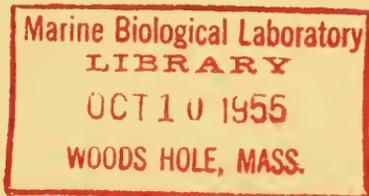


THE BALD EAGLE

and its economic status



CIRCULAR 30

FISH AND WILDLIFE SERVICE

UNITED STATES DEPARTMENT OF THE INTERIOR

THE BALD EAGLE

and its economic status

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UNITED STATES DEPARTMENT OF THE INTERIOR, Douglas McKay, *Secretary*
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The bald eagle; juvenile above and adult below. (From a Fish and Wildlife Service 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. Herriek (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 sharpening 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. McAttee. 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 mid-section 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 South-

eastern 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 excep-

tion 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.

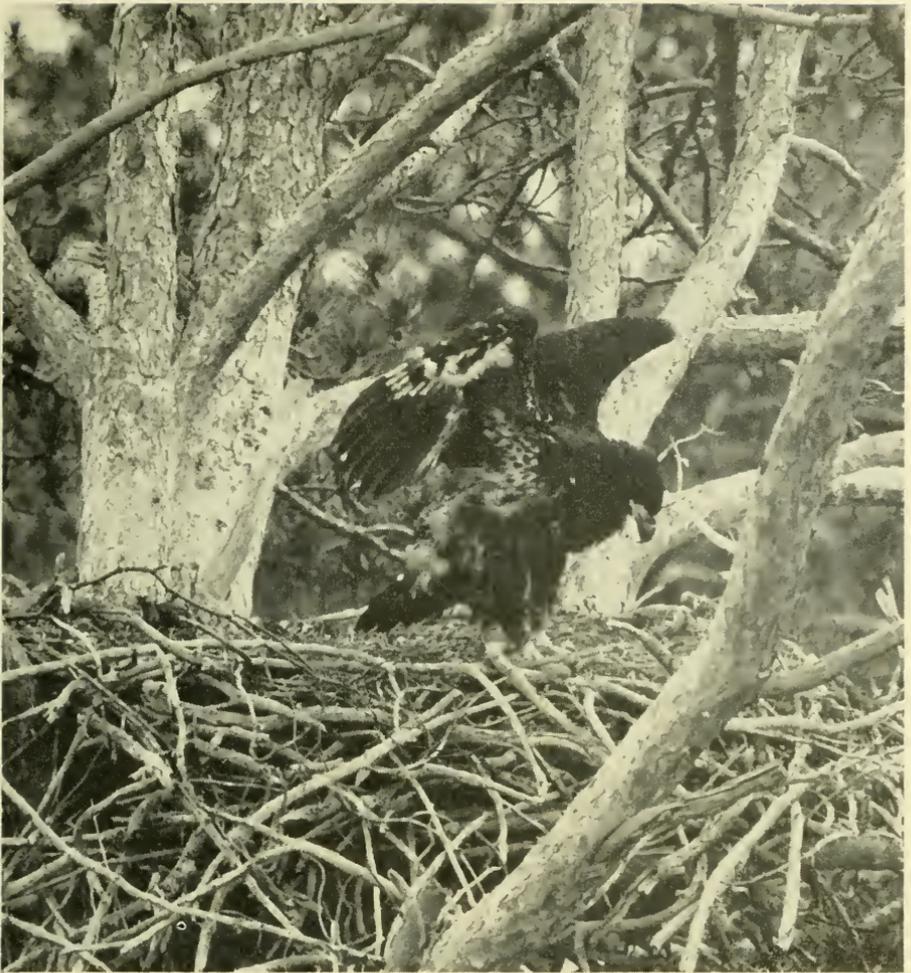


FIGURE 4.—A nearly fledged young bald eagle, Seney National Wildlife Refuge, Mich. Flexing its wings, it is almost ready to take its first short flight. The characteristic flat-topped nest of sticks is lined with finer material and is located 65 feet from the ground in a red pine. (Photograph by C. J. 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 526.5 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 success-

ful 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, pro-

visions 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 re-enacted 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 outnumbered 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	-----	23.3	-----	2.0	11.8	24.1	35.8	85.0	25.4	9.1	-----	16.9
Gadidae ²	28.8	44.2	-----	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	4.5	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
Carion	-----	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, murrees, 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 (<i>Salvelinus malma</i>).....	1	0.2
Handsawfish (<i>Alepisaurus</i> sp.).....	4	.9
Pollack (<i>Theragra chalcogramma</i>).....	9	2.0
Pacific cod (<i>Gadus macrocephalus</i>).....	1	.2
Rockfish (<i>Sebastes</i> sp.).....	1	.2
Greenling (<i>Hexagrammos</i> sp.).....	4	.9
Atka mackerel (<i>Pleurogrammus monopterygius</i>).....	14	3.1
Sculpins (Cottidae).....	7	1.6
Unidentified fish.....	3	.7
Total.....	44	9.8
BIRDS:		
Shearwater (<i>Puffinus</i> sp.).....	21	4.7
Fulmar (<i>Fulmarus glacialis</i>).....	81	18.3
Forked-tailed petrel (<i>Oceanodroma furcata</i>).....	1	.2
Cormorant (<i>Phalacrocorax</i> sp.).....	24	5.4
Emperor goose (<i>Phalacrocorax cananica</i>).....	2	.4
Pintail (<i>Anas acuta</i>).....	1	.2
Teal (probably <i>Anas crecca</i>).....	1	.2
Old-squaw (<i>Clangula hyemalis</i>).....	10	2.2
Harlequin duck (<i>Histrionicus histrionicus</i>).....	3	.7
Unidentified duck.....	3	.7
Common eider (<i>Somateria molissima</i>).....	7	1.6
Red-breasted merganser (<i>Mergus serrator</i>).....	1	.2
Bald eagle nestling (<i>Haliaeetus leucocephalus</i>).....	1	.2
Rock ptarmigan (<i>Lagopus mutus</i>).....	1	.2
Glaucous gull (<i>Larus hyperboreus</i>).....	2	.4
Glaucous-winged gull (<i>Larus glaucescens</i>).....	31	6.9
Kittiwake (<i>Pissa tridactyla</i>).....	3	.7
Murre (<i>Uria aalge</i> , <i>U. lomvia</i>).....	34	7.6
Pigeon guillemot (<i>Coccyzus columba</i>).....	6	1.3
Ancient murrelet (<i>Synthliboramphus antiquum</i>).....	10	2.2
Paroquet auklet (<i>Cyclorhynchus psittacula</i>).....	10	2.2
Crested auklet (<i>Aethia cristatella</i>).....	41	9.2
Least auklet (<i>Aethia pusilla</i>).....	15	3.6
Horned puffin (<i>Fralercula corniculata</i>).....	13	2.9
Tufted puffin (<i>Lunda cirrhata</i>).....	27	6.1
Unidentified alcid.....	5	1.1
Raven (<i>Corvus corax</i>).....	2	.4
Unidentified bird.....	4	.9
Total.....	360	80.7
MAMMALS:		
Domestic sheep.....	2	.4
Blue fox (<i>Alopex</i> sp.).....	1	.2
Aleutian ground squirrel (<i>Citellus p. albusus</i>).....	22	5.1
Field mouse (<i>Microtus amakensis</i>).....	3	.7
House rat (<i>Rattus norvegicus</i>).....	1	.2
Sea lion (<i>Eumetopias jubata</i>).....	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 (<i>Cyprinus carpio</i>).....	3	.....
Channel cat (<i>Ictalurus punctatus</i>).....	6	.....
Catfish (<i>Ameiurus</i> sp.).....	19	.....
Bass (Centrarchidae).....	1	.....
Unidentified fish.....	2	.....
Total.....	33	52.4
BIRDS:		
Horned grebe (<i>Colymbus auritus</i>).....	2	.....
Great blue heron (<i>Ardea herodias</i>).....	1	.....
Common mallard (<i>Anas platyrhynchos</i>) (?).....	2	.....
Black duck (<i>Anas rubripes</i>).....	4	.....
Pintail (<i>Anas acuta</i>).....	1	.....
Ring-necked duck (<i>Aythya collaris</i>).....	2	.....
Lesser scaup duck (<i>Aythya affinis</i>).....	2	.....
Unidentified duck.....	1	.....
Bald eagle (<i>Haliaeetus leucocephalus</i>).....	2	.....
Gallinaceous bird.....	1	.....
Coot (<i>Fulica americana</i>).....	1	.....
Domestic pigeon (<i>Columba livia</i>).....	1	.....
Long-eared owl (<i>Asio wilsonianus</i>).....	1	.....
Total.....	21	33.3
MAMMALS: Muskrat (<i>Ondatra zibethicus</i>).....		
	3	4.7
REPTILES:		
Mud turtle (<i>Kinosternon subrubrum</i>).....	3	.....
Painted turtle (<i>Chrysemys picta</i>).....	1	.....
Total.....	4	6.3
VEGETABLE MATTER: Seeds of persimmon (<i>Diospyros virginiana</i>).....		
	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.

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

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 (<i>Dorosoma cepedianum</i>)	1	
Fresh-water eel (<i>Anguilla rostrata</i>)	2	
Toadfish (<i>Opsanus tau</i>)	1	
Unidentified fishes	2	
Total	6	4.2
BIRDS:		
Pied-billed grebe (<i>Podilymbus podiceps</i>)	2	
Atlantic brant (<i>Branta bernicla</i>)	1	
Common mallard (<i>Anas platyrhynchos</i>)	3	
Pintail (<i>Anas acuta</i>)	1	
Green-winged teal (<i>Anas carolinensis</i>)	4	
Unidentified <i>Anas</i>	5	
Baldpate (<i>Mareca americana</i>)	3	
Woodduck (<i>Aix sponsa</i>)	1	
Canvasback (<i>Aythya valisineria</i>)	2	
Unidentified <i>Aythya</i>	7	
Ruddy duck (<i>Oxyura jamaicensis</i>)	1	
Hooded merganser (<i>Lophodytes cucullatus</i>)	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 (<i>Ondatra zibethicus</i>)	29	
Meadow mouse (<i>Microtus</i>)	1	
Cottontail rabbit (<i>Sylvilagus floridanus</i>)	5	
Wool of domestic sheep	6	
Total	42	29.8
REPTILES:		
Racer (<i>Coluber</i>)	1	
Unidentified snakes	2	
Total	3	2.1
CRUSTACEANS: Edible crab (<i>Callinectes</i>)		
	1	0.7
VEGETABLE MATTER:		
Kernels of corn	8	
Vegetable debris	10	
Total	18	12.8

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 *Sebastes*, 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 east 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 South-eastern 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. albicollis*), 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, murre, 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 Coney (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 (Grimmell, 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 beach-combing 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 interpret 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 Aleutian 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 alleviated, 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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