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RAPTOR DENSITIES ALONG THE PARAGUAY RIVER: SEASONAL, GEOGRAPHICAL AND TIME OF DAY VARIATION

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ABSTRACT.—Nineteen species of diurnal raptors were recorded during four censuses from ships along 859 km of the Paraguay River in June, August and October 1988 and January 1989. Seasonal, geographical and time of day variation in linear densities was documented for several of the common species. Most species of non-migratory hunting raptors were most common in June; they may have been exploiting prey concentrated in emergent vegetation when the river was flooded. The Lesser Yellow-headed Vulture (*Cathartes burrovianus*) appeared to be most abundant when water levels were low. Both the Lesser Yellow-headed Vulture and Snail Kite (*Rostrhamus sociabilis*) were more common farther north where marshes were more extensive; the Black Vulture (*Coragyps atratus*) was more common farther south where human habitations were more prevalent. Both the Snail Kite and Crested Caracara (*Polyborus plancus*) were most active in the early morning whereas the Lesser Yellow-headed and Black Vultures were more active at midday.

Densidades poblacionales de aves raptoras a lo largo del río Paraguay: variaciones con la estación, la geografía y la hora del día

EXTRACTO.—Se registraron 19 especies de rapaces diurnas, durante cuatro censos desde barcos, a lo largo de 859 km del río Paraguay durante los meses de junio, agosto y octubre de 1988, y enero de 1989. Se documentó la variación de densidades lineales para algunas especies de rapaces comunes durante diferentes épocas, regiones geográficas y períodos del día. La mayoría de las especies de rapaces cazadoras no-migratorias fue más común en junio; pudiera ser que las rapaces estuvieran explotando presas concentradas en la vegetación emergente cuando el río estaba desbordado. El *Cathartes burrovianus* parecía ser más común cuando los niveles de agua estaban bajos. El *C. burrovianus* y el *Rostrhamus sociabilis* (caracolero) eran más comunes hacia el norte donde los esteros son más extensos; el *Coragyps atratus* resultó ser más común hacia el sur donde los asentamientos humanos prevalecen. El *R. sociabilis* y el *Polyborus plancus* estuvieron más activos temprano por la mañana, mientras que el *C. burrovianus* y el *C. atratus* desplegaron mayor actividad al medio día.

[Traducción de S. Soret]

Few studies have attempted to determine raptor densities in specific areas of South America (e.g., Wilson 1983, Albuquerque 1986, Thiollay 1989a, 1989b). In view of the accelerating rate of habitat destruction on the continent, information on raptor populations is urgently needed in order to monitor the long-term responses of raptor populations to changing environmental conditions and to design protected areas large enough to maintain viable populations.

The status and distribution of raptors in the Republic of Paraguay, a land-locked country in south-central South America, have been summarized recently by Contreras et al. (1987). However, most of their data were obtained from published records and

