THE AUK

A QUARTERLY JOURNAL OF

ORNITHOLOGY

VOL. 74 JANUARY, 1957 NO. 1

NOTES ON THE AMERICAN SPARROW HAWK

BY A. I. ROEST

THE American Sparrow Hawk (*Falco sparverius*) occurs abundantly throughout the nation and has been well known to science for many years. In spite of this familiarity, knowledge of its natural history is rather sketchy. The accounts in the literature, with few exceptions, are primarily concerned with distribution records, nesting dates, and food habits, plus scattered descriptions of behavior (see Friedmann, 1950: 726–739). The present study was undertaken to investigate some of the less well known aspects of the life of the Sparrow Hawk.

Field observations were made at Corvallis, Oregon, from January 1951 to September 1952, and at Bend, Oregon, from September 1952 until December 1954. Notes made prior to 1951 in California, New York, and Virginia were also utilized. Fourteen captive birds kept for varying periods provided supplementary data.

Additional information came from a number of sources. The Banding Office of the U. S. Fish and Wildlife Service supplied data on Sparrow Hawk banding returns up to 1953. A postcard questionnaire requesting data on sex ratios and plumages was sent to 50 museums and zoos throughout the United States and Canada, and information on 1952 specimens was obtained. Dr. Alden H. Miller of the University of California and Dr. Robert W. Storer of the University of Michigan kindly supplied weight data for specimens in the collections at their respective institutions. Dr. K. L. Gordon of Oregon State College was especially helpful in preparing the manuscript, and the Braly Egg Collection at that institution was carefully analyzed. I would like to take this opportunity to thank the above individuals and institutions for their assistance in this project.

In order to avoid repetition, only new or relatively neglected material is presented here; only references pertinent to the present discussion are cited. For simplicity, material dealing with the an-

nual cycle of the Sparrow Hawk is presented first, in chronological order, beginning with the return of the birds to their nesting grounds in the spring. Following this are sections dealing with the more general topics of behavior and populations.

Pre-nesting Behavior.—In the vicinity of Bend, the first males arrive about the end of March (March 20–28), and the first females only a day or two later (earliest, March 29). By the first week in April the local breeding population has arrived, and nesting commences almost immediately. In other parts of the country, especially at lower elevations, nesting may be earlier, but there seems to be little correlation with latitude. The Braly Egg Collection includes a set of Sparrow Hawk eggs from Florida taken April 11, and a set from Canada dated April 12. Actual dates in any locality are probably dependent largely on local weather conditions.

An observation made in Bend, on April 20, 1954, indicates that the female may select her mate rather than the reverse. A wild female was seen twice that day in a tree near our backyard. A captive male was tethered there, and on each visit he became quite excited, yelling loudly, although the female remained quiet. The female stayed about five minutes each time. The captive male had yelled considerably on each of the preceding four days, possibly reacting to earlier visits of which I was not aware.

Dr. Donald Dunlap, of Washington State College, told me of a group of Sparrow Hawks he had seen in a dead tree near Pullman early in 1952. There were four hawks, three of them moving about almost continually in one part of the tree, while the fourth sat quietly in the opposite side of the tree. Such a group gathered early in the year may have been engaged in courtship activity. This report, together with those of Childs and Mossman (1952) and Fast and Barnes (1950), may indicate that some degree of polygamy or polyandry occurs in this species.

I observed copulation only once during this study, on April 25, 1953, near Bend. The observation involved a mated pair, with eggs already laid. Both birds were first seen in a snag near the nest site, hopping about among the bare branches. After a few minutes the female flew off, the male following; then both quickly returned. Again they hopped about, eventually coming to rest on the same branch about two feet apart. The female turned her back to the male and assumed a horizontal position, flipping her tail up and down a few times. The male flipped his tail also, and moved up until the two birds were side by side. Then he quickly mounted and copulation took place, with some gentle wing fluttering on the part of the male

to maintain his balance. Copulation lasted twenty or thirty seconds, after which the male hopped over to another branch. Both birds began to preen, but the male flew off after about two minutes, leaving the female still preening. The female apparently initiated copulation by flipping her tail while in the horizontal position. A similar observation is recorded by Bishop (1925).

Nesting and Incubation.—The typical nest site of the Sparrow Hawk has been adequately described in the literature (see Bent, 1938). Tables 1 and 2, summarizing data from the Braly Egg Collection and

TABLE 1

NEST SITES USED BY SPARROW HAWKS

	Natural Cavity	*Flicker Hole*	*Woodpecker Hole*	*Magpie Nest*	*Hole in Cliff*	*Building*
Author's data						
Oregon	2	6				3
Virginia	1	1				
New York	1					
Braly Collection						
Oregon		1			1	
California	12	15	3	2		
Canada	1	13	3			
Other	2	2				
Totals	19	38	6	2	1	3

TABLE 2

HEIGHT OF NEST ABOVE THE GROUND

Height (Feet)	*Author's Data*			*Braly Collection*			
	Ore.	*Va.*	*N. Y.*	*Ore.*	*Calif.*	*Canada*	*Totals*
4 to 9				1		1	2
10 to 14	3			1	1	8	13
15 to 19	1		1		2	1	5
20 to 24	1	1		1	1	3	7
25 to 29	1				2	3	6
30 to 34	2				4		6
35 to 39					3		3
40 to 49					4	1	5
50 plus		1			2		3

my own notes on nest sites, provide additional information. In brief, the favorite nesting site is an old flicker hole or natural cavity 10 to 35 feet above the ground.

