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# The American Eagles and their Economic Status

E. R. Kalmbach
*US Fish and Wildlife Service*

Ralph H. Imler
*US Fish and Wildlife Service*

Lee W. Arnold
*US Fish and Wildlife Service*

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**E. R. Kalmbach**
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TED STATES DEPARTMENT OF THE INTERIOR
I AND WILDLIFE SERVICE
EAU OF SPORT FISHERIES AND WILDLIFE

# The AMERICAN EAGLES and their economic status, 1964

Comprising an introduction:
Recent Changes in Status
of the American Eagles,
by John W. Aldrich

and reprints of two reports:
The Bald Eagle and its Economic
Status, by Ralph H. Imler and
E. R. Kalmbach (U.S. Fish and
Wildlife Service Circular 30,
issued in 1955)

and The Golden Eagle and Its Economic
Status, by Lee W. Arnold (U.S.
Fish and Wildlife Service Circular 27,
issued in 1954)

UNITED STATES DEPARTMENT OF THE INTERIOR

Stewart L. Udall, *Secretary*

Stanley A. Cain, *Assistant Secretary for Fish and Wildlife and Pa*

FISH AND WILDLIFE SERVICE

Clarence F. Pautzke, *Commissioner*

BUREAU OF SPORT FISHERIES AND WILDLIFE

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The Department of the Interior, created in 1849, is a Department of Conservation, concerned with management, conservation, and development of the Nation's water, wildlife, fish, mineral, forest, and park and recreational resources. It has major responsibilities also for Indian and Territorial affairs.

As America's principal conservation agency, the Department works to assure that nonrenewable resources are developed and used wisely, that park and recreational resources are conserved for the future, and that renewable resources make their full contribution to the progress, prosperity, and security of the United States, now and in the future.

# NORTH AMERICAN EAGLES

For centuries eagles have captured the fancy of man the world over. Because of its extensive range in the northern hemisphere, the golden eagle is the most widely known of this group of birds. Its use in falconry was the sport of kings. The frequency of its appearance in royal coats of arms indicated its importance. It is the national emblem of Germany and Mexico.

In North America the bald eagle as well as the golden eagle represents this group of powerful birds of prey. The bald eagle is strictly an American species, and the founders of the United States government selected it as our national emblem; its likeness is on the official seal. In 1940, the Bald Eagle Act placed the national bird under protection of Federal law.

In recent years there has been growing concern over the decline in numbers of eagles in the United States, particularly of bald eagles in the southeastern States. Of special moment was the paucity of brown-headed young birds – an indication that the population may not be maintaining its numbers. Wide application of pesticides was suspected as one of the reasons. The National Audubon Society initiated a special study of the populations and production of the bald eagle, and the Bureau of Sport Fisheries and Wildlife began a study of the effects of pesticidal chemicals on these birds. These studies have reaffirmed the decrease in rate of reproduction of the bald eagle in the eastern United States except in Everglades National Park and a few other areas in south Florida. In January 1963 a survey – as complete as was practicable – produced a record of 3,547 bald eagles in the 48 contiguous States. Only 22 percent of these eagles were subadults or immature, a decline from the 27 percent recorded in 1961. These are low numbers considering that the immature plumage is retained for 4 years until the birds become sexually mature.

In the pesticide studies it was found that most of the dead bald eagles examined had DDT in their systems. Experiments showed that eagles can be killed by 160 parts of DDT per million parts of their diet. This chemical is frequently found in dead fish in coastal waters, and bald eagles are fish eaters. Whether pesticides are an influence – by reducing reproductive rates – remains to be determined.

Shooting of bald eagles by irresponsible persons, despite the Federal law against it, has continued to deplete the numbers. Young bald eagles were more

likely to be shot than adults because they look so much like golden eagles, which have been unprotected until recently. Reports of large-scale killing of golden eagles from airplanes in the sheep-ranching country brought fear for the safety not only of that species, but of the bald eagle which might be mistakenly included in the killing. This fear resulted in revision of the Bald Eagle Act of 1940 to include the golden eagle – the amended act was passed by Congress in October 1962. This law prohibits the molesting of bald or golden eagles, except where they are found to be causing financial losses to ranchers by killing livestock. The Bureau of Sport Fisheries and Wildlife has instituted a research program to determine the incidence of loss of domestic animals to golden eagles and to obtain the necessary facts on the distribution, migration, and population status of these birds, so that they can be effectively managed to assure their survival.

This publication combines, under one cover, reprints of two circulars, "The Golden Eagle and its Economic Status" and "The Bald Eagle and its Economic Status," published by the Fish and Wildlife Service, Department of the Interior, in 1954 and 1955. The information in them on distribution and abundance is now somewhat out of date (particularly is this true of the bald eagle which has been the subject of recent study) but much of the rest of the information is of current interest.

Chandler S. Robbins noted, in a publication on "Status of the Bald Eagle, Summer of 1959" (Wildlife Leaflet 418, Bureau of Sport Fisheries and Wildlife, March 1960) that although the bald eagle formerly nested in almost every State, records indicate that its nesting is now restricted primarily to Alaska, the Great Lakes region, Ontario, tidewater areas of the Middle Atlantic and South Atlantic States, and the State of Florida (some bald eagles nest in the north, in summer; others nest in the south, in winter). In the period 1955 to 1959 confirmed records of breeding outside these areas were reported only from Arkansas, Maine, Tennessee, Texas, and Washington.

Some non-nesting bald eagles, chiefly young, move away from their nesting areas and mingle in favorable localities all over the continental United States and Canada. They may concentrate around open bodies of water, especially along the coast and offshore islands of Alaska, the upper Mississippi River, the Great Plains, and the Klamath Basin in Oregon.

After the nesting season, some southern bald eagles move northward, primarily in April and May, and then southward again in August, September, and October. Bald eagles banded as nestlings in Florida have been recovered in 24 States and Canadian Provinces – about 70 percent east of the Appalachians and only two records west of the Mississippi River. Data available at present are not sufficient to show the migratory pattern of any bald eagles except those that nest in Florida.

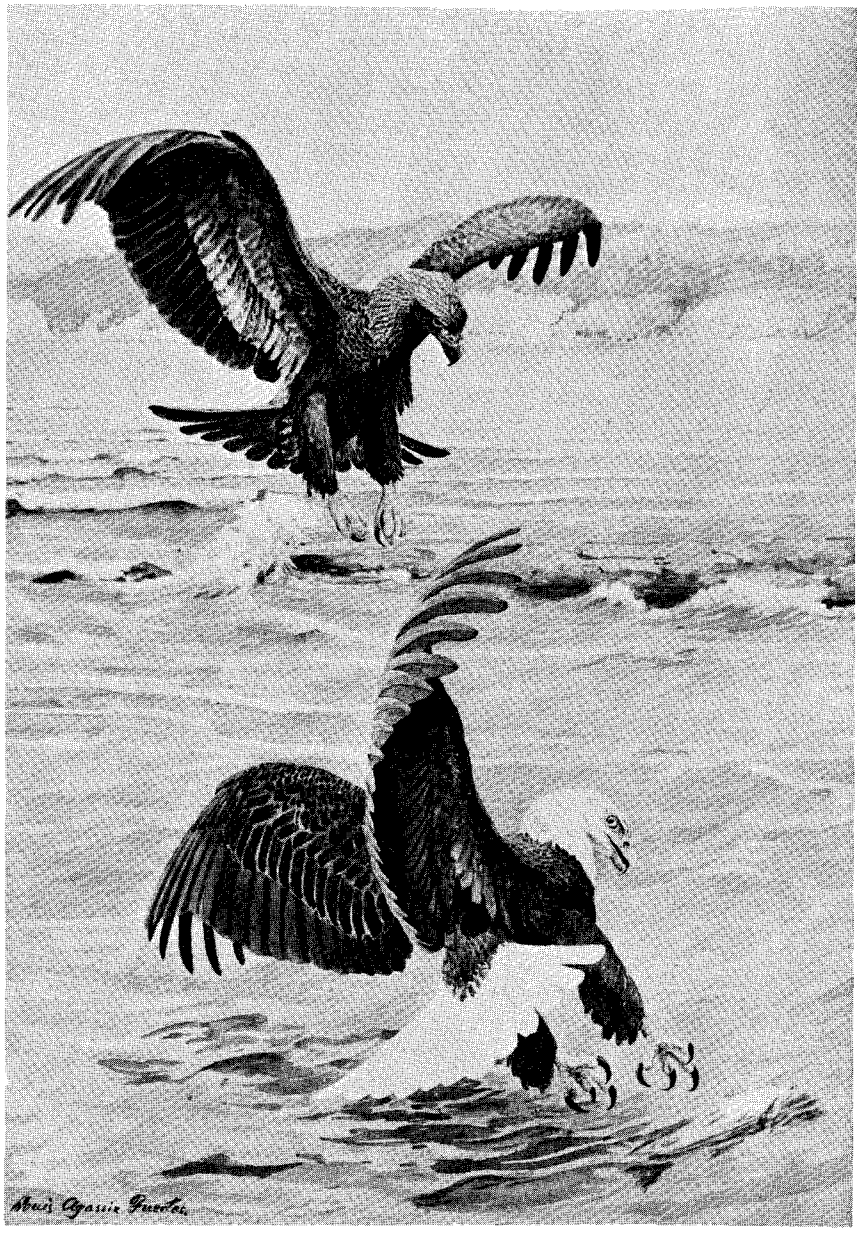
John W. Aldrich
*Division of Wildlife Research*

# THE BALD EAGLE

## and its economic status

By RALPH H. IMLER and E. R. KALMBACH

*Biologists*



The bald eagle; juvenile above and adult below. (From a Fish and Wildlife Ser painting in color by Louis Agassiz Fuertes.)

# THE BALD EAGLE
## and its economic status

Attached to the bald eagle is a degree of popular interest far beyond that normally associated with our birds of prey. Early in the Nation's history the bald eagle, of all the varied forms of wildlife in North America, was selected as our national emblem. By act of the Congress, June 20, 1782, a design for the national coat-of-arms displaying the bald eagle was adopted. As narrated by Dr. Francis H. Herrick (1924a, p. 90):

> The principal figure in the obverse was thus described in the report of William Barton and Charles Thomson, Secretary of Congress. "The Escutcheon placed on the Breast of an American (the bald-headed) Eagle, displayed proper, holding in his Beak a Scroll, inscribed with the Motto, viz., 'E pluribus Unum'—and in his dexter Talon a Palm or an Olive Branch—in the other a Bundle of 13 Arrows; all proper."

Despite the esteem in which many have held the bald eagle through the years, some have seen it in a less complimentary light. This impression goes back, in at least one notable instance, to one of the founders of the Republic, Benjamin Franklin. Gaillard Hunt (1909, p. 65) in his History of the Seal of the United States, quoted Franklin as having written:

> For my part, I wish the bald eagle had not been chosen as the representative of our country; he is a bird of bad moral character; he does not get his living honestly; you may have seen him perched on some dead tree, where, too lazy to fish for himself, he watches the labor of the fishing-hawk; and, when that diligent bird has at length taken a fish, and is bearing it to his nest for the support of his mate and young ones, the bald eagle pursues him, and takes it from him. With all this injustice he is never in good case; but, like those among men who live by sharping and robbing, he is generally poor, and often very lousy. Besides, he is a rank coward; the little *king-bird*, not bigger than a sparrow, attacks him boldly, and drives him out of the district.

No attempt is made here to judge the merits of the selection of the bald eagle as the emblem of this country, nor to appraise the ethics or the bravery of the bird. Instead, information has been assembled from reliable sources and from the examination of a series of bald eagle stomachs and crops, and food remains at nests, to permit a current appraisal of the economics of the bird both within the borders of the United States and in the Territory of Alaska. A brief summary is made of data on its distribution, abundance, migration, and general life history.

Study of the economics of the bald eagle was prompted largely by the need for information to appraise the merits of bounty and other legislation affecting the eagle in the Territory of Alaska, where it long has been the subject of controversy. There also was need for information regarding the influence of the bald eagle in the United States, where its economic status was little understood.

These demands led to the assignment of the senior author to a summer's fieldwork (May to September 1941) in Southeastern Alaska. Assisted by Game Management Agent Hosea R. Sarber, he collected eagle stomachs and recorded pertinent information. Previous to this, Sarber collected stomachs of bald eagles in 1940 and continued to do so during 1942 and 1943. The senior author was again in Alaska in 1945 and 1946 to study the food habits of hair seals and sea lions and, in the course of that work, he collected additional information and stomachs of eagles in Southeastern Alaska and at points westward along the coast. The stomachs were later examined by him mainly at the Denver Wildlife Research Laboratory, and by personnel of the Patuxent (Md.) Wildlife Research Refuge, particularly Francis M. Uhler, who assisted in identifying individual food items. At a later date, the junior author tabulated and analyzed the data from stomach examinations, reviewed the published literature, and prepared the manuscript.

Two earlier expeditions to the Aleutian Islands (in 1936 and 1937) led by Olaus J. Murie, assisted by C. S. Williams, Victor B. Scheffer, and others, collected valuable food-habits data at 28 nests of the bald eagle on a number of the islands in this chain west of the Alaskan Peninsula. This work, reported on by Murie (1940), has supplied information concerning the bald eagle in the western part of its range in Alaska.

To complete the historical record, mention should be made of three earlier publications issued by the U. S. Department of Agriculture. The first of these appeared in 1893 as Bulletin 3 of the Division of Ornithology and Mammalogy, The Hawks and Owls of the United States in Their Relation to Agriculture, by A. K. Fisher, and contained a section devoted to the bald eagle. The second appeared in 1906 as Bulletin 27 of the Biological Survey, The North American Eagles and Their Economic Relations, by H. C. Oberholser. Its text was devoted to a discussion of both the bald and the golden eagle. The third was Circular 370, Food Habits of Common Hawks, by W. L. McAtee. Published in 1935, it contained brief summaries of the food habits of both the golden and the bald eagle.

Literature on the bald eagle which has appeared through other channels is voluminous, and in the assembling of this paper judicious use has been made of it. Manuals dealing with the ornithology of several States have been fruitful sources of information. The most extensive contribution on the habits and ecology of the bald eagle pub-

lished in this country is the series of documents by Dr. Francis H. Herrick based on his studies of this bird at nesting sites in northern Ohio, made over a period of many years. Outstanding also is the study of the bald eagle in Florida carried on for many years by Charles L. Broley, who, to a greater extent than any other individual, has banded juvenile bald eagles and reported on their movements. Shorter articles and notes that have appeared in ornithological journals are legion, and only a significant few could be drawn upon in the preparation of this text. Appreciation for employment of numerous published notes is expressed collectively at this point.

Acknowledgment also is made of assistance given by the managers of national wildlife refuges throughout the country who have submitted information on the abundance and economic status of the bald eagle on areas under their jurisdiction.

## RANGE AND ABUNDANCE

The bald eagle in its two subspecific forms, *Haliaeetus leucocephalus leucocephalus* (Linnaeus) and *H. l. washingtonii* Audubon, is essentially a North American bird. The northern form (*washingtonii*) is found from northeastern Siberia (formerly), northwestern Alaska, Mackenzie, Manitoba, northeastern Quebec, and Newfoundland, southwardly across the continent where it intergrades with the southern form in a broad belt across the midsection of the United States (Friedmann 1950). South of the area of integration, the southern form ranges eastward from Baja (Lower) California, Arizona, New Mexico, and Texas to Florida, and southwardly to the Gulf of Mexico.

Throughout this continent-wide range, the bald eagle is most common in the vicinity of the seacoast or bodies of fresh water where it is assured an ample supply of its staple food, fish. For that reason, concentrations are found in Southeastern Alaska, around the Great Lakes, and at points along the Atlantic coast, especially in the vicinity of Chesapeake Bay, and in Florida. Migration also concentrates numbers of bald eagles in winter along the Mississippi and other large rivers in Illinois, Iowa, and Missouri, and even westward in Oklahoma.

In recent years, there has been an appreciable reduction in bald eagle numbers in many areas in the United States where these birds formerly were abundant. J. C. Howell (1937, 1941) has pointed out that in a section of northeastern Florida where Dr. William L. Ralph found more than 100 occupied nests in 1886, only 24 were located in 1935. In his more recent appraisal of that population, Howell (1949) stated that during the period 1935–46 the nesting population had decreased almost 30 percent. This was corroborated by Broley (1950, 1951, 1952) who has noted a pronounced reduction in the number of nesting eagles in Florida

where he banded more than 800 young during the period, 1939–46. Since that time he has encountered a steady reduction in their numbers. Whereas, formerly he banded 100 or more young birds in a season, in 1950 he was able to band only 25 young; in 1951, 24; in 1952, but 15; and in 1953, 18. Not all of this decrease can be charged against killing of the birds since, in many instances, there has been a marked change in the environment through cutting of timber and exposure of nesting sites to the elements. Broley (1951) is inclined to believe that the severe storm that swept the Atlantic coast in 1950 played an important part in the destruction of nests and the abandonment of others.