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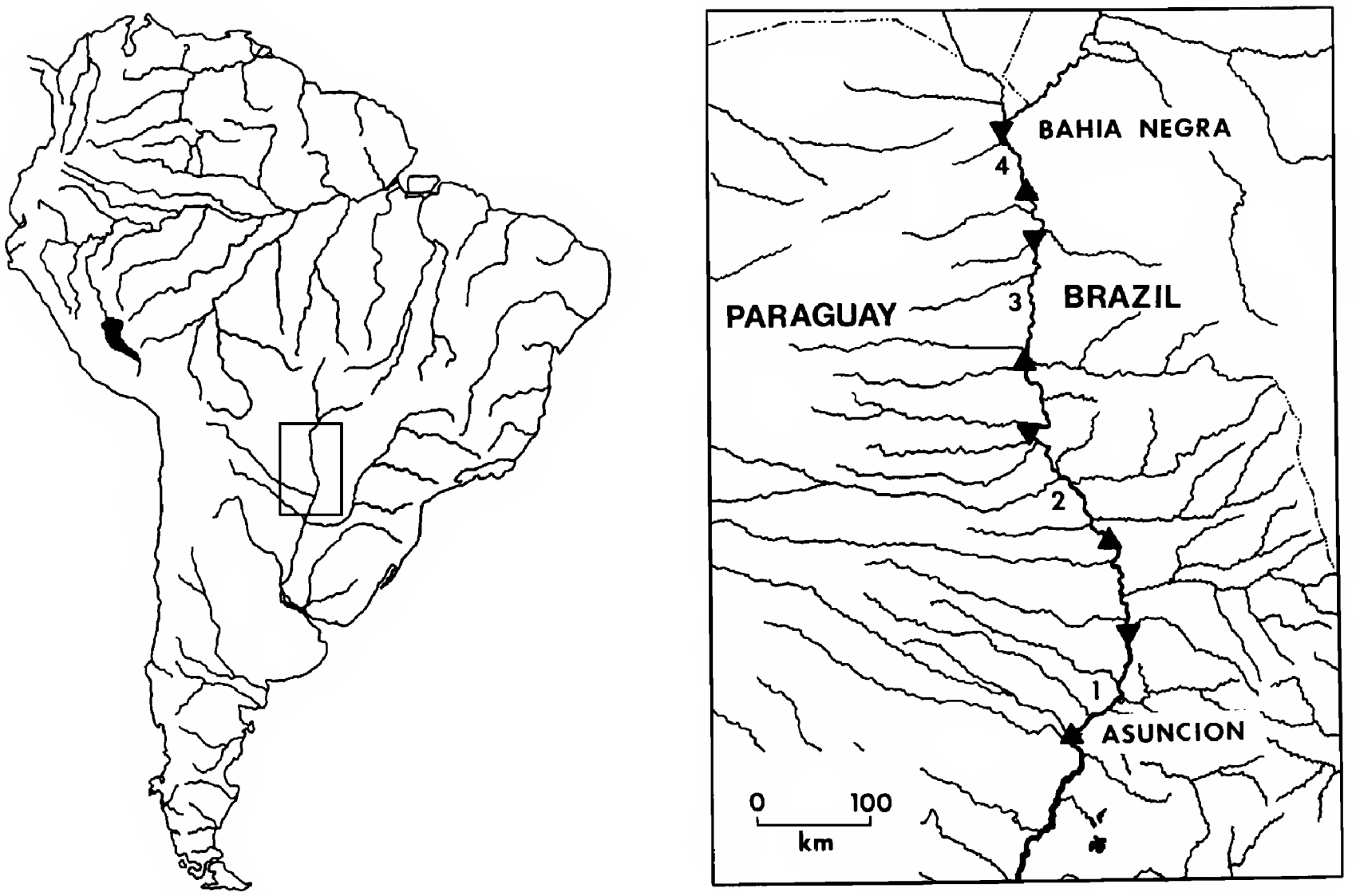

Figure 1. Major South American river systems, and Paraguay River (inset) showing the locations of geographical sectors 1–4.

museum specimens, with little information given on the actual abundance of raptors based on field work. Here I report data on raptor densities along the Paraguay River based on censuses conducted from ships during 1988 and 1989. I examine variation in raptor densities during different seasons, in different geographical areas and during different periods of the day, and discuss the factors that may cause variation.

STUDY AREA

Originating from surface waters in the Pantanal region of Brazil, the Paraguay River flows southward through central South America until it forms the La Plata River at its confluence with the Paraná River (Fig. 1). The La Plata River basin, which encompasses both the Paraguay and Paraná River basins, constitutes the largest and most important watershed of South America south of the Amazon River, draining an area of approximately 3 100 100 km^2 (Anonymous 1985). The Paraguay River is relatively shallow and sluggish. Its depth and width vary considerably; at a given locality, extremes in water levels during a single year may exceed 5 m and the width may vary from several hundred m to several km.

Compared with most river systems whose levels fluctuate directly with the quantity of precipitation, the Paraguay River is enigmatic; water levels are maximal during the dry winter months, from May to August, and are minimal during the rainy summer months, from November to February. This inversion of the typical pattern for rivers results partly from the seasonal pattern of rainfall at the river's sources, and partly from the inability of the river's drainage system to pass along immediately the large volumes of water it receives periodically in the form of precipitation (Anonymous 1985). Flooding of the river in 1988 reached unprecedented proportions along many sections of the river; it was the highest ever at Bahía Negra and the second highest at Asunción (Dirección de Hidrografía, unpubl. data).

The habitats along the margins of the Paraguay River comprise sandbars and mudflats when water levels are low, grassy marshes, brush-choked channels and ponds of variable sizes, wet or dry palm savannas, natural and man-made grasslands and subtropical riparian deciduous forest. As one proceeds northward from Asunción the river gradually narrows, becomes increasingly subdivided by channels, marshes bordering the river become more extensive and human habitations along the banks of the river become more widely spaced apart. Although human habitations are scattered along the entire length of the river, most of

Table 1. Dates, minutes of observation, kilometers surveyed, ship speed (km/hr) and water levels (cm) during four transects along the Paraguay River.

