.

Packard (1946), who studied eagle-bighorn relationships in Rocky Mountain National Park, also found no evidence to indicate that golden eagles preyed on bighorn sheep. Supporting this contention was the observation that eagles were seen soaring low over banks that contained lambs without paying any noticeable attention to the young animals.

Honess and Frost (1942), studying the factors responsible for the decline of bighorns in Wyoming, made observations June 1 to August 1, 1940, on an eagle's nest in the very heart of the lambing grounds but found no remains of lamb or adult bighorns. They also stated that no predation by eagles on bighorns had been seen by any survey member nor had one been reported during the time of the study.

Therefore, they concluded that eagles could be exonerated of any serious blame for the decline of the Crystal Creek bighorn herd.

Coney (1944) reports that in the Sun River area, in Montana, bighorn ewes with small lambs were seen in the vicinity of an eagle's nest but that the sheep were unconcerned even when the eagles flew over them in search of food.

The Idaho mountain-sheep survey (Ellis 1941) also revealed no reliable evidence of predation by eagles on lambs or mature bighorns during the year-long study. It was concluded that, although the eagles are capable of killing young lambs, "the survival of the lambs through the yearling stage would seem to discredit the menace of the eagle * * *."

With regard to the relation of the golden eagle to the Dall sheep of Mount McKinley National Park, Murie (1944) reported that no authentic case of an eagle's having killed a lamb came to his attention although he did find pellets indicating that the bird had eaten lamb. His statement that "it is apparent that their (golden eagles') predation on sheep is negligible" is based on 3 years intensive field study.

When the overall problem is analyzed in the light of available data, it is the writer's opinion that the influence exerted by the golden eagle in either decimating the former populations of bighorns or inhibiting their restoration has been relatively minor when compared with other factors controlling bighorn sheep populations.

GAME BIRDS

The relationship of the golden eagle to upland game birds has long been a matter of debate. In England and on the continent, the black grouse (*Lyrurus tetrix*) and other gallinaceous birds have been reported preyed on by the eagle. During the 19th century this one factor was considered responsible for the serious depletion of game-bird populations in some European areas (Oberholser 1906).

In this country, little regard has been given to the possible effect of this large bird on various species of grouse until recent years. Among earlier workers, Ridgway (1877) reported a pair of golden eagles giving chase to and capturing a sage hen. In this instance the eagles pursued the grouse on the wing until it dropped to the ground from exhaustion, where it was picked up by the foremost of the large birds.

Sharp-tailed Grouse.—That golden eagles at times may levy a substantial toll upon sharp-tailed grouse first gained emphasis when Cameron (1905) reported that one eagle nest under observation in Montana always had the remains of grouse in it when visited. He also noted that when the young eagles were nearly grown they were fed almost exclusively on this game bird. Later, Cameron (1908) pointed out that eagles nesting in territory where grouse were not plentiful fed their young largely on jackrabbits and prairie dogs.

The effectiveness of cover in protecting prey species from attack by the golden eagle was recognized by Barrows (1912). He tells of three

instances in which golden eagles were caught alive after becoming entangled in bushes and vines where evidently, they had plunged after some quarry they had failed to capture. A similar case was recorded by Prudy (1898) near Northville, Mich., in which a golden eagle was so intent on its pursuit of a covey of bobwhites that it entangled itself in a thicket of raspberry bushes.

Pheasant.—The golden eagle's influence on pheasant populations varies with local conditions. Illustrative of this is the somewhat extreme situation that existed at a game farm near Dawson, N. Dak., late in the winters of 1939-40 and 1940-41. The North Dakota Game Department had sanctioned the killing of eagles on this area of pheasant concentration during the 2 winters. This decision was based on investigations which disclosed definite predation on and disturbance of the pheasant population by eagles. The game farm had an estimated population of 15,000 pheasants, and cover was not dense over most of the area.

The depredations by the eagles were described as follows by E. M. Lee, chief game warden:

As soon as the eagles had finished their meal they would perch in tall cottonwood trees which are growing in scattered places over the farm. Game birds noting the perching eagles would remain in hiding for hours. After one pair of eagles had been killed everything was quiet for two or three days, and then another pair would invade the ranch. At times a week would intervene before the successors came. * * * I have personally observed eagles at two different times take pheasants, and the pheasants taken were both feeding. Apparently they do not see

the oncoming enemy until it is too late to fly, and they squat on open ground where the eagle has no trouble in grabbing its prey on the first attempt.