An idea of the density of nesting bald eagles in an optimum nesting area may be gained from Howell's reference to nests found in Volusia County, Fla., in 1935. In the 18 miles between the towns of Shiloh and New Smyrna there was an eagle nest to each 2 square miles and one nest in use to each 3 square miles. In 1940, the manager of the St. Marks National Wildlife Refuge reported nine known nests and possibly three to five others on that 65,000-acre area along the gulf coast in northwestern Florida.

In contrast with its abundance as a breeder in some of our coastal areas, the bald eagle is relatively scarce in the interior. If the birds encountered during migration were excluded and only resident birds considered, the bald eagle certainly would be termed an uncommon bird throughout most of our eastern mountains, the central valleys (exclusive of the Great Lakes area), the plains, and the western mountains. This appraisal has been substantiated by the testimony of informed individuals in numerous States. Speaking with respect to the whole of Canada, Taverner (1934, p. 137) stated that "except on the seacoasts the Bald Eagle is nothing more than a rare, interesting, and picturesque feature of the landscape." Even in Michigan with its abundance of suitable habitat for bald eagles, the Department of Conservation reported in 1940 and 1941 that, conservatively estimated, there were 50 breeding pairs of these birds in the State (Wood 1951). In other widely separated States including New Jersey, Massachusetts, Minnesota, Louisiana, and California, reliable published information indicates that the bald eagle is much reduced in numbers or absent as a breeding bird from areas where it once nested regularly.

That food supply affects eagle movement and local abundance during winter is evident in the Midwest where these birds congregate in open-water areas of the large rivers. Musselman (1949) has recorded fluctuations in their numbers along the Mississippi River in western Illinois. He states:

> Bald eagles (*Haliaeetus leucocephalus*) have been seen at Keokuk [Iowa] in small numbers for more than half a century. Originally they were attracted by offal thrown into the river from the pork packing houses to the south. The water of the river was almost always open during the winter due to the Des Moines rapids; an occasional dead fish along with the offal supplied an abundance of food.

The packing houses are gone, yet recently the number of these great birds has increased due to the fact that the water below the Keokuk dam is always open, and an abundance of fish are killed as they pass through the turbines which are creating electricity.

In the winter of 1947 and 1948, there was the largest accumulation of eagles in the history of this location. Mr. Cyrus Phillips makes almost daily trips through the territory in which these birds roost and reports that he counted 83 eagles at one time. * * * The birds start to gather about December 15, and fly north about February 15 when the upper river begins to open.

An appraisal of the abundance of bald eagles on national wildlife refuges in 1940 revealed that of 37 refuges reporting, 16 were not frequented by bald eagles, 10 had them in moderate numbers, mainly during migration, and 11 reported them as common with greatest numbers during migration or in winter. Whereas the terms "moderate numbers" and "common" are subject to a wide range of interpretation and the sizes of the various refuges also add a variable to the picture, it was evident that refuges in the Northwest, on the South Atlantic coast, and along the Mississippi River were visited by the greater number of eagles. At only one, the St. Marks Refuge in Florida, was an increase reported in the years previous to the 1940 census.

Similar appraisals were made of bald-eagle abundance on national wildlife refuges in subsequent years, the last survey being conducted in the fall, winter, and spring of 1953–54. At that time, comparisons were made with the numbers recorded in former years. The map (fig. 1) presents the result of this appraisal, and the legend explains the code used in recording the data. Of 89 refuges reporting, 21 showed an increase, 41 no change, and 27 a decrease in eagle numbers. Yet, of the 23 refuges reporting the larger numbers (10 or more), 16 showed an increase, 3 no change, and 4 a decrease. The aggregation of bald eagles along the Mississippi River in the Central States may have been a reflection of the mild winter of 1953–54, with open water prevalent. In addition to 300 bald eagles recorded in 1953–54 on the extensive Upper Mississippi National Wildlife Refuge, the Louisa Refuge in Iowa recorded 40, Reelfoot in Tennessee 100, Swan Lake in Missouri 40, and Salt Plains to the west in Oklahoma reported 108 eagles, probably more than three-fourths of which were bald eagles (Van den Akker 1954).

An analysis of bald eagle records that appeared in the Christmas bird counts sponsored by the National Association of Audubon Societies was made by Chandler Robbins. This appraisal, covering the period 1930 to 1953, clearly indicated the concentration of these birds in the Chesapeake Bay area, the South Atlantic coast, Florida, and the central Mississippi River drainage. Fluctuating numbers characterized the returns with increases noted in the Mississippi Valley and in Oklahoma in recent years. These data have, in the main, been substantiated by records of U. S. game-management agents who report on the abundance of the bald eagle in their respective areas.

At the Hawk Mountain Sanctu-

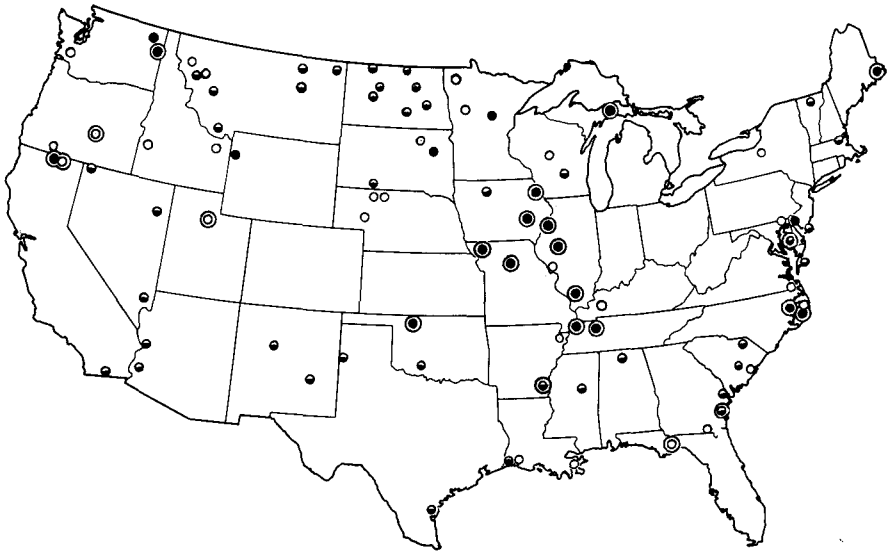


FIGURE 1.—Bald-eagle abundance on 89 national wildlife refuges in the fall, winter, and spring of 1953–54 compared with that of former years. The solid black dots indicate an increase from estimates made in the 1940's; the half-black dots, no change; and the circles, a decrease. An outer circle indicates 10 or more eagles reported. The greatest number was on the Upper Mississippi River Wild Life and Fish Refuge, an extensive area reaching into the States of Minnesota, Wisconsin, Illinois, and Iowa, where 300 bald eagles were reported in the winter of 1953–54.

ary located on a principal flyway for birds of prey in east-central Pennsylvania, Dr. Maurice Broun has recorded an appreciable increase in the number of bald eagles passing through in recent years. Although the number noted has increased appreciably at this point during the past 20 years, part of this may be the result of more extensive field observations. He states (in correspondence) that the high count of 142 eagles in 1950 was due in large part to ideal flight conditions—strong winds from the northwest over a period of time. In 1953, poor flight weather obtained and only 60 individuals were counted. Of significance may be Dr. Broun's observation that in the early 1930's, about 50 percent of the bald eagles passing through were immature birds, while in recent years the figure remained consistently around 20 percent. This variation in the proportion of yearling birds may be indicative of a decrease in the eastern population of the bald eagle.

Even in areas where the bald eagle is only moderately abundant there is a tendency for the birds to gather at nightly roosts, and an exaggerated idea of their numbers often results locally. The senior author (1934) observed such a roost near Stockton, Kans., in the early thirties that was said to have been occupied since the settlement of the country. The first birds appeared at this roost in November and the last left in March. At one time,

Imler saw 23 eagles concentrated here.

Although adult bald eagles, once established in a nesting area, may spend much of the year in that vicinity, they usually migrate southward when confronted with severe cold weather. Not only do northern birds move southward with the arrival of cold weather but the young of southern nesters wander northward in summer after they have acquired their powers of flight. The latter fact has been conclusively demonstrated by Charles L. Broley, who, during the period 1939–46, banded and released 814 young bald eagles along the gulf coast of Florida (Broley 1947). Most of these birds were released in January and February and 48 returns were obtained from them. Whereas no recoveries were recorded north of Florida during January, February, or March, none was made in Florida during the period June to October, indicating that the young leave the State soon after they can fly. Several had travelled more than 1,000 miles to the northeast and one had reached Kings County, Prince Edward Island, Canada, in the Gulf of St. Lawrence, more than 1,600 miles away.

Bruce Wright (1953, p. 56) has picked up evidence of this northward drift of bald eagles in late summer on the estuary of the St. John River in New Brunswick, Canada. He states:

> The peak population is reached by August 1st. After this date there is a steady decline until only a few are left in mid-September. In 1949 the peak population on the 40-square mile study area was counted and estimated to be 54, and in 1950 it was 45. This is in excess of one eagle per square mile, which suggests a total population of at least 100 eagles in the area. * * * They are not a local population, although there are a few breeding records. Banding recoveries show that birds raised in areas as far apart as Ontario and Florida summer in the estuary.

Elsewhere in the United States and Canada there is less information on the seasonal movements of bald eagles based on the returns from banded birds. Broley (1947) has called attention to the fact that at "Hawk Mountain" in northern New Jersey the peak of southward eagle migration is in September, but he attributes this to the return of southern birds that had moved northward after the nesting season. Northern breeders, he pointed out, leave for the South at a later date.

In Southeastern Alaska, before the bounty had reduced their numbers, bald eagles were recognized as the most abundant predatory bird, other than possibly the raven. George Willett, who was well acquainted with conditions there, had the following to say in 1923 (in correspondence):

> I would hesitate even to make a guess at the number of eagles that are within 50 miles of Craig, but they would undoubtedly number several thousand. Along a great part of our shoreline there would probably be a nest every half mile at least and there is plenty of shoreline. In March, when the herring spawn here in Klawak Inlet, I have seen over 40 eagles in one tree and have counted over 700 in 3 miles, and these were probably only a small portion of those that were present.

Writing at about that same time, E. P. Walker, executive officer of

the Alaska Game Commission, commented in a similar vein when he stated that—

> In Alaska they are still probably more abundant than they ever were in the States and the majority of the Alaska lands adjacent to the coastline frequented by eagles are so rugged and uninhabited that when the eagles get away from salt water or away from the immediate lower reaches of the streams they are practically free from danger from molestation by human beings.

Notwithstanding the fact that during the period of bounty payments the bald eagle of the coastal region of Alaska was reduced in numbers, the area still is one of great eagle abundance, far exceeding that existing any place in the States. This is a fact seldom appreciated by those who have never witnessed the bald eagle in and adjacent to the waterways of Southeastern Alaska. This thought was expressed by Dr. T. Gilbert Pearson (1928), former president of the National Association of Audubon Societies, who made a personal inspection of the area in 1927, when the bounty law had been in effect for 10 years and more than 40,000 bald eagles had been removed. Although he stated that the "bald eagle had been greatly reduced in numbers, * * * as a species, it cannot be considered as being in any immediate danger of extermination." No doubt that statement has complete application today in Alaska, where the bald eagle is now relieved of the pressure formerly exerted by the bounty and may be killed only when causing damage.

In the course of field studies conducted in Southeastern Alaska

FIGURE 2.—Typical bald-eagle habitat, mouth of Rodman Creek, Baranof Island, Alaska. Nineteen bald eagles were in sight at this point at one time on August 9, 1941. (Photograph by R. H. Imler.)

during the summer of 1941, the senior author recorded 677 bald eagles along 837 miles of shoreline. Other eagles, particularly the less-conspicuous immature birds, no doubt were present but were not seen. After making allowance for them, it was believed that an estimate of 12 to 15 eagles for each 10 miles of shoreline was a reasonable one. Concentrations were observed usually in areas of abundant food, as on Baranof Island, where for a distance of 6 miles along the shore and up a salmon stream, at least 45 eagles were seen. At one point along the stream 19 birds were in sight at one time (fig. 2).

# CHARACTERISTICS

## PLUMAGE

The newly hatched bald eagle is clothed in a thick, light-gray down which fades into white on the head and underparts (fig. 3). In about 3 weeks, this first down is followed by another coat of darker-hued down that is retained until it is pushed out by the young bird's juvenal plumage. The juvenal plumage begins to appear when the eaglet is 5 or 6 weeks old, and is rather uniformly brown with flight feathers of the wings nearly black. It is the plumage of the young birds when they leave the nest at about 12 weeks of age and is retained until the first annual molt, which takes place during their second summer (figs. 4 and 5). Through subsequent annual molts the bird ultimately acquires the whiteness of head and tail so characteristic of the species. Complete maturity of plumage is not attained until the bird is 3 or more years old (frontispiece). Etta S. Wilson (1922) described a captive bald eagle which retained its juvenal plumage through its third year, but the feathers of both head and tail were pure white a year later. On the other hand, Lee S. Crandall (1941) has reported the development of the plumage of a captive bird which did not acquire a white head and nearly white tail until its sixth year and did not possess a completely white tail until its eleventh year. Once attained, the immaculate whiteness of the head and tail are retained throughout the rest of the bird's life.

## AGE

Little is known of the length of life of bald eagles living in the wild, but the longevity of captive birds may be construed as an indication of what happens when the hazards of outdoor life are removed. Stott (1948), summarizing longevity records of birds in the San Diego, Calif., zoo, reports two eagles that lived 15 years.

## SEX RATIO

That the sex ratio of the bald eagle is about 1:1 was revealed by the dissection of 187 specimens by the senior author in the course of his Alaskan fieldwork in 1941. Of these, 54 were immature birds, half of which were males and half

FIGURE 3.—Downy young of the northern bald eagle on Ananiuliak Island in the Aleutian Islands, Alaska. (Photograph by V. B. Scheffer.)

females. Of 133 adults, 64 were males and 69 females.

## SIZE AND WEIGHT

In size and weight, the bald eagle is not greatly different from the golden eagle, and with the exception of the California condor these eagles are the largest birds of prey in North America. Only in the tail, which is somewhat longer in the golden eagle, is there a noticeable difference in the dimensions of the two species.

FIGURE 4.—A nearly fledged young bald eagle, Seney National Wildlife Refuge, Mich. Flexing its wings, it is almost ready to take its first short flight. The characteristic flat-topped nest of sticks is lined with finer material and is located 65 feet from the ground in a red pine. (Photograph by C. J. Henry.)

As in most birds of prey, the female bald eagle is larger and heavier than the male. Friedmann (1950) stated that the average wing length of 16 adult male bald eagles from Southern United States was 529.2 millimeters (20.83 inches) and that of 29 adult male northern bald eagles, 588.6 mm. (23.18 in.). Comparable measurements for the wings of adult females were 576.5 mm. (22.70 in.) in 11 southern birds and 640.2 mm. (25.21 in.) in 42 Alaskan birds. Similar differences were disclosed in the measurements of the tail, bill, and other features of the two groups of birds.

In the course of Alaskan fieldwork, the senior author recorded the dimensions and weights of 108

FIGURE 5.—A nearly fledged young bald eagle, Atka Island, Aleutian Islands, Alaska. The dark plumage of the head, the dark bill, and the dark iris of the eye are in marked contrast with the coloration of the adult bird with its white head and light-yellow bill and iris. (Photograph by V. B. Scheffer.)

bald eagles including adults and juveniles of both sexes. These data appear in table 1.

The adult females averaged 2.26 pounds heavier than the adult males and the immature females averaged 2.31 pounds heavier than the immature males. In fact, the difference in weight between the sexes (both adult and immature birds) was so pronounced that little overlapping occurred even between weights of the heaviest males and the lightest females.

The immature birds (1 year or older) revealed average measurements (except that of the bill) greater than those of the mature birds of the same sex. On the other hand, the average weight of the immature birds was less than that of adults of the same sex, indicating that the greater dimensions of the young birds are attributable to greater length of wing and tail feathers, and not to greater body size.

The greater size of the Alaskan birds is reflected even in the eggs. Bent (1937) has assembled data showing that the average size of the eggs of the bald eagle increases gradually northward through the bird's range.

