

FOOD HABITS OF SOUTHERN WISCONSIN RAPTORS

PART II. HAWKS

By PAUL L. ERRINGTON

The data on hawks to be discussed, like those on owls taken up in Part I (1932b), were gathered with special reference to the relation of hawk species to the Eastern Bobwhite (*Colinus virginianus virginianus*) (1930b, 1931a), as well as from the standpoint of day-by-day food habits. As compared with the owl data, those pertaining to hawks are not so complete for important species and for important seasons, nor are they from sources as satisfactory quantitatively.

Because the efficiency of hawk digestive action may be more than much of the bony material can withstand—notably in the case of buteos and where calcium-hungry juveniles have eaten soft-boned juvenile prey (1930a, 1932a)—and because of the infrequency with which indubitably specific hawk pellets can be collected in numbers (save during the nesting season and sometimes about favorite roosting and feeding places), the pellet analysis method of study has not shown the utility for hawks that it has for owls. In the following discussions, only data from the highest grade of hawk pellets, that is, those with well preserved osseous contents, are used at all and they but sparingly.

“Sign reading” or the ex post facto recording of raptor kills encountered in the field should not be regarded as a proper source of quantitative data, on account of the conspicuousness of certain types of kills (large and medium-sized birds) and the inconspicuousness of other types (small mammals). Sign reading should be used only to detect whether *any* of certain species, such as quail, have been killed and should be used with its short-comings in mind, lest erroneous impressions obscure the true proportions of one prey species to another in raptorial diets.

Eligible for consideration as sources of hawk quantitative data might be mentioned random field observations in which capture or eating of prey was witnessed, prey retrieved from hawks under natural conditions, *fresh* prey from nests and feeding sites, gullet contents from live juveniles, contents of stomachs, and to some extent the comparatively undigested material which occurs now and then in pellets. Of these, gullet contents, procured daily a few weeks to a couple of months from nestlings and tethered young (1932a), have proved especially productive during nesting and post-nesting seasons. Stomachs from taxidermy shops and from hawks shot by the populace and strung up on fences and buildings have also been of value in supplying data otherwise difficult to obtain. These sources are not by any means beyond criticism; each without exception has drawbacks, but imperfect tools are better than none at all.

The accumulated data, mainly from three adjoining counties (Dane, Sauk, and Columbia), represent research in what I would call the major environmental types to be found in southern Wisconsin. The data listed below include none from game farms, or from large commercial poultry raising establishments, and few from other places where unnatural concentrations of more or less handicapped or defenseless species are likely to influence predators into extreme departure from their ordinary food habits.

MARSH HAWK *Circus hudsonius*

Of the data to be presented, those relating to prey retrieved from adult hawks are believed to be of the greatest quantitative importance. Next in order may rank those from gullets (most of mine from juveniles), stomachs, very fresh prey (not

fur or feathers but meaty remains) from nests or feeding places, and, lastly, bony contents of pellets. Pellet contents, where given, constitute for the most part pre-nesting data or are supplementary to data conspicuously fragmentary. On the whole, my summer marsh hawk pellets, while showing by contained fur, feathers, or scales, the *kinds* of prey eaten, do not show the number of individuals (1930a, 1932a). Therefore, in order that the pellets used may have some value quantitatively, *only* the prey represented by undigested bones will be listed, whatever the weaknesses of this method.

No. 1. *Madison (Wingra Wild Life Refuge)*.—Data from 4 nesting pairs and young:

July, 1929, retrieved from adult hawks: meadow mouse (*Microtus*), 2. Prey seen in possession of adults but not retrieved: small mammal, probably *Microtus*, 7. Bony contents of pellets (Biological Survey analyses): striped ground squirrel (*Citellus tridecemlineatus*), 2; meadow mouse, 22; shrew (*Blarina*), 1; meadowlark, 1.

March 28, 1930, observation: Marsh Hawk feeding on carrion cottontail.

June, 1930, retrieved from adult hawks: juvenile cottontail, 1; striped ground squirrel, 4; meadow mouse, 2; meadowlark, 1. Gullet contents of nestlings: juvenile cottontail, 2; striped ground squirrel, 1; chipmunk (*Tamias*), 1; meadow mouse, 1. Fresh prey from feeding places: striped ground squirrel, 2. Bony contents of pellets (pre-nesting): striped ground squirrel, 2; meadow mouse, 6; small bird, 1.