Fourteen golden eagles were killed between January 1 and March 15, 1940, and 15 were taken during a similar period in 1941. The eagles killed in 1940 were without exception in good physical condition. The crop and stomach contents of all 29 were examined at the Wildlife Research Laboratory of the Fish and Wildlife Service at Denver, Colo. Eight of the crops and gizzards were empty; 3 contained only jackrabbits: 1, a cottontail rabbit; 14, pheasants; and 3 showed evidence of the eagles having taken both a jackrabbit and a pheasant. In short, of the 21 golden eagles which contained food, approximately 81 percent had eaten pheasant.

A somewhat similar situation arose in the winter of 1947-48 on the Lacreek National Wildlife Refuge in South Dakota. A report from that area stated that—

the pheasants survived the winter with little loss except predation by golden eagles. The eagles appeared unusually aggressive this season in attacking pheasants, and refuge personnel witnessed four birds seized by them in a single day.

Besides showing the capabilities of the golden eagle under peculiar local conditions, the foregoing incidents reveal one of the weaknesses of generalizations as to wildlife food habits when appraised solely through stomach analysis unsupported with associated evidence of field conditions. Without such knowledge, deductions based on these crop and stomach contents

would make it appear that the ring-necked pheasant ranked second to jackrabbits as a food item of the golden eagle (see table 2). Over the general range of the two birds this would not be a true picture. Inadequate data, no matter how sincerely presented, can thus be as great a perjurer of wildlife testimony as can circumstantial evidence in the hands of one attempting to "prove" a preconceived point.

Sage Grouse.—More recently, Batterson and Morse (1948) contended that in an Oregon area studied, the chief predator of sage grouse during the strutting season was the golden eagle. They tell of the killing of two male grouse by this eagle on a strutting area during the 1942 season when the maximum number of males present was 67.

Scott (1942) observed golden eagles disrupting sage-grouse strutting and mating activities, but stated that the time of day at which mating occurs is probably a helpful adaptation for protection against the "most dreaded of all enemies, the golden eagle." He noted that golden eagles seldom flew over the strutting grounds before sunrise and that more than 50 percent of all matings recorded occurred before that time of day.

Wild Turkey.—This study sheds no new light on the relation of the golden eagle to the wild turkey, but the following previously unpublished testimony is presented.

W. C. Glazener, of the Texas Game and Fish Commission, reports:

On January 11, 1945, I flushed an immature golden eagle from a live oak mott

approximately 18 miles southwest of Falfurrias, Brooks County, Texas. Upon going into the mott, I found the remains of a freshly killed turkey hen, with a number of large tracks around in the loose sand. The breast of the turkey had been pretty well eaten. No further sight or record of the eagle had been secured, but it was evident that this bird had been the one that had fed on the turkey. Whether it did the killing, I cannot say, but the circumstantial evidence was very strong, with no indication of any other predator having been present. The site was at a turkey baiting station.

Another golden eagle-wild turkey episode was recorded by Brownlow Wilson of Colfax County, N. Mex., on April 27, 1948. He relates:

This week I was riding in the Cerrososo Canyon and observed a golden eagle soaring overhead as if it had something located. All at once it disappeared from view and apparently dived on its prey, although I did not see this actually happen. I then started up a trail onto the hill top. When about 300 feet up I came upon a sight such as I have never seen before. Here was the golden eagle perched on the back of a large turkey gobbler feeding on it. The gobbler, still alive, seemed paralyzed all except its head and neck.

Biologist C. M. Aldous, United States Fish and Wildlife Service, reported the following observation made on the Mescalero Indian Reservation, N. Mex.:

On about the first of October 1945, superintendent Robert D. Holtz, regional forester William H. Zeh, and reservation forester Bert Shields were traveling by car going northeast from Snake Wells when they saw a golden eagle plummet earthward at a terrific speed about one-half to 1 mile away. When they reached the point where they judged the eagle had landed, they flushed the bird from a freshly killed full-grown turkey. The eagle had consumed almost the entire

edible portion of the carcass by the time they arrived.

Such is the nature of the data concerning depredations on wild turkey by the golden eagle. The preceding quotations and published records dating even to the pre-Audubon period substantiate the fact that on occasion the golden eagle kills wild turkeys. The quantitative significance remains to be determined.

In general, the problems of interrelationship of upland game birds and eagles are as varied as the habitats and species involved. A complex problem is made even more complicated by the fact that the golden eagle also preys on other animals such as skunks and snakes which may at times exert pressure on upland-game-bird populations. In short, the relationship presents a difficult ecological problem which can be solved only locally by qualified wildlife technicians.