My own data, combined with material from the Braly Collection, show the following distribution of clutch size for 60 nests: 3 sets had 3 eggs, 13 had 4, 41 had 5, and 3 had 6. Williams and Matteson

(1948: 76) mention a set of 8 eggs in a nest near Ft. McKinney, Wyoming.

Sumner (1929) gives the weights of Sparrow Hawk eggs as 14 and 15 grams; my notes show weights of 11.5 (for a sterile egg) and 15 grams. The incubation period is 29 days according to Sherman (1913), but in the vicinity of Bend is 30 to 31 days.

During incubation, the male assists the female by bringing food or by taking over the night shift. Behavior of this type was observed at two nests near Bend. At one, about a half hour before sunset on May 1, 1953, the male arrived in the vicinity of the nest and began moving from tree to tree, occasionally swooping at passing birds. Finally the female looked out of the nest hole and uttered a soft 'kree-kree.' The male then flew to a nearby juniper, searched about among the branches, and flew back to the nest tree with the hindquarters of a field mouse. He began plucking fur from it and fed a little. Soon the female left the nest and flew up into the tree close to the male. The latter came down to her, whereupon the female moved over, took the mouse, and began to feed. The male remained near her for about ten minutes, while she fed, but then dropped down to the nest and entered. After five minutes he emerged again, but reentered almost immediately. The female continued feeding until almost dark, finally flying off to another tree. The male had not come out of the nest cavity by the time observations ceased, with complete darkness.

In this instance the male must have stored the mouse remains in the tree previously. Food storing was also noted frequently in captive birds. These observations support those of Tordoff (1955).

At the other nest the male was seen perched near the nest tree shortly before sunset on May 3, 1953. The female came out of the nest, flying off to return after about five minutes. She perched in the nest tree as the male came down to her and held the hind portion of a lizard out to her, which she accepted. He then flew to a higher branch, where he remained as she flew away again. She returned a few minutes later without the lizard, entering the nest again, and about twenty minutes later the male flew off. In this case the male did not take over at the nest for the night, but the feeding behavior took place as at the first nest.

Nestlings and Development.—Young Sparrow Hawks dry out within an hour after hatching and are then covered with sparse white down through which pinkish skin is visible. Parts without down show the same pink shade, the legs having a hint of yellow while the bill, claws, and cere are almost white. The down is sparser over the

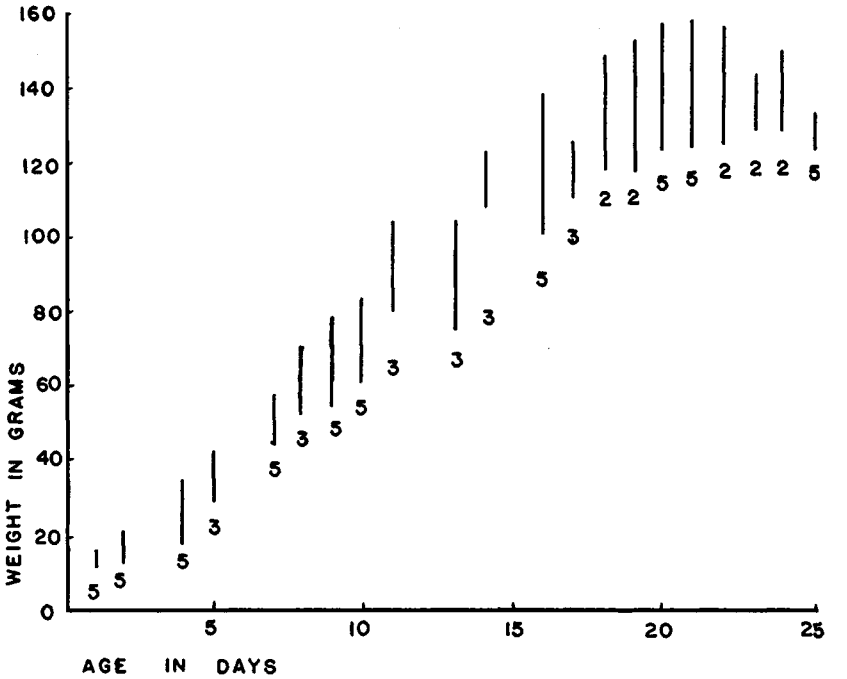

FIGURE 1. Weight increase in thirteen young Sparrow Hawks from three nests. The numbers below each bar indicate the size of the sample. In general, males weigh less than females after the fifth day. Variations are in part due to how recently the birds were fed before weighing.

abdominal and perineal regions, and the former protrudes as a "pot-belly." The wings resemble downy flippers. The egg tooth is prominent, projecting in some birds as much as 2 mm. Although the bill lacks a hook at the end, the typical falcon tooth is present.

Within two days the dark bluish-black eyes are partially open. The young hawks utter a faint buzzy cheeping when disturbed. The feet show a feeble grasping reflex. Although unable to sit erect, the birds can raise their heads shakily and open their beaks. Weights at this and later stages are presented in Figure 1.