TABLE 1.—*Weights and measurements of 108 bald eagles collected in Alaska*

| Maturity and sex [1] | Weight (pounds) | | Measurements (inches) of— | | | | |
|---|---|---|---|---|---|---|---|
| | Gross | Net | Wing | Tail | Spread [3] | Length [4] | Bill [5] |
| Adult males (35): | | | | | | | |
| Maximum | 10.70 | 10.61 | 24.1 | 11.9 | 85.50 | 34.75 | 2.69 |
| Minimum | 8.10 | 8.01 | 21.87 | 10.8 | 80.75 | 31.25 | 2.44 |
| Average | 9.30 | 9.09 | 23.06 | 11.41 | 82.83 | 33.19 | 2.57 |
| Adult females (37): | | | | | | | |
| Maximum | 14.10 | 14.09 | 25.80 | 12.80 | 91.87 | 37.80 | 2.94 |
| Minimum | 10.20 | 10.11 | 23.25 | 11.10 | 85.00 | 34.20 | 2.69 |
| Average | 11.78 | 11.56 | 24.61 | 11.97 | 88.36 | 35.88 | 2.81 |
| Immature males (18): | | | | | | | |
| Maximum | 10.10 | 10.07 | 24.70 | 13.50 | 88.50 | 35.70 | 2.65 |
| Minimum | 7.80 | 7.77 | 22.62 | 11.50 | 81.62 | 33.40 | 2.50 |
| Average | 8.91 | 8.85 | 23.85 | 12.48 | 84.34 | 34.33 | 2.57 |
| Immature females (18): | | | | | | | |
| Maximum | 13.20 | 12.69 | 27.25 | 14.75 | 95.50 | 39.87 | 2.95 |
| Minimum | 10.15 | 9.61 | 24.50 | 12.20 | 87.87 | 35.25 | 2.69 |
| Average | 11.48 | 11.22 | 25.68 | 13.43 | 91.63 | 37.37 | 2.79 |

[1] Number of specimens in parentheses.
[2] Obtained by subtracting weight of the food in the stomach and crop from bird's gross weight.
[3] The lateral measurement from wingtip to wingtip when the wings are extended to their limit on a flat surface.
[4] The measurement from the tip of the bill to the tip of the longest tail feather when the bird is fully extended.
[5] The measurement from tip of bill to the feathers at base of the cere.

# NESTS AND YOUNG

We owe much of our knowledge of the nesting habits of the bald eagle to the initiative and perseverance of Dr. Francis H. Herrick, head of the department of biology at Western Reserve University, who, during the years 1922 to 1930, conducted intimate studies of this bird in northern Ohio. From towers constructed at the nesting sites, he observed and photographed the courtship, nest building, egg laying, incubation, and raising of the young eagles to flying age. In the course of his studies, an original wooden structure was extended to a greater height, and this in turn was replaced by a steel tower 80 feet high. When this tower was uprooted in a severe storm in 1929, a second, 96 feet high, was constructed and used to the end of the studies. The steel tower, equipped with a platform and blind at the top, was moved from one nest to another as required by changing conditions.

Bald eagles are inclined to use the same nest year after year unless disturbed (fig. 4). Herrick (1924a, p. 94) traced the history of six successive nests in the vicinity of Vermilion, Ohio, over a period of nearly a century. One of these nests, the oldest and the largest, was destroyed during a storm in the 36th year of its occupancy. Having been added to throughout the years, it had acquired enormous proportions, and near the end of its existence was 12 feet high and 8½ feet across the top. The upper surface had an area of nearly 50 square feet and its total weight was computed to be about a ton (Herrick 1924b).

Broley (1947) records a still larger nest near St. Petersburg,

Fla., which he concludes may have been the largest in America. This nest, typical of many found in that State, was higher than it was wide—20 feet deep and 9½ feet across at the top.

Another nest of substantial size formerly located on the Eastern Shore of Maryland has been described by Frank R. Smith (1936). This nest had been occupied for more than 30 years when a hurricane blew it down in 1933. "The remains of the nest were carefully sifted by hand and placed in baskets for weighing. * * * The forty-three bushels of material in the nest weighed 1274 pounds." Had sticks which remained attached to the nest tree been included, the total weight would have been more than 1,300 pounds.

The main structure of the bald eagle's nest is composed of sticks and small limbs, and clods of earth and masses of vegetation are added in the central portion. There may be a lining of pliable vegetation, but the nest surface is nearly flat surrounded by a rim of sticks (fig. 4). As the nest is reconditioned in subsequent years more material is added, thus gradually increasing the weight of the nest in height and in width until it finally may crash because of the extreme weight.

In Ohio, Dr. Herrick found that eagles chose hickory, elm, or sycamore trees for nesting sites. Originally, many of these trees were in the borders of wood lots, but as time went on some of them became isolated by the cutting of surrounding timber, and the nesting trees were preserved only through the solicitude of landowners. In the Pacific Northwest and in Southeastern Alaska, tall conifers are used as nesting sites. Altitude, as a rule, is sought (fig. 6), and nests in Ohio often are 70–80 feet above the ground, while those in the spruces and hemlocks of the Northwest may be more than 100 feet from the ground.

In the course of his Alaskan fieldwork, the senior author computed bald-eagle nests to average about 5½ feet high and 6¾ feet across. On the basis of 11 nests measured or estimated, the height from the ground to the top of the nest varied from 45 to 137 feet, with an average of 77 feet. In this region, Sitka spruce was the favorite nesting tree.

In contrast with the nesting sites described, bald eagles may be forced by lack of tall arboreal growth to nest in low vegetation, or even on the ground. Such a condition prevails in the Aleutian Islands in Alaska, where their nests are placed on rocky cliffs or pinnacles (fig. 7); and in Florida, Broley (1947) recorded a nest only 15 feet above water in a mangrove. Bendire (1892), quoting Capt. B. F. Grove, reported the finding of two eagle nests placed on the ground of small islands in the Gulf of Mexico off the Texas coast. One, established by a pair of birds still in their immature plumage, consisted of a few sticks on the otherwise bare ground. The other nest had been built up through successive years of use to a height of 6 feet. Also on record is the nesting of a

FIGURE 6.—A typical nest of the bald eagle, Seney National Wildlife Refuge, Mich. Located in a dead red pine, 40 feet from the ground, it was used for several years in the late 1940's. A Canada goose used its platform as a nest site in 1950. (Photograph by C. J. Henry.)

FIGURE 7.—Young bald eagles in their nest on offshore pinnacle, Rat Island, Aleutian Islands, Alaska. (Photograph by V. B. Scheffer.)

pair of eagles on the ground in Crawford County, Mich. Here the birds had constructed their nest on a knoll in the burned-over plain of a pine forest (Sharritt 1939).

Although the laying of eggs by one species of bird in the nest of another occurs frequently, nesting in the occupied nest of another species is less common. Yet, such an instance was reported by J. Warren Jacobs (1908), when he found a great horned owl incubating two of its eggs in a cavity in the side of the large nest of a bald eagle. The eagle was also incubating a set of its own eggs at the top of the great nest pile. The diurnal fish-eating habit of the eagles apparently did not conflict unduly with the nocturnal rodent feeding of the owls. Dr. Herrick (1933) observed a pair of English sparrows that had built their nest in the side of a bald eagle's domicile and availed themselves of the down shed by the eaglets to line their nest.

That bald eagles mate for life is a common and apparently a well-substantiated belief. If one of a pair is killed, the other usually acquires a new mate and may continue to nest at the former site. Since bald eagles apparently become sexually mature even before they have acquired adult plumage, it is possible to find a bird in juvenal plumage mated with one in full adult

dress. Hoxie (1910) reports a case of both birds of a mated pair being in juvenal plumage.

Dr. Herrick (1932, p. 311) recorded a female which had four different mates, namely, in 1924, 1925, 1928, and 1931. In the latter year, her mate apparently was killed, and after an absence of 14 weeks she returned with another. They successfully raised a brood the following year.

The clutch of the bald eagle may vary from 1 to 3 eggs with 2 being the normal number. Frequently only 1 of the young is raised to maturity. According to Herrick (1932, p. 318), the normal incubation period in northern Ohio is 34 to 35 days. In Florida, Nicholson (1952) established the incubation period as 35 days. The period of egg laying varies greatly from the southern to the northern portion of the bald eagle's extensive range. Bent (1937) has shown that from Georgia and Florida to Texas eggs may be found from the end of October to the end of February, with half of the records falling between the dates of December 8 and January 27. From New Jersey to Virginia, he found that the spread was from February 2 to May 27, with half of the records falling between February 27 and March 9. Six records from the area, Maine to Michigan, revealed that egg laying took place between April 1 and April 21. In Alaska and Arctic America, eggs were laid from March 24 to June 24, with half of the records falling between May 7 and May 14. On the basis of these figures, the median dates of egg laying for Florida, New Jersey, Michigan, and Alaska are roughly, January 2, March 3, April 10, and May 10, respectively.

In the southern part of the bald eagle's range, should the eggs be removed from a nest or a nest destroyed during the egg laying or early part of the incubation period, a second clutch often is laid. The same nest may be used, but usually there is a shift to a new location. Farther north, except possibly in the mild climate of Southeastern Alaska, the shortness of the season and the necessity of finding food for the young over an extended period prevent the laying and hatching of second clutches.

The nestling life of the bald eagle, as determined by Dr. Herrick in northern Ohio, lasts from 10 to 13 weeks during which the young undergo one change of downy plumage and gradually acquire their juvenal plumage with which they leave the nest (fig. 4). Even after the young leave the nest they often remain in the vicinity and at times are fed at the nest site by their parents throughout their first summer. In this respect, the young of the bald eagle are quite different from the offspring of most passerine birds, which, once they have left the nest, seldom return to it. On the other hand, the young bald eagles are not permitted to use their home territory for breeding purposes unless in later years one of them should be mated with a parent.

# ENEMIES

The bald eagle has few if any vertebrate enemies other than man. Many of the smaller birds are prone to pester bald eagles, particularly during the nesting season, but nothing more serious than temporary discomfort can be charged to these attacks. The crow and the eastern kingbird frequently harass the bald eagle, which on rare occasions will turn on its tormentors. Herrick relates an incident in which a pair of diminutive gnatcatchers, only slightly larger than hummingbirds, irritated an adult eagle to the point that it moved to another perch farther from the home territory of the small birds.

Man, however, has had a marked effect on the abundance of the bald eagle. This was amply demonstrated in the coastal region of Alaska where, over a period of 34 years, possibly as many as 100,000 bald eagles were killed as the result of the bounty law. It is the consensus of many competent observers that bald eagle numbers were materially reduced along the principal waterways in the southeastern part of the Territory.

Throughout the United States the status of the bald eagle has been one of steadily decreasing numbers largely because of the activities of man either against the birds themselves or through modification of their habitat and destruction of nesting sites. Of significance in this connection is the fact that the nestling bald eagles banded by Charles L. Broley (1947) during the period 1939–46 and recovered later (48 of them) were, with two exceptions, killed within 1 year after their release. And this degree of shooting pressure was exerted in our Eastern States largely through a period of years when the bald eagle had been given complete protection under Federal law (see p. 19).

Periodically, storms of hurricane intensity have dealt havoc to nesting eagles not only by destroying their nests but also the young, which require 12 or more weeks before they are equipped to live away from their home.

# LEGISLATION

## UNITED STATES

Although the Continental Congress adopted the bald eagle as a national symbol to be used on the Great Seal of the United States, on coins, and in other ways, laws protecting the bird were not considered until many years later. Early in 1930, a serious and nearly successful effort was made to enact Federal legislation to protect it. On January 6, bills entitled "Bald Eagle Protection Act" were introduced in both the Senate and the House of Representatives. This would have afforded protection to the bald eagle with the proviso that "it shall not be unlawful to kill any such eagle * * * when in the act of destroying wild

or tame lambs or fawns or foxes on fox farms." Favorably acted on by the Senate after certain amendments, the bill later failed of passage in the House of Representatives.

Companion bills to protect the bald eagle again were introduced in the Senate and the House of Representatives in the spring of 1940. Their provisions followed closely those of the earlier bills with the exception that the Territory of Alaska was excluded, a situation brought about by strenuous objection to the protection of the bald eagle in an area where it was abundant and had potentialities for harm to fishing and fur-farming industries. This act was passed, signed by the President and became a law (Title 54, Stat. 250) on June 8, 1940.

The salient features of this legislation provide that, except in the Territory of Alaska, it shall be unlawful to "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or in any manner, any bald eagle, commonly known as the American eagle, alive or dead, or any part, nest or egg thereof." The act also provides for the granting of permits to collect eagles for scientific purposes and for the protection of wildlife or agricultural or other interests locally. Authority and moneys provided under the Migratory Bird Treaty Act of July 3, 1918, were made available for the administration and enforcement of the Bald Eagle Act.

With the bald eagle now afforded protection under Federal law, provisions in State laws contrary thereto lose their import. A review of State statutes made several years prior to the protection of the eagle disclosed that in 5 States the bird was specifically protected, in 39 it was protected by implication, and in 1 it was unprotected. Consequently, in the United States enactment of a Federal law for the protection of the bald eagle conformed to prevalent thought and strengthened enforcement procedures.

## ALASKA

Legislation enacted by the Territorial Legislature of Alaska regarding the bald eagle has been that connected with enactment or repeal of bounties for the birds' destruction. In appraising such legislative action, one must take into consideration the circumstances prevailing in the areas affected by such action. Although there have been marked changes in human populations and activities in recent years in this expansive region, throughout much of the bounty-payment period, Alaska was largely a primitive, sparsely populated area. The abundance of bald eagles in the coastal region of Alaska, to which they are partial, was and still is many times that prevailing in those areas in the States where the bird is most plentiful. If we consider also that, in its fisheries and fox farming, Alaska has industries that could be vulnerable to eagle depredations, and that a bounty system often is looked upon as a source of income, the reason for the popularity of such a law in the Territory becomes obvious.

The initial bounty law, enacted by the Territorial Legislature in 1917, provided a payment of 50 cents for each pair of eagle feet. In that year and in subsequent years, payments were made on the following numbers of eagles: 1917, 2,048; 1918, 3,181; 1919, 2,641; 1920, 2,377; 1921, 2,121; 1922, 3,318; or a total of 15,745 in the 5-year period. In 1923, the bounty was increased to $1 and from then until 1940 available records show that an additional 79,746 eagles were killed. In this computation, however, there appear to be some discrepancies, and, no doubt, many eagles were killed and not retrieved or were crippled only to die later.

Although the bounty remained in force in subsequent years, no money was appropriated by the Territorial Legislature for biennial periods either in 1941 or 1943. In 1945, the law was repealed only to be reenacted in 1949 with the bounty increased to $2 for each pair of eagles' feet. To February 11, 1951, payments were made on 7,455 eagles under the revised statute.

On July 1, 1952, a regulation adopted under the provisions of the Alaska Game Law, provided that—

> these birds may be killed only when committing damage to fishes, other wildlife, domestic birds and animals. No carcass or any part thereof including feathers of birds so taken may be possessed or transported for any purpose.

Eight months later, March 2, 1953, the territorial eagle bounty law was repealed. Consequently, the bald eagle no longer has a bounty on its head in Alaska and may be killed only when causing damage.

That the bounty law reduced the number of eagles in the coastal region of Alaska is attested by a number of reliable observers. George Willett, able ornithologist and field observer of many years of experience in Southeastern Alaska, had the following to say regarding the number of eagles in Alaska at about the time the bounty law was enacted (Pearson 1928):

> Bird lovers in the States, to whom the sight of an eagle is an event, can hardly conceive of the great numbers of the birds to be seen along the Alaskan Coast. In this region the eagle probably outnumbers all other raptorial birds a thousand to one.

After several years' absence from Alaska, Willett again spent a summer along the southeastern coast. The following comment (in correspondence) made at a time when the bounty had been in effect for 19 years, gives his impression of the reduction in eagle numbers:

> I spent the summer of 1936 in southeastern Alaska and found that the eagles had decreased to such an extent that destruction by them must be small. This was admitted by many Alaskans with whom I talked. * * * Unfortunately, the question has stopped being one of conservation and has become economic, in that many Indians and some whites * * * have come to consider the eagle bounty as part of their income.

Even after the bounty had been in effect for only a short period, those who were in close touch with the problem became aware of the reduction in eagle numbers. C. D. Garfield, Secretary of the Alaska Fish and Game Club, wrote apprehensively in 1920:

> Since December 6, 1918, bounty has been paid on 3,256 eagles or a total of

8,356 since the passage of the Act * * * A vast difference is noted in the numbers of this bird showing in southeastern Alaska and it is a safe prediction that, if the slaughter continues for a few years longer, the species will become practically extinct.

Ernest P. Walker, formerly executive officer of the Alaska Game Commission, stated in 1927:

The Eagle bounty system has considerably reduced the Eagles in southeastern Alaska in the ten years that it has been in effect, and to a lesser degree it has reduced Eagles along the southern coastline westward as far as the Kadiak region. It is doubtful, however, if the birds have been materially reduced farther westward, and evidence that they have been materially affected through the interior and northern country is lacking.

Hosea Sarber, an observant and reliable game-management agent of the U. S. Fish and Wildlife Service, stationed for many years at Petersburg, Alaska, commented (in correspondence) on the possible effect of the failure of the Legislature to provide the necessary bounty funds in 1941 and 1943, as follows:

There is no question but that the eagle will increase now to its former numbers. They are still plentiful throughout the country and they will now increase unmolested as no one will be shooting them * * *.