Waterfowl.—As both the eagle and waterfowl are migratory, their interrelationship is unique. The simultaneous appearance of golden eagles and waterfowl in an area in fall and winter often leads to the deduction that the eagles are following the waterfowl.

That the golden eagle, on occasion, may kill ducks or geese is beyond dispute. Records of golden eagles' "stooping" on waterfowl or feeding on dead ducks are numerous and of their catching live waterfowl are occasional. Whether the ducks they catch are chiefly sick or injured birds still is an unanswered question.

Several methods were utilized to

obtain information on the relative importance of golden-eagle predation on waterfowl. Managers of migratory waterfowl refuges were solicited; files of the United States Fish and Wildlife Service in Washington, D. C., were reviewed; and sportsmen, game-law-enforcement officers, and waterfowl specialists were consulted.

The following comments have been selected from the reports of managers of Federal refuges as being representative of the facts and opinions held on the relative importance of golden-eagle predation:

BOWDOIN REFUGE, MONT.—As many as six golden eagles are commonly observed during the fall and winter, especially when the lake freezes over, at which time they prey on the wounded and crippled birds left over from the hunting season and continue to feed on the frozen carcasses well into the winter. (B. M. Hazeltine.)

MEDICINE LAKE REFUGE, MONT.—The fall migrants feed on rabbits, muskrats, and waterfowl. No observations were made on the actual kills of rabbits or waterfowl, but on one occasion, in November, an eagle was seen to take a live muskrat off the edge of the ice. Remains of three muskrats were found on the landings of the subheadquarters tower where they had been carried for devouring. (T. C. Hoed.)

RED ROCK LAKES REFUGE, MONT.—In the fall of the year when they are most common on the refuge, golden eagles have been observed feeding on dead or wounded ducks that were not retrieved by hunters. They have also been observed feeding on dead animal carcasses. We have never observed eagles feeding on or attacking healthy individual ducks or other forms of bird life on the refuge. (A. V. Hull.)

SACRAMENTO REFUGE, CALIF.—It is believed . . . that they feed to a large extent on weak and crippled birds. Most

of their food is waterfowl, at least in the fall, based on their actions and the locations frequented. Records in 1938 showed an eagle pursuing a cackling goose on two occasions but in each case it missed its prey. (P. J. Van Huizen.)

SAND LAKE REFUGE, S. DAK.—During cold, snowy weather, most of the food of the golden eagle on this refuge consists of wild ducks; at least this was the case last winter (1939-40). Many of the wild mallards on the refuge last winter suffered from lead poisoning and it is possible that some of the ducks eaten by eagles were ill. (R. C. Winslow.)

WICHITA MOUNTAINS REFUGE, OKLA.—Golden eagles have been noticed feeding on the carcass of a deer, flying low over jackrabbits, and chasing ducks in the Rush Lake area. Ranger William E. Drummond observed a golden eagle chase a skunk into a thicket in the spring of 1939 and watched the bird beat around the edges of the brush until it was driven off. (E. J. Greenwalt.)

In addition to these comments from refuge administrators, the results of a one-season nesting study of the golden eagle carried out on the Malheur National Wildlife Refuge in Oregon by Frank W. Groves are available.

During the nesting season of 1940, Groves made a study of the food utilized by four pairs of golden eagles. For purposes of comparison these nests are grouped into two categories. Three nests located a mile or more from the duck nesting area will be considered jointly as contrasted with one nest situated approximately 100 yards from the water. Only those animal remains found in the nests and identified in the field were considered. Food remains found at the three nests a mile or more from the water area included more than 40 jackrabbits, 1 cottontail, and 1 mallard duck.

The debris in the nest near water included 10 ducks, 1 coot, 1 jack-rabbit, 1 cottontail, and 2 marmots. Three of the ducks, 2 mallards, and 1 cinnamon teal, were examined for evidence of cause of death, and Groves states that "as nearly as could be determined, all three had been healthy individuals. Two of the birds showed talon marks on the shoulders and neck." He added that—

with the small number of nests under observation and the limited amount of time spent on this study it would be impossible to draw any definite conclusions as to the economic status of the golden eagle on the Malheur National Wildlife Refuge. Indications point to the fact that the eagles are probably much more beneficial than harmful.

Whereas the foregoing testimony indicates a relation between the golden eagle and waterfowl, the effect can best be determined by those who actually manage waterfowl areas and thus are in constant touch with the ever-changing picture.