At nests near Bend, the buzzy cheeping had been replaced by a chirp at the age of three days, and the immature 'killy-killy' mentioned by Sherman (1913) was noted. At the age of five days, one young male, removed from the nest, was able to sit up and turn about so as to face away from the sun.

By the end of the first week the skin under the down has begun to turn bluish on the wings, shoulders, back, and crown. The claws are beginning to darken, and the egg tooth is considerably smaller.

It seems to wear off rather than to drop off as a unit. The eyes are wide open, a dark chocolate-brown iris surrounding a deep cloudy-blue pupil; the nictitating membrane functions. When a card is waved slowly in front of the young hawks they are able to follow its movement. The wing quills have just started to develop. As yet the birds show no real fear, but become excited when handled, and display the characteristic defense attitude of young hawks, rolling over on their backs and presenting taloned feet toward the intruder. Belly and perineal area are completely bare, the down having rubbed off. Body temperatures average 101° F. (air temperature 68° F.).

At the age of two weeks feathers have sprouted over the entire body but are thickest on the wings, tail, back, chest, and crown. The egg tooth is completely gone. Sex can be fairly accurately determined now by comparing sizes, the females being larger. In slightly older birds sufficient feathers have broken from their sheaths to permit accurate sexing: grayish feathers on the wings of the males, brownish on the females. At this stage the tail quills are 2 to 3 cm. long, and about one-third of the vane has broken from the sheath.

By the age of sixteen days the young Sparrow Hawks spend most of their waking hours on their feet. When prodded or teased they

TABLE 3

WEIGHTS OF SPARROW HAWKS

*Locality**	*Number Males*	*Mean*	*Number Females*	*Mean*
British Columbia (MVZ)	2	110.1 gm.	3	139.6 gm.
Washington (MVZ)			1	117.0
Idaho (MVZ) (UM)	4	106.8	2	109.6
Montana (MVZ)	2	96.6	3	130.0
Michigan (UM)	3	105.0	2	123.5
Oregon (MVZ) (OSC)	17	108.5	8	107.8
Wyoming (UM)			2	116.4
South Dakota (UM)	1	87.0		
California (MVZ)	32	102.7	32	116.5
Nevada (MVZ)	6	96.0	4	107.3
New Mexico (MVZ)	2	103.0	1	122.0
Texas (MVZ) (UM)	3	100.1	4	132.6
Lower California (MVZ)	10	100.5	7	117.3
Chihuahua, Mexico (MVZ)	6	92.2		
Florida (UM)			1	123.0
Yucatan, Mexico (UM)			2	129.8
	88		72	

Mean of all males— 102.5 gm. Extremes: 80.0–143.0 gm.
Mean of all females—119.0 gm. Extremes: 86.0–164.8 gm.

* Localities are listed from west to east, and from north to south. MVZ—Specimens from Museum of Vertebrate Zoology, Berkeley, Calif. UM—Specimens from University of Michigan Museum of Zoology, Ann Arbor, Mich. OSC—Specimens from Oregon State College, Corvallis, Ore.

revert to the squatting position, from which they can quickly roll over on their backs. When teased to this extent they may also utter a typical 'killy-killy' cry, although some individuals remain silent. When being fed, captives emit a cheeping sound, with bill closed, resembling the peeping of baby chicks. As Sherman (1913) noted, a marked difference in the behavior of males and females becomes noticeable now.

At twenty days the young falcons are well feathered, the remaining down being concentrated on the head and along the radius and ulna. The tail feathers are 6 to 6.5 cm. long. Much time is spent in preening and cleaning the developing feathers. They leave the nest about thirty or thirty-one days after hatching, at which time the wings are nearly fully developed. The tail is still decidedly shorter than that of an adult, and a few tendrils of down usually cling to the back of the head.

Figure 1 illustrates the change in weight as the young develop, showing the typical 'S' curve exhibited by most young birds. A peak is reached about the time the young leave the nest, when they weigh more than the adults. Table 3 presents the weight of 160 Sparrow Hawks, including both adults and immatures; no distinction was made when the data were collected.

Care of the Young.—During the earlier part of the nesting season, both parent birds are usually present at or near the nest, where the male is in most cases more aggressive in defending the nest against human intrusion than his mate. Whether nesting territories are actively defended against other Sparrow Hawks could not be determined. On May 20, 1953, while I was watching a female hunting near Bend, I saw a second female fly within 10 feet of the first, heading for a nearby nesting area. Neither paid the slightest attention to the other. Near Charlottesville, Virginia, on April 25, 1945, a pair of Sparrow Hawks loudly protesting having their nest investigated were joined by a third, a female, who entered into the proceedings more vigorously than the female of the pair.

After the young have hatched, the male is frequently absent from the nesting area, apparently in quest of food. When a nest is disturbed at this time the female will make an effort at defense, but in most cases her attack is not very effective. At one nest the female yelled once as she was flushed and then perched quietly nearby. The male soon appeared and began to attack, coming at times within arm's length of me in his gyrations. When the visit was over, the male disappeared quickly, and the female returned to the nest within 5 minutes.