There is little question but that with the removal of possibly 100,000 birds during the years the bounty laws were in operation the number of eagles was noticeably reduced, at least along the Southeastern Alaska coast, where the population is concentrated. Farther to the west where the birds are less abundant and certainly inland, where relatively few exist, the effect on their total number was never appreciable. As with the operation of most bounty systems, where the birds were not abundant or where the hunting pressure was limited, a surviving nucleus remained. This was true even in Southeastern Alaska in the area of greatest hunting pressure. With the termination of bounty hunting, the residual eagle population can be expected to recoup normal numbers within a few years. That something of that nature has taken place might be inferred from the observations of enforcement agent Clarence Matson, who reported an estimated 750 eagles in the Haines area at the northern end of the Lynn Canal early in 1954.

## CANADA

In British Columbia, bounties were paid on golden eagles taken during the period 1910 to 1924, but in the course of this program payment no doubt had been made on numbers of juvenile bald eagles. Whereas $3 was paid in 1910, in later years it was reduced to $1. Even with the lessened payment, 7,095 eagles were reported to have been killed in 1922. Subsequent to 1924 no bounties were paid on eagles in British Columbia but numbers of them were removed by game wardens. Again, there may have been bald eagles among the total of 902 eagles killed in that Province during the 5-year period, 1948–52.

# FOOD

Information on the food of the bald eagle as revealed by stomach examinations and data assembled from field sources has been presented separately for Alaska, the United States, and Canada. There are several reasons for this. The bald eagle is much more abundant in Alaska than in other parts of its range in North America with a resultant increase in its economic influence in that area. In Alaska, it is also thrown into direct contact with commercial fisheries and fox-farming—activities that are less extensive or even nonexistent elsewhere in its range. In addition, in Alaska the bald eagle has had a background of bounty history supported to a large extent by popular opinion, which is markedly at variance with the public attitude throughout the United States, where it has had legislative protection since 1940. Such varied conditions and attitudes have compelled the writers frequently to discuss the status of the eagle against the environmental background where it arose, and have led to the inevitable overall conclusion that, in several respects, the economic role of the bald eagle in Alaska may be quite different from that in the States.

## SOURCES OF INFORMATION

### ALASKA

*Southeastern Alaska.*—The collecting of bald eagle stomachs in Alaska for this study began early in 1940 when Hosea R. Sarber gathered material on Prince of Wales Island, the Stikine River Flats, and elsewhere in the southeastern part of the Territory. In the following year Sarber continued his collecting and was joined, early in May, by the senior author and together they collected on the islands and mainland of Southeastern Alaska until late in August. For the remainder of 1941 and during the following 2 years Sarber gathered additional stomach material. In 1945, the senior author collected eagle stomachs not only in Southeastern Alaska but also at points to the northwest. In 1946, he collected additional eagle stomachs on the Copper River Flats and also in Southeastern Alaska. As a result of this intensified effort, approximately 500 stomachs were collected during the period 1940–46, of which Sarber, working alone, took about 130 during the fall and winter months.

Notwithstanding the fact that Alaska is much better represented than the States, the eagle stomachs collected in the Territory were obtained largely in the coastal area south and southeast of Juneau (fig. 2). Only 20 were obtained elsewhere, mainly near the mouth of the Copper River, the shores of Cook Inlet, and on Kodiak Island to the west. Consequently, analysis of bald eagle stomachs from Alaska must be construed as an appraisal of the bird primarily in the area of

its greatest abundance, the coastal area south of Juneau. The number of Alaskan eagle stomachs that contained sufficient food for the estimation of percentages is set forth, by months, in table 2.

*Aleutian Islands.*—Because of the peculiarities of the prey fauna of the bald eagle on the Aleutian Islands, the available information on its food habits on those far-flung islands has been segregated here. Much of our knowledge on the subject rests on the observations made and specimens collected by Olaus J. Murie and his associates in 1936 and 1937 (Murie 1940). Although the eagle studies were incidental to a more comprehensive biological survey of the area, food remnants and ejected pellets of the bald eagle were gathered from 10 nests in 1936 and 18 nests in 1937, and a total of 399 food items identified therefrom. Collections were made at various points from the end of the Alaskan Peninsula to islands near the end of the chain, 700–800 miles to the west. Material from the 1936 expedition was examined by Cecil S. Williams in Washington, D. C., while the remainder was examined by Murie, aided (in a few determinations) by the senior author of this paper.

Table 3, condensed from two tables in the earlier article (Murie 1940), and including a few additions from later identifications, reveals the bald eagle's dominant foods on the Aleutian Islands. Because of the nature of the material, the percentages listed for the different items have been based on the proportion that the number of individuals of each species bears to

TABLE 2.—*Food of 435 Alaskan bald eagles, expressed as volumetric percentages of the several groups of items and arranged under the months of the year*

[Based on stomach analyses]

| Food item | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of stomachs | 10 | 28 | 30 | 25 | 98 | 70 | 59 | 64 | 23 | 11 | 11 | 6 | |
| Fishes: | | | | | | | | | | | | | |
| Salmonidae [1] | 10.0 | | | | 2.0 | 11.8 | 24.1 | 35.8 | 85.0 | 25.4 | 9.1 | | 16.9 |
| Gadidae [2] | 28.8 | 44.2 | 23.3 | 5.7 | 22.0 | 16.7 | 10.5 | 5.2 | | | 9.1 | 33.3 | 16.6 |
| Cataphracti [3] | 20.0 | 13.7 | 14.4 | 30.2 | 6.1 | 8.0 | 11.0 | 6.5 | Trace | 3.8 | | | 9.4 |
| Heterosomata [4] | 22.0 | 15.9 | | 21.6 | 11.4 | 14.4 | 17.4 | 5.6 | 1.8 | 1.8 | | | 9.3 |
| Clupeidae [5] | | | 10.0 | | 9.0 | 1.4 | 2.3 | 4.7 | .2 | | | | 2.3 |
| Other fish | | | 10.0 | 12.2 | 19.5 | 18.5 | 8.0 | 13.0 | | 27.3 | 9.1 | 16.7 | 11.2 |
| Total | 80.8 | 73.8 | 57.7 | 69.7 | 70.0 | 70.8 | 73.3 | 70.8 | 87.0 | 58.3 | 27.3 | 50.0 | 65.7 |
| Birds: | | | | | | | | | | | | | |
| Anatidae [6] | 19.2 | 3.6 | 8.7 | 22.3 | 2.2 | 2.1 | | | | 5.3 | 52.7 | | 9.7 |
| Other birds [7] | Trace | 9.6 | 25.4 | 4.0 | 2.9 | 4.3 | 6.4 | 2.5 | 2.6 | 9.1 | 9.1 | 33.3 | 9.1 |
| Total | 19.2 | 13.2 | 34.1 | 26.3 | 5.1 | 6.4 | 6.4 | 2.5 | 2.6 | 14.4 | 61.8 | 33.3 | 18.8 |
| Mammals | | | | | 6.1 | 4.2 | | | 4.3 | | | | 1.2 |
| Invertebrates [8] | | 4.8 | 1.5 | | 8.2 | 2.2 | 3.9 | .6 | 1.8 | | | | 2.0 |
| Carrion | | 8.2 | 6.7 | 4.0 | 10.6 | 16.4 | 16.4 | 26.1 | 4.3 | 27.3 | 10.9 | 16.7 | 12.3 |

[1] Salmon, trout.
[2] Pollack, cod.
[3] Sculpins, scorpionfishes, rockfishes.
[4] Flounders, halibut.
[5] Herrings, anchovies.
[6] Ducks, geese.
[7] Mainly auklets, murres, and other sea birds.
[8] Crustaceans and miscellaneous invertebrates.

TABLE 3.—*Food remains collected at nests of bald eagles on the Aleutian Islands, 1936 and 1937*

| Food item | Occurrence | |
|---|---|---|
| | Number | Percent |
| FISHES: | | |
| Dolly Varden trout (*Salvelinus malma*) | 1 | 0.2 |
| Handsawfish (*Alepisaurus* sp.) | 4 | .9 |
| Pollack (*Theragra chalcogramma*) | 9 | 2.0 |
| Pacific cod (*Gadus macrocephalus*) | 1 | .2 |
| Rockfish (*Sebastodes* sp.) | 1 | .2 |
| Greenling (*Hexagrammos* sp.) | 4 | .9 |
| Atka mackerel (*Pleurogrammus monopterygius*) | 14 | 3.1 |
| Sculpins (Cottidae) | 7 | 1.6 |
| Unidentified fish | 3 | .7 |
| Total | 44 | 9.8 |
| BIRDS: | | |
| Shearwater (*Puffinus* sp.) | 21 | 4.7 |
| Fulmar (*Fulmarus glacialis*) | 81 | 18.3 |
| Forked-tailed petrel (*Oceanodroma furcata*) | 1 | .2 |
| Cormorant (*Phalacrocorax* sp.) | 24 | 5.4 |
| Emperor goose (*Philacte canagica*) | 2 | .4 |
| Pintail (*Anas acuta*) | 1 | .2 |
| Teal (probably *Anas crecca*) | 1 | .2 |
| Old-squaw (*Clangula hyemalis*) | 10 | 2.2 |
| Harlequin duck (*Histrionicus histrionicus*) | 3 | .7 |
| Unidentified duck | 3 | .7 |
| Common eider (*Somateria mollisima*) | 7 | 1.6 |
| Red-breasted merganser (*Mergus serrator*) | 1 | .2 |
| Bald eagle nestling (*Haliaeetus leucocephalus*) | 1 | .2 |
| Rock ptarmigan (*Lagopus mutus*) | 1 | .2 |
| Glaucous gull (*Larus hyperboreus*) | 2 | .4 |
| Glaucous-winged gull (*Larus glaucescens*) | 31 | 6.9 |
| Kittiwake (*Rissa tridactyla*) | 3 | .7 |
| Murres (*Uria aalge, U. lomvia*) | 34 | 7.6 |
| Pigeon guillemot (*Cepphus columba*) | 6 | 1.3 |
| Ancient murrelet (*Synthliboramphus antiquum*) | 10 | 2.2 |
| Paroquet auklet (*Cyclorrhynchus psittacula*) | 10 | 2.2 |
| Crested auklet (*Aethia cristatella*) | 41 | 9.2 |
| Least auklet (*Aethia pusilla*) | 15 | 3.6 |
| Horned puffin (*Fratercula corniculata*) | 13 | 2.9 |
| Tufted puffin (*Lunda cirrhata*) | 27 | 6.1 |
| Unidentified alcid | 5 | 1.1 |
| Raven (*Corvus corax*) | 2 | .4 |
| Unidentified bird | 4 | .9 |
| Total | 360 | 80.7 |
| MAMMALS: | | |
| Domestic sheep | 2 | .4 |
| Blue fox (*Alopex* sp.) | 1 | .2 |
| Aleutian ground squirrel (*Citellus p. albusus*) | 22 | 5.1 |
| Field mouse (*Microtus amakensis*) | 3 | .7 |
| House rat (*Rattus norvegicus*) | 1 | .2 |
| Sea lion (*Eumetopias jubata*) | 1 | .2 |
| Total | 30 | 6.8 |
| INVERTEBRATES: | | |
| Squid (Chondrophora) | 1 | .2 |
| Snail (Gastropoda) | 6 | 1.4 |
| Crab (Oxyrhyncha) | 4 | .9 |
| Clam worm (Nereidae) | 1 | .2 |
| Total | 12 | 2.7 |
| Grand total | 446 | 100.0 |

the total number of food items collected.

In appraising this type of material, which contains food pellets as well as nest debris, attention should be called to the fact that, when eagles are feeding exclusively on fish, compact pellets are seldom formed. On the other hand, when mammals are eaten and, to a less extent, birds, pellets usually are formed. It is possible, therefore, that the recorded amount of fish eaten by these Aleutian eagles may have been minimized somewhat in the tabulation.

## UNITED STATES

In marked contrast with the stomach material from Alaska, gathered in recent years and in considerable volume, that available from the United States was collected largely in earlier years (more than half of it in the past century), and the 31 stomachs so assembled were from 18 different States. Furthermore, earlier examinations, while adequate with respect to the identity of the items, were not conducted in conformity with modern volumetric methods, and thus prevented their combining with more-nearly current examinations. For these reasons, a tabular presentation of the data from bald-eagle stomachs taken in the United States is impractical. Further insight into the food preferences of bald eagles in the mid-Atlantic States is obtainable, however, from the analyses of pellets and food debris found at nests and roosts. In table 4, food items found at the nests of bald eagles in coastal areas

of Maryland and Virginia by W. B. Tyrell during the spring months of 1936 and 1937 are listed. These food-habit examinations were made by C. F. Smith and Clarence A. Sooter.

TABLE 4.—*Food remains collected at nests of bald eagles in coastal regions of Maryland and Virginia, 1936 and 1937*

| Food item | Occurrence | |
|---|---|---|
| | Number | Percent |
| FISHES: | | |
| Herring (Clupeidae) | 1 | |
| Cyprinidae (other than carp) | 1 | |
| Carp (*Cyprinus carpio*) | 3 | |
| Channel cat (*Ictalurus punctatus*) | 6 | |
| Catfish (*Ameiurus* sp.) | 19 | |
| Bass (Centrarchidae) | 1 | |
| Unidentified fish | 2 | |
| Total | 33 | 52.4 |
| BIRDS: | | |
| Horned grebe (*Colymbus auritus*) | 2 | |
| Great blue heron (*Ardea herodias*) | 1 | |
| Common mallard (*Anas platyrhynchos*) (?) | 2 | |
| Black duck (*Anas rubripes*) | 4 | |
| Pintail (*Anas acuta*) | 1 | |
| Ring-necked duck (*Aythya collaris*) | 2 | |
| Lesser scaup duck (*Aythya affinis*) | 2 | |
| Unidentified duck | 1 | |
| Bald eagle (*Haliaeetus leucocephalus*) | 2 | |
| Gallinaceous bird | 1 | |
| Coot (*Fulica americana*) | 1 | |
| Domestic pigeon (*Columba livia*) | 1 | |
| Long-eared owl (*Asio wilsonianus*) | 1 | |
| Total | 21 | 33.3 |
| MAMMALS: Muskrat (*Ondatra zibethicus*) | 3 | 4.7 |
| REPTILES: | | |
| Mud turtle (*Kinosternon subrubrum*) | 3 | |
| Painted turtle (*Chrysemys picta*) | 1 | |
| Total | 4 | 6.3 |
| VEGETABLE MATTER: Seeds of persimmon (*Diospyros virginiana*) | 2 | 3.3 |

Additional data on the food preferences of the bald eagle in the Chesapeake Bay region are obtainable from pellets collected by F. R. Smith on the Blackwater National Wildlife Refuge in Maryland during the period March 1933 to March 1934. Table 5 presents this information in detail, but it is important to point out that pellet material alone tends to minimize the recording of fish which the eagles may have eaten to the exclusion of animals clothed in fur or feathers. Many of the smaller fish bones are completely digested in the eagle's stomach and, without a binding material, the bones of fishes eaten are likely to be scattered when regurgitated and no definite pellet formed. Accordingly, it is safe to assume that the amount of fish eaten by the Chesapeake Bay eagles was somewhat greater than that indicated. These pellets were examined and the material identified by A. L. Nelson and C. S. Williams. The number of occurrences of a food item indicates the frequency with which it was recorded in the material examined and the percent indicates the proportion comprised by each major group.

Examination of 630 bald-eagle pellets collected by the senior author near Stockton, Kans., during the winters of 1935–41, revealed that the birds were subsisting almost entirely on rabbits. Their remains were found in 619 (98.3 percent) of the pellets and 607 of these contained nothing else. Jackrabbits, very largely if not entirely the black-tailed form (*Lepus californicus*), comprised the bulk of the rabbits eaten. The remains of cottontails (*Sylvilagus floridanus*) were found in 12 of the pellets. Rodents, constituting 1.6 percent of the remains, included prairie dogs (*Cynomys ludovicianus*) in 3 pellets, fox squirrels (*Sciurus niger*) in 3, a wood rat (*Neotoma floridana*) in 1, and unidentified cricetids in 3.

Remains of moles (*Scalopus aquaticus*) were present in 3 pellets. Birds were found in 7 (about 1 percent) of the pellets and of these, 3 were domestic chickens, 1 a meadowlark (*Sturnella*), and 3 were unidentified.