OTHER BIRDS

The capture of and feeding on lesser raptors by golden eagles has been recorded on several occasions. Maurice Broun of the Hawk Mountain Sanctuary in Pennsylvania witnessed the capture in midair of a red-shouldered hawk by a golden eagle it had been harassing (Broun 1947). The smaller bird persisted in annoying its fellow traveller until the golden eagle

*** made a sudden thrust forward, executed an "Immelmann turn" *** and then seized the smaller hawk which seemed to put up a momentary, hopeless struggle. Down came the two birds pre-

cipitously, the eagle with set wings and clutching its victim.

Oscar T. Thordarson, making a study of the food of predatory species on the Upper Souris Wildlife Refuge, N. Dak., shot and wounded a great horned owl. Before he could arrive at the point where the owl had come to earth a pair of golden eagles appeared and one picked up and carried away the still-struggling owl (Henry 1939). H. H. Brimley (correspondence) in Nash County, N. C., reports he found the remains of a crow in the stomach of a golden eagle.

With respect to domestic poultry, the golden eagle is only an occasional predator. Such predation is most likely to occur during the winter months when the large birds, pressed for food, concentrate in the vicinity of unprotected poultry. The remains of a single chicken in the stomach of 1 of the 102 eagles examined (table 2) attest to the infrequency of such feeding.

LIVESTOCK

Sheep.—The domestic sheep is a highly bred, man-controlled exotic without the defenses against hostile elements in its environment found in native species. Furthermore, there has been a growing tendency in recent years to replace sheep herding with large, fenced pastures in which sheep are permitted to roam.

As in every other problem of economics, the element of profit is the yardstick. Whichever proves the more profitable technique—that of herding or that of fencing and rigorously controlling the environ-

ment—is likely to be the one used. Consequently, methods vary considerably from one section of the country to another. When factors such as range utilization, relative abundance of ground predators, time of lambing, presence and absence of buffer species, availability of carrion, unseasonal freezes or extremely hot weather, screw worms, disease, and poisonous plants are taken into account, any attempt to fit the golden eagle into the picture becomes a complicated problem.

During this study, two areas in which combined cattle and sheep raising was the principal land use were compared. One of these was country north of Fort Collins, Colo., on the eastern piedmont plain of the Rocky Mountains in northern Colorado and southern Wyoming; the other the sheep-raising country of west Texas.

The Colorado-Wyoming area includes rolling foothills, scattered bluffs and buttes, and open prairie. In general, it is Upper Sonoran prairie grassland with brushy cover on the slopes. The resident eagle population varies from place to place depending on the availability of suitable nesting territories, but it approximates one pair to a township. Sheep usually are herded in flocks of about 600 to the herder during the late-winter and pre-lambing season. Lambing is from March 25 to mid-May, and usually occurs in sheds with the ewes and lambs being confined for 10 days. The flocks are kept under close supervision until summer herds of approximately 1,300 lambs and ewes

are formed. Grazing pressure varies from moderate to heavy.

In this region, sheepmen feel that the golden eagle is no particular problem. W. H. Delvin, foreman for one outfit in the Colorado area, stated that he has neither seen nor heard of an eagle's killing a lamb or a sheep in this area during his 20 years of experience. On the other hand, his observations lead him to believe that they are quick to find and devour any sheep dying from other causes.

The Texas area west of the Pecos is devoted to cattle (60 percent) and to sheep and goats (40 percent). Topographically, this region is characterized by scattered mountain ranges separated by rolling hills and flat valleys. The flora is semiarid grassland or scrub in the lowlands, diffusing into scattered brushy cover on the steeper slopes. Although the eagle population has been disrupted in recent years, early observations indicate that before control operations were initiated the golden eagle population compared favorably in numbers with that in the Colorado-Wyoming area. Sheep are restricted to fenced areas. The peak of the lambing season is about March 15, although some young are born as early as December. For the most part, lambing is in pastures rather than in sheds. Grazing pressure varies from heavy to extremely heavy, and land use may be abusive.

In the Texas area, many ranchers consider the golden eagle one of the most detrimental factors with which they have to contend in raising sheep. Even though observations of

eagles killing lambs are rare, this may not be significant when one considers the wariness of these large birds of prey and the wide range of the sheep at lambing time. When C. C. Sperry³ worked in the area in 1937, all ranchers interviewed had seen eagles feeding on dead lambs, and many had examined the carcasses to determine the cause of death. The general conclusion was that death resulted from claw punctures at the base of the skull. The observers agreed that eagles seldom bother lambs more than a week or 10 days old and that the most vulnerable period for the lambs is the first few hours of life.