The female's absences are few and of short duration. Apparently

the male hunts not only for the nestlings but for the female as well. Feeding of the young, however, is done almost exclusively by the female. Only once, at a nest near Corvallis, was a male observed to bring food directly to the young, entering the nest to do so.

After leaving the nest, the young stay with the adults for a short period. At this time a complete family group, adults and four or five immatures, may be seen cruising over a field together, or perched along a fence. Within a few days the young begin to drift away, and by the middle of July all young birds hatched in the spring are living independently.

Migration.—Near Bend, the summer population begins to drift south in September, the exact date depending largely on local food and weather conditions. They are gone by the middle of September, but during the middle of October migrants from farther north traverse the region. After October 25, no Sparrow Hawks are seen except for a few stray males which wander up from lower elevations during spells of warm weather.

The banding returns on Sparrow Hawks provide an idea of the general movements of the species. Although not nearly enough returns (only 210) are available to determine the migratory movements of this species as accurately as has been done for some other birds, certain trends are evident. Birds from New England and the central Atlantic coast move southward to winter in the Carolinas and Georgia, while birds from Kentucky, Ohio, Michigan, Minnesota, Saskatchewan, and Alberta concentrate in Texas, Arkansas, and Louisiana. No records from farther west are available except for two birds, banded in Arizona, that were subsequently reported from Sonora, Mexico.

Sparrow Hawks from northern areas appear to migrate farther to the south than those in more temperate areas. Birds from Pennsylvania and Maryland are most often recovered in North Carolina, whereas New England birds are picked up in South Carolina. A bird from Nova Scotia turned up in Florida, and two from near Edmonton, Alberta, were recovered in southern Texas, distances of over 1600 miles in each case. The record is held by a Sparrow Hawk banded at Peers, Alberta, and later killed near Kauki, Campeche, Mexico—an airline distance of over 2600 miles.

There is some indication that juveniles may move northward during late summer after leaving the nest. The following records of birds banded in June or July and recovered before October indicate this movement: Massachusetts to Maine; Ohio to Michigan; Oregon to Washington.

In some parts of the range, Sparrow Hawks may remain to spend the winter. In addition, birds from farther north may come down to winter with residents which have not migrated; this results in a population which is almost as large as that in summer. Western Oregon has such a wintering population, the birds congregating in the open country of the Willamette Valley (Tables 4 and 5).

TABLE 4

ROAD CENSUS FIGURES FOR SPARROW HAWKS IN OREGON AT DIFFERENT SEASONS

Date	*Route*	*Miles*	*Birds Seen*
February 23, 1952	Corvallis—Oceanlake	75	7
April 10, 1952	Corvallis—Eugene	40	1
April 10, 1952	Eugene—Cottage Grove	22	1
December 22, 1951	Corvallis—Eugene	40	11
December 28, 1951	Corvallis—Eugene	40	14

TABLE 5

WINTERING SPARROW HAWKS IN OREGON
(TAKEN FROM THE NATIONAL AUDUBON SOCIETY'S FIELD NOTES MAGAZINE: CHRISTMAS CENSUSES FOR THE YEARS INDICATED)

	1939	*1942*	*1943*	*1944*	*1945*	*1946*	*1952*	*1954*
Western Oregon:								
Tillamook	1							
Portland	28	20	18	14	24	13		15
Eugene		9		21	6	29		31
Eastern Oregon:								
Medford								1
Warm Springs								3
Bend								0
Malheur Refuge	0		2	2				
Klamath Falls				3			0	

In eastern Oregon a few areas support small numbers of wintering birds, among them the grain country around Madras, the Malheur Refuge, and the Klamath Falls region. During periods of warmer weather these birds may wander widely. At Bend such individuals, all males, have been noted November 16, December 13, January 29, February 15, and March 3 in 1952 and 1953.

Molting and Plumages.—The annual molt takes place from July to October and may extend into November. In two juvenile captives at Corvallis, in 1952, the molt during their first fall commenced August 3, when one cinnamon feather appeared on the chest of the male. By August 6 the female showed ruffled, partially featherless areas about a centimeter wide on each shoulder, the result of losing 3 or 4 feathers from each spot. The male had two adult cinnamon-colored chest feathers by August 17. Both birds began to molt heavily

about the first of September, and by September 10 looked rather patchy. The male had the entire chest area outlined in cinnamon at this time, and by the 15th this region was completely refeathered in the adult shade. Up to this date, most of the feathers dropped were small contour feathers, but on the 17th larger feathers, from the back and wing coverts, were lost. By October 5 the molt was nearly complete, but a few feathers continued to drop until October 19. No flight feathers were lost at this time. (See also Parkes, 1955.)

During their second fall, Sparrow Hawks undergo a complete molt of both body and flight feathers. In a captive male this molt began July 3, when 2 primaries and 3 secondaries, plus some body feathers, were shed. One or two flight feathers were dropped every 2 or 3 days until July 15, when the rate slowed to one every week or 10 days. The first primaries lost came from the proximal portion of the wing, the molt working out distally. Bastard quills were dropped July 4 and 10, and the first tail feather (the first feather to the left of center) on July 14. Between August 22 and October 11 no wing feathers were shed, but on the latter date two secondaries were dropped and on November 5 two more, at which time the molt was over. During this molt the body feathers were also shed, but the new plumage differed little from the old except for a reduction in the number of spots on the chest.