Transect Dates	Min of Obs	Km Surveyed	Ship Speed	Water Levels[a]			
				Asunción	Concepción	Fuerte Olimpo	Bahía Negra
14–17 June 1988	580	138.2	14.3	706+	823+	958−	685−
09–11 Aug. 1988	680	159.8	14.1	739−	763−	823−	583−
25–28 Oct. 1988	780	195.0	15.0	425−	417−	432−	298−
24–27 Jan. 1989	870	185.6	12.8	260+	316+	346+	247+

[a] Plus sign denotes rising water levels, minus sign denotes falling water levels. The zero mark is arbitrary at each site, hence comparisons between sites are relative rather than exact.

the habitat along the river's banks remains relatively undisturbed and the general appearance of the river remains rural except in small ports and in a few densely populated areas (e.g., Asunción, Concepción, Porto Murtiñho and Bahía Negra).

METHODS

From June 1988 to January 1989, I conducted four separate raptor censuses along 859 km of the Paraguay River between Asunción and Bahía Negra (Table 1). While censusing raptors I scanned the forests and sky on both sides of the river by unaided eye or with 7 × 35 binoculars; during 10 min observation periods I counted all raptors seen within 500 m of an observation post situated 8–10 m above the river on the deck of one of the identical passenger ships *Presidente Stroessner* (subsequently renamed *Bahía Negra*) or *Presidente Carlos Antonio López*. The birds were identified by consulting Narosky and Yzurieta (1987). No counts were taken during periods of rain, within 30 min of sunrise or sunset or in areas densely populated by humans (Asunción, Concepción, Porto Murtiñho and Bahía Negra). Ship speed (Table 1) was calculated by timing the interval between fixed markers. Because the ship often stopped to embark or unload passengers and supplies, I counted raptors only while the ship was cruising at full speed. Data on water levels were obtained from the Dirección de Hidrografía of the Armada Nacional, in Asunción (Table 1). The taxonomy of raptors follows Altman and Swift (1989).

Linear densities were calculated as the number of birds/10 km of river. To determine whether the densities of birds varied geographically, I compared counts along four different geographical sectors: (1) from Asunción, Dept. Central, to Rosario, Dept. San Pedro; (2) from Puerto Tacurú Pytá, Dept. San Pedro, to Puerto Itapucú Mí, Dept. Concepción; (3) from Puerto Valle Mí, Dept. Concepción, to Fuerte Olimpo, Dept. Alto Paraguay; and (4) from Puerto Mihanovick, Dept. Alto Paraguay, to Bahía Negra, Dept. Alto Paraguay (Fig. 1). I also compared the densities (or detectability) of raptors during six periods of the day: 0600–0800, 0800–1000, 1000–1200, 1200–1400, 1400–1600 and 1600–1800 H.

Kruskal-Wallis tests (H statistic; Zar 1984) were used to compare the density of each species during different seasons, in different geographical sectors and during different periods of the day. Chi-square tests (χ^2 statistic; Zar 1984) were used to compare the number of 10 min count periods in each sector during the four censuses and also the number of count periods in each time period during the four censuses. The binomial test (Zar 1984) was used to compare the maximum density of non-migratory hunting raptor species during different seasons. Species richness was calculated as the number of species recorded during each census. Species diversity during each census was computed using the Shannon diversity index (H' statistic; Zar 1984). The Kruskal-Wallis, chi-square and binomial tests were computed with Statistix software (Heisey and Nimis 1985), using two-tailed probabilities with $\alpha = 0.05$.

RESULTS

Seasonal Variation. Nineteen species of diurnal raptors were recorded during the study. Of these, the densities of seven species varied seasonally (Table 2). The Black Vulture (*Coragyps atratus*), usually the most common raptor, occurred in low densities during the August census. The Lesser Yellow-headed Vulture (*Cathartes burrovianus*) was least common in June and most common in January. The Osprey (*Pandion haliaetus*), a Nearctic migrant (Hayes et al. 1990), was fairly common in October and January and virtually absent during June and August. Although a permanent resident in Paraguay, the Snail Kite (*Rostrhamus sociabilis*) is partially migratory and occurred most commonly in October, when large numbers were migrating southward in loose flocks. The Savanna Hawk (*Heterospizias meridionalis*), Black-collared Hawk (*Busarellus nigricollis*) and Crested Caracara (*Polyborus plancus*) all occurred most commonly in June; Crested Caracaras were also common in October. Two species, the Great Black Hawk (*Buteogallus urubitinga*) and the Roadside Hawk (*Buteo magnirostris*), did not vary seasonally in abundance.