July, 1930, retrieved from adult hawks: striped ground squirrel, 3. Gullet contents of nestlings: juvenile cottontail, 2; striped ground squirrel, 7; meadow mouse, 1; jumping mouse (*Zapus*), 1; red-winged blackbird, 1; meadowlark, 1; house wren, 1. Fresh prey from feeding place: striped ground squirrel, 1. Bony contents of pellets (post-nesting): meadow mouse, 4; small bird, 1.

June, 1931, retrieved from adults: striped ground squirrel, 2; meadow mouse, 2. Gullet contents of nestlings: juvenile cottontail, 7; striped ground squirrel, 30; chipmunk, 1; meadow mouse, 4; robin, 2; red-winged blackbird, 1; meadowlark, 4; catbird, 1; small bird, 11; frog, 3. Fresh prey from feeding places: striped ground squirrel, 2; red-winged blackbird, 1; small bird, 1.

July, 1931, gullet contents of nestlings: juvenile cottontail, 5; striped ground squirrel, 6; meadow mouse, 2; meadowlark, 2; red-winged blackbird, 1. Stomach contents of 3 young Marsh Hawks killed by a mink: juvenile cottontail, 1; striped ground squirrel, 3; meadow mouse, 1; shrew (*Blarina*), 1.

No. 2 *Madison (Fish Hatchery Marsh)*.—Data from 7 nesting pairs and young:

July and August, 1929, fresh prey from feeding places: meadow mouse, 4; cowbird, 1. Bony contents of pellets (mostly Biological Survey analyses): striped ground squirrel, 1; meadow mouse, 31; shrew (*Sorex*), 1; meadowlark, 1.

May, 1930, fresh prey from feeding places: meadow mouse, 2.

June, 1930, retrieved from adults: striped ground squirrel, 6; meadow mouse, 3. Gullet contents of nestlings: juvenile cottontail, 4; striped ground squirrel, 11; meadow mouse, 9; vesper sparrow, 1; small bird, 3; frog, 4. Fresh prey from feeding places: juvenile cottontail, 1; striped ground squirrel, 1; grasshopper sparrow, 1.

July, 1930, retrieved from adults: striped ground squirrel, 2. Gullet contents of nestlings: striped ground squirrel, 2; juvenile squirrel (*Sciurus*), 1. Fresh prey from feeding places: juvenile cottontail, 2; striped ground squirrel, 5; field sparrow, 1; young domestic chicken, 1; frog, 1.

June, 1931, prey seen in possession of adults: striped ground squirrel, 3. Gullet contents of nestlings: juvenile cottontail, 3; striped ground squirrel, 18; meadow mouse, 1; meadowlark, 1; flicker, 1; medium-sized unidentified bird, 1; small bird, 3; frog, 1.

July, 1931, gullet contents of nestlings: juvenile cottontail, 3; striped ground squirrel, 10; chipmunk, 1; meadow mouse, 6; deer mouse (*Peromyscus*), 1; bluebird, 1; small bird, 1.

I might list parenthetically the bony contents of pellets gathered during the gullet studies to illustrate the checking of one method against the other: juvenile cottontail, 1; striped ground squirrel, 4; meadow mouse, 4; deer mouse, 2; shrew (*Blarina*), 1; frog, 1. These latter items are not necessarily to be considered as kills separate from the preceding.

No. 3. *North of McFarland*.—Data from a late nesting pair and young: June 14 to July 11, 1930, retrieved from adults: meadow mouse, 1. Gullet contents of nestlings: striped ground squirrel, 3; frog, 4. Fresh prey from nest: frog, 1.

Miscellaneous quantitative data from stomachs, observations, etc., for all seasons, 1929-31: juvenile cottontail, 2; striped ground squirrel, 1; meadow mouse, 14; red-winged blackbird, 1; frog, 1.

The 359 kills from the above quantitative sources occur in the proportions of 295 mammals (82.17%), 49 birds (13.65%), and 15 amphibians (4.18%); specifically: juvenile cottontail, 33; ground squirrel, 128; other Sciuridae, 4; mouse (*Microtus* except for a *Zapus* and a *Peromyscus*), 127; shrew (2 *Blarina*, 1 *Sorex*), 3; small and a few medium-sized birds, 48; young domestic chicken, 1; frog, 15.

The cottontails ranged in size from very small individuals up to those a quarter grown, and the ground squirrels from a third grown to adults. Perhaps half of the bird kills were finches and other small birds of the lowlands, most of the rest being fledgling icterids such as meadowlarks and red-winged blackbirds. During the summer relatively helpless immatures comprise the greater part of the diet, the actual proportion of species taken depending upon availability. In 1929, when meadow mice were overrunning south-central Wisconsin, they bore the brunt of Marsh Hawk pressure; the hawks of area no. 3, nesting at the edge of a wet meadow, turned more to frogs. On the other hand, 7 out of 10 pellets gathered in July, 1930, from a Marsh Hawk perch in the extensive Wisconsin River marshy bottoms north of Mazomanie, were made up largely or wholly of small bird remains, simply because birds were more available than rodents in the dense vegetation.