The following episodes, reported to the writer during a short stay in the Texas area in 1948, illustrate the type of evidence leading to rancher support of locally organized eagle control. E. G. Pope, assistant district agent, United States Fish and Wildlife Service, Lubbock, Tex., stated that during the spring of 1935, while flying over the "H6" pasture at the foot of the Guadalupe Mountains in west Texas, he noted a golden eagle flying from the foothills toward the valley. Later he saw a lamb and a ewe standing close together in the valley. The eagle flew over the two, made a small circle, and dropped on the lamb with such force that it actually appeared to bounce. During that spring it was reported to Pope that eagles in the general area were eating from 15 to 20 lambs a day, but he ob-

served that at the time there was little else for eagles to eat.

In the spring of 1946, M. E. Bomar, of Marfa, Tex., saw an eagle dive twice on a lamb, hitting the animal both times. Although the eagle was shot, the lamb died a few minutes after the attack.

These records and others both in this country and abroad establish the fact that golden eagles are capable of killing lambs. The extent of this loss under varying conditions cannot be computed from the data now at hand.

Most of the successful sheep raisers in the area where intensive eagle control is practiced are attempting to control all factors limiting sheep production. These include such divergent things as removing locoweed and trapping flies at water holes to control screwworm. The attitude of most ranchers paying the bill for eagle control is that it is a "necessary chore," and they are convinced that the value received in increased livestock crops is worth the price. That control is an extensive, annual process, is indicated by the number of eagles killed under a project sponsored by the Big Bend Eagle Club of west Texas. This organization of about 100 ranchmen hired a pilot to shoot eagles from an airplane. The numbers killed over a 6-year period are as follows: 657 in 1941-42, 667 in 1942-43, 1,008 in 1943-44, 800 in 1944-45, 867 in 1945-46, and 819 in 1946-47, for a total of 4,818 (Buechner 1950).

The extent of eagle damage under former conditions of less rigid control in this same area is reflected

³ Eagles vs. lambs in western Texas, 1937. MS. in files of United States Fish and Wildlife Service, Washington, D. C.

in Sperry's report⁵ in which he stated:

Some more definite data on lamb losses due to eagle depredations were obtained from J. W. Lawhorn, manager of the Thompson Brothers Ranch in Schleicher County east of the Pecos River. For a number of years 5 or 6 eagles have been noted during the winter on that 25,000-acre ranch. They came late in November and stayed through January, but invariably left about February 1. For the past 10 years such has been the case and, as lambing did not start until February 1, no losses were charged to eagles. This year (1937), however, the eagles did not leave on schedule and there were about 25 present during February. Depredations on newborn lambs were soon noted but no effective means of checking them was found until late in February when 10 eagles were killed from an airplane. A checkup late in March revealed a heavy lamb loss chargeable to eagles. Records of 5 or more years showed that the average lamb markup for the Thompson Brothers Ranch was 90 percent, and that for 1937 it should have been well above average because the spring was extremely favorable for lambing. In fact, a small group of ewes (47) moved from a large pasture (later frequented by eagles) to a small enclosure near the ranch buildings actually gave a lamb crop of 105 percent, while a markup from 178 ewes in the large pasture and 330 in an adjacent one—in both of which lambs were exposed to eagle attack—was only 75 and 87 percent, respectively.

It has not been possible in this study to determine the magnitude of the total damage done to sheep in this area by the golden eagle. Here, again, the relative acceptability of carrion to the bird prevents objective analysis. This was brought out

by R. H. Imler,⁶ who worked in the sheep-raising area of southern New Mexico and west Texas and obtained 29 crops and stomachs of golden eagles, principally from birds killed by local eagle hunters.

Although many of the birds had been dead for months, the food items were still readily identified and the data regarding them were obtained from those who had killed the eagles. It was impossible, however, in most cases to determine which items had been taken as carrion.

Of the 29 stomachs, 14 contained portions of domestic sheep or goats, of which at least 4 were classified as carrion. Fourteen of the stomachs contained remains of rabbits, of which 3 were considered to be carrion. With respect to the remains of skunks (3), bobcat (1), coyote (1), wood rat (1), and turkey vulture (1), there was no conclusive evidence as to whether the items were live prey or carrion.

It may be of interest that 6 of these eagles were shot near Cloverdale, N. Mex., on range occupied by very young lambs and kids. Their stomachs contained respectively, skunk, 100 percent in 2 stomachs; bobcat, 100 percent; coyote, 100 percent; skunk and rabbit, 60 and 40 percent; and rabbit and domestic sheep or goat, 43 and 57 percent. What part of these items was carrion could not be determined.

Available information indicates that losses of lambs as well as of goat kids, attributable to eagles are

⁵ Eagles vs. lambs in western Texas, 1937. MS. in files of United States Fish and Wildlife Service, Washington, D. C.