The third annual molt in this particular bird began June 27, 1954, with two primaries. In the following weeks body, wing, and tail feathers were all molted. On September 3, only two of the old tail feathers remained, the new ones were half grown, and the bird had achieved a nearly immaculate cinnamon chest, with only a very few black spots around the edges.

Although there is a great amount of individual variation, especially in males, actual abnormal plumages appear to be rare. The questionnaires sent to museums and zoos turned up only two out of 1952 specimens. At the Chicago Museum of Natural History is a partially albinistic male, having the crown, back of neck, and wings smudged with black, the back tinged with reddish, and the tail patterned, although much paler than is usual. It was collected February 15, 1928, at Roswell, Georgia, by L. M. Taylor. A completely albinistic male is mounted and on display at the Museum of Natural History at the University of Oregon, Eugene, Oregon. Mr. George Brock collected it at Scio, Oregon, on November 8, 1900, and it was subsequently prepared by Dr. A. G. Prill of Scio.

Hunting and Feeding.—Sparrow Hawks spend much time perched quietly on an observation point during the middle of the day. Hunting

is done primarily in the morning and late afternoon. Characteristically the hunt occurs over open fields, the entire area being covered methodically by a combination of flying, hovering, and soaring. Flying appears effortless, with a quick wingbeat, and the hawk can easily maintain a speed of 20 miles per hour. (Checked at Corvallis, January 16, 1951, by car.)

If something attracts the hawk's interest, it hovers over the spot. In hovering, the tail is usually spread fully, while the distal portions of the wings are winnowed rapidly through an arc of 4 to 6 inches (equal distances above and below). The head is nearly always pointed into the wind, and the tail is lower than the body. In this fashion the Sparrow Hawk may hang over a spot on the ground, head turned down to watch anything worth closer attention, for periods up to a full minute, rarely longer. Then with a flip of its wings it will glide or fly over to a new location and repeat the performance. This stage of the hunting usually takes place at from 50 to 75 feet above the ground, but may be much higher. If prey is detected from this height, the Sparrow Hawk partially folds its wings and drops headfirst to a lower elevation to hover again. After a moment another drop is made to an even lower level, and the final distance to the ground is made with a pouncing swoop during which the feet are brought forward to grab the prey.

In hunting insects the same general pattern is followed, except that the final swoop is replaced by a slow, feet-first descent, with wings fluttering above the hawk's back, and ends with a quick drop.

A third type of hunting frequently observed is conducted from a vantage point, such as a telephone line. The hawk keeps the immediate vicinity under close observation and if suitable prey presents itself, flies directly to the spot and makes the capture. This hunting style, although often used for mammals and reptiles, seems to be more effective for insects. Frequently tadpoles or water beetles in a roadside ditch may be located in this manner.

In soaring, the hawk spreads its wings to their fullest extent, so that they appear less pointed than usual. The tail is also spread, but not to the same degree as in hovering. Circles and figure-eights are the most frequent patterns followed, and control is accomplished by adjusting the spread of the tail, or by twisting it.

The capture of prey is made by the feet in most cases, and if large it is killed by a quick bite at the base of the skull. Insects are rendered helpless by the grip of the feet, or by biting. After capture, the prey is taken to a suitable perch, anything from a bush 2 feet high to a building of several stories. The head is almost always attacked

first, perhaps because the skin elsewhere does not offer a good purchase. Captives, for example, hold a mouse or young rat in the lumbar region with one or two claws on each foot, then bite the head, crushing the skull. No tearing is attempted until the beak encounters a good grip on an eyelid, ear, or lip, after which the skin is quickly torn off in small strips to expose the underlying flesh. The strips may be either discarded with a toss of the head or swallowed. Small insects are swallowed whole, but large ones are held by the abdomen in one foot while successive bites work down from the head, very much as a small boy eats a hot dog.

Only once was a captive seen to drink. This bird, taken on a three-day trip through northwestern California, Nevada, and the Mojave Desert, in August, 1953, took several beakfuls of water at the end of the trip. Wild birds were never seen to drink.

Behavior of Captives.—The behavior of young birds during their development has been outlined above, but one exception noted only in captives should be mentioned. At least 5 captives displayed an attitude which may best be termed "setting." It occurred at the age of 5 or 6 weeks, and consisted of lying flat, the wings sagging limply on the ground. The feet were either tucked up under the body or extended posteriorly, while the head was usually erect, although hunched down on the shoulders. In this position the young hawks would often lie in the morning sun, picking ants off the grass in front of them. Later in the day they would "set" on their perches, so relaxed that wings and tail drooped down.

This "setting" attitude may be associated with the fact that the young birds' muscles and bones have not yet become accustomed to sitting for long hours on a hard perch, as they do in captivity. In the wild, the strain on feet and legs is relieved by periods of flying.

On hot days most birds relish a shower from a garden hose with nozzle adjusted to a fine spray. When hosed down in this manner they crouch and ruffle their feathers, dipping and bobbing their heads as though bathing in a pool. Such bathing activity was once noted in a hawk perched four feet above the ground in its cage, during a mild summer rain.