Commonly the Marsh Hawk chooses prey that its weak feet can handle with facility. Quarter-grown cottontails and adult ground squirrels are near the usual upper size limit for mammals; meadowlarks and flickers for birds. The most formidable animal I have ever found at a feeding place was an adult muskrat, and I suspect that this was carrion. The awareness of the old birds of their physical limitations I think is shown by their observed behavior in the presence of large game (1930c). I have seen them ignore full-sized pheasants, sharp-tailed grouse and domestic chickens that happened to be within striking distance. However, on rare occasions surprisingly large prey—such as a half-grown domestic chicken—may be killed, especially by juveniles learning to hunt and driven by hunger or inexperience to chance a struggle for the sake of a meal.

Since the bulk of my data are from June and July, the balance of the year is so badly represented that I can only suggest the general trends of observed food habits for the other months. Marsh Hawks do not ordinarily winter in my observational areas, but they arrive in appreciable numbers about March. Their food from this time until the middle of June seems to be predominantly meadow mice, plus a few small birds. From mid-June to mid-July, the diet runs heavily to ground squirrels, young cottontails and the young of small birds abundant in open grassy habitats. With the cutting of grain and hay fields in July, mice again become available.

Late summer is also a season of increased availability of young poultry and partly grown game birds from which some toll is taken. I have not over-many data for this period, but what I have cause me to doubt that the damage is very serious in localities where "buffer species" are correspondingly available. Personal notes show the occurrence of but one young pheasant and two young chickens on summer feeding places, though reports of depredations are received now and then, dealing mostly with situations where game or poultry is forced to live at a disadvantage.

Pertaining to the relation of Marsh Hawks to wild ducklings, young Prairie Chickens, etc., I have nothing to offer except the comment that on this topic we need

less opinion and more data. The combined technique of gullet examination and tethering of nestling hawks (1932a) worked out by the Wisconsin investigation might be useful to persons desiring to study summer phases of Marsh Hawk food habits on duck or prairie chicken breeding grounds; late broods of Marsh Hawks, properly tethered and tended, might yield quantitative data as far into the summer as the middle of August.

I have as yet no reason to regard the Marsh Hawk as a species, as an important quail enemy, though the evidence is that certain individuals may be. My records reveal 7 quail killed by this raptor, of which three were victims of a single Marsh Hawk during a two-day snow storm when low visibility allowed unusual opportunities for unobserved approach. Of the others, 2 were starving birds. The 331 items representing the quantitative data for no. 1 and no. 2—and these areas, by the way, had been selected for study primarily on account of their high quail populations—certainly have not betrayed any heavy pressure upon bob-white for June and July, nor have the qualitative traces of prey about nests and feeding places. Whether there is or is not a fall leakage of unsophisticated young quail due to Marsh Hawks my data do not say.

All in all, the probabilities of bob-whites falling prey to Marsh Hawks should decrease as the education and development of the former progresses. There might possibly be losses to young birds about the time that their conspicuousness is suddenly enhanced by early snowfalls. Their availability decreases as they become seasoned to winter emergencies, assuming that their environment is suited to them. If they have trouble getting what they need to eat, for example, they may be captured by predators which they, when fit, could elude with ease. Danger-tried vigorous bob-whites living under favorable conditions are nearly proof against diurnal predators by spring.

To summarize the discussion of the Marsh Hawk, it may be said that the food habits of this slow-flying raptor are governed by what small vertebrate prey he finds within range of his long, agile legs. His habit of gliding low over marshes and fields sometimes affords him opportunity to catch speedy, alert birds by surprise, especially where the profile of the vegetation is pitted by openings. Mice, ground squirrels, young rabbits, fledglings of small birds, frogs, etc., are staple Marsh Hawk foods simply because they are easy to find, easy to handle, and are not so adept about getting away.

SHARP-SHINNED HAWK *Accipiter velox*

The Wisconsin investigation has almost no data on the food habits of the Sharp-shinned Hawk, with the exception of three 1931 fall stomachs, all of which contained small birds (including a chickadee and an English sparrow). These hawks are frequently seen in migration but they seem to pay most attention to passerines of warbler and finch sizes. Whether the species takes appreciable toll from September and October young quail is a question I cannot answer. I am inclined to think that a grown quail is larger game than a sharp-shin likes to handle, though large sharp-shins ought to be capable of doing anything that some of the smaller Cooper Hawks do.