TABLE 5.—*Analysis of 59 pellets of bald eagles collected on the Blackwater National Wildlife Refuge, Md., March 1933 to March 1934*

| Food item | Occurrence | |
|---|---|---|
| | Number | Percent |
| FISHES: | | |
| Gizzard shad (*Dorosoma cepedianum*) | 1 | |
| Fresh-water eel (*Anguilla rostrata*) | 2 | |
| Toadfish (*Opsanus tau*) | 1 | |
| Unidentified fishes | 2 | |
| Total | 6 | 4.2 |
| BIRDS: | | |
| Pied-billed grebe (*Podilymbus podiceps*) | 2 | |
| Atlantic brant (*Branta bernicla*) | 1 | |
| Common mallard (*Anas platyrhynchos*) | 4 | |
| Pintail (*Anas acuta*) | 3 | |
| Green-winged teal (*Anas carolinensis*) | 4 | |
| Unidentified *Anas* | 5 | |
| Baldpate (*Mareca americana*) | 3 | |
| Woodduck (*Aix sponsa*) | 1 | |
| Canvasback (*Aythya valisineria*) | 2 | |
| Unidentified *Aythya* | 7 | |
| Ruddy duck (*Oxyura jamaicensis*) | 1 | |
| Hooded merganser (*Lophodytes cucullatus*) | 1 | |
| Unidentified merganser | 1 | |
| Unidentified ducks | 17 | |
| Unidentified gallinaceous birds | 2 | |
| Domestic chicken | 9 | |
| Domestic pigeon | 1 | |
| Unidentified birds | 6 | |
| Unidentified bird's egg | 1 | |
| Total | 71 | 50.4 |
| MAMMALS: | | |
| Unidentified shrew | 1 | |
| Muskrat (*Ondatra zibethicus*) | 29 | |
| Meadow mouse (*Microtus*) | 1 | |
| Cottontail rabbit (*Sylvilagus floridanus*) | 5 | |
| Wool of domestic sheep | 6 | |
| Total | 42 | 29.8 |
| REPTILES: | | |
| Racer (*Coluber*) | 1 | |
| Unidentified snakes | 2 | |
| Total | 3 | 2.1 |
| CRUSTACEANS: Edible crab (*Callinectes*) | 1 | 0.7 |
| VEGETABLE MATTER: | | |
| Kernels of corn | 8 | |
| Vegetable debris | 10 | |
| Total | 18 | 12.8 |

# ANALYSIS OF FOOD

## Fish

### ALASKA

That fish are the "staff of life" of Alaskan bald eagles has been emphatically demonstrated by examination of the 435 stomachs of these birds collected in the Territory. Fish in some form and quantity appeared in 325 of the 435 stomachs (74.7 percent by volume), either as freshly caught prey or as carrion (see table 2). Of the 227 stomachs collected during the summer period, June to October, only 15 (6.6 percent) of the eagles had failed to feed on fish. Although the fish was construed by the examiner to have been carrion in only 37 instances, there is reason to believe that much more of the fish eaten had such an origin. In fact, the senior author who helped collect much of this material considers that much more than half of the fish eaten by Alaskan eagles were dead when found by the birds.

When digestion of fish is far advanced there is little evidence left to reveal to the examiner the nature of the food eaten. The same process when prolonged, also obliterates many diagnostic bones and other parts from which identification of the fish can be made. This has resulted in unidentified fish being recorded in a substantial number of stomachs (56), and in numerous others only the genus or the family to which the fish belonged could be determined.

An undetermined portion of the fish eaten by eagles in Alaska must be construed as carrion in origin. Murie (1940) comments that this

must be true of the deep-water fishes such as the cod, although "at times fishes were seen at the surface of the water under circumstances that would permit capture by an eagle. This was particularly true of the Atka mackerel." The total amount of fish taken by the bald eagle in the Aleutians definitely is much less than that eaten by this bird in Southeastern Alaska. In fact, on the basis of these data, our national bird appears to have no significant economic effect on the fishing industry of the Aleutians, unless it be at the extreme eastern end of the chain, in the vicinity of False Pass.

It is impossible to say whether the fluctuation in the amounts taken from month to month indicates a variation in acceptance, supply, or simply an inadequate sample of stomachs. All three factors may have entered the picture, but it would appear that seasonal changes in the diet of the bald eagle in Alaska are governed, not by the supply of fish, which is ample at all times, but by the bird's feeding on other birds, a subject discussed later.

*Salmon.*—Salmon and a few trout were present in one-third (108) of the 325 stomachs in which fish occurred and, in volume, they comprised nearly 17 percent of the annual food. The bulk of this food item was consumed in late summer and early fall (table 2). The humpback, or pink, salmon (*Oncorhynchus gorbuscha*) was most frequently identified (39 stomachs), while lesser numbers of the sockeye (*O. nerka*), dog (*O. keta*), and chinook salmon (*O. tshawytscha*), were found. In two instances the remains of Dolly Varden trout (*Salvelinus malma*), a persistent feeder on salmon eggs, were detected. In 9 stomachs the eggs of salmon were present, but in at least 2 of these the whole mass was considered carrion.

It was the considered opinion of the senior author and Hosea Sarber, his companion in the collecting of the Alaskan eagle stomachs, that the salmon eaten by the bald eagle was principally carrion, and that, at least during the period when they were collecting material in Southeastern Alaska, probably much less than 10 percent of the salmon eaten were captured alive (fig. 8).

As recorded by Imler in notes taken July 11, 1941, on Anan Creek:

> Three eagles, each at a different place were observed while feeding on salmon. When later examined the fish were observed to have been dead a day or two since their gills were discolored and the flesh was a milky gray. An estimated 350,000 salmon were in the creek at the time and, although spawning had not started, many dead fish were observed in the stream.

And again in July 24 the comment was made that—

> on Pack Creek, on Admiralty Island, eagles were observed feeding on two salmon, both in a stale condition. One was a dog salmon and the other probably a humpback but the latter was so disintegrated that identification could not be made with certainty. All the eagles here seem to be feeding entirely on stale, dead salmon. Two collected yesterday gave off a disagreeable odor from the decayed fish held in the gullet.

Speaking of conditions before 1927, Ernest P. Walker, formerly executive officer of the Alaska Game Commission, had the following to

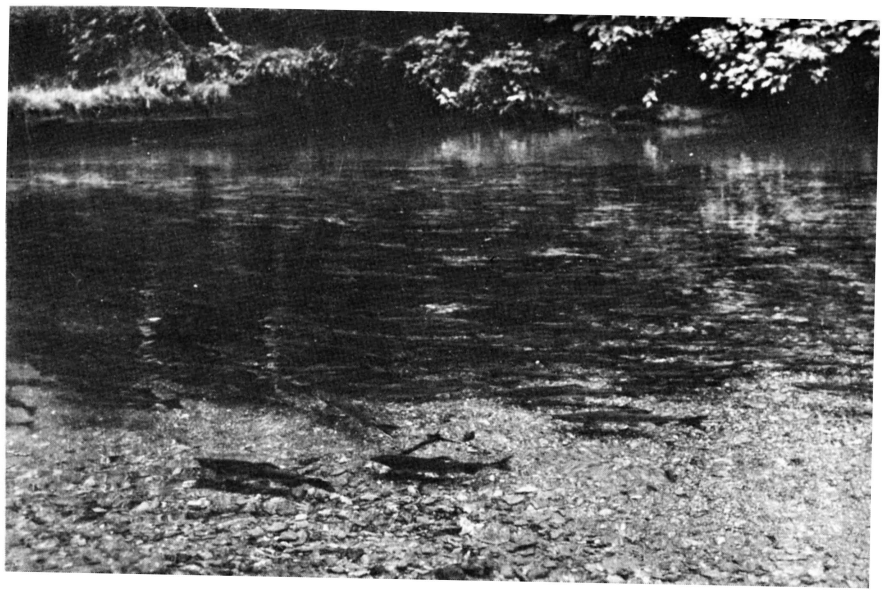


FIGURE 8.—Pink salmon in Rodman Creek, Baranof Island, Alaska, on August 10, 1941. Observations revealed that bald eagles were feeding on salmon which was largely, if not entirely, carrion. (Photograph by R. H. Imler.)

say regarding the relation of the bald eagle to salmon.

> The fish [salmon] taken are mainly those that have exhausted themselves in spawning, but unspawned fish are often taken when they are in shallow water on riffles or rising at the surface of quiet shallow pools. Eagles also make use of fish which are left on the banks by bears and wolves. * * * I have counted 150 Eagles from one point, and there were others nearby, though out of sight.

Allan Brooks (1922, p. 556) made a somewhat different appraisal in neighboring British Columbia when he commented:

> My first acquaintance with the species was in the lower Fraser Valley where, although it was a very scarce breeder, large numbers were resident throughout the year, but increasing in the fall when the run of the various salmon was at its height. Here they confined themselves mainly to a fish diet as this was available throughout the year. Salmon were largely taken before they had spawned and there were always large numbers of eagles watching the wide shallow estuary of the Chilliwack or Veddar River where it empties into Sumas Lake. Here the salmon, except such species as ascended in June and July when the water was deep, had a very hard time, very large fish were eaten alive as they attempted to cross the shallow bars, a strong fish would often flounder clear of the Eagle's claws a dozen times before it succumbed.

With such diverse conclusions being reached regarding the relation of the bald eagle to salmon, one must assume that local conditions play an important part in deciding the eagle's role. Certainly the relative abundance of eagles from place to place is important, and a broader, more comprehensive perspective of the problem is called for. In this connection, the words of John H Cobb (1931) formerly Dean of the

College of Fisheries at the University of Washington may be restated.

> Much is said by certain people of the ravages amongst the salmon of certain animals as the seal, sea lion, bear, eagle, kingfisher, crane, duck, loon, and hawk. While in the aggregate the ravages of these animals are considerable, they are not a drop in the bucket as compared with the direct or indirect ravages of man and his agencies.

*Pollack and cod.*—Nearly equaling the salmon as a favorite food of Alaskan bald eagles are the pollack and cod (Gadidae). These fish were present in 101 of the 325 stomachs examined that contained fish and comprised nearly 17 percent of the volume. The Alaska pollack, or whiting (*Theragra chalcogramma*), was dominant in 57 stomachs and the Pacific cod (*Gadus macrocephalus*), in 27 stomachs, was next.

The seasonal pattern of the bald eagle's feeding on these fish was irregular but greater quantities were taken during the colder months (table 2). In marked contrast with the abundant references to the bald eagle's relation to salmon is the almost complete absence of recorded information on its relation to the pollack and the cod. This is true despite the fact that these two fishes comprise approximately the same proportion of the bald eagle's food as the salmon, on the basis of stomach examinations. Two possible explanations present themselves, one being that predation by the eagle on living codfish seldom comes to the immediate attention of commercial fishermen and the other (which appears plausible) is that much of the codfish was picked up as carrion on the beaches. Nevertheless, the Alaska pollack often feeds near the water surface and at such times may be captured alive by the bald eagle.

*Rockfishes and scorpionfishes.*—The varied group of fishes (Cataphracti) under which are classified the rockfishes, scorpionfishes, sculpins, sea ravens, and others, appeared in 83 stomachs, and comprised 9.4 percent of the food of the eagles examined—the bulk of these fish being taken during the first half of the year (table 2). No less than eight different genera (mainly sculpins) were identified. Conspicuous among these were the widely distributed red sculpin, or Irish lord (*Hemilepidotus*), in 19 stomachs, rockfishes of the genus *Sebastodes*, in 11, and the smooth sculpin (*Leptocottus armatus*), in 13. These fishes, like the cod, were taken largely during the first half of the calendar year.

Although it appears logical that deep-water fishes such as rockfishes and sculpins would fall prey to the bald eagle only after they had floated to the surface or drifted to the beach as carrion, the senior author witnessed numerous instances in which these fishes, as well as flounders, were taken alive by bald eagles. Sculpins often were isolated in exposed shallow pools by the receding tide whereupon they became easy prey not only for the eagles but for the innumerable gulls as well.

*Flounders and other flatfishes.*—The flounders and flatfishes (Heterosomata) in 57 stomachs, comprise a group equal to the Cataphracti in

the food (9.3 percent) of the Alaska bald eagles (table 2). Of these, the starry flounder (*Platichthys stellatus*), identified in 28 of the stomachs, was most frequently found. Halibuts of the genera *Atheresthes*, *Hippoglossus*, and *Hippoglossoides*, and flounders (*Lepidopsetta bilineata*) were disclosed in a total of 14 stomachs, although the same species doubtless occurred in others when identification could not accurately be made.

The starry flounders were common in the shallow waters of the tidal flats and stream mouths of Southeastern Alaska and were easy prey for the eagles. At Keku Strait on June 29, 1941, a female eagle visited its nest twice during the evening hours, each time bringing in a flounder of about 1½ to 2 pounds. This eagle and another, carrying a fresh flounder, were collected for their stomachs; in each case the feathers of the underparts were wet indicating that the birds probably removed the living fish from the water. In this area, eagles were seen bringing in not only freshly killed flounders but living ones as well.

*Herring.*—Herring were identified in 20 of the 435 Alaskan bald eagle stomachs (table 2). This does not indicate a significant consumption of herring in these northern waters, but the finding of 18 in 1 stomach shows that when the birds encounter a convenient supply they satiate themselves on it. Ernest P. Walker (1927) has described eagle activity in the presence of a herring run in the following words:

> When the herring congregate in certain favorable regions for a considerable period prior to spawning, many kinds of birds, including the Eagle, also congregate there. Eagles then feed largely on herring found dead on the beaches and occasionally live herring are picked up from the water when at the surface. * * * The damage under such circumstances to the herring * * * is wholly negligible.

On May 30, 1941, the senior author observed bald eagles diving for and capturing live herring near Kootznahoo Inlet on Admiralty Island; of 14 attempts, 5 were successful.

How the bald eagle may take advantage of the activities of other fish-eaters is well illustrated by an incident recorded by Joseph S. Dixon (1909, p. 190). One afternoon this observer noticed a commotion in an Alaskan bay where a flock of loons was fishing, possibly on herring. An eagle was seen to leave a nearby perch, swoop down, and strike a fish in the water and then return to its perch, where it gave a shrill scream. According to Dixon:

> At the sound, eagles began to come from all directions to the spot where he had secured his fish, and within five minutes there were more than twenty eagles assembled. Only the first ones secured fish, as the fish which had evidently been driven to the surface of the water by the loons, went down again; * * *

*Other fishes.*—Other fishes, insignificant in the total food of the Alaskan bald eagle, included smelts (*Thaleichthys pacificus*), sand lances (*Ammodytes tobianus*), blennies (*Pholis*), Alaska blackfish (*Dallia pectoralis*), and wolffish (*Anarrhichthys*).

## UNITED STATES

Elsewhere, as in Alaska, fishes of various kinds are important in the diet of the bald eagle. This fact was brought out even by the limited series of 31 stomachs collected in the United States (p. 24). Fish were present in 18 of these stomachs, of which an indeterminate portion was carrion in origin. Among the kinds identified were perch, goldfish, catfish, and eels.

Indication of the preference of the bald eagle for fish in the Middle Atlantic States may be gained from the data set forth in table 4. Of the fishes, the catfishes *Ameiurus* and *Ictalurus* were most frequently encountered, while the birds were best represented by waterfowl, particularly ducks. Feathers of the bald eagle in the stomachs may have been indicative of cannibalism or excessive preening of its own feathers by the eagle involved. The seeds of persimmon probably were in the stomach contents of some prey on which the eagle had fed.

The importance of fish in the diet of the bald eagle was clearly shown in the observations by Dr. Herrick (1924 b, pp. 404 and 406) at nests in northern Ohio. Here, as is their frequent custom, the eagles had constructed their nest about a mile from the shore of Lake Erie, thus increasing the availability of their favorite food and at the same time reducing the hours of search needed to supply the dietary needs of themselves and their growing young. In 1922, Dr. Herrick found that 70 percent of the food brought to the nest was fish. In the following year fish constituted 96 percent of the young eagles' food. In explanation, Herrick comments:

> Among the fish, which were of various sizes up to a possible weight of 3 or 4 pounds, and * * * often lacked the head, we recognized the lake and common catfish, sheepshead, sand and blue pike, carp and perch—all common forms which can be found almost any day, and in great numbers after northerly storms have cast them up on the beach. * * * We have seen the eagles at Vermilion feeding regularly on the dead fish which are swept on the shores of the lake; their preference is undoubtedly for living prey, but like all raptors they take readily to carrion when nothing better is at hand and in this respect perform a useful service.

At another time Herrick (1933, p. 51) stated that the fish "might be taken off the beach, or captured by immersing at the surface of the lake; in many instances these fish were alive when they reached the nest, although they may have travelled from three to four miles in the eagle's clutches."

Mention has been made of the bald eagle taking advantage of the activities of other fish-eaters (loons) to locate and attack schools of fish in the water. The classical incident of the opportunism of the eagle is that associated with the osprey, particularly along the Atlantic coast in areas where both the bald eagle and osprey are reasonably common. At such times the eagle, usually at a height, will watch and wait for the osprey to make a strike and rise from the water with its prey. Then by persistent and threatening swoops the eagle either compels the osprey to release its prey or, by striking from beneath, will actually take the fish from the talons of the osprey. If

it has induced the osprey to release the fish, a swift dive often retrieves the fish before it reaches the water.