Differences in behavior between the sexes have been mentioned earlier; some examples may clarify this situation. A young male and female taken from a nest near Corvallis were typical. The male quickly adjusted to the routine of being approached, handled, weighed, and fed, and after 3 or 4 days submitted to such treatment with little protest. The female continued to yell, rear back, and attempt to escape for nearly 10 days.

Even when the birds had been in captivity for a year or more, this difference was quite noticeable. The male would permit a close approach when the cage was entered, but the female became extremely excited at such times. These examples are not isolated ones. Of the fourteen Sparrow Hawks kept captive during this study, the 6 males were all much the easier to handle, although treated identically as the females. Various observers have noted similar differences in behavior (Holland, 1923; May, 1927; Sherman, 1913). In wild birds the difference is not noticeable except in connection with defense of the nest.

It appears to me that the male Sparrow Hawk may have the greater ability to adjust to changed conditions. This ability may have evolutionary significance when new range extensions are being established and may partially explain the preponderance of males in the population (see Sex Ratios below).

Sparrow Hawks also show considerable variation in individual behavior. One captive male quickly became so tame that I could walk right up, hold out my finger, and have him step up on it to 'chrrr' gently. Even when not hungry, he would fly to my shoulder to be carried about when I entered the cage to clean it. He remained extremely shy of strangers, however, in contrast to another bird. This second hawk, also male, could be approached and handled by anyone and even ignored dogs which came up to sniff. He was by no means the pet that the first male was, however. A female captive showed the opposite extreme, becoming very excited, yelling and flying about in the cage even at such routine disturbances as feeding. Even after 15 months she seemed no tamer than the day she was taken from the nest.

A juvenile male was given to me in 1953, showing hunger streaks—signs of poor feeding when the flight feathers were developing. In preening during the first fall molt this bird encountered these weak spots and chewed at them. In two months all flight feathers in wings and tail had been removed, leaving only half-inch stubs. Later a minor injury to one toe started him biting at his feet. Although the original injury had been just a scratch, continued pecking enlarged it, causing the talon to be lost and the bone exposed. Because of the constant pecking the wound could not heal. On March 25, 1954, a large blood vessel was exposed, and bleeding was continuous thereafter. On the morning of March 28, following a night of 18° F. temperature, this bird was found dead. Apparently loss of blood and cold were responsible.

Interspecific Relations and Mortality.—The Sparrow Hawk is sub-

jected to a certain amount of harassing by other birds. Brewer's Blackbirds frequently chase them when in flight, but do not seem to be so bold when the hawk is perched. In flight the blackbirds follow closely, and on occasion may peck the hawk on the back. On June 7, 1953, near Bend, a male Sparrow Hawk was observed feeding unconcernedly as blackbirds hopped all about, not more than a foot away. They made no attack until the hawk finished eating and flew off, upon which 8 or 10 followed closely, heckling all the way. Robins and Clark Nutcrackers were also seen to chase Sparrow Hawks. Male Robins may spend hours yelling at young captives, diving within a few inches of them. Other birds, such as House Finches, House Sparrows, goldfinches, and swallows, protest the presence of the young hawks by chirping or flying about but leave after 10 or 15 minutes.

The Sparrow Hawk is not always the receiver in interspecific encounters. During this study they have been seen to chase and harry Robins, Band-tailed Pigeons, and Red-tailed Hawks, the latter usually when they are carrying prey. On January 21, 1955, Mr. Robert Jewell and I watched a male Sparrow Hawk making repeated dives at a perched Goshawk. At each pass the Goshawk crouched and fluttered its wings. After about 25 such passes (in about 1 minute) the Goshawk flew off, closely pursued by the Sparrow Hawk.

Sparrow Hawks have relatively few known natural enemies, some of the larger birds of prey being most important in this respect (Cade, 1951; Carnie, 1954; Fitch, 1947). Fish and Wildlife Service banding records mention two Sparrow Hawks killed by other hawks, one of which is identified as a Red-tailed Hawk. Dr. Robert W. Storer informs me that Sparrow Hawk remains have been found in the stomachs of a female Sharp-shinned Hawk and a male Cooper's Hawk (data from the U. S. Fish and Wildlife Service stomach analysis records). In Corvallis a Cooper's Hawk made an unsuccessful attack on two captives tethered in the backyard.

Man is probably the most serious enemy of the Sparrow Hawk. Banding returns show that of 185 birds for which the cause of death was listed, 45 were shot. Two other categories, "found dead" (52) and "killed" (33) probably include a number of birds which were shot. Other causes of death, most of which may be attributed to man, include "trapped" (28), "captured" (12), and "died" (15).

Some unusual cases should be mentioned. The banding records include one bird which was "attacked by kingbirds, protecting their nests, driven to the ground and killed by two other Sparrow Hawks." One each was "killed by jays," "by a cat," "by lightning," "flying

into a window," "hit by car," and "hit by locomotive." One died of starvation, another "from cold," and a third from parasites.

Only a few species of parasites have been reported from the Sparrow Hawk. During the present study only two were observed. A single louse, determined to be *Degeeriella giebeli* Hopk. by Dr. C. F. Muesebeck of the U. S. National Museum, was obtained from an adult female. In the spring of 1953, black flies were found in great numbers at one nest near Bend, biting the young hawks through their down and causing local irritation. Dr. A. Stone (USNM) identified specimens collected at this nest as *Simulium canonicolum* (D. & S.). The five young and the adult female at this nest showed excessive yellow pigmentation of the legs, cere, and circumocular skin, these areas appearing almost orange. In addition, the legs were so swollen that an aluminum band of the proper size could not be fitted so as to allow room for it to turn on the leg. Subsequently two of the young at this nest disappeared; the remaining three were females.

This pigmented condition was mentioned to Dr. Patricia O'Connor, veterinarian at the Staten Island Zoological Park, New York, who replied that a similar condition had appeared in several birds at the zoo, including a King Vulture. Upon its death autopsy showed a distinct nephritis, but whether this had any connection with the swelling of the legs could not be determined.

The band of one of the two young hawks which disappeared at the above nest was found in debris at the bottom of the nest in 1954. It was filled with a mass of fibrous material similar to that found in a hawk casting, and hence it seems likely that this young hawk, the runt at the time of its disappearance, had been eaten by its nest-mates.

Very little information is available concerning the life span of wild birds, banding records being the only source of data. Up to 1949 2661 Sparrow Hawks had been banded, an average of only 92 a year since 1920. Only 210 bands were recovered between 1924 and 1953—approximately 7 each year. Considering the abundance of Sparrow Hawks, this represents a very small sample and the following results, based on analysis of this sample, may be far afield.

The reports provide data on 150 birds of known age (adult or juvenile) at the time of banding (Table 6). On the basis of an average annual mortality of 57 per cent, the life expectancy of banded Sparrow Hawks is about 1 year and 3 months. Bond (1943) mentions that 75 per cent of all mortality occurs between August and November, amounting to from two-thirds to one-third of the entire population. The oldest bird reported was a female, recovered 5 years and 11 months after being banded as a juvenile.

TABLE 6

MORTALITY OF BANDED SPARROW HAWKS

	Years after banding					
	1	*2*	*3*	*4*	*5*	*6*
Adults:						
Number of banded hawks alive at beginning of year:	45	18	9	4		
Number of banded hawks which died during the year:	27	9	5	4		
Mortality (per cent)	60	50	55			
Juveniles:						
Number of banded hawks alive at beginning of year:	105	39	12	7	3	1
Number of banded hawks which died during the year:	66	27	5	4	2	1
Mortality (per cent)	63	70	43	57	60	
Average annual mortality: 57 per cent.						

TABLE 7

AGE OF CAPTIVE SPARROW HAWKS

Institution	*Age*
Chicago Zool. Park, Brookfield, Ill.	3 yr. 5 mo.
Lincoln Park Zoo, Chicago, Ill.	4 yr.
City Zoo, Buffalo, N. Y.	4 yr.
Washington Park Zoo, Portland, Ore.	4 yr. 7 mo.
Philadelphia Zool. Park, Phila., Penn.	6 yr.
Philadelphia Zool. Park, Phila., Penn.	6 yr.
Philadelphia Zool. Park, Phila., Penn.	6 yr.
City Zoo, Memphis, Tennessee	7 yr.
National Zool. Park, Washington, D. C.	9 yr.
City Zoo, Calgary, Alberta, Canada	2 yr.

Data from questionnaires—for list see Table 8.

In captivity Sparrow Hawks show an average life span of 5 years and 2 months (Table 7). An exceptional case (not listed in the table) was that of a male kept as a house pet for 14 years before strangling on a curtain cord (letter from Mr. Jack Marks, Director of the Washington Park Zoo, Portland, Oregon, dated February 5, 1953).

Sex Ratios.—Information from a number of sources indicates that there are more males than females in the Sparrow Hawk population. On longer trips taken during this study, the sexes of Sparrow Hawks seen were recorded whenever they could be determined. To insure inclusion of females which might be at the nest, only late summer, fall, and winter records were included in this tabulation. These records totalled 107 birds, of which 67, or 63 per cent, were males.

TABLE 8

SPARROW HAWK SEX RATIOS

	Museums	*Males*	*Females*
Arizona	Univ. of Arizona, Tucson	4	5
California	Cal. Acad. Sci., San Francisco	78	54
	Los Angeles Museum, Los Angeles	27	24
	Mus. Vert. Zoology, Berkeley	178	194
	San Diego MNH, San Diego	48	50
	Santa Barbara MNH, Santa Barbara	12	7
Colorado	Denver MNH, Denver	36	19
	Univ. of Colorado, Boulder	10	4
Idaho	Univ. of Idaho, Moscow	7	3
Illinois	Chicago MNH, Chicago	133	121
Iowa	Iowa State College, Ames	1	1
	Univ. of Iowa, Iowa City	30	7
Kansas	Univ. of Kansas, Lawrence	38	29
Michigan	Mich. St. College, East Lansing	5	1
	Univ. of Michigan, Ann Arbor	107	135
New Mexico	Univ. of New Mexico, Albuquerque	2	1
New York	American MNH, New York City	116	118
	Cornell University, Ithaca	41	24
Ohio	Cleveland MNH, Cleveland	36	21
Oregon	Ore. St. College, Corvallis	18	15
	Univ. of Oregon, Eugene	6	2
Pennsylvania	Penn. St. Coll., State College	11	4
Washington	Wash. St. College, Pullman	8	8
	Univ. of Washington, Seattle	20	12
Wisconsin	Univ. of Wisconsin, Madison	6	3
	Totals:	978	862
	Zoological Parks		
Colorado	Denver Zoo, Denver	'scores'	
Illinois	Brookfield Zoo, Brookfield	11	6
	Lincoln Park Zoo, Chicago	1	3
Kansas	Wichita Zoo, Wichita	0	0
New York	Bronx Zoo, New York City	'many'	
	Buffalo Zoo, Buffalo	1	0
	Staten Island Zoo, Staten Island	'many'	
Oregon	Washington Park Zoo, Portland	1	0
Pennsylvania	Philadelphia Zoo, Philadelphia	35	43
Tennessee	Memphis Zoo, Memphis	3	7
Canada	Calgary Zoo, Calgary, Alberta	1	0
	Winnipeg Zoo, Winnipeg, Manitoba	0	0
	Totals:	53	59