COOPER HAWK *Accipiter cooperii*

Quantitative studies on the year-round food habits of the Cooper Hawk have been virtually impossible; only for the summer months are my data voluminous enough to have significance, and for these months they are not too plentiful. My best material was procured from the gullets of nestlings and from nests and feeding places

(as fresh, partly eaten specimens). Less reliable from the quantitative standpoint are a number of kills encountered at random in the course of field work, but since Cooper Hawk prey is strongly avian and rather uniformly conspicuous, the recording of these kills should not be quite as inviting to error as for species preying upon mammals.

Not included among the quantitative data are the quail kills discovered while watching the coveys in regular observational areas (1931a, 1931c). These kills were found at times when I was doing little else than ascertaining the mortality of the bob-white alone; hence they could not be used quantitatively without upsetting the actual proportion of one prey to another in the Cooper Hawk's day-by-day diet.

No. 4. *North of Verona*.—Data from late nesting pair and young: July and August, 1930, gullet contents of nestlings: striped ground squirrel, 2; robin, 2; flicker, 4; unidentified small bird, 4. Fresh prey from feeding places (separate from gullet contents): striped ground squirrel, 1; flicker, 1; very small domestic chicken, 1. Material from nestling pellets for days upon which other data were not obtained: chestnut-sided warbler, 1; meadowlark, 1; flicker, 4; small unidentified bird, 2.

The gullet and pellet analyses for this area were made by the Biological Survey. Items possibly represented in two sources of data are listed only in one, to avoid duplications.

No. 5. *North of Pine Bluff*.—Data from nesting pair and young: June and July, 1931, gullet contents of nestlings: striped ground squirrel, 4; red-headed woodpecker, 1; unidentified small bird, 1. Fresh prey from feeding places: robin, 1; song sparrow, 1; bluejay, 3; flicker, 5; red-headed woodpecker, 3; young ruffed grouse, 3; unidentified small bird, 3. No duplications.

No. 6. *West of Pine Bluff*.—Data from nesting pair and young: July, 1931, gullet contents of nestlings: striped ground squirrel, 1; flicker, 1; red-headed woodpecker, 1; unidentified small bird, 3. Fresh prey from feeding places: red-headed woodpecker, 2. No duplications.

Miscellaneous data, probably of fair quantitative status, from other nests and from field observations, 1929-31: chipmunk, 1; robin, 1; tree sparrow, 1; English sparrow, 1; flicker, 2; domestic pigeon, 1; mourning dove, 1; ruffed grouse, 1; quail, 1; small unidentified bird, 2.

The Cooper Hawk, like the Marsh Hawk, takes the prey that is most available and which his adaptations fit him for taking. Although his short, rounded wings, long versatile tail and general design for speed and agility allow him no small choice as to quarry, he also turns to the easiest living. Occasional rodents, slow-flying Picidae, robins, small and medium-sized avian immatures make up most of his food in times of plenty; not until fall do my scanty data show the Cooper Hawk preying upon game really worthy of his powers. Out of the 77 examples of quantitative prey, the four that could be expected to give an accipiter something of a chase—domestic pigeon, Mourning Dove, quail, and adult ruffed grouse—were all non-summer kills.

In addition to the types preferred—robins, Red-headed Woodpeckers, and flickers—warblers and finches may be taken at one extreme, and hen pheasants at the other. It was seen in the winter of 1930-31, incidental to following up the fortunes of the bob-white coveys in my observational areas, that the Cooper Hawks were taking advantage of tree sparrow and other small bird populations, possibly subsisting to a large extent upon them.

The three young ruffed grouse of no. 5, brought in on alternate days just before loss of my one tethered juvenile that terminated the studies, arouse the question of how severe a grouse enemy the Cooper Hawk can be. I cannot answer it. Let it be pointed out, however, that ruffed grouse were abundant in the range of wooded hills in which the hawk nest was located, and that a spring fire had destroyed most of

the ground cover in the area. Areas no. 4 and no. 6 had fair and good ruffed grouse populations, respectively, but yielded no evidence of kills.