⁶ Report on field trip to Texas and New Mexico in 1942. In files of the United States Fish and Wildlife Service, Washington, D. C.

spasmodic in this area and may vary considerably under changing local conditions. Comparison of the situation in the Texas area with that in the Colorado-Wyoming area (p. 27) appears to indicate that the problem is local in nature and one to be handled locally as it occurs.

Cattle.—There are occasional records of the golden eagle killing calves. Most of the cattle ranchers interviewed during this study felt that such occurrences either were so rare that they did not warrant eagle control, or the losses were outweighed by the good done by the species. As with the sheepmen, the cattlemen's primary interest is governed by economics. One example of this attitude encountered near Middlewater in the Texas Panhandle should suffice. When questioned concerning the activities of a certain pair of eagles nesting near a cattle watering trough, the ranch foreman stated:

The birds have been there for 5 or 6 years. Year before last I destroyed their eggs in an effort to discourage them, but last year I let them raise young so I could see for myself what they were doing. During the season every time I checked the nest there were rabbit feet under it. In all, I would say they had a barrel full. I did not find any parts of antelope even though I was looking for them. I have heard that sometimes they eat calves, but now I am beginning to wonder if perhaps they do me more good than harm.

Near the plain of San Augustine, Catron County, N. Mex., E. A. Goldman (field notes, United States Bi-

ological Survey) wrote in 1909, "Some cattlemen believe that eagles kill small calves. Several told me they had seen them eating carcasses but none had seen an eagle kill a calf." E. G. Pope (field notes, United States Biological Survey) in 1905 reported that one of his assistants in the mountains near Alamogordo, N. Mex., was attracted by the frantic bleating of a young calf which was being fiercely attacked by a large eagle. The eagle was shot.

D. T. Wood (1946) writes of an experienced cattleman from the Lompoc area, Calif., who observed an eagle perched on a newborn calf estimated to weigh about 25 pounds. When the observer arrived at the spot, he found the calf near death and bleeding considerably about the back and head.

Owen W. Morris, United States Fish and Wildlife Service, reported an incident in which an adult cow, attacked by an eagle, lost its footing on an icy incline above a high ledge and plunged to its death. Shortly after, the eagle commenced to feed on the cow.

Such is the nature of the general evidence concerning the effect of the golden eagle on cattle. The significant fact is that in the average cattleman's analysis of the situation the bird is considered at least a neutral if not a beneficial wildlife species. With respect to the survival of the golden eagle this is significant, as the bird is afforded relative security on many of the large cattle ranches.

SUMMARY AND CONCLUSIONS

1. The golden eagle is widely distributed in mountains and adjacent plains throughout much of the Northern Hemisphere. Its principal breeding range in North America extends from the Arctic Ocean south into Mexico, westward from the 99th meridian. As it nests from near sea level to timberline, it may be found in a wide variety of habitats, and in winter it occurs practically throughout this country. Its food habits are as varied as the diversified habitats in which it lives.

2. The golden eagle has been known to kill and eat more than 60 different kinds of animals ranging from full-grown deer and antelope to mice, birds, frogs, and insects. Both living creatures and dead are included in its diet, and at times it accepts carrion even though living prey is available.

3. Rabbits and rodents form the staple diet of the golden eagle, the proportion taken varying with local conditions. During the nesting season on a Colorado antelope range, rabbits supplied most of the golden eagles' food; under winter conditions on a North Dakota pheasant refuge, they comprised approximately 19 percent.

4. On occasion, the bird will kill adult and young antelope, although in northern Colorado, where four pairs of eagles nested in close proximity to antelope at fawning time such predation was negligible.

5. Although the golden eagle will kill either the adult or the young of deer, no evidence was found to indicate that the bird is more than

a minor influence when compared to other factors controlling deer populations.

6. One fairly conclusive account of golden-eagle predation on a bighorn lamb is cited, but available information indicates that any danger to bighorn sheep either in decimating populations or inhibiting their restoration has been relatively minor.

7. Depending on local conditions, the golden eagle exerts a varying pressure on upland game birds, and at times this pressure may be sufficient to warrant eagle control. Harassment of upland game, thus keeping it from feeding properly in severe weather, may be more serious than the actual killing activities of the eagle. That being the case, it appears that time and effort might be wisely spent in developing cover which will give permanent protection from the golden eagle rather than in assuming the never-ending task of control. Golden eagles kill wild turkeys, but the significance of this activity on present-day wild-turkey populations was not determined in this study.

8. When nesting in the vicinity of waterfowl areas, the golden eagle may feed its young largely on waterfowl. In one study cited, it was shown that pressure on waterfowl was applied principally by a pair of eagles in whose nesting territory the prey was found.

9. Golden eagles at times kill domestic lambs. The extent of this damage varies with local conditions. Conservative local control, properly

executed in areas of severe damage, should not unduly influence the overall status of the species. Because the birds tend to congregate, especially in winter, in areas where carrion is available, it would be to the sheep rancher's own advantage to determine whether the eagles on his ranch are preying on live lambs or on those that died from other causes that perhaps could be remedied.

10. On occasion, golden eagles kill calves or may even contribute to the death of full-grown cattle. All evidence indicates that this is an exceptional activity and the general attitude of cattlemen interviewed during this study has not been antagonistic to the eagle.

11. Golden eagles occur in varying numbers on more than 65 Federal wildlife refuges where, in general, they serve a beneficial purpose in consuming wounded, sick, or dead ducks and forage-consuming jackrabbits and rodents. On those

areas where not detrimental, they are given full protection.

12. The golden eagle may vary in influence, depending on its habitat, from the one extreme where it may be endangering the young of the rare trumpeter swan to the opposite extreme where it may be a contributing factor in saving some rancher appreciable forage which would be eaten by jackrabbits. Its harmful activities should not be allowed to go unbridled. Neither should its beneficial influence be dissipated for want of insight into the complexities of present-day wildlife problems. In the final analysis of any wildlife situation in which the golden eagle is involved, its management calls for local appraisal combined with an impartial and thorough understanding of the broader aspects of its influence. Let it not be forgotten that the golden eagle will always be looked upon as a noble and priceless heritage of our mountains and western plains.

LITERATURE CITED

- ALLEN, JOSEPH C.
1939. Ecology and management of Nelson's bighorn on the Nevada mountain ranges. *Trans. Fourth North Amer. Wildlife Conf.*, pp. 253-256.
- ANDERSON, NILLO A.
1940. Mountain goat study. *Washington Dept. Game, Biological Bull.* 2, 21 pp., illus.
- ARNOLD, LEE W.
1948. Eagle attacks boy. *Audubon Mag.*, vol. 50, pp. 256-257.
- AUDUBON, JOHN JAMES.
1834. *Ornithological biography; or an account of the habits of the birds of the United States of America*, vol. 2, pp. 464-470. Boston.
- BAILEY, FLORENCE MERRIAM.
1928. *Birds of New Mexico*. New Mexico Dept. Game and Fish in cooperation with State Game Protective Association and U. S. Bureau of Biological Survey, pp. 176-180.
- BAIRD, S. F., T. M. BREWER, and R. RIDGWAY.
1874. *A history of North American birds*. *Land Birds*, vol. III, 560 pp. Little, Brown, and Company, Boston.
- BARROWS, WALTER BRADFORD.
1912. *Michigan bird life*. Michigan Agricultural College, Dept. Zool. and Physiol., Special Bull., 822 pp.
- BATTERSON, WESTEN M., and WM. B. MORSE.
1948. Oregon sage grouse. Oregon State Game Commission, Fauna Series No. 1, 29 pp.
- BENDIRE, CHARLES.
1892. *Life histories of North American birds*. U. S. Natl. Mus., Special Bull. No. 1, pp. 263-270.
- BENT, ARTHUR CLEVELAND.
1938. *Life histories of North American birds of prey*. Part 2. U. S. Natl. Mus. Bull. 170, 482 pp., illus.
- BROUN, MAURICE.
1939. Fall migrations of hawks at Hawk Mountain, Pennsylvania, 1934-38. *Auk*, vol. 56, No. 4, pp. 429-441. October.
1947. Golden eagle captures red-shouldered hawk. *Auk*, vol. 64, No. 2, pp. 317-318. April.
- BUECHNER, HELMUT K.
1950. Life history, ecology, and range use of the pronghorn antelope in Trans-Pecos, Texas. *Amer. Midland Nat.*, vol. 43, pp. 257-354.
- CAMERON, E. S.
1905. Nesting of the golden eagle in Montana. *Auk*, vol. 22, pp. 158-167.
1908. Observations on the golden eagle in Montana. *Auk*, vol. 25, pp. 251-269.
- COUEY, FAYE.
1944. Golden eagle vs. bighorn sheep. *Montana Wildlife Bull.*, vol. 1, pp. 2-3.
- DIXON, JAMES B.
1937. The golden eagle in San Diego County, California. *Condor*, vol. 39, No. 2, pp. 49-56, illus. March-April.

ELLIS, F. GORDON.

1941. Progress summary report, Idaho mountain sheep survey. Federal aid to wildlife project No. 7-R-C, 38 pp.

ERRINGTON, PAUL L.

1930. The pellet analysis method of raptor food habits study. *Condor*, vol. 32, No. 6, pp. 292-296. November-December.

GLADING, BEN, D. F. TILLOTSON, and DAVID M. SELLECK.

1943. Raptor pellets as indicators of food habits. *California Fish and Game*, vol. 29, No. 3, pp. 92-121. July.

HENRY, C. J.

1939. Golden eagle takes wounded horned owl. *Auk*, vol. 56, No. 1, p. 75. January.

HONESS, RALPH F., and NEDWARD M. FROST.

1942. A Wyoming bighorn sheep study. *Wyoming Game and Fish Dept., Bull.* 1, p. 56, Eagles as predators.

HOWARD, HILDEGARDE.

1930. A census of the Pleistocene birds of Rancho LaBrea from the collections of the Los Angeles Museum. *Condor*, vol. 32, pp. 81-88.

HOWARD, HILDEGARDE, and ALDEN H. MILLER.

1933. Bird remains from cave deposits in New Mexico. *Condor*, vol. 35, No. 1, pp. 15-18. January-February.

JOLLIE, MALCOLM T.

1947. Plumage changes in the golden eagle. *Auk*, vol. 64, No. 4, pp. 549-576, illus. October.

KENNEDY, CECIL A.

1948. Golden eagle kills bighorn lamb. *Jour. Mammal.*, vol. 29, No. 1, pp. 68-69. February.

LEHTI, ROBERT W.

1947. The golden eagle attacking antelope. *Jour. Wildlife Mangt.*, vol. 11, No. 4, pp. 348-349. October.

MURIE, ADOLPH.

1944. The wolves of Mt. McKinley. U. S. National Park Service, Fauna Series No. 5, 238 pp.

OBERHOLSER, HARRY C.

1906. The North American eagles and their economic relations. U. S. Department Agriculture, Biol. Survey Bull. No. 27, pp. 20-31.

PACKARD, FRED MALLERY.

1946. An ecological study of the bighorn sheep in Rocky Mountain National Park, Colorado. *Jour. Mammal.*, vol. 27, No. 1, pp. 3-28, illus. February.

PETERS, JAMES LEE.

1931. Check-list of birds of the world. Vol. 1, 345 pp. Harvard University Press, Cambridge, Mass.

PIERCE, WRIGHT M.

1927. Status of the golden eagle in southern California. *California Fish and Game*, vol. 13, No. 1, p. 66. January.

POOLE, EARL L.

1938. Weights and wing areas in North American birds. *Auk*, vol. 55, pp. 511-517.

PRUDY, JAMES B.

1898. The golden eagle and barn owl at Northville, Wayne Co., Michigan. *Auk*, vol. 16, p. 77.

RIDGWAY, ROBERT.

1877. United States geological exploration of the fortieth parallel. Vol. 4, pt. III. Ornithology, p. 591.

1889. The ornithology of Illinois. Part I. 2d ed. Illinois Natural History Survey, vol. 1, p. 484.

SCOTT, JOHN W.

1942. Mating behavior of the sage grouse. *Auk*, vol. 59, pp. 477-498.

SHELDON, CHARLES.

1908. List of birds observed on the upper Toklat River near Mount McKinley, Alaska. *Auk*, vol. 26, p. 68.

SPENCER, CLIFFORD C.

1943. Notes of the life history of Rocky Mountain bighorn sheep in the Tarryall Mountains of Colorado. *Jour. Mammal.*, vol. 24, No. 1, pp. 1-11. February.

SUMNER, E. L., JR.

1929. Golden eagle in Death Valley. *Condor*, vol. 31, p. 127.

1929a. Notes on the growth and behavior of young golden eagles. *Auk*, vol. 46, pp. 161-169.

SUTTON, GEORGE MIKSCH.

1928. An introduction to the birds of Pennsylvania. J. Horace McFarland Co., Harrisburg, Pa., 161 pp.

WALKER, LEWIS, and MARIAN WALKER.

1940. Headlines on eagles. *Nature Mag.*, vol. 33, pp. 321-323. June-July.

WILLIAMS, RALPH B., and CLYDE P. MATTESON.

1948. Wyoming hawks. *Wyoming Wildlife*, Wyoming Game and Fish Dept., Bull. 5, 84 pp.

WOOD, DALE T.

1946. Eyewitness account of golden eagle killing calf. *Condor*, vol. 48, p. 143.



MBL WHOI Library - Serials



5 WHSE 00090