Table 2. Densities, species richness and species diversity of raptors along the Paraguay River during different seasons (1988–1989).

SPECIES	BIRDS/10 KM				H
	JUNE	AUG.	OCT.	JAN.	
Black Vulture	8.25	1.94	8.97	11.10	11.76[a]
Lesser Yellow-headed Vulture[c]	2.03	3.00	4.21	5.66	14.83[a]
Osprey	0.07	0	1.13	0.86	25.51[b]
Gray-headed Kite	0	0.13	0	0	—
Snail Kite	0.43	0.63	27.74	0.75	175.36[b]
Mississippi Kite	0	0	0.15	0	—
Long-winged Harrier	0.07	0.06	0	0	—
Sharp-shinned Hawk	0	0	0	0.05	—
Crane Hawk[d]	0.22	0.06	+	0	—
Great Black Hawk	0.65	0.50	0.41	0.05	6.38
Savanna Hawk	1.30	0.63	0.31	0.27	16.88[a]
Black-collared Hawk	0.80	0	0.15	0.16	14.41[a]
Roadside Hawk	0.65	0.56	0.15	0.22	5.55
Crested Caracara	7.09	3.63	6.26	2.59	26.55[b]
Yellow-headed Caracara	0.22	0	0.10	0.11	—
Laughing Falcon	0.22	0.13	0	0	—
American Kestrel	0.07	0	0	0	—
Peregrine Falcon	0	0	0	0.05	—
Unidentified	3.62	1.50	1.03	0.75	—
All raptors combined	25.69	12.77	50.62	22.63	—
Species richness	15	12	13	13	—
Species diversity	0.74	0.78	0.58	0.61	—

[a] $P < 0.01$.
[b] $P < 0.001$.
[c] The Turkey Vulture was observed in small numbers (<5) during each census, but because of the difficulty in distinguishing it from the Lesser Yellow-headed Vulture, densities of both species are combined under the latter species.
[d] Observed during the October census, but not during an actual 10 min count period.

The densities of 10 raptor species were too low to permit statistical comparisons (Table 2). These included the Turkey Vulture (*Cathartes aura*), Gray-headed Kite (*Leptodon cayanensis*), Mississippi Kite (*Ictinia mississippiensis*), Long-winged Harrier (*Circus buffoni*), Sharp-shinned Hawk (*Accipiter striatus*), Crane Hawk (*Geranospiza caerulescens*), Yellow-headed Caracara (*Milvago chimachima*), Laughing Falcon (*Herpetotheres cachinnans*), American Kestrel (*Falco sparverius*) and Peregrine Falcon (*Falco peregrinus*). Of these, the Mississippi Kite and probably the Peregrine Falcon are Nearctic migrants (Hayes et al. 1990); all others are permanent residents (F.E. Hayes, unpubl. data). Although data from the Turkey Vulture were combined with the Lesser Yellow-headed Vulture (Tables 2–4), the numbers of the former species were so small that results for seasonal, geographical and time of day variation in abundance of the Lesser Yellow-headed Vulture should not be affected.

Species richness was greatest in June, and species diversity was greatest during June and August (Table 1). Of the 12 species of non-migratory raptors which hunt live prey (excluding vultures, Nearctic migrants and the Snail Kite), the abundance of 10 was greatest during June; this was more than would be expected by chance (binomial test, $P < 0.001$). Furthermore, a Kruskal-Wallis test comparing the densities of all 12 species combined revealed significant differences in seasonal means, with the highest density in June ($H = 43.29$, $P < 0.001$; densities = 11.29 birds/10 km for June, 5.44 for August, 7.33 for October and 3.29 for January). Even when data were removed for the Crested Caracara, which accounted for 70.7% of the data, the density of non-migratory hunting raptors was still highest in June

Table 3. Mean number of birds per 10 min count along four geographical sectors of the Paraguay River. Data during all censuses are combined.