While the Cooper Hawk is doubtless the most formidable predaceous enemy the quail has (Stoddard, 1931), except when goshawks arrive, my winter, spring, and summer studies indicate that for these seasons damage done to quail may be surprisingly light. Areas no. 4 and no. 6 were in good quail country, as were summer areas elsewhere which were productive of lesser quantitative but some qualitative data, yet no kills were detected. I also had, from December, 1930, to March, 1931, an excellent opportunity to evaluate the depredations of wintering Cooper Hawks on well-censused, fairly heavy quail populations (1931a). The latter suffered a Cooper Hawk mortality of only around 2% for the season. Usually after the sacrifice of a bird or two, the coveys became so hawk-wise that, granted access to correct food and cover combinations, even accipiters found them unprofitable hunting; some coveys, observed to be harassed on occasion, came through the census periods (up to three and one-half months) without loss.

What do Cooper Hawks do in late summer and fall to the season's increase of young quail? Again, I do not know, but I have an idea that they do enough. A great many things happen at this time and leave little concrete evidence as to their magnitude.

GOSHAWK *Astur atricapillus*

I have no personal data on the food habits of Goshawks for Wisconsin, though I am familiar with the species from experience elsewhere. From the paucity of accurate information at my disposal I am unable to build up even a probable cross-section of what may constitute the Goshawk's diet on the occasions when he comes down from the north. The opinion held by observant residents qualified to distinguish between hawks is that this species lives largely upon quail and ruffed grouse. This I am not now ready to accept, inasmuch as my recent studies on the Cooper Hawk have profoundly modified and to some extent reversed certain of my former ideas based on second-hand or qualitative data.

I do not question so much what a goshawk *can do* but rather what he actually *does*. What this raptor can do is expressed by Stoddard, who writes me from his notes that the Goshawk invasion of 1907-08 just about wiped out the ruffed grouse of a section north of Prairie du Sac, Wisconsin, he having found grouse kills corresponding to more birds than he had known to be resident in the area. Schorger (1929), relative to the Wingra Wild Life Refuge at Madison, states: "An adult goshawk remained . . . from January 1 to March 5, 1927. On one occasion it was flushed from the skeleton of a rabbit, but its main diet during the above period was bob-white."

It appears very likely that some of the severest consequences of Goshawk pressure upon quail are due to a badly distributed and inadequate supply of quail food or to poor cover or both. This is borne out by the character of all environments in Dane and Columbia counties from which I have received reports of unusual quail mortality during the infrequent "goshawk winters." Further supporting the food-cover hypothesis might be mentioned an out-of-state observation by Prof. H. M. Wight of the University of Michigan; his 1928 notes (unpublished) indicate that a Goshawk got most of a precariously situated covey of eleven quail attempting to winter in an open woodlot southwest of Ann Arbor. I have at present no means of estimating, except by analogy with Cooper Hawks, whether fit quail in a fit environment can cope with Goshawks; that half-starved coveys in brushless woods cannot, I think does not need to be proved.

The Goshawk's speed and strength thoroughly adapt him for his mode of living. A heavy invasion of these raptors such as occurred in 1907 may call for drastic measures if serious losses to gallinaceous game are to be averted, but sporadic appearances of lone individuals hardly justify any great alarm. A certain amount of local damage to ruffed grouse and quail should be offset by the intrinsic ornithological interest of a rare visitor from the wilderness, particularly one we may regard the supreme avian predator of its type.

SPARROW HAWK *Falco sparverius*

No. 7. *Northwest of Verona*.—May to July, 1930, material from a nest in a farm-yard and from field observations: striped ground squirrel (mouse-size juveniles), 10; meadow mouse, 4; deer mouse (probably *Peromyscus maniculatus bairdii*), 7; English sparrow, 5; incalculable numbers of grasshoppers, June beetles, etc.

From the occurrence of immature ground squirrels of a uniformly small size, as well as the absence of vertebrates much larger, it would seem that these little hawks exercise considerable care not to attack prey beyond their capabilities of handling. The mammals and birds were mostly kills of May and June, insects making up the bulk of the July diet.

DUCK HAWK *Falco peregrinus anatum*

No. 8. *Northwest and southwest of Prairie du Sac*.—Material from beneath 3 nests and from sandstone bluff feeding ledges along and to the west of the Wisconsin River: Summers of 1930 and 1931, freshest prey from ledges (some represented only by feathers): red-winged blackbird, 2; bluejay, 2; chimney swift, 1; nighthawk, 1; sparrow hawk, 1; domestic pigeon, 6; mourning dove, 2; green-winged teal, 1. Old bony remains: robin, 2; purple martin, 1; meadowlark, 1; bobolink, 1; bluejay, 8; flicker, 3; yellow-bellied sapsucker, 1; hairy woodpecker, 1; large domestic pigeon, 43; small domestic pigeon and mourning dove (I was unable to separate all of these satisfactorily on the basis of sternal fragments), 23; domestic chicken (part-grown), 4; killdeer, 1; green heron, 1; black tern, 1; horned grebe, 1; unidentified small bird, 7. Other species of which evidence was seen: bluebird, cardinal, whip-poor-will, red-headed woodpecker.

The above data are not to be looked upon as truly quantitative, though I have checked my sources against each other in an effort to arrive at an approximate cross-section of the peregrine's diet. Most of the larger skeletons such as pigeons and domestic chickens were left on the feeding ledges; skulls, mandibles, wings, and other parts of small birds had a way of accumulating on talus slopes beneath. Pellets gave a strong indication of the percentage of lesser avian prey, but I had neither the time nor the skill to conduct in detail such difficult analyses.

Regardless of the deficiencies in the data, it is plain that domestic pigeon is the Prairie du Sac peregrine's main staple. Bluejays, flickers, and icterids figure prominently. Next in order might be considered mourning doves, nighthawks, killdeers, and young domestic chickens. I have record of but the one duck (green-winged teal) from the feeding places, although Wisconsin, of course, is not much of a waterfowl state. Mammals do not seem to be brought in at all.

Various authors cite definite instances of ruffed grouse preyed upon by peregrines, but, while my nests were in excellent ruffed grouse country, I have not found a single trace in bone and feather debris from the Wisconsin falcons. Indeed drumming logs were located within 50 to 150 yards of two of the peregrine nest sites, and I cannot recall a visit at which grouse were not to be flushed. The impunity with which these grouse habitually frequented the vicinity of the peregrine haunts I ascribe to the

entirely different habitats and adaptations of the two birds; the falcon's long pointed wings are ill-designed to whip into the brush in pursuit of a short-winged compact flyer like the ruffed grouse.

Quail populations in the Duck Hawk nesting territories were so sparse that I am not entitled to draw conclusions as to relations between these species.

According to ordinary standards of economic ornithology, the food habits of the peregrine would be difficult to defend, but it is a species of such exceptional esthetic and scientific value (and here I add my futile plea to the futile hundreds or thousands already in print) that we as a public can surely afford to keep the few that we have, especially the ones having food habits no more harmful than those of the Wisconsin birds studied. Pigeons are spoken of as a nuisance by most of the farmers with whom I am acquainted; the rest of the prey is drawn largely from species that plainly thrive in spite of—or perhaps because of—the predator pressure they have always borne. And the Mourning Doves, swifts, nighthawks, martins and teal one might be pardoned for reckoning fair and legitimate game for an aerial hunter equipped only with natural weapons, however superb.

AMERICAN ROUGH-LEGGED HAWK *Buteo lagopus s.johannis*

No. 9. *Dane and Columbia Counties*.—Falls of 1929 and 1930, stomach contents of 5 Rough-legged Hawks shot by hunters and farmers: meadow mouse, 8; shrew (*Sorex*), 1; insects, mainly crickets.

BROAD-WINGED HAWK *Buteo platyterus*

No. 10. *Madison (Wingra Wild Life Refuge)*.—July, 1929, material from one nest: chipmunk, 1; meadow mouse, 1; shrew (*Blarina*), 4; red-winged blackbird, 1; garter snake, 1; unknown quantities of insects.

RED-SHOULDERED HAWK *Buteo lineatus*

No. 11. *North of Mazomanie (along the Wisconsin River bottoms)*.—May, 1930, gullet contents of nestlings: snake, 1; frog, 1. Fresh prey in nest: meadow mouse, 1. Nest litter contained feathers of a red-winged blackbird, considerable quantities of pellet mouse fur, snake scales, and crayfish exoskeletal fragments.

RED-TAILED HAWK *Buteo borealis*

The red-tail—and this applies to the other buteos—to me has been anything but an easy species to study. Aside from nest studies and gullet examinations (the period of which was prolonged in 1931 as in the case of the Marsh Hawk by tethering of juveniles), the main sources of data approaching quantitative standards were stomach analyses and field observations, the latter two particularly for late summer, fall, winter, and early spring months.

Stomachs were procurable in varying numbers from hawks sent in to taxidermy shops, or from those shot, in most instances wantonly, by the public. The observational method of study appeared quantitatively sound, provided that the killing or eating of prey was witnessed, and provided that the aim of the observer was to ascertain the typical day-by-day food habits of the raptor. Observations from special viewpoints may be extremely misleading if broad generalizations are drawn from them. Pellets were of negligible utility, for seldom was it possible to collect those which I knew with reasonable certainty to be of red-tail origin (except from nestlings). Then, too, the thoroughness of the red-tail's digestion left little diagnostic bony material in the majority of the castings.

No. 12. *Madison (south of the Fish Hatchery)*.—April and May, 1930, retrieved from adult hawk: striped ground squirrel, 1. Fresh prey from nest: cottontail (incl.

6 juveniles), 9; arboreal squirrel (*Sciurus*), 2; Franklin ground squirrel (*C. franklini*), 3; striped ground squirrel, 11; chipmunk, 2; Norway rat, 1; meadow mouse, 3.

No. 13. *Southwest of Lodi (Crystal Lake)*.—May, 1930, gullet contents of nestling: meadow mouse, 1. Fresh prey from nest: cottontail, 3; arboreal squirrel, 2; striped ground squirrel, 2; meadow mouse, 1; domestic pigeon (young?), 1; bull snake, 1; frog, 1.

No. 14. *Northwest of Verona*.—April and May, 1930, gullet contents of nestling: young domestic chicken, 1. Fresh prey from nest: juvenile cottontail, 1; striped ground squirrel, 17; meadow mouse, 8; young pairie horned lark, 1; young domestic chicken, 3; Florida gallinule, 1; garter snake, 3.

No. 15. *Dane and Sauk Counties*.—April and May, 1930, fresh prey from 5 nests lumped: cottontail, 2; arboreal squirrel, 1; striped ground squirrel, 11; meadow mouse, 1; domestic chicken (one very young and one adult), 2.

No. 16. *North of Middleton*.—May to July, 1931, gullet contents of nestlings: young domestic chicken, 3. Fresh prey at feeding place: chipmunk, 1; young domestic chicken, 1. Bony contents of pellets from tethered juvenile: cottontail, 1; striped ground squirrel, 2; deer mouse, 1; young domestic chicken, 3. No duplications.

I was unable to obtain many real quantitative data on the above nest, but, judging by the masses of feathers always in sight and by the pellets from the youngsters, I feel safe in stating that this family of red-tails lived almost exclusively upon young domestic chickens from the last of April to the forepart of June. From June 8 to about June 20, the diet was cottontail and ground squirrel, with some chicken. From the last third of June to July 9, the pellets of the tethered juvenile showed little except cottontail, ground squirrel, and mouse.

No. 17. *South of South Middleton*.—May to July, 1931, gullet contents of nestlings: arboreal squirrel, 2; striped ground squirrel, 1; young domestic chicken, 1. Fresh prey from feeding place: juvenile cottontail, 1; arboreal squirrel, 4; striped ground squirrel, 2; meadow mouse, 3; young domestic chicken, 2. Bony contents of late pellets from tethered juvenile: cottontail, 1; striped ground squirrel, 2; meadow mouse, 1. No duplications.

The above data, from the most reliable quantitative sources available, are too few to give an unquestionable cross-section of this family's food habits. The ratio of 3 chickens to 17 mammals is higher than that which my notes indicate. For about the first month of the study, evidence was seen of only one chicken at the nest, whereas the large volume of nestling pellet debris was composed of fox squirrel and meadow mouse fur. Chickens occurred most prominently May 21 to June 5, sparingly afterward.

Miscellaneous data from south-central Wisconsin, mostly for winters of 1929-30 and 1930-31: Stomach contents of 15 red-tails shot by hunters and farmers: meadow mouse, 12; deer mouse, 2; house mouse, 1; shrew (*Sorex*), 1; adult and young domestic chicken (summer stomachs of birds shot while attacking poultry), 2. Bony contents of the most certain winter red-tail pellets picked up in the field: meadow mouse, 12; deer mouse, 1; shrew (*Blarina*), 5; weasel, 1.

A composite of the red-tail's food habits might be compiled from the 165 individuals of prey tabulated as quantitative data: cottontail (including 8 or more juvenile), 18; arboreal squirrel, 11; Franklin ground squirrel, 3; striped ground squirrel, 49; chipmunk, 3; Norway rat, 1; meadow mouse, 42; deer mouse, 4; house mouse, 1; weasel, 1; shrew (5 *Blarina*, 1 *Sorex*), 6; young horned lark, 1; domestic pigeon (young?), 1; domestic chicken (all young but two), 18; gallinule, 1; snake, 4; frog, 1. In this list the 18 chickens would be likely to provoke the most complaint, though many were of size and breed as to be replaceable for 15 to 25 cents each.

That the red-tail can do damage to barnyard flocks is obvious enough. The amount of the damage varies with the individual hawk and with the degree of exposure of the fowls and their ability to look out for themselves. Old red-tails that distrust man keep away from habitations where most poultry is congregated; these wary ones rarely get chickens except a few that wander far out in coverless fields. Juveniles, awkward hunters, seem to be the boldest raiders, but adults unusually tempted may lose some of their caution.

For all of the disfavor with which the red-tail is viewed by the poultryman, I am coming more and more, for reasons to be touched upon, to regard it as being one of our most valuable wild life species and one having too low a reproductive rate (13 nesting pairs studied in 1930 and 1931 averaged 1.38 young) to hold up under the terrific persecution it receives throughout the United States. I am not advocating a passive tolerance to economic loss from red-tails; I do contend that human head-work can reduce much of the loss by practical and non-lethal means. Is it inconceivable that a property owner or tenant in typical wooded, hilly red-tail country, whose brush-barren poultry range is possessed of isolated trees ideal for hawk look-out perches, could provide a little cover to which chickens could run with some chance of safety? Or that a red-tail may often be taught to stay away from a farmyard by a shot charge that stings and frightens at a hundred yards about as conveniently as it may be killed at thirty?

With far less factual foundation than the poultryman's grievance my data show the sportsman's enmity against the red-tail. The species, handicapped by inherent slowness, does not as a rule catch alert and active prey. Mammals, sluggish poultry, semi-helpless young birds, snakes, all sorts of out-of-condition wild life, and carrion (in winter) fall within the ordinary scope of the red-tail's diet. Mature small birds sometimes taken are flickers and hairy woodpeckers, and my notes mention also a fox sparrow, a meadowlark, and a Baltimore oriole. The speediest birds I have ever known brought to nests were a mourning dove, a quail, and a ruffed grouse; of the circumstances having to do with their demise, I have no knowledge. As a result of my field experience with quail, I would suspect, though, something to be wrong with adult individuals of strong-flying species that let themselves be caught by hawks of the genus *Buteo*.

Two out of the three quail victims personally noted were starving birds; the third was represented in a nest only by feathers, so nothing can be said with respect to its physical condition. The red-tail has been the commonest winter hawk in my observational areas and I have paid special attention to its relation to the bob-white, yet I have never been able to record an example of this raptor taking a quail that was in good shape.

Leopold (1932) fears that winter attendance upon quail coveys even by buteos might prevent their feeding, thus perhaps bringing about weakness contributory to their ultimate capture. My data—insufficient to settle this question, I will admit—are indicative that the quail must be weak or precariously situated in the first place to be harmfully confined to foodless cover by slow predators. Two of my observational coveys (strong birds) that wintered with no loss were known to have the requisite confidence in their physical powers to feed openly in the presence of red-tails, though such behavior seems exceptional.

Could red-tails cause trouble to coveys fit but not having access to good brushy cover? I do not know, but in red-tail hunting territory I have observed coveys wintering under nearly coverless conditions without losses. What part does the red-tail play in the education of the season's young quail, and what summer or fall tribute

does he exact, if any? Once more, I am obliged to say that I don't know; this again leads back to the questions cloaked behind one of the abysmal enigmas of my research—that of bob-white juvenile mortality.

A widely selective preying upon subnormal wild life is hinted at by the visible condition of some Sciuridae taken in April and May, 1930, from red-tail nests. Three out of five arboreal squirrels, two out of two Franklin ground squirrels, and perhaps one-third of 42 striped ground squirrels were conspicuously afflicted with a mange-like skin disease which may have caused them to relax vigilance or may have lowered distinctly their vitality. A fox squirrel found dead in the woods was in a nearly hairless state but bore no marks of violence.

I must confess that the incidence of the above ailment was not checked in anything approximating a scientific manner; I had no idea of the potential significance of what I was stumbling into until toward the end of the red-tail nesting season. The figures pertaining to arboreal squirrels and Franklin ground squirrels were taken from notes; those regarding striped ground squirrels were estimated from memory some months afterward. The few samples of contemporaneous sciurine fauna (striped ground squirrels) I had time to collect were normal in appearance.

The foregoing loose and fragmentary observations on diseased rodent prey of the red-tail are not advanced as proof of anything. At the most they are but indications requiring research to establish their relative values. But whatever they mean or do not mean, they reveal problems that may lead somewhere—problems that may be linked with the very foundation of permanent wild life management.

I have avoided incorporating into this paper my lower grades of hawk food habits data (from juvenile pellets as a whole, old kills, qualitative material from feeding places) except in sections where they might have unusual pertinence. While the data are unevenly distributed for seasons, localities, and for species, they present portions of an ecological story, which though incomplete should be somewhat more sound than vague suppositions or the uninformed opinion of the public.

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