The Condor 87:336–342

THE DIET OF THE APLOMADO FALCON (*FALCO FEMORALIS*) IN EASTERN MEXICO

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ABSTRACT.—I describe here breeding season diets of Aplomado Falcons (*Falco femoralis*) at 18 sites in Veracruz, Campeche, and Chiapas, Mexico, based on 256 animals in prey remains and 234 prey that I detected while watching the falcons' feeding behavior. Birds comprised 94% of individuals in prey remains, but only 35% of prey that I saw being taken. Although the remainder and majority of the prey that I saw being taken were insects, 97% of prey biomass in this sample was birds. Common prey were moths, beetles, doves, cuckoos, and grackles. Prey animals ranged in weight from less than 1 g to over 500 g. Avian prey that I saw being taken averaged 67 g. In at least one case, prey size may have influenced prey selection within species since the falcons preferentially took female Great-tailed Grackles (*Quiscalus mexicanus*), which are smaller than males. The swiftness of Aplomado Falcons in flight, coupled with their agility on foot and tendency to hunt cooperatively, may account for their broad prey preferences. They do not, however, capture swifts and swallows. The high proportion of birds in the diet may explain the falcon's heavy contamination with residues of DDT.

The Aplomado Falcon (*Falco femoralis*) inhabits neotropical savannas and desert grasslands from the southwestern United States to Tierra del Fuego (Blake 1977). Before 1930, this falcon nested regularly in Arizona, Texas, and New Mexico, but today, it is rare north of Mexico (Ligon 1961, Phillips et al. 1964, Oberholser 1974).

In eastern Mexico, Aplomado Falcons are heavily contaminated with residues of DDT and lay eggs with shells nearly 30% thinner than pre-DDT (pre-1947) eggshells from the same region (Kiff et al. 1980). Unlike raptors that eat insects or small mammals, bird-eating and fish-eating raptors have been seriously affected by pesticide contamination (Newton 1979). Situated at the upper levels of extensive food webs, these species ingest greater amounts of environmental contaminants than those at lower trophic levels. In the Peregrine Falcon (*F. peregrinus*) and Osprey (*Pandion haliaetus*), levels of pesticide contamination are tightly correlated with the degree of eggshell thinning and egg breakage (Ratcliffe 1980). The contamination of Aplomado Falcons with DDE (the primary metabolite of DDT) suggests that the species feeds mainly on birds, and that it might be subject to pesticide-related reproductive problems.

Many brief descriptions of the food of the Aplomado Falcon have been reported. Known avian prey include: quail, teal (*Anas* sp.), pigeons (*Columba* sp.), and sandpipers (Grayson *in* Lawrence 1874); ground-doves (Mader 1981); a wren (*Campylorhynchus* sp.), snipe (*Gallinago* sp.), antshrike (*Thamnophilus* sp.; Cherrie 1916); Horned Lark (*Eremophila alpestris*; Kellogg *in* Bailey 1928); Cassin's Sparrow (*Aimophila cassinii*; Strecker 1930); plovers, sandpipers, nighthawks, Ruddy Ground-Dove (*Columbina talpacoti*), Scaled Dove (*Scardafella squammata*), Pale-vented Pigeon (*Columba cayennensis*), Rock Dove (*C. livia*), and a fledgling hummingbird (Friedmann and Smith 1950, 1955); Lark Bunting (*Calamospiza melanocorys*), and Lark Sparrow (*Chondestes grammacus*; Ligon 1961); doves and quail (Wetmore 1965); tinamou (Johnson 1965); Plain-breasted Ground-Dove (*Columbina minuta*; Howell 1972); and Dickcissel (*Spiza americana*; ffrench 1973). Other vertebrate prey are: bats (Ligon 1961, ffrench 1973, and Mader 1981); kangaroo rats (specimen notes of R. D. Camp); pocket mice (*Perognathus* sp.), white-footed mice (*Peromyscus* sp.; Strecker 1930); lizards (Bendire 1887, Wetmore 1965); frogs (Haverschmidt 1968); and small fish (Cherrie 1916). Invertebrate prey include locusts, beetles, dragonflies, crickets, butterflies, wasps, and bees (Bendire 1887, Cherrie 1916, Bailey 1928, Brooks 1933, and Mitchell 1957).