SPECIES	1	2	3	4	*H*
Black Vulture	1.60	2.76	1.36	0.10	7.85[a]
Lesser Yellow-headed Vulture[d]	0.39	0.97	1.01	1.90	12.91[b]
Osprey	0.09	0.11	0.19	0.10	3.62
Snail Kite	0.24	2.04	2.99	2.90	24.18[c]
Great Black Hawk	0.05	0.10	0.13	0.00	2.95
Savanna Hawk	0.03	0.04	0.33	0.05	34.49[c]
Black-collared Hawk	0.14	0.04	0.03	0.00	5.59
Roadside Hawk	0.09	0.05	0.07	0.05	0.47
Crested Caracara	1.10	1.23	1.08	0.85	2.25
Number of counts	74	99	98	20	

[a] $P < 0.05$.
[b] $P < 0.01$.
[c] $P < 0.001$.
[d] See [c] in Table 2.

($H = 32.10$, $P < 0.001$; densities = 4.20 birds/10 km for June, 1.81 for August, 1.54 for October and 0.75 for January).

Geographical Variation. Because the number of 10 min count periods in each sector varied during the four censuses ($\chi^2 = 27.07$, df = 9, $P < 0.002$), tests for geographical variation in abundance were computed for each census and for all censuses combined. The abundance of four species varied geographically when data from all four censuses were combined. The Black Vulture was most common in sector 2 and least common in sector 4 (Table 3); however, no geographical variation in abundance occurred during any single census. Both the Lesser Yellow-headed Vulture and Snail Kite were scarce in the southern sectors and most abundant in the northern sectors (Table 3); during individual censuses significant geographical variation occurred only in October ($H = 7.81$, $P < 0.05$) for the Lesser Yellow-headed Vulture and during all but the January census for the Snail Kite (June, $H = 11.15$, $P < 0.01$; August, $H = 11.14$, $P < 0.01$; October, $H = 20.82$, $P < 0.001$). The Savanna Hawk was most common in the third sector and virtually absent elsewhere (Table 3); this was true during all but the January census (June, $H = 31.28$, $P < 0.001$; August, $H = 5.83$, $P = 0.05$; October, $H = 9.96$, $P < 0.05$). The other five species with sufficient data for analysis showed no geographical variation in abundance for any given census or when all data were combined (Table 3), except for the Crested Caracara, which was most common in sector 2 during October ($H = 13.10$, $P < 0.01$) but not during any other census.

Time of Day Variation. The number of 10 min count periods in each time period varied during the four censuses ($\chi^2 = 35.96$, df = 15, $P < 0.002$), hence tests for time of day variation in abundance were computed for each census and for all censuses combined. The abundance or detectability of birds during different periods of the day varied significantly for four species when all data for the four censuses were combined. Both species of vultures were detected most frequently during midday; the Black Vulture was commonest from 1000–1200 H and the Lesser Yellow-headed Vulture from 1200–1400 H (Table 4). The Black Vulture showed no time of day variation during any single census; the Lesser Yellow-headed Vulture was most common from 1200–1400 H during each census except in June, when no variation occurred (August, $H = 13.10$, $P < 0.05$; October, $H = 21.55$, $P < 0.001$; January, $H = 12.93$, $P < 0.05$). The abundance of the Snail Kite did not vary significantly when all data were combined, but during the October census, when it was most common, it was observed most frequently during the early morning hours, from 0600–1000 H (Table 4). The Crested Caracara was observed most frequently from 0800–1000 H when all data were combined (Table 4), but the only census with significant variation was in August ($H = 12.88$, $P < 0.05$).

Table 4. Mean number of birds per 10 min count during different periods of the day. Data during all censuses are combined unless noted otherwise.

SPECIES	0600–0800	0800–1000	1000–1200	1200–1400	1400–1600	1600–1800	*H*
Black Vulture	0.76	3.03	4.15	2.12	0.95	0.58	17.34[a]
L. Y.-headed Vulture[c]	0.16	0.48	1.47	1.76	1.09	0.47	39.63[b]
Osprey	0.16	0.20	0.09	0.09	0.13	0.13	2.22
Snail Kite	4.16	3.85	1.35	1.15	1.25	0.83	9.32
October census	10.30	10.76	5.71	4.11	5.85	2.50	17.77[a]
Great Black Hawk	0.12	0.02	0.21	0.24	0.05	0.08	6.07
Savanna Hawk	0.24	0.08	0.09	0.24	0.16	0.11	7.55
Black-collared Hawk	0.04	0.05	0.00	0.18	0.05	0.06	7.50
Roadside Hawk	0.04	0.07	0.03	0.18	0.08	0.03	4.33
Crested Caracara	1.36	1.88	0.88	1.21	0.72	0.80	20.72[b]
Number of counts	25	60	34	33	64	64	
October census	10	21	7	9	13	16	

[a] $P < 0.01$.
[b] $P < 0.001$.
[c] See [c] in Table 2.