### CANADA

Although only two of the six bald eagle stomachs collected in Canada contained the remains of fish, a carp and a salmonid, meager data from the North give further evidence of the importance of fish in the bald eagle's fare. Taverner (1934) reported on the examination of 15 stomachs of which 9 contained fish.

## Wild Birds

The literature frequently records incidents of predation of the bald eagle on other birds and, although identification may not have been determined with unfailing accuracy in all cases, the general character of the birds eaten is apparent. Among those so reported have been loons, four species of grebes, young pelicans, cormorants, six species of herons including the great blue, Canada geese and black brant, seven species of puddle ducks and six of divers, wild turkeys and pheasants, coots, sora and clapper rails, killdeer, three species of gulls and two of terns and, lastly, the crow which delights in pestering the bald eagle at every opportunity.

### ALASKA

Remains of birds were found in 71 of the 435 stomachs of eagles collected in Alaska, and, in volume, comprised nearly 19 percent of the annual food. Reference to table 2 shows that, on a volumetric basis, birds are taken largely during the colder months, October through April. Circumstances associated with the collecting of the stomachs indicate that much of this food is taken as live prey, not carrion. Nevertheless, it is conceivable that decreased availability of fish in the form of carrion during the winter months had a bearing on the greater consumption of birds at that time.

Water birds, particularly ducks, were dominant among the avian food of eagles collected in Southeastern Alaska. Twenty-nine records were of waterfowl, including 7 species of ducks and the Canada goose. The mallard (*Anas platyrhynchos*) with 7 records and the surf scoter (*Melanitta perspicillata*) with 6 were the most frequent items. The white-winged scoter (*M. fusca*), a scaup (*Aythya*), goldeneye (*Bucephala*), bufflehead (*B. albeola*), and a green-winged teal (*Anas carolinensis*), also were included.

Remains of four horned grebes (*Colymbus auritus*), one red-necked grebe (*Colymbus grisegena*), and two loons, one of which was a red-throated loon (*Gavia stellata*), in the stomachs examined testify to the ability of the bald eagle to capture these persistent and capable divers. In fact, the eagle which had fed on the red-throated loon was shot as it was feeding on the freshly killed bird. Some of the same marine species of waterfowl, commonly fed on by bald eagles in the Aleutians (see p. 24) also were taken by eagles in Southeastern Alaska. The most vulnerable to attack was the murre (*Uria aalge*), of which 10 specimens were de-

tected; a few specimens of the crested auklet (*Aethia cristatella*), the horned puffin (*Fratercula corniculata*), and the pigeon guillemot (*Cepphus columba*) also were identified. Two gulls, the glaucous-winged (*Larus glaucescens*) and the mew (*L. canus*), with which the eagle often feeds, likewise were victims, and, on the basis of somewhat doubtful identification, the remains of a heron, a tern, crow or raven, and sandpiper have been added to the list. Finding the remains of a young eaglet in one stomach indicated that cannibalism may at times occur in the eagle household. Feathers and other fragments of a domestic fowl found in the stomach of an eagle collected at a fox farm may have been carrion in origin.

Many of the birds captured were taken under conditions of adversity for either the eagle or the victim. Severe weather with frozen lakes or deep snow always adds to the likelihood of unusual prey being captured. Also in areas of abundance, as in the case of dense flocks of coots or of herons and ducks in Florida waters, ease of capture determines the issue.

The senior author observed a bald eagle feeding on a freshly killed loon in Pybus Bay, Southeastern Alaska, on May 10, 1941, and later in the same year the remains of a bird apparently a mew, were found in an eagle's nest nearby. At another time the feathers of a recently killed scoter were picked up at a point where a bald eagle had been seen feeding.

The alertness of the bald eagle in detecting the disability of avian prey is exemplified by the experience of Alfred M. Bailey (1927), who shot at and crippled a duck at the mouth of the Stikine River in Southeastern Alaska. The bird glided down to the offshore ice, where it was promptly picked up by a passing bald eagle which flew shoreward. The collector again fired, this time at the eagle, and missed completely, but the shot so startled the big bird that it dropped its prey on the beach where the duck was retrieved.

Probably nowhere in its range does the bald eagle subsist on birds to the extent it does in the Aleutian Islands. Much of the information on which this conclusion is based comes from the field studies and material collected by Olaus J. Murie and his associates in 1936 and 1937. Since its food includes items other than birds, the reader is referred to table 3, where he will find a list of the avian victims of eagle predation.

Murie (1940) separated the data for the 2 years of collecting in the Aleutians and found that an appreciably higher percentage of bird remains was recorded in 1937 than in 1936. For this he gives a logical explanation that—

> It is likely that the material obtained in 1937, consisting of 325 items [as against 121 for 1936], is somewhat more representative of the Bald Eagle's diet in the Aleutian Islands as a whole.

To simplify matters and to include all available information, the data for the 2 years have been combined in table 3.

Our conclusions relative to the feeding of the bald eagle on other birds are essentially the same as those advanced by Murie, who stated that—

> birds are the chief food, and this would be expected in view of their supremacy in the fauna of the Aleutian Islands. It is significant also that the eagles prey extensively on so-called sea birds, which are the most plentiful there * * *.

On a percentage basis, those birds most frequently captured, as revealed by a combination of the 2 years' data, were fulmars, crested auklets, murres, glaucous-winged gulls, tufted puffins, cormorants, and shearwaters. In the aggregate, birds of all kinds comprised more than four-fifths of the food of the bald eagle in the Aleutian Islands.

## UNITED STATES

Bird remains, all waterfowl, were found in 6 of the 31 stomachs of bald eagles collected in the United States in earlier days. All were taken during winter and early spring and in one case a lead shot surrounded by a mass of duck feathers indicated that that individual probably was a cripple or dead bird when picked up by the eagle.

The attack of bald eagles on waterfowl usually is a dramatic episode most frequently observed during winter when the waterfowl are congregated and the eagles are pressed for food. Although not usually considered to possess great speed in flight, when in pursuit of waterfowl the bald eagle can maneuver with the speed and dexterity of a falcon. William Brewster (Bent 1937) in earlier days witnessed attacks on geese and brant along the Virginia coast:

> When close upon its quarry the Eagle suddenly sweeps beneath it, and, turning back downward, thrusts its powerful talons into its breast. A Brant or Duck is carried off bodily to the nearest marsh or sand-bar, but a Canada Goose is too heavy to be thus easily disposed of. The two great birds fall together to the water beneath, where the Eagle literally tows his prize along the surface until the shore is reached. In this way one has been known to drag a large Goose for nearly half a mile.

An incident that occurred on the Tule Lake National Wildlife Refuge in northern California reveals that, on occasion, the bald eagle may attack and kill pheasants. In April 1939, two ring-necked pheasants attempted to cross an opening between clumps of tules. Suddenly a bald eagle swooped out of the skies and struck one of the birds with such force that, although the eagle was driven off, the pheasant died after a brief struggle.

In earlier days, when both eagles and wild turkeys were more abundant, predation on the latter was occasionally observed. Examination of food debris associated with a bald eagle's nest at Gadsen Point, Hillsborough County, Fla., in 1913, revealed the bones and feathers of a wild turkey.

Although robbing the osprey of its legitimate fish has frequently been recorded, larceny by the bald eagle of other birds' food is seldom noted. Such an event, however, was observed on the Cape Romain

National Wildlife Refuge in 1939. In the words of the refuge manager:

as we looked over the dead *Spartina* marsh, we saw a marsh hawk drop to the ground several times after prey. A few minutes later it flew out over the adjacent ocean beach, fairly close to us. At this point an adult bald eagle which had been circling above, dropped on the marsh hawk and forced it to release its prey. The eagle quickly landed on the beach and, within a few steps, seized the object and was off again. Arriving at the spot we picked up a few scattered feathers which proved to be those of a sora rail (*Porzana carolina*).

## CANADA

In eastern Canada, Bruce S. Wright (1948) presented an unusual aspect of eagle-waterfowl relations which might easily be overlooked were all pertinent facts not available:

This eagle is the most important waterfowl predator on the area, but what data we have show that, exclusive of the hunting season where it takes many cripples, the diet of the eagle is made up of four-fifths fish and carrion and one-fifth ducks. The most frequently taken fish is the eastern chain pickerel (*Esox niger*), and the pickerel taken are usually large enough to be duckling predators themselves. Therefore, it appears to be good management to retain the eagles as they do more damage to the pickerel, an undesirable species in a duck marsh, than they do to the ducks.

At another time Wright (1953) presented the seasonal picture of eagle predation.

As the winter progresses and shore ice forms in the shallows, they have been known to concentrate around flocks of wintering waterfowl and to become predators of first importance. However the total number of eagles remaining in the north throughout the winter is not large, and their depredations are only of local importance.

At the first signs of open water inland they leave the coast once more for the freshwater habitat and resume their fish diet as soon as possible. The waterfowl gradually lose the fear of the eagles they have acquired during the winter months and both pass the summer together in harmony on the marshes. A few eagles persist in taking ducks at intervals all summer, but they are the exceptions.

As a defensive measure against the attacks of the bald eagle, coots have evolved a unique method of defense that has been observed on a number of occasions. In the words of James A. Munro (1938), who has witnessed the performance in British Columbia:

When attacked the Coots come together in a close flock and move rapidly across the water with necks outstretched; they do not dive. The pursuing eagle planes down but checks its flight when a few feet above the mass of birds, ascends, circles over the flock, then again hurls downward with tremendous force that again is suddenly braked. This maneuver may be repeated a dozen times without a capture being made and each time, terrified by the eagle's nearness, the Coots surge across the water. Apparently the eagle rarely takes a bird from the midst of the flock, although it would seem an easy thing to do, but pursues directly any straggler, and almost invariably captures it.

A very similar performance has been observed in Florida (Bent 1937), where wintering flocks of coots supply a frequent item of diet of the eagle. While in massed concentrations the coots appear to be reasonably secure, but the moment an individual bird forsakes the flock it is a doomed bird.

## Mammals

### BIG GAME

*Deer*—Stomach examinations supplied some corroborative evidence of the eagle's reported predation on deer in Alaska, remains of this animal being found in 12 of the 435 bald-eagle stomachs (table 2). In four instances the material definitely was carrion when eaten; the remains of a fawn was found in another.

In the course of the senior author's field studies in Southeastern Alaska in 1940, deer were often seen along the beach throughout the summer in the presence of an abundant eagle population, yet, at no time, was evidence of eagles molesting them encountered. During 17 days (June 15–July 2) spent in the vicinity of Keku Strait, deer including some fawns were seen almost daily. At times they would swim the strait in direct view of numerous eagles which disclosed no predatory inclinations towards them. No opportunity was afforded to appraise deer-eagle relations in areas inland from the coast.

George Willett (1927, p. 591), an ornithologist of wide experience in Alaska, often contended that the casual visitor to the Territory was not in a position to judge the activities of the bald eagle with respect to the killing of deer fawns. He wrote that unless the observer is able to appraise matters in the month of July when the fawns are small and helpless and the eaglets are large and hungry, he would not encounter eagle predation at its worst.

Bald eagles, in common with most other predators, apparently avail themselves of the helplessness of other animals and may resort to "gang attack" to gain their end. Such a circumstance was reported from the eastern shore of Lake Huron late in the last century (Thurston 1891–92). The narrator stated:

> The winter of 1890–1891, I spent in company with a friend trapping in that section of country lying north-west of Lake Joseph. Returning one day from a visit to our traps, we were going round an arm of the lake when five eagles rose from the ice. * * * We went to where they rose from, and found the remains of a doe fawn of about seventy-five pounds weight; the animal had ventured out on the ice, and being some distance from cover had fallen an easy prey to the flock of hungry birds. We went back on the tracks some distance, and not seeing the tracks of any other animal were quite sure that it was killed by the Eagles.

*Mountain goat.*—The finding of a substantial quantity of hair of a mountain goat (*Oreamnos*) in the stomach of a bald eagle collected May 17, 1946, on one of the Brothers Islands near the southern end of Admiralty Island, presents an unusual situation since no mountain goats have been reported on this small island although these game mammals are present on the mainland to the east and were introduced some years ago on Baranof Island, to the west. Even at the nearest point it would appear that the gorged bird had travelled at least 15 miles after it had fed on the goat.

In a Montana area, where golden eagles were dominant, the following incident concerning a bald eagle and mountain goats has been re-

corded by Brown and Couey (1950). The observer, Stewart Brandborg, in the Sun River country witnessed a bald eagle fly past cliffs on which two nannies, two kids, and a yearling were feeding. As related:

> One of the nannies, that was feeding in a narrow ravine, was seen to crowd close to the side of her kid as the bird circled about 25 feet above her. The eagle then swooped within a few feet of these two goats and landed on a pinnacle of rock ten feet above where they stood. The nanny started toward the eagle and was within five feet of the bird, when it jumped from where it had been perched, glided low to pick up the kid, and sail out over the face of the cliff. The kid hung helplessly from the talons of the bird as it sailed to a point where it began to lose elevation, and finally landed a third of a mile away and just out of sight of the observers. The mother goat was seen to spend several minutes searching up and down the slope near the point where she had left the kid. * * * The kid * * * could not have weighed more than six or seven pounds and was probably not more than a few days old. The eagle soared without moving its wings during the entire flight with the kid.

*Antelope.*—Although the golden eagle is more common than the bald eagle in antelope country, the latter may at times attack the fleet-footed ruminant. R. L. Clennon of Buffalo, S. Dak., describes (in correspondence) such an incident in the following words:

> On November 8, 1938, while running some coyote traps * * * in Harding County south of the State Antelope Preserve, I noticed an eagle wheel over the edge of a small rocky butte as if pursuing some animal. * * * Upon looking over the butte I saw three American or bald eagles. One was an old bird, the other two were young. The birds were circling over and diving at a young (three-fourths grown) antelope. * * * The eagles kept diving and striking with breast and talons until the antelope went down and then they started to tear away the flesh. * * * When I walked to the antelope it was dead.

## SMALL MAMMALS

*Rabbits and rodents.*—Both stomach examinations and field observation disclose the fact that the bald eagle, normally, is not as persistent an enemy of rabbits and rodents as is the golden eagle. Yet, it would appear that when these animals are available the bald eagle adapts itself to such a diet.

Among the 435 Alaskan bald-eagle stomachs examined, small mammals were recorded only twice, a meadow mouse in one and a shrew in another. Rabbits or small rodents also were detected in 5 of the 31 stomachs collected in the United States, largely in earlier years.

Understanding of field conditions is essential for the proper interpretation of the amount and nature of the mammal food eaten. As Murie (1940) has pointed out:

> Small rodents are not available on most of the [Aleutian] islands. Ground squirrels have been introduced on Kavalga Island for fox food, and the eagles apparently take full advantage of that supply. These rodents are not available on the other islands where nests were examined, except on Unimak Island. House rats are common on Rat Island. Probably on only three other islands could these be found by eagles.

It is evident that of all the mammals eaten, including the blue fox and domesticated sheep of which there was a herd on Unimak Island, the Aleutian ground squirrel was the most frequent victim. The sin-

gle record of a sea lion no doubt represented feeding on carrion.

Norman Criddle (1917), a keen observer of wildlife generally in Canada, believed that both golden and bald eagles exerted a marked suppressive effect on varying hares in the North. At the other extreme of the bald eagle's range, Florida, where the bird is essentially a fish eater, O. E. Baynard (correspondence) noted that, at more than 1,000 nests examined, rabbits comprised at least 20 percent of the food remains.

Bald-eagle pellets collected adjacent to the marshes of Chesapeake Bay in Maryland are characterized by an abundance of muskrat remains. The muskrat also appears in the diet of eagles living near the marshes of the Sandusky River in northern Ohio where Dr. Herrick (1932) found at least 14 muskrat traps in the ruins of an old eagle nest that had been destroyed.

On western plains, the bald eagle, like the golden, may feed extensively on rabbits during winter. This fact was brought out by studies of the senior author in Kansas. (See page 25.)

*Sea otter.*—Some apprehension has been felt regarding the possible hazard of the bald eagle to sea otters, particularly in the Aleutians, where these marine furbearers have increased in numbers. Murie (1940) encountered reports among the natives that eagles kill young sea otters and he was inclined to believe that some of these accounts were correct, but he was unable to learn the frequency of such incidents. He was strongly of the opinion that much of this food was carrion, since carcasses of sea otters not infrequently are washed up on the beach where they would be available to both foxes and eagles.

## Domestic Animals

### BLUE FOX

Of all the domesticated animals on which the bald eagle has been accused of preying in Alaska, the blue fox has aroused the greatest concern, at least in earlier days. Predation on blue foxes is discussed at this point, even though many of the conditions under which these fur animals were formerly raised could hardly be considered domestic.

During the summer of 1941, the senior author had an opportunity to interview numerous fox farmers and to appraise the relation of bald eagles to blue foxes in Southeastern Alaska. Practically without exception those persons interviewed accused eagles of preying on their stock and several of them related acts of predation they had seen. While the accuracy of some of these accounts is unquestionable, it is believed that the owner, knowingly or not, is likely to exaggerate the loss involved. Under the limitations of fieldwork, it was impossible to interview more than a small part of the fox farmers of Alaska or to visit more than a few of the islands on which these furbearing animals were raised. Consequently, the conclusions reached were based on the assumption that the sample appraised was representative of the whole.

The semidomesticated blue fox, allowed to roam free on small islands devoted to the industry, presented a unique problem with respect to the bald eagle. Such animals received only food and, at most, nominal care and were trapped every 2 or 3 years. Because of the concentrated population, vulnerability to eagle attack was probably greater than that which would be experienced by a normal population of completely wild foxes. Such conditions were encountered by O. J. Murie and his associates on the Aleutians in 1936 and 1937, yet the remains of only a single fox pup was found among the bald eagle nest material collected there. Murie's comments were, as follows:

> On Amchitka Island, within 200 yards of an eagle's nest containing no fox remains, a family of young foxes was living unmolested. There was another fox family at a somewhat greater distance in the opposite direction. Foxes were seen on the beach within easy reach of eagles on Kavalga Island. Many such instances could be cited. * * * At any rate, the evidence shows that eagles are not a serious menace to the blue foxes in the Aleutian Islands. An excellent fur crop is generally harvested on islands with suitable productive beaches.

Murie also pointed out that on islands where both foxes and eagles originally subsisted largely on sea birds that later were drastically reduced in numbers, the foxes may have become a more important item of eagle food.

Despite the adverse opinion of the bald eagle encountered in the course of field studies in Southeastern Alaska in 1941, no first-hand evidence of eagles feeding on foxes was found. Eagles were collected in localities where they had an opportunity to prey on blue foxes yet in none of the 435 stomachs examined was the remains of a blue fox found. Thus, the senior author was convinced that under the conditions then prevailing depredations on blue foxes were not severe enough to warrant a bounty or other concerted effort to reduce the numbers of bald eagles in fox-farming areas.

Since the time of that field appraisal (in 1941) a marked change has taken place in the blue-fox industry which has had a bearing on the relation of the bald eagle to the industry. Prices paid for long-haired furs had so decreased by the early 1950's that most of the blue-fox farmers of Southeastern Alaska had gone out of business. Furthermore, James R. Leekley, biologist in charge of the experimental fur station of the U. S. Bureau of Animal Industry at Petersburg, Alaska, is of the opinion that—

> even though fox prices were to come back, blue foxes would probably never be raised on a free running island management plan again. Research at the station and actual practice by several of the more progressive island ranchers has shown conclusively that pen raising is much more practical and profitable. It is doubtful whether complaints against the bald eagle will again be received from blue fox farmers.

This statement is based on conditions prevailing in Southeastern Alaska and may not apply to possible future operations on larger islands in the Aleutians.

Under prevailing regulations, action may be taken against the bald eagle wherever it threatens damage to domestic or wild animals. Thus,

the fox farmer is in a position to protect his property against eagle depredations without fear of violating the law.

## OTHER DOMESTIC ANIMALS

Reports, obviously gross misrepresentations but given wide publicity and credence, have long been associated with the bald eagle's relation to the common domestic animals. For example, an eagle in Maine was reported to have carried off a 30-pound pig; another in California to have flown away with a 50-pound lamb; and still others are said to have carried calves in their talons. Another aspect of the case, frequently exaggerated, concerns the digestive capacity of the bald eagle. A news item in a southwestern paper carried the statement of a rancher that an eagle ate 40 pounds of flesh at one meal. Even a tenth of this amount would have exceeded the facts.

Stomach examinations have thrown little light on the relation of the bald eagle to farm livestock, including poultry. It is apparent that the relation of the bald eagle to such creatures will have to be determined largely from published records. The records, however, are confused by the fact that observers often fail to distinguish between golden and bald eagles. Since much livestock is raised in sections where the golden eagle is prevalent, it is apparent that many of the stock-killing episodes reported are chargeable to that bird. Nevertheless, there are some records of stock-killing for which the bald eagle is to blame.

One of the 31 bald eagle stomachs collected in earlier years in the United States contained the remains of a lamb, the origin of which was not clear. Three of six bald eagles collected in Canada disclosed the flesh and wool of domestic sheep. These were obtained on a coastal island of British Columbia during the month of March.

Reports from the foothill country east of the Sacramento Valley (Grinnell, Dixon, and Linsdale 1930) indicate that bald eagles formerly visited the area in substantial numbers in late winter and early spring and that in certain years they killed many lambs.

Near Blackfoot, Idaho, in February 1945, a Federal game management agent was asked to investigate the shooting of a bald eagle by a rancher. The circumstances, supported by the body of the dead eagle and that of the lamb which it had killed, verified the rancher's contention that the eagle had killed the lamb.

The occasional tale of eagles carrying off calves should be relegated to the category of fables. But the molesting of cattle, at times resulting in serious injury, is within the capability of both bald and golden eagles. The rarity of such events, however, make them of no significance in determining the overall economic status of the bald eagle. A single incident of this type reported (in correspondence) by a former supervisor of the Colville National Forest in Washington reveals the tactics used by the bird. The attack was made upon a 2-year-old Hereford heifer and

lasted for nearly 2 hours. The eagle alighted on the animal's head or neck and, by beating its wings, turned the heifer aside whenever she tried to rejoin the herd from which she had been separated by the bird's attack. When finally rescued the heifer was in a state of exhaustion.

## POULTRY

In areas where the bald eagle is abundant, its tendencies, be they for good or bad, are apt to be intensified. Should that abundance occur where poultry is available, farmers are almost certain to voice complaints. Such, apparently, was the situation that prevailed on an island in the Kennebec River in Maine, where a farmer kept a flock of turkeys in an open-top runway fully a mile from his home. In 1933, the farmer lost 70 turkeys and was obliged to move the remainder of the flock to a covered runway nearer to farm buildings.

In writing of the food brought into the great bald eagle nest at Vermilion, Ohio, Herrick (1924 b, p. 405) stated:

> The chickens brought to the eyrie were commonly white, to judge from the few remaining feathers, and of broiler size; these were always plucked nearly clean, and as with the fish they were often lacking the head. The farmers naturally resent the loss of their chickens, and are commonly sworn enemies of the Eagle in consequence; but when we consider the wide area over which these birds range in the course of the season, and the relatively small number of domestic fowl destroyed, only one in sixteen days in 1923, it is evident that individual losses are bound to be small.

Despite the local seriousness of such predation, the bald eagle has been so drastically reduced in the United States as to preclude its being a significant menace to poultry.

Remains of a single chicken, which may have been carrion picked up in the vicinity of a fox farm, was the only evidence of this kind disclosed in the 435 Alaskan bald eagle stomachs examined during this study.

## Invertebrates

Crustacea and other aquatic invertebrates comprised 2 percent of Alaskan bald eagles' food as revealed by the 435 stomachs examined (table 2), and reflect the beachcombing habits of the bird. Here again it is problematical what portion of this food was dead when found by the birds but, whatever its character, little of economic significance can be attached to it. Crabs of several species were found in 33 stomachs, the most frequently identified being the common edible crab (*Cancer magister*). The remains of a small octopus, a shrimp, and an amphipod testify to the variety of marine invertebrate food that the bald eagle may pick up on the beach. It would appear from the contents of the stomachs that the eagle discards the heavily chitinized terminal joints of the legs of crabs. These seldom were found, whereas the basal joints of the legs were common in the stomach contents.

## Carrion

In the wildlife field, the term "carrion" is applied to any dead

flesh. It may include flesh from an animal that has just ceased to live to that in the final stages of bacterial disintegration. In short, the word has been used largely to distinguish the dead from the living. If that connotation is applied, the bald eagle may be considered a confirmed carrion feeder, particularly in its feeding on fish washed onto the beach, killed and not entirely eaten by bears on salmon streams, or fish that may have been killed by, and then stolen from, the osprey.

The carrion eaten by the bald eagle comes from several sources, but fishes and mammals supply the bulk. The uncertainty of determining the nature of flesh eaten by a predator is a perplexing problem to the food analyst. Consequently, the volume and frequency with which carrion appears in any food appraisal (table 2) are subject to wide interpretation. Although the appellation of carrion was placed on no less than 60 items in the 435 Alaskan eagle stomachs examined, it is apparent that this represents only an uncertain fraction of the total carrion consumed. Among the mammal remains considered to have been carrion when eaten were deer and two common marine mammals, the harbor seal (*Phoca*) and the northern sea lion (*Eumetopias jubata*). Several eagles were shot in the vicinity of carcasses of these mammals that had been washed up on the beach.

In volume, food classified as carrion comprised 12.3 percent of the annual food of the Alaskan eagles (table 2), and, although there was some irregularity in the amount of carrion eaten from month to month, the great bulk of it was taken when fish were plentiful, thus indicating the carrion character of much of the fish eaten.

Fortunately, the senior author participated in the collecting of much of the Alaskan material and was closely associated with the late Hosea R. Sarber, who collected most of the remainder from the southeastern part of the Territory. Thus, much pertinent information concerning the environment and character of the foods taken by the eagles was available to him. It is against such a background that he has drawn his conclusions regarding the carrion nature of the food in the stomachs of eagles taken in Alaska.

Although the bald eagle has often been reported feeding alongside the turkey buzzard, a recognized carrion eater, as a rule the eagle's carrion food is not in as advanced a stage of decay. Much of it, especially the fish on the beach and the carcasses on the highway, may be considered essentially fresh meat. Dead flesh, however, requires no effort in capture and it often may be found in substantial quantity. Consequently, when the bald eagle is feeding on a dead creature it is merely following the natural instinct of most predators: to make a living in the easiest way possible. For this reason, bald eagles are abundant when salmon have spawned and lived their life span, and when dead or crippled waterfowl are to be found on areas being hunted. Even along highways the bald eagle is not averse to joining

the magpie and crow to feed on the remains of the traffic's wildlife victims.

On the Brevard National Wildlife Refuge in Florida, bald eagles have been observed feeding on the waste and regurgitated fish in a nesting colony of brown pelicans; in Yellowstone National Park they have been seen feeding on the carcasses of elk in winter. With such a diversity of items classified as carrion, it is no mean problem to inter pret much of the partially digested food found in the stomachs of bald eagles, alternately aggressive predators or lowly carrion feeders. Seldom when an eagle's stomach is opened for examination can the remains of a freshly killed creature be distinguished from that of one found dead by the eagle. Under such conditions the evidence brought from the field by the collector is indispensable—without it the decision may be a surmise, at best.

The bald eagle in the role of a carrion feeder has repeatedly been observed on the Bear River Migratory Bird Refuge in Utah. As winter visitors, the eagles may be seen feeding on dead ducks and carp frozen in the ice on the shallow, flooded flats. An unusual concentration of fully a hundred eagles, both bald and golden, joined by numbers of California gulls, occurred in January 1954, when the birds collected to feed on the many carp killed by pollution in Bear River the previous fall.

That the bald eagle, even in areas that are nearly metropolitan in character, commonly resorts to carrion as food is a matter of record. Along the lower reaches of the Hudson River immediately above New York City, bald eagles may be found floating downstream in winter on cakes of ice and, in conjunction with gulls, feeding on dead fish and other carrion. Not infrequently, they have been seen to take advantage of a gathering of gulls fighting for possession of a dead fish. The tussle ends when the eagle swoops in and removes the object of the conflict.

Despite the large numbers of waterfowl available to them, bald eagles wintering on the Cape Romain National Wildlife Refuge in South Carolina are largely carrion feeders. The refuge manager reported that—

> on Bull's Island, eagles fed commonly with vultures on carrion hogs. On a pond that was turning from salt to brackish, hundreds of impounded marine fish died. Several hundred gulls, vultures, crows, and a dozen eagles were attracted to the area by the sudden supply of food. The eagles obtained the dead and dying fish by wading into the shallow water and pulling them ashore, or picking the smaller ones off the water.

Munro (1938) has pointed out that local conditions and the time of year greatly modify the carrion-feeding habits of bald eagles in British Columbia. Along the tidal flats on Graham Island the bald eagle was found to be as "predatory as a turkey vulture" and timed its feeding with periods of low tide when drifting carrion became available. Here, he stated:

> Dogfish drifted ashore in considerable numbers; at one time I counted thirteen on about a mile of beach and each of these had been partially eaten by eagles as could be told, in some instances, by the

tracks around them. Several times eagles were seen feeding on dogfish and as they tore at the carcass one or more Glaucous-winged Gulls stood motionless a few feet away awaiting their turn at the carcass.

One morning it was noticed that since the previous evening a doe deer had washed up on the beach and been nearly all consumed. Standing here and there around the carcass on drift logs and on the sand were eight eagles and three ravens—their immobility indicating repletion—while two Glaucous-winged Gulls pulled at the shreds of meat still adhering to the bones.

How an abundance of carrion in the form of dogfish left stranded by receding tides on an island off the coast of British Columbia assured the safety of living prey against the attacks of bald eagles also has been pointed out by Munro. His first observations led him to believe that the eagles were feeding on an abundance of introduced rabbits and pheasants, but he stated—

> a diligent search revealed no "kills." * * * This seemed the more remarkable in view of the fact that rabbits nearly always were in view hopping across the open mossy glades. Pheasants were more plentiful in this limited area than in any other district of comparable size in British Columbia according to my observations. It seems doubtful that this species could have increased to such an extent, from the small stock introduced about fifteen years ago, if eagles had preyed upon them consistently.
>
> A flock of sheep accompanied by a number of young lambs pastured these woods and frequently in their wanderings loitered and sometimes lay down within a few yards of trees in which eagles were perched. The eagles paid no attention to the lambs. For the past five years two settlers have run flocks of sheep in this area without suffering any losses through eagles.

In New Brunswick, Bruce Wright (1953) endeavored to discover the preference of the bald eagle for several types of carrion by placing various combinations of bait beneath or near favorite roosting trees. These were exposed from the middle of June until near the end of August, at which time most of the eagles had left. The remains of black ducks and snowshoe rabbits were offered along with one or more species of fishes. In no case did the eagles take a duck or a rabbit in preference to the fish. Among the latter were white suckers, eastern chain pickerel, chub, perch, and brown bullhead; of these, the latter was accepted on every occasion when it was exposed.

### Vegetable Matter

The bald eagle ingests vegetable food only by chance or by consuming the stomach contents of some vegetarian prey. Through some such circumstances, needles of hemlock and other conifers, bits of ferns and mosses, small fragments of eelgrass (*Zostera*), and miscellaneous vegetable debris were found in the Alaskan eagle stomachs.

## ATTACKING HUMANS

Reports of attacks by the bald eagle on people are less frequent than those by the golden eagle, although in either case the records usually have been colored to provide exciting news copy. As would be expected, such attacks are most frequently reported during periods

that the eagles have eggs or young to defend. Herrick (1932) related how a pair flew menacingly at a group of persons examining the remains of an eagle's nest that had just been blown down by high winds. And then there are those occasions when the mere presence of an eagle causes people to surmise what might have happened had someone not intervened. Such a situation was the basis of a tale emanating from Connecticut early in this century. On that occasion, a bald eagle perched on an arbor 8 feet above a 2-year-old child led to the suspicion that an attack was imminent, yet nothing happened. Alexander Wilson et al. (1832), pioneer American ornithologist, recorded an incident in which a bald eagle struck a small child and tore its clothing. Thomas Nuttall (1832), Wilson's contemporary, tells an even more startling tale of an infant carried to the eagle's eyrie several miles distant. Realizing the definite limitations on the weight that can be carried by an eagle, one is inclined to discount severely the accuracy of such anecdotes. One of the more fantastic of these stories gained wide circulation in the late 1920's and concerned a bald eagle in Kentucky that was alleged to have attacked an 8-year-old boy, carried him aloft 75 feet, and transported him 200 feet.

It is not unreasonable to assume that the lifting power of the bald eagle is not greatly different from that of the golden eagle, since the two birds are essentially the same in body weight and wing spread. Accordingly, the results obtained by Walker and Walker (1940) in tests with a captive golden eagle trained in falconry are worth reciting. When a 1-pound weight was attached to each foot, the bird averaged 165 yards in normal, effortless flight before alighting. With the weight doubled, it flew 64 and 58 yards in two trials during which flight was labored. When the weights were increased to 4 pounds on each foot, the distances were cut down to 10 and 14 yards in two tests even though the bird was liberated from the roof of a small building. Arnold (1954, p. 3) has presented additional information on the weight-lifting ability of the golden eagle.

The weight-lifting limitation of the bald eagle was demonstrated by N. R. Casillo (1937), who anchored a 4-pound pickerel to a large rock with the dead fish floating on the surface of the water. A female bald eagle grasped the fish but was unable to lift it and the rock from the water. Even though the submerged rock weighed something less than 10 pounds, the bird succeeded in dragging it only about 20 feet along the bottom.

In view of the bald eagle's limited capacity to lift burdens, one need not be seriously concerned over the tales that have appeared in the public press regarding the eagle's aggressive predation on human beings. This appears to be sound reasoning regardless of the fact that such factors as favorable air currents, gliding flights, and wind velocity may at times greatly increase the ability of an eagle to lift and carry a burden.

Coupled with the physical limitations confronting an eagle attempting to carry an excessive weight, which would tend to discount the likelihood of their transporting human prey, is the mistaken interpretation that often is placed on eagle flight activities. Herrick (1924b, p. 407) has well described the different approaches employed by the bald eagle when merely swooping, more or less as a flight maneuver, and when seriously intent on killing its prey.

> When an Eagle stoops at an enemy or at his prey, and is deterred at the striking point, he will immediately rise, and might carry off a cap, as has been known to occur when the attack was upon a man who had invaded the nest, or "a fragment of a frock" if a child were assailed; but whenever he strikes in earnest and endeavours to master his prey and rise with it in the air, as is said to have been the case in the instances given above, his action is very different. His aim then being to maim or kill, the Eagle instantly drives his talons with all his power into the body of his victim. If danger is scented he will make every effort to lift his prey bodily from the ground and bear it to a place of safety; but if the place and time are propitious he tries to finish the business on the spot by repeated thrusts of beak and claw, often "treading" his quarry, until its vitals have been reached and resistance is at an end. It is evident that an Eagle, with claws nearly two inches long, or more if measured on their curve, could not strike a child of whatever age and strive to bear it away, without the certainty of inflicting grievous injuries, irrespective of the success of his efforts.

## SUMMARY


1. Study of the economics of the bald eagle was prompted largely by the need for information to appraise the merits of bounty and other legislation affecting the eagle in the Territory of Alaska, where it long has been the subject of controversy. To accomplish this, fieldwork by the senior author was carried on mainly in 1941 with additional observations being made in 1945 and 1946. Subsequently, he examined the stomach material collected and prepared initial tabulations of food items. The junior author completed tabulation of the examined stomachs, reviewed pertinent literature, and compiled the manuscript in its present form.

2. As a background for better understanding of the economics of the bald eagle, this paper assembles information concerning its characteristics and life history. Included are data on range, abundance, movements, plumages, age, sex ratio, dimensions, weight, nesting, eggs, young, and enemies.

3. Although the bald eagle was noticeably reduced in Southeastern Alaska during the years of bounty payments subsequent to 1917, there are indications that the bird is now recouping its numbers and may again assume its former abundance in favored areas. In the United States, even in its favorite habitats in Florida and the mid-Atlantic States, the nesting bald eagle has decreased in numbers with a corresponding lessening of its economic influence. During fall, winter, and spring, migrating eagles gather at favorable feeding areas and in some

of these places increased numbers have been seen.

4. A brief résumé has been presented of bounties and other legislation affecting the bald eagle in Alaska, the United States, and Canada.

5. As a basis for laboratory food studies, 435 stomachs of Alaskan bald eagles were collected and examined. In addition, there are available data from 31 stomachs collected in the United States, and 6 stomachs collected in Canada. Analysis of pellets and food debris found at nests aided in judging the food habits of the bald eagle at points in the States and on the Alentian Islands in Alaska.

6. Nearly two-thirds (65.7 percent) of the food of Alaskan eagles was composed of fish and of this about one-fourth (16.9 percent) was salmon. It is the considered opinion of the senior author who participated in the collecting of much of this material that most of the salmon was carrion when found by the birds. An appreciable, but uncertain, portion of the other fish consumed also was dead when located by the eagles. Although it is not possible to determine statistically from the data available the significance of the eagle's feeding on commercially valuable salmon, under conditions prevalent at the time of the field studies, we are convinced that the bald eagle was not a serious drain on that fishery resource. This same appraisal applies to the other commercially valuable fish in the eagle's diet.

7. Less than one-fifth (18.8 percent) of the Alaskan eagles' food was derived from birds, about half of which were ducks and geese, the remainder being various marine species so plentiful in the north Pacific. Whereas there is no question that during winter the bald eagle takes a certain toll of migratory waterfowl, many of them may have been hunting casualties or birds weakened by the elements. Because of the eagle's decreased numbers along the Atlantic coast, predation on the waterfowl of that area is not serious. Along the North Pacific coast, including the Aleutians, the bald eagle preys more heavily on birds, particularly in winter, but even then the pressure is absorbed largely by scoters and sea birds—fulmars, murres, auklets, and puffins—which are exceedingly abundant there.

8. Stomach examination has substantiated to a limited extent the reported predation of the bald eagle on deer, yet the senior author witnessed nothing of this kind during the period of his fieldwork in Alaska which included three fawning seasons. The greater incidence of mammal remains in eagle stomachs taken in May and June (table 2) may be indicative that juveniles are more vulnerable to eagle attack than are adults, as has been emphasized by field observers. Whether this pressure is significant in the welfare of Alaskan deer was not determined by this study; but whatever its effect, it would be restricted largely to the coastal areas where the bald eagle maintains its greatest numbers. There is no evidence that the bald eagle exerts an appreciable effect on the population

of small mammals unless it should be during winter when numbers of these birds may congregate in areas where jackrabbits are abundant.

9. Only in Alaska is the bald eagle abundant enough to constitute a significant hazard to domestic livestock, and even there its most important relation is with the semi-domesticated blue fox. No remains of foxes were found in any of the 435 stomachs collected in that Territory, yet testimony of the eagle's predation on these furbearers was frequently encountered. In recent years, this problem has been materially allevinated, not only by a great reduction in the blue-fox industry by reason of a lessened market, but by the more progressive raisers confining their animals under screens. Within the United States, the bald eagle has occasionally preyed on domestic poultry, but here again the small number it takes makes the total effect insignificant.

10. The carrion-feeding habits of the bald eagle may be construed as neutral in their total economic effect. About one-eighth of the bird's annual food (based on the examination of 435 Alaskan bald eagle stomachs) was interpreted to be of that character. There is much uncertainty connected with this interpretation and, were all the facts available, this portion of the bald eagles' food might be appreciably greater. By far the larger portion of the carrion eaten stems from the dead fish which the eagle finds on the beach.

In summarizing briefly the economic status of the bald eagle, it will be well to recall the words of an eminent ornithologist expressed more than 40 years ago regarding the bird's status in Michigan (Barrows 1912, p. 288):

> Although it frequently captures worthy prey, in open fight or by direct attack, it often robs the Fish Hawk, compelling it to relinquish the fish which it has just captured. When nothing better offers it feeds freely upon decomposing fish washed up along the shore, or upon carrion, in company with the Crow and the Raven. True, it kills many rabbits, grouse, ducks and waterfowl of various kinds, and even stoops to squirrels, mice and snakes; but on the whole it confers no decided benefits on the agriculturist, although on the other hand, it is not commonly injurious. On rare occasions it picks up a hen, usually at a distance from the house, and in early spring it has been known to destroy young lambs, but these are not common offenses.

This is still essentially true in the United States, the principal difference being that, because of decreased numbers, the influence of the bald eagle for either good or harm is significantly less now than formerly.

In Alaska, an area of much greater eagle abundance, the influence of the bald eagle is correspondingly greater. It is one of a great number of factors that affect the abundance and welfare of the salmon; it also exerts pressure (more so formerly than now) on the domestic blue-fox industry. With present regulations permitting control of individual birds causing damage to domestic stock or wildlife, reasonable provision for property protection and rational management are provided. Under prevailing conditions, there is no need for any general reductional program through bounties, or otherwise.

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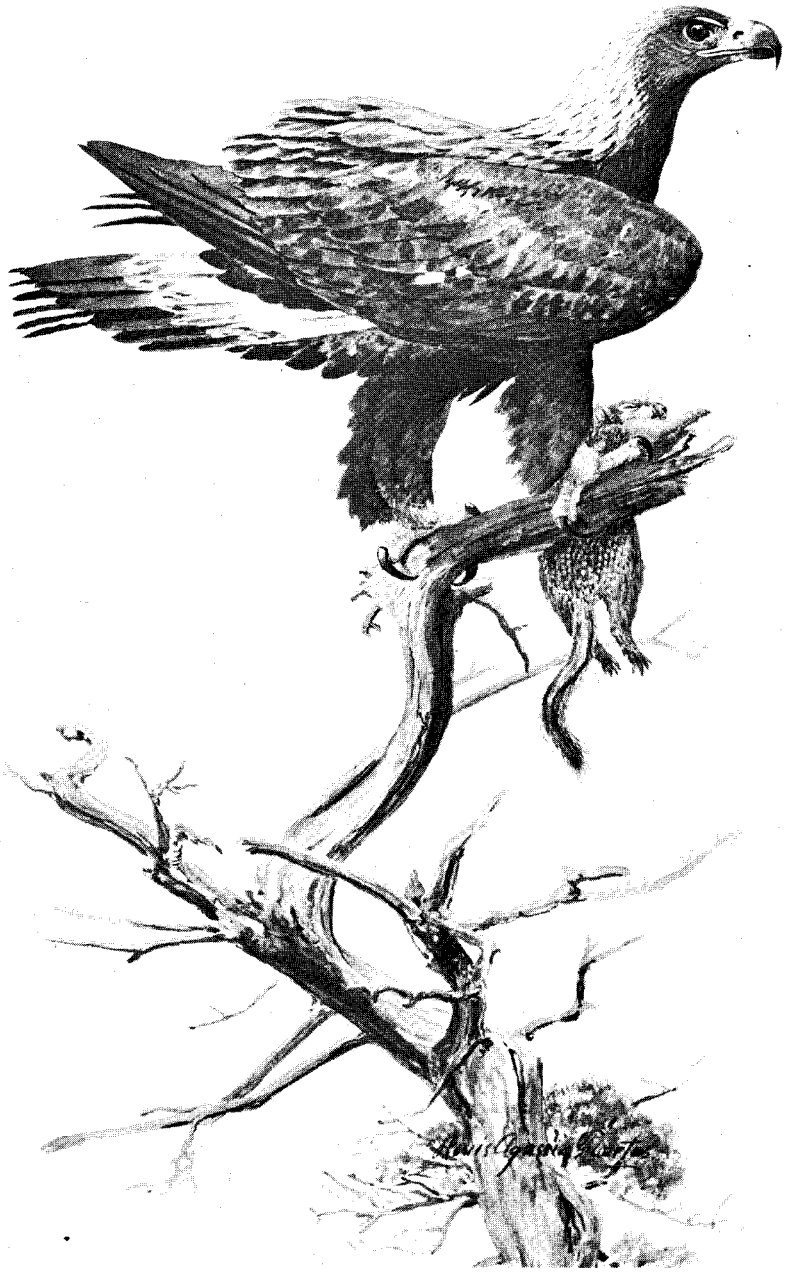
# THE GOLDEN EAGLE
## and its economic status

By LEE W. ARNOLD

*Biologist*



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.



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 species [1] 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 ocherous 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]

[2] Tail 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, Sumner 1929a, Bent 1938, and Jollie [3]). 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.

[3] Malcolm 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 endeavored 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, jackrabbits, 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 | [1] 21 | | | | | | | | | | | 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] | Upland game birds [4] | Waterfowl [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 | [9] 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 (*Rangifer*).
[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 (*Rangifer*), 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-

rion 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) | Jackrabbit | Cottontail | Ground squirrel | Wood rat | Sheep (bones) | Sage hen | Waterfowl | 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. Couey (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

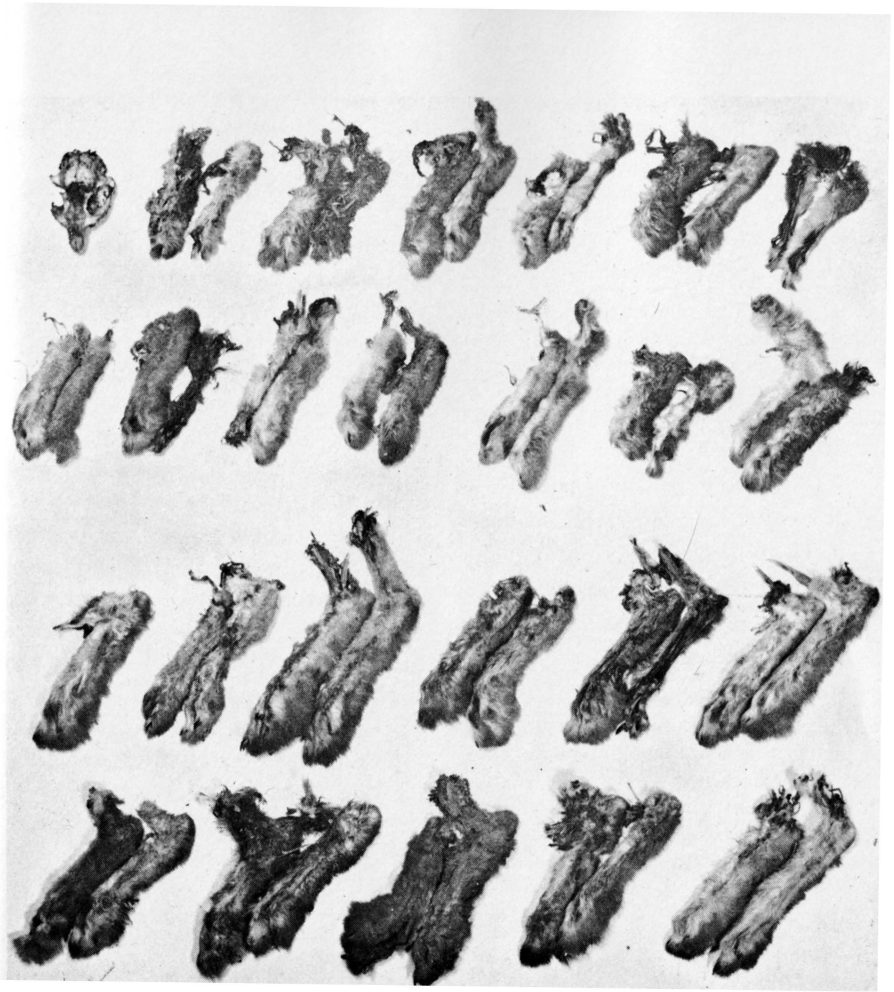


FIGURE 3.—Food remains found at nest of golden eagle on Colorado State Antelope Refuge in 1947. They include the skull of a prairie dog, 26 hind feet of cottontails, and 21 hind feet of jackrabbits. (Photograph by E. R. Kalmbach.)

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.

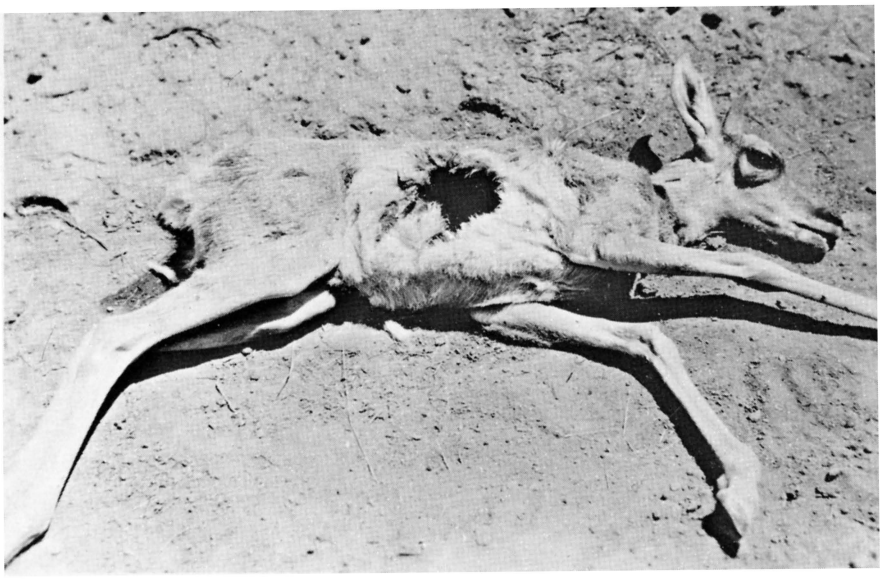


FIGURE 4.—Remains of antelope kid killed by a golden eagle near Magdalena, N. Mex., June 19, 1943. (Photograph by W. W. Lahnum.)

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, approxi mately 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 determine 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.

*Deer.*—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 detriment 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.

Couey (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. Zeb, 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. Horn.)

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 jackrabbit, 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 precipitously, 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 prelambing 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. Sperry [4] 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 observed 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

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

in Sperry's report[5] 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 Biological 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.

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