This list of prey species indicates the variety of animals captured by Aplomado Falcons, but says nothing about the relative importance of various prey in the diet. Many older descriptions of these birds stated that they subsist on insects, small mammals, and reptiles (Bendire 1887, Sclater and Hudson 1889, Bailey 1928, Sprunt 1955, and Ligon 1961). These assertions conflict with evidence that the species is an upper trophic-level predator (Kiff et al. 1980), and have led at least one recent authority to suggest that the Aplomado Falcon

should not be sensitive to pesticide contamination (Bond 1972). Other authorities, however, reported that these falcons feed mainly on small birds (Lawrence 1874, Crawshay 1907, Cherrie 1916, Wetmore 1965, and Johnson 1965). Owing to such contradictory views, it has been unclear whether this species hunts birds, as the peregrine does, or insects and rodents, as the American Kestrel (*F. sparverius*) does. In order to resolve this question, I studied the feeding behavior of Aplomado Falcons breeding in Veracruz, Chiapas, and Campeche, Mexico. My data form the basis of the present paper. Improved knowledge of the falcon's dietary niche might help to account for its disappearance from the United States, and explain the high levels of pesticides found in Aplomado Falcons in eastern Mexico.

STUDY AREAS AND METHODS

I found Aplomado Falcons by driving through likely-looking habitat, then exploring on foot areas where I had spotted birds from the road. All areas regularly frequented by falcons were true territories in that they were defended against conspecifics (and other raptors).

During 10 March–15 June 1977, 25 March–15 April 1978, and 12 May–15 June 1979, I located 18 territories in northern and central Veracruz, northern Chiapas, western Campeche, and eastern Tabasco between 17–23°N and 91–99°W. This is a region of rolling hills and low volcanic mountain ranges covered by patches of farmland, open pasture, and tropical forest. Meandering streams and marshes are common in most areas.

Aplomado Falcons were found in various savanna associations. Dominant plants at falcon territories were oaks (e.g., *Quercus oleiodes*), palms (*Sabal mexicana, Acrocomia mexicana,* or *Scheelia liebmanii*), *Crescentia cujete,* huisache (*Acacia farnesiana*), and palo de rosa (*Tabebuia rosea*). In addition, I found two nests in fallow cornfields.

During each visit to a territory, I collected all remains of prey animals. Some remains came from nest platforms or beneath nest trees; however, I found the majority beneath perches where falcons had eaten or defeathered prey. I seldom found food pellets, and did not use them as a source of dietary information in this report. I saw no other raptor species using falcon feeding perches. This, plus the fact that Aplomado Falcons aggressively excluded other raptors from their territories, made it unlikely that I collected remains of animals not captured by the study animal.

When possible, I estimated weights of prey animals using weights of freshly-killed specimens. When I could not identify an animal to species, however, I assigned it the weight of a known prey species of similar size. In the field, I weighed specimens with a triple-beam balance or pesola scales. Most weight estimates came either from specimens I collected or from specimens at the Texas A&M Cooperative Wildlife Collections. Weights for the following species were obtained from the literature: Plain Chachalaca (*Ortalis vetula*; Leopold 1972), Pale-vented Pigeon (Howell 1972), Mourning (*Zenaida macroura*) and White-winged doves (*Z. asiatica*; Cottam and Trefethen 1968), and Lesser Nighthawk (*Chordeiles acutipennis*; Johnson 1968). Because of the difficulty of assigning weights to categories of insect prey, I assumed all insects to weigh 1 g. This may slightly overestimate the contribution of insects to prey biomass, since most examples of typical insect prey weighed a gram or less.

Feathers collected as prey remains were identified to species and were classified according to type (e.g., right remex, left remex, or rectrix). I next divided the number of feathers in each group by the number of feathers of that type found in that species. At times, this procedure gave different values for each feather type. I used the largest of these values to estimate the number of individuals in the sample. Body feathers were used for identifications when no flight feathers could be found.

Because the falcons did not seem appreciably disturbed by my presence, I observed hunting activities from exposed, ground-level vantage posts located 50–200 m from nests or perch trees. The openness of typical nesting habitat allowed me to view most feeding activities. Whenever possible, I identified prey by examining remains left after feedings that I watched. In many cases, however, I was forced to make distant, visual identifications.

Small items were under-represented in my samples of prey remains, a known bias (Errington 1932, Snyder and Wiley 1976). Consequently, I assumed that the sample of prey that I saw being taken provides the best information on the relative importance of various classes of prey in the falcon's diet. My estimates of dietary importance are given in terms of percentage total prey individuals (% TPI) and percentage total prey biomass (% TPB).

RESULTS

CONTENTS OF REMAINS

I collected prey remains at 18 sites; however, 65% of detected prey animals ($n = 168$) came from seven sites. A total of 192 prey animals (75%) was collected at nine sites during nestling and fledgling periods; remains of 46 prey

TABLE 1. Species of prey detected in remains and observed captured or eaten by adult Aplomado Falcons in eastern Mexico. % TPI = percent total prey individuals. % TPB = percent total prey biomass.

Prey animals	Weight (g)	Prey remains			Observed prey		
		n	% TPI	% TPB	*n*	% TPI	% TPB
Birds							
Plain Chachalaca, *Ortalis vetula*	577	1	0.4	2.8	—	—	—
Northern Bobwhite, *Colinus virginianus*	156	6	2.3	4.5	1	0.4	2.8
Killdeer, *Charadrius vociferus*	88	1	0.4	0.4	—	—	—
Pale-vented Pigeon, *Columba cayennensis*	260	1	0.4	1.2	—	—	—
Mourning Dove, *Zenaida macroura*	126	27	10.5	16.4	6	2.6	13.6
White-winged Dove, *Z. asiatica*	168	13	5.1	10.5	7	3.0	21.1
Unidentified *Zenaida* spp.	147	3	1.2	2.1	—	—	—
Common Ground-Dove, *Columbina passerina*	40	5	1.9	1.0	5	2.1	3.6
Unidentified *Columbina* spp.	40	11	4.3	2.1	3	1.3	2.2
Aztec Parakeet, *Aratinga astec*	62	2	0.8	0.6	1	0.4	1.1
Yellow-billed Cuckoo, *Coccyzus americanus*	57	19	7.4	5.2	3	1.3	3.1
Mangrove Cuckoo, *C. minor*	57	1	0.4	0.3	—	—	—
Black-billed Cuckoo, *C. erythropthalmus*	57	1	0.4	0.3	—	—	—
Unidentified *Coccyzus* sp.	57	1	0.4	0.3	—	—	—
Squirrel Cuckoo, *Piaya cayana*	107	2	0.8	1.0	1	4.3	1.7
Groove-billed Ani, *Crotophaga sulcirostris*	83	25	9.8	10.0	2	0.8	3.0
Common Pauraque, *Nyctidromus albicollis*	55	3	1.2	0.8	—	—	—
Whip-poor-will, *Caprimulgus vociferus*	57	2	0.8	0.5	—	—	—
Lesser Nighthawk, *Chordeiles acutipennis*	80	1	0.4	0.4	—	—	—
Citreoline Trogon, *Trogon citreolus*	75	1	0.4	0.4	1	0.4	1.3
Green Kingfisher, *Chloroceryle americana*	40	1	0.4	0.2	1	0.4	0.7
Acorn Woodpecker, *Melanerpes formicivorus*	76	1	0.4	0.4	—	—	—
Golden-fronted Woodpecker, *Melanerpes aurifrons*	75	5	1.9	1.8	1	0.4	1.3
Northern Flicker, *Colaptes auratus*	113	1	0.4	0.5	—	—	—
Unidentified Picidae	75	1	0.4	0.4	—	—	—
Great Kiskadee, *Pitangus sulphuratus*	74	3	1.2	1.1	1	0.4	1.3
Great Crested Flycatcher, *Myiarchus crinitus*	34	3	1.2	0.5	—	—	—
Tropical Kingbird, *Tyrannus melancholicus*	43	4	1.6	0.8	—	—	—
Eastern Kingbird, *T. tyrannus*	37	2	0.8	0.4	—	—	—
Scissor-tailed Flycatcher, *T. forficatus*	39	1	0.4	0.2	—	—	—
Unidentified Tyrannidae	40	3	1.2	0.6	—	—	—
House Wren, *Troglodytes aedon*	13	2	0.8	0.1	—	—	—
Swainson's Thrush, *Catharus ustulatus*	31	2	0.8	0.3	—	—	—
Unidentified *Catharus* spp.	31	1	0.4	0.1	—	—	—
Clay-colored Robin, *Turdus grayi*	79	4	1.6	1.5	—	—	—
American Robin, *T. migratorius*	73	2	0.8	0.7	—	—	—
Tropical Parula, *Parula pitiayumi*	8	1	0.4	0.1	—	—	—
Blue-gray Tanager, *Thraupis episcopus*	37	1	0.4	0.2	—	—	—
Melodious Blackbird, *Dives dives*	97	5	1.9	2.3	—	—	—
Great-tailed Grackle, *Quiscalus mexicanus*							
Males	251	3	1.2	3.6	—	—	—
Females	130	14	5.5	8.6	2	0.8	4.7
Sex Unknown	190	5	2.0	4.5	1	0.4	3.4
Meadowlarks, *Sturnella* sp.	101	9	3.5	4.3	1	0.4	1.8
Bronzed Cowbird, *Molothrus aeneus*	60	3	1.2	0.9	—	—	—
Orchard Oriole, *Icterus spurius*	20	3	1.2	0.3	1	0.4	0.4
Hooded Oriole, *I. cucullatus*	27	4	1.6	0.5	—	—	—
Altamira Oriole, *I. gularis*	69	3	1.2	1.0	2	0.8	2.5
Northern Oriole, *I. galbula*	38	2	0.8	0.4	—	—	—
Unidentified *Icterus* spp.	38	1	0.4	0.2	—	—	—
Grayish Saltator, *Saltator coerulescens*	58	2	0.8	0.5	—	—	—
Black-headed Saltator, *S. atriceps*	83	1	0.4	0.4	—	—	—
Indigo Bunting, *Passerina cyanea*	14	1	0.4	0.1	—	—	—
Unidentified small birds	20	20	7.8	1.9	22	9.4	7.9
	60	—	—	—	20	8.5	21.6
Subtotals		240	93.8	99.8	82	35.0	97.3
Mammals							
Chiroptera	5	1	0.4	0.1	—	—	—
Insects							
Lepidoptera							
Moths	1	5	1.9	0.1	21	9.0	0.4

TABLE 1. Continued.

Prey animals	Weight (g)	Prey remains			Observed prey		
		n	% TPI	% TPB	*n*	% TPI	% TPB
Butterflies	1	—	—	—	1	0.4	0.1
Unidentified Lepidoptera	1	—	—	—	3	1.3	0.1
Homoptera (cicadas)	1	4	1.6	0.1	—	—	—
Orthoptera	1	2	0.8	0.1	4	1.7	0.1
Hymenoptera (wasps)	1	2	0.8	0.1	1	0.4	0.1
Coleoptera	1	2	0.8	0.1	19	8.1	0.3
Odonata	1	—	—	—	1	0.4	0.1
Unidentified insects	1	—	—	—	102	43.6	1.8
Subtotals		15	5.8	0.1	152	65.0	2.7
Totals		256		20,862 g	234		5,564 g

animals (18%) were collected at eight territories with incubating falcons. The remainder came from non-breeding birds.

The remains contained 241 (94%) vertebrates and 15 (6%) insects (Table 1). Except for one bat, all vertebrate prey were birds; I identified 43 species, representing 17 families. Doves, icterids, and cuckoos accounted for 63% of the birds in this sample. The Mourning Dove was the species most often detected, followed by the Groove-billed Ani (*Crotophaga sulcirostris*), Great-tailed Grackle (*Quiscalus mexicanus*), Yellow-billed Cuckoo (*Coccyzus americanus*), and White-winged Dove (Table 1). Moths and cicadas were the most common insect prey.

The remains contained 22 Great-tailed Grackles, of which only three were males, judging by their larger size. The distribution of grackles by sex was significantly different from a uniform distribution with unsexed individuals included ($0.01 < P < 0.025$, $G = 8.9$, $df = 2$), and excluded ($0.005 < P < 0.01$, $G = 7.7$, $df = 1$).

OBSERVED PREY ANIMALS

I saw 234 prey animals (82 birds and 152 insects) captured, eaten, or cached during 323 hours of observations (Table 1). Within this sample, I witnessed captures of 184 animals; I saw the remainder ($n = 50$) being eaten or cached, but not captured. The majority (91%) of prey animals that I saw being taken was detected at six sites. Of the observed prey, I saw 73% at sites with young, and 24% during the incubation period.

Birds made up 97% TPB and 35% TPI. Sixteen species and nine families were represented. Doves, icterids, and cuckoos were the most important avian prey, both by %TPI and %TPB. White-winged Doves, Mourning Doves, Great-tailed Grackles, Common Ground-Doves (*Columbina passerina*), Yellow-billed Cuckoos, and Groove-billed Anis made up over half of TPB. Unidentified small birds (20-g and 60-g classes) accounted for 30% TPB.

Insects comprised 65% TPI ($n = 152$) in the sample of hunts, feedings, and cachings that I saw. Of 184 observed captures, 143 (78%) involved insects. Insects, however, accounted for only nine (18%) of 50 prey that I saw eaten or cached but not captured. Moths and beetles accounted for 80% ($n = 40$) of identified insect prey.

The food of nestlings contained 46 birds (65%) and 25 insects (35%). The food of adults contained 27 birds (20%) and 122 insects (80%). It is unlikely that differences between adult and nestling diets were due to chance ($P < 0.001$, $G = 75.02$, $df = 1$). Birds contributed 95% TPB to adult diets, and 99% TPB to nestling diets.

SIZE OF PREY

In remains, 67% of prey weighed 100 g or less; only four animals weighed more than 200 g; 91% of prey that I saw being taken weighed 100 g or less. Among observed avian prey, 77% weighed 100 g or less. Mean weights and standard deviations of categories of captured prey are as follows: (1) all animals detected in prey remains, 82.2 ± 70.4 g; (2) all observed prey, 24.3 ± 42.5 g; (3) birds detected in remains, 87.6 ± 69.5 g; and (4) observed avian prey, 67.4 ± 47.8 g. *T*-tests applied to the natural logarithms of prey weights suggested that the average weight of prey in remains was greater than the average weight of prey that I saw taken ($P < 0.001$, $T = 17.89$, $df = 488$). This was true even when I excluded insect prey from the comparison ($P < 0.005$, $T = 3.25$, $df = 321$).

The largest prey animal was a Plain Chachalaca, represented by a tarsometatarsus found among remains of typical falcon prey. Chachalacas from eastern Mexico weigh 470–685 g (Leopold 1972). Other large prey were the Pale-vented Pigeon (241–336 g; Leopold 1972), and Great-tailed Grackle. Four male grackles from Veracruz and Chiapas weighed 187–270 g (Hector, specimen notes). The

smallest birds captured were the Tropical Parula (*Parula pitiayumi*; 8 g), and House Wren (*Troglodytes aedon*; 13 g).

DISCUSSION

SELECTION OF PREY

Within my study areas, Aplomado Falcons usually pursued prey in direct flights from observation posts. Prey were either captured in mid-air or forced to the ground and pursued on foot. The falcons readily entered thick cover when chasing grounded animals. Less often, the falcons hunted while soaring, and dived on prospective prey. These falcons often hunt in pairs when chasing birds (Cherrie 1916, Ligon 1961, Mader 1981, Hector 1981), a common foraging mode in eastern Mexico. Because Aplomado Falcons capture prey not only in the air but also on the ground, and they hunt cooperatively, it is not surprising that they take a variety of animals.

The falcons, however, did not capture swifts and swallows, even though the White-collared Swift (*Streptoprocne zonaris*), Mangrove Swallow (*Tachycineta albilinea*), and Caribbean Martin (*Progne dominicensis*) were common at most sites. Furthermore, swifts and swallows are not mentioned as prey in the literature. These birds are eaten by the Peregrine Falcon, Bat Falcon (*Falco rufigularis*), and Northern Hobby (*F. subbuteo*), species which hunt while aloft and dive on prey (Cramp and Simmons 1980, Cade 1982). Some advantage in altitude likely makes possible the efficient capture of such speedy and maneuverable prey. Aplomado Falcons do capture other aerial insectivores, such as Lesser Nighthawks, Common Pauraques (*Nyctidromus albicollis*), and Whip-poor-wills (*Caprimulgus vociferus*), but these birds seem slower than swifts and swallows. In addition, they roost in trees and nest on the ground, so they may be vulnerable to falcons when they are inadvertently flushed by humans or livestock. Among insects, slower, direct-flying forms, such as beetles, cicadas, and moths, were selected over swifter, more maneuverable insects, such as dragonflies.

Although Aplomado Falcons inhabit open country, my samples contained cuckoos, trogons, saltators, and a chachalaca—all woodland birds (Table 1). These species, however, frequent forest edges and forage in nearby cleared areas where they could be attacked by Aplomado Falcons. Furthermore, Yellow-billed Cuckoos are migratory in eastern Mexico until late spring (Friedmann et al. 1950). During migration, they may be captured frequently because of fatigue, unfamiliarity with local terrain, the necessity of crossing open areas, or simply because of their greater abundance.

The dietary preferences of raptors stem largely from interaction between the foraging behavior and habitat preferences of the birds and their potential prey. In addition, prey selection should reflect the relative sizes of predator and prey (Hespenheide 1973). Aplomado Falcons are smaller than peregrines (610–950 g), but larger than Merlins (*F. columbarius*; 158–213 g; weights from Snyder and Wiley 1976). Seven male Aplomado Falcons from eastern Mexico weighed 208–305 g ($\bar{x}$ = 260.5), while six females weighed 310–500 g ($\bar{x}$ = 406.7; Hector 1981). Accordingly, the prey of the Aplomado Falcon should be intermediate in size between the prey of these other species. For example, the average weight of birds in a sample of prey remains from Utah Peregrine Falcons was 98 g, and the most frequently captured taxa weighed 115–280 g (Porter and White 1973). Newton et al. (1978) reported that over 50% of the prey of the Merlin (mostly birds in prey remains) weighed less than 50 g. These estimates bracket the value of 87.6 g derived for birds found in Aplomado Falcon prey remains.

A preference for smaller prey may account for unequal numbers of male and female grackles in remains. Male grackles weigh nearly twice as much as females, and about the same as a male Aplomado Falcon. Females, therefore, could be preferred because of their smaller size. Alternatively, McIlhenny (1940), and Skutch (1954) found populations of grackles to contain more females than males by ratios of two or three to one. Aplomado Falcons may simply have had more opportunities to capture females than males. Selander (1960, 1961), however, pointed out that unequal sex ratios found in grackles may not be representative of entire populations, but only of nesting colonies.

UTILIZATION OF OTHER VERTEBRATES AND INSECTS

My data show that birds are the most important prey of the Aplomado Falcon, at least as a source of dietary biomass. This conflicts with reports by Bendire (1892), Sclater and Hudson (1889), Smith (1910), Sprunt (1955), and Oberholser (1974) that the falcon feeds mainly on insects, small mammals, and reptiles. This difference may be due to two reasons. First, most previous descriptions have been based on small samples of observations, and consequently may not accurately characterize the overall diet. In eastern Mexico, for example, most captures of birds took place during early morning hours.

Later in the day, falcons engaged in long bouts of hawking insects (Hector, unpubl.). Obviously, if this routine is typical for Aplomado Falcons, then the timing of brief observations of feeding behavior would have a great effect on an observer's opinion of the species' diet.

Second, under some conditions, Aplomado Falcons may feed more on non-avian prey. For example, blooming shrubs near falcon nests attract many wasps and beetles, and may thereby increase rates of insect captures by the resident falcons (Hector, pers. observ.). These falcons also capitalize on the superabundance of insects flushed into the open by grassfires (Brooks 1933; Hector, pers. observ.).

Although I have few data from outside the breeding season, my comparison of adult and nestling diets suggests that non-breeding falcons eat more insects than do falcons with young. This would be true if adult diets are the same in breeding and non-breeding seasons. Other species, such as the Eleonora's Falcon (*F. eleonorae*; Walter 1979), Sooty Falcon (*F. concolor*), and Northern Hobby (*F. subbuteo*; Cramp and Simmons 1980), switch to insects when not breeding. My observations, however, suggest that constraints imposed by nest defense activities may promote the frequent taking of easily captured insects and limit the opportunities for female falcons to hunt birds. Non-nesting falcons, freed of the necessity of defending nests, may feed less on insects than do nesting falcons. Even if non-breeding adults eat more insects than breeding ones, the falcons would have to capture birds very infrequently before insects would constitute the bulk of dietary biomass.

Aplomado Falcons likely feed more on rodents and reptiles in drier areas where ground cover is less dense and avian prey are scarce. In eastern Mexico, birds are extremely abundant. For example, Emlen transects (Emlen 1977) that I conducted at falcon nesting territories gave an estimate of 290 individuals/40 ha for known avian prey. By comparison, Raitt and Maze (1968) estimated only 42 birds/40 ha at a desert scrub site near a former Aplomado Falcon nesting area in south-central New Mexico. If birds are the preferred type of vertebrate prey, then Aplomado Falcons in eastern Mexico may have little opportunity or cause to capture other vertebrates.

Aplomado Falcons occasionally take kills from other raptors (Hector, pers. observ.), which suggests that some recorded prey species may not have been captured by the falcons themselves. This could explain the appearance of some mammals, and unusual prey such as fish (Cherrie 1916), in their diet. During my field work, in fact, I saw Aplomado Falcons taking small mammals from American Kestrels and White-tailed Kites (*Elanus leucurus*). Both species occur commonly throughout most of the range of the Aplomado Falcon, and feed on rodents and reptiles (Brown and Amadon 1968). Clark and Bloom (pers. comm.) even saw an Aplomado Falcon taking crayfish from herons.

In conclusion, the Aplomado Falcon appears to feed principally on birds, yet it is also highly insectivorous, and, in some areas, may eat rodents and reptiles. These broad dietary preferences suggest that its decline in the United States was not caused by disturbance to its prey base. On the other hand, if these falcons typically subsist on birds, then, like peregrines, they should tend to accumulate pesticide residues and show signs of pesticide-related reproductive problems. Before the magnitude of this threat can be determined, however, eggshell thinning, nesting productivity, and levels of pesticide contamination must be examined in eastern Mexico and other parts of the species' range.

ACKNOWLEDGMENTS

This project was supported by the National Wildlife Federation's Environmental Conservation Fellowship Program, the Hawk Mountain Sanctuary Association, the Oklahoma Cooperative Wildlife Research Unit, the Frank M. Chapman Memorial Fund, the Chihuahuan Desert Research Institute, and the Western Foundation of Vertebrate Zoology. I thank G. Hunt, J. Langford, H. Flanders. V. Wade, G. Falxa, D. Whitacre, D. Ukrain, J. Murphy, F. Knopf, S. Fox, J. Bissonette, J. Shaw, B. Ward, L. and J. Kiff, L. Ashford, D. Latham, P. Duval, K. Arnold, C. White, N. Snyder, T. Howell, J. Wiley, and an anonymous reviewer for their assistance.

LITERATURE CITED

BAILEY, F. M. 1928. Birds of New Mexico. New Mexico Dep. of Game and Fish, Santa Fe.

BENDIRE, C. E. 1887. Notes on a collection of birds' nests and eggs from southern Arizona territory. Proc. U.S. Natl. Mus. 11:551–558.

BENDIRE, C. E. 1892. Life histories of North American birds. U.S. Natl. Mus. Special Bull. No. 1. Government Printing Office, Washington, DC.

BLAKE, E. R. 1977. Manual of Neotropical birds. Univ. of Chicago Press, Chicago.

BOND, F. M. 1972. The peregrine, prairie, and aplomado falcons in the southwest, p. 51–55. *In* Symposium on rare and endangered wildlife of the southwestern United States. New Mexico Dep. of Game and Fish, Santa Fe.

BROOKS, A. 1933. Some notes on the birds of Brownsville, Texas. Auk 50:59–63.

BROWN, L., AND D. AMADON. 1968. Eagles, hawks and falcons of the World. Country Life Books, London.

CADE, T. J. 1982. The falcons of the World. Cornell Univ. Press, Ithaca, NY.

CHERRIE, G. K. 1916. A contribution to the ornithology of the Orinoco region. Brooklyn Arts & Sci. Mus., Sci. Bull. 2:133–374.

COTTAM, C., AND J. B. TREFETHEN. 1968. Whitewings. D. Van Nostrand Co., Princeton, NJ.
CRAMP, S., AND K. E. L. SIMMONS [EDS.]. 1980. The birds of the western Palearctic. Vol. II. Oxford Univ. Press, Oxford.
CRAWSHAY, R. 1907. The birds of Tierra del Fuego. Bernard Quaritch, London.
EMLEN, J. T. 1977. Estimating breeding season bird densities from transect counts. Auk 94:455–460.
ERRINGTON, P. L. 1932. Technique of raptor food habits study. Condor 34:75–86.
FFRENCH, R. 1973. A guide to the birds of Trinidad and Tobago. Livingston Publ. Co., Narberth, PA.
FRIEDMANN, H., L. GRISCOM, AND R. T. MOORE. 1950. Distributional checklist of the birds of Mexico. Part I. Pacific Coast Avifauna 29:1–436.
FRIEDMANN, H., AND F. D. SMITH. 1950. A contribution to the ornithology of northeastern Venezuela. Proc. U.S. Natl. Mus. 100:411–538.
FRIEDMANN, H., AND F. D. SMITH. 1955. A further contribution to the ornithology of northeastern Venezuela. Proc. U.S. Natl. Mus. 104:463–524.
HAVERSCHMIDT, F. 1968. Birds of Surinam. Oliver and Boyd, London.
HECTOR, D. P. 1981. The habitat, diet, and foraging behavior of the Aplomado Falcon, *Falco femoralis* (Temminck). M.Sc. thesis. Oklahoma Cooperative Wildlife Research Unit, Oklahoma State Univ., Stillwater.
HESPENHEIDE, H. A. 1973. Ecological inferences from morphological data. Annu. Rev. Ecol. Syst. 4:213–229.
HOWELL, T. R. 1972. Birds of the lowland pine savanna of northeastern Nicaragua. Condor 74:316–340.
JOHNSON, A. W. 1965. The birds of Chile and adjacent regions of Argentina, Bolivia and Peru. Platt Establecimientos Graficos, Buenos Aires.
JOHNSON, O. W. 1968. Some morphological features of avian kidneys. Auk 85:216–228.
KIFF, L. F., D. P. PEAKALL, AND D. P. HECTOR. 1980. Eggshell thinning and organochlorine residues in the Bat and Aplomado falcons in Mexico. Proc. XVII Int. Ornithol. Congr. (1978):949–952.
LAWRENCE, G. N. 1874. The birds of western and northwestern Mexico. Mem. Boston Soc. Nat. Hist. Vol. II.
LEOPOLD, A. S. 1972. Wildlife of Mexico: the game birds and mammals. Univ. of California Press, Berkeley.
LIGON, J. S. 1961. New Mexico birds and where to find them. Univ. of New Mexico Press, Albuquerque.
MADER, W. J. 1981. Notes on nesting raptors in the llanos of Venezuela. Condor 83:48–51.
MCILHENNY, E. A. 1940. Sex ratios in wild birds. Auk 57:85–93.
MITCHELL, M. H. 1957. Observation on birds of southeastern Brazil. Univ. of Toronto Press, Toronto.
NEWTON, I. 1979. Population ecology of raptors. T & D Poyser, Carlton, England.
NEWTON, I., E. R. MEEK, AND B. LITTLE. 1978. Breeding ecology of the Merlin in Northumberland. Br. Birds 71:376–398.
OBERHOLSER, H. C. 1974. The bird life of Texas. Univ. of Texas Press, Austin.
PHILLIPS, A., J. MARSHALL, AND G. MONSON. 1964. The birds of Arizona. Univ. of Arizona Press, Tucson.
PORTER, R. D., AND C. M. WHITE. 1973. The Peregrine Falcon in Utah. Brigham Young Univ. Sci. Bull. Biol. Ser. 18:1–74.
RATCLIFFE, D. 1980. The Peregrine Falcon. T & D Poyser, Carlton, England.
RAITT, R. T., AND R. C. MAZE. 1968. Densities and species composition of breeding birds of a creosote bush community in southern New Mexico. Condor 70:193–205.
SCLATER, P. L., AND W. H. HUDSON. 1889. Argentine ornithology, a catalogue of the birds of the Argentine Republic. Taylor and Francis, London.
SELANDER, R. K. 1960. Sex ratios of nestlings and clutch size in the Boat-tailed Grackle. Condor 62:34–44.
SELANDER, R. K. 1961. Supplemental data on the sex ratio in nestling Boat-tailed Grackles. Condor 63:504.
SKUTCH, A. F. 1954. Life histories of Central American birds. Pacific Coast Avifauna No. 31.
SMITH, A. P. 1910. Miscellaneous bird notes from the lower Rio Grande. Condor 12:93–103.
SNYDER, N. F., AND J. W. WILEY. 1976. Sexual size dimorphism in hawks and owls of North America. A.O.U. Ornithol. Monogr. No. 20.
SPRUNT, A. 1955. North American birds of prey. Harper & Bros., New York.
STRECKER, J. S. 1930. Field notes on west Texas birds. Contrib. Baylor Univ. Mus. 22:1–14.
WALTER, H. 1979. Eleonora's Falcon, adaptations to prey and habitat in a social raptor. Univ. of Chicago Press, Chicago.
WETMORE, A. 1965. The birds of the Republic of Panama. Smithson. Misc. Collect. 150.

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