DISCUSSION

Seasonal Variation. Seasonal variation in the abundance of the Osprey and Snail Kite is apparently due to their migratory habits; the same should apply to the Mississippi Kite and Peregrine Falcon (Hayes et al. 1990). The greater abundance of the Savanna Hawk, Black-collared Hawk and Crested Caracara in June corresponded with the highest water levels along most sections of the Paraguay River. On 25 May and 2 June 1988, Vincent Roth (an arachnologist) and I observed from a rowboat large concentrations of insects, arachnids and two legless lizards trapped in emergent vegetation along the flooded Paraguay River at Asunción. The concentrations of invertebrates were the largest either of us had ever seen. The raptors may have been attracted to this ephemeral resource, which presumably also attracted small rodents, amphibians and other reptiles, along the river while the water level was rising. The greater abundance of non-migratory hunting raptors along the river in June and the greater species richness at this time support this hypothesis. In apparent contrast, the abundance of the Lesser Yellow-headed Vulture appeared to be negatively correlated with water levels, possibly because more carrion was exposed at lower water levels. The Black Vulture often appeared in flocks, especially near human dwellings; its occurrence was sporadic, hence conclusions about seasonal variation in abundance are unwarranted.

Two alternative explanations may account for the apparent increase in abundance of several raptor species along the river in June. The first may be due to the partial defoliation of trees at this time since June marks the onset of the austral winter. Defoliation of trees might increase the detectability of raptors by an observer. However, raptors typically perch on exposed limbs where they would be equally visible regardless of the quantity of foliation in the surrounding vegetation. Furthermore, the trees along the river's banks were still partially defoliated in August, when the quantity of non-migratory hunting raptors observed decreased. The second possible explanation may be that migrant birds from further south may have been concentrated along the river during the austral winter, some of which had already left by August. But because virtually nothing is known about seasonal movements of raptors in South America, this hypothesis cannot be evaluated at present. If this were the case, one would expect to observe a parallel increase in the densities of raptors in areas away from the river during the austral winter; this could be tested by conducting censuses elsewhere.

Seasonal variation in the abundance of raptors along the Paraguay River contrasts with that of waterbirds, most of which were most common during periods of low water. The differences in seasonal abundance between these two groups likely reflect differences in the abundance of preferred food resources and their respective foraging strategies. While

many raptors apparently exploit concentrations of terrestrial invertebrates and small vertebrates trapped in emergent vegetation during high water levels, waterbirds prefer to forage in shallow water and on mudflats where aquatic prey is concentrated and more easily accessible when water levels are low and more habitat is available.

Geographical Variation. The species with the most obvious geographical trends in abundance were the Lesser Yellow-headed Vulture and Snail Kite, both of which were most abundant farther north along the Paraguay River where marshes, their preferred habitat, are more extensive along the margins of the river. The Black Vulture, often associated with human dwellings, appeared to be more common farther south where human activity is more prevalent. I can offer no explanation for the greater abundance of the Savanna Hawk in sector 3.

Time of Day Variation. Time of day variation in abundance for several species of raptors suggests that certain species are more active, and hence more visible, along the river during certain periods of the day. Also, the time of day when activity is greatest apparently varies between species. The Snail Kite appeared to be most active in the early morning, the Crested Caracara during early morning and early afternoon, the Black Vulture during late morning, and the Lesser Yellow-headed Vulture during late morning and early afternoon. These differences presumably reflect differences in the foraging activities of each species. The activity of other raptor species may also vary during different periods of the day, but the data were too few to statistically detect such differences.