Total males: 1031, or 52.8 per cent. Total females: 921, or 47.2 per cent.

Only institutions which answered the questionnaire are listed. Where a college or university is named, the questionnaire was sent to the Museum of Natural History (MNH) at that college.

Males amounted to 53 per cent of the 1952 specimens reported in the questionnaires which were sent out (Table 8). The weights of 160 Sparrow Hawks were obtained, males representing 56 per cent of that sample. Exactly 65 per cent of all returns on banded birds are males. And finally, at Hawk Mountain Sanctuary in Penn-

sylvania, Broun (1949: 171) reports that 65 per cent of the migrating Sparrow Hawks observed are males.

In contrast to these figures, notes from nine Oregon nests where the sexes of the nestlings were recorded show only 12 out of 34 (35 per cent) were males.

SUMMARY

Among Sparrow Hawks there is evidence that polygamy or polyandry may occur, and that the female selects her mate and initiates copulation. The female is assisted in incubation by the male, who also brings food to her and the nestlings, and is more active in defense of the nest. Food may be stored for future use.

The young at various ages are characterized by feather development and voice. They leave the nest about a month after hatching. Weights of both young and adults are presented. Banding returns indicate the young may drift northward in late summer. Migration begins in September, the most northerly nesting birds travelling farthest south. In favorable northern areas Sparrow Hawks may remain through the winter.

The annual molt starts in July and ends in late October. The first year this is a body molt only, but a complete molt occurs in the second year. The same appears true for the third annual molt. Two albinistic birds were reported from among 1952 specimens.

There is considerable individual variation in behavior, and a definite difference in behavior between the sexes, most noticeable in captives. The males seem to be more adaptable to new situations.

Banding records indicate an average annual mortality of 57 per cent, pointing to a life span of about one and one fourth years. Captives may reach an age of 14 years. Evidence indicates that about 60 per cent of the population are males.

LITERATURE CITED

BENT, A. C. 1938. Life histories of North American birds of prey, Part 2. U. S. Natl. Mus. Bull. 170: 107–127.

BISHOP, S. C. 1925. Notes on the mating habits of the Sparrow Hawk. Auk, **42:** 268–269.

BOND, R. M. 1943. Variation in western Sparrow Hawks. Condor, **45:** 168–185.

BROUN, M. 1949. Hawks aloft: the story of Hawk Mountain. (New York, Dodd, Mead) 222 pp.

CADE, T. 1951. Food of the peregrine falcon, *Falco peregrinus*, in interior Alaska. Auk, **68:** 373–374.

CARNIE, S. K. 1954. Food habits of nesting Golden Eagles in the coast ranges of California. Condor, **56:** 3–12.

CHILDS, H. E., JR., and A. S. MOSSMAN. 1952. Notes on the sexual behavior of two falcons. Condor, **54:** 207–208.

FAST, A. H., and L. H. BARNES. 1950. Behavior of Sparrow Hawks. Wilson Bull., **62:** 38.

FITCH, H. S. 1947. Predation by owls in the Sierran foothills of California. Condor, **49:** 137–151.

FRIEDMANN, H. 1950. The birds of North and Middle America, Part 11. U. S. Natl. Mus. Bull. 50: 726–739.

HOLLAND, H. M. 1923. Young Sparrow Hawks. Bird-lore, **25:** 185–186.

MAY, J. B. 1927. Nestling Sparrow Hawks. Bull. Northeastern Bird-banding Assoc., **3:** 20.

PARKES, K. C. 1955. Notes on the molts and plumages of the Sparrow Hawk. Wilson Bull., **67:** 194–199.

SHERMAN, A. R. 1913. The nest life of the Sparrow Hawk. Auk, **30:** 406–418.

SUMNER, E. L., JR. 1929. Comparative studies in the growth of young raptores. Condor, **31:** 85–111.

TORDOFF, H. B. 1955. Food-storing in the Sparrow Hawk. Wilson Bull., **67:** 139–140.

WILLIAMS, R. B., and C. P. MATTESON, JR. 1948. Wyoming hawks. Wyo. Game and Fish Dept. Bull. 5: 75–79.

California State Polytechnic College, San Luis Obispo, California, January 2, 1954.