Implications for Census Methods. Although many methods have been devised to estimate raptor densities, the use of a ship along a river transect has seldom been employed (see Fuller and Mosher 1981). Most methods of censusing birds, including those along a linear transect, have been oriented toward estimating densities over a unit surface area, but because of the linear nature of rivers such a density measure would be meaningless. Shipboard censuses are the only practical method of estimating raptor densities along a river. Advantages include the ease with which birds may be viewed with unobstructed vision, the fairly constant and slow rate of travel and the long distance which may be sampled over an environmental gradient. A disadvantage is that species which are either smaller, seldom soar or seldom leave the forest canopy or understory are more difficult to detect, hence their calculated densities are conservative and relatively small compared to the more conspicuous species. To compensate one could conduct line transects by foot in forest along the river's edge.

In order to eliminate the biases of geographical and time of day variation when making seasonal comparisons of raptor densities along a linear transect, an equal amount of counts should be conducted for each geographical sector during a given census and also for each time period. Otherwise, complex interactions may occur between variables, as in this study, which may complicate the interpretation of results.

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LITERATURE CITED

ALBUQUERQUE, J.L.B. 1986. A roadside count of diurnal raptors in Rio Grande do Sul, Brazil. *Birds Prey Bull.* 3:82–87.

ALTMAN, A. AND B. SWIFT. 1989. Checklist of the birds of South America. St. Mary's Press, Washington, D.C.

ANONYMOUS. 1985. Environmental profile of Paraguay. International Institute for Environment and Development, Technical Planning Secretariat and United States Agency for International Development, Washington, D.C.

CONTRERAS, J.R., C. ACEVEDO GÓMEZ AND N. LÓPEZ HUERTA. 1987. Evaluación preliminar del conocimiento y del status de conservación de las rapaces del Paraguay (Aves: Accipitridae, Pandionidae y Falconidae). Unpubl. report, Centro de Datos para la Conservación, Asunción, Paraguay.

FULLER, M.R. AND J.A. MOSHER. 1981. Methods of detecting and counting raptors: a review. Pages 235–246. *in* C.J. Ralph and J.M. Scott [EDS.], Estimating numbers of terrestrial birds. Vol. 6. *Studies in Avian Biology,* Cooper Ornithological Society, Lawrence, KS.

HAYES, F.E., S.M. GOODMAN, J.A. FOX, T. GRANIZO TAMAYO AND N.E. LÓPEZ. 1990. North American bird migrants in Paraguay. *Condor* 92:947–960.

HEISEY, D. AND G. NIMIS. 1985. Statistix: an interactive statistical program for microcomputers. NH Analytical Software, St. Paul, MN.

NAROSKY, T. AND D. YZURIETA. 1987. Guía para la

identificación de las aves de Argentina y Uruguay. Asociación Ornitológica del Plata, Buenos Aires, Argentina.

THIOLLAY, J.M. 1989a. Area requirements for the conservation of rain forest raptors and game birds in French Guiana. *Conserv. Biol.* 3:128–137.

———. 1989b. Censusing of diurnal raptors in a primary rain forest: comparative methods and species detectability. *J. Raptor Res.* 23:72–84.

WILSON, D.B. 1983. Nota sobre rapaces en el camino entre Mercedes y Corrientes. *Hornero* 12:127–128.

ZAR, J.H. 1984. Biostatistical analysis. Prentice-Hall, Inc., Englewood Cliffs, NJ.

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THE DIET OF CHESAPEAKE BAY OSPREYS AND THEIR IMPACT ON THE LOCAL FISHERY

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ABSTRACT.—Ospreys (*Pandion haliaetus*), were observed at seven nests located in southwestern Chesapeake Bay, for 642 hr between 21 May and 25 July 1985. On average 5.4 fish/day were delivered to the nests. The size of fish delivered ranged from 4 to 43 cm, and the mean weight of fish delivered was 156.9 g. Atlantic Menhaden (*Brevortia tyrannus*) accounted for nearly 75% of the diet, although White Perch (*Morone americana*), Atlantic Croaker (*Micropogonias undulatus*), Oyster Toadfish (*Opsanus tau*), and American Eel (*Anguilla rostrata*) also were common prey. Chesapeake Bay Ospreys, estimated at 3000 breeding pairs, would be expected to eat about 132 171 kg of fish during the 52-day nestling period. This "harvest" represents 0.004% of the annual Chesapeake Bay commercial harvest and likely has a minimal impact on the local fishery.

La dieta de Águila Pescadora (*Pandion haliaetus*) en la Bahía Chesapeake y su impacto en la pesca local

EXTRACTO.—Águilas Pescadoras (*Pandion haliaetus*) en siete nidos ubicados en la zona sudoeste de la Bahía Chesapeake, fueron observadas por 642 horas entre el 21 de mayo y el 25 de julio de 1985. Un promedio de 5.4 pesces/día fueron llevados a cada nido. El tamaño del pescado que fue llevado al nido osciló entre 4 y 43 cm, y el peso medio fue de 156.9 g. Los peces de la especie *Brevortia tyrannus* constituyeron cerca del 75% de la dieta, aunque peces de las especies *Morone americana, Micropogonias undulatus, Opsanus tau, Anguilla rostrata* también fueron presa común. Se estima que 3000 pares de Áquilas Pescadoras de la Bahía de Chesapeake, en la época reproductiva, podrían comer aproximadamente 132 171 kg de pescado durante los 52 días del período en que las crías están en el nido. Esta "cosecha" de peces representa 0.004% de la pesca comercial anual de la Bahía de Chesapeake y al parecer tiene un impacto mínimo en la industria de pesca local.

[Traducción de Eudoxio Paredes-Ruiz]

Few studies have reported on the feeding ecology of Ospreys (*Pandion haliaetus*) in the Chesapeake Bay (Stinson 1978, McLean 1986). Because Ospreys might compete with commercial fishermen for the bay's ever-diminishing fish populations, this paper reports on the food habits of Ospreys of southwestern Chesapeake Bay and their bearing on the bay's fishery.

MATERIALS AND METHODS

Between 21 May and 25 July 1985, we observed seven Osprey nests located in Mathews and Lancaster Counties, Virginia. Nests were approximately 25 to 125 m from shore making them easy to observe and accessible by boat. At three sites, nests were close enough to allow two to be observed simultaneously. Ospreys were observed 4 d/wk. Each day included two 7.5 hr observation periods (0530–1300 and 1300–2030 H) which were arranged systematically to allow 16 hr of observation per nest. We used 20 by 60, 40 by 60 and 40 by 80 spotting scopes for observation of the number, species and size of fish delivered to the nest. We estimated the size of fish using reference points in and around the nest including the resident Osprey's tarsus. We also affixed a wooden rod, graduated at 12 cm intervals, to the nest to improve our size estimates. We later converted size estimates to grams using length-weight relationships specific for each fish (Table 1), and we based our calculation of species composition in the diet on wet weight values.

To further substantiate diet composition, we visited each nest twice a week to collect prey remains. Later, using a reference collection at the Virginia Institute of Marine Science and the assistance of the collection curator, the remains were identified. Diet composition was based on frequency of occurrence of the prey item.

RESULTS AND DISCUSSION

We observed 378 fish being delivered in 642 hr of observation, giving an average of 54 fish/nest (SD = 12.5, $N = 7$) for the 10 wk. This delivery rate is equivalent to 5.4 fish/d given one observation day for each nest per week. Fish lengths ranged approximately 4–43 cm. During one nest visit, we noticed the occupants eating a very large Menhaden (*Brevoortia tyrannus*) measured later at 43 cm, but

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Table 1. Length-weight relationships of fish eaten by Chesapeake Bay Ospreys in 1985.

SPECIES	EQUATION[a]
Menhaden (*Brevoortia tyrannus*)	Ln W = −12.075 + 3.215 Ln fork L[b]
Eel (*Anguilla rostrata*)	Log W = −6.56 + 3.34 Log L[c]
Hogchoker (*Trinectes maculatus*)	Log W = −3.71095 + 2.65844 Log L[d]
Perch (*Morone americana*)	Log W = −5.172 + 3.190 Log L[e]
Flounder (*Paralichthys dentatus*)	Log W = −5.8759 + 3.3238 Log L[f]
Catfish (*Ictalurus catus*)	Log Y = 1.9791 + 0.1689 Log X[g]
Oyster Toadfish (*Opsanus tau*)	Log W = −5.223 + 3.223 Log L[h]
Seatrout (*Cynoscion nebulosus*)	Log W = −4.423 + 2.861 Log L[i]
Butterfish (*Peprilus triacanthus*)	Log W = −5.1852 + 3.2646 Log L[j]

[a] W or Y = Weight (g), L or X = Length (mm).
[b] From J. Merriner (National Marine Fisheries Service, unpubl. data).
[c] From Harrell and Loyacano (1980).
[d] From Dawson (1962) and D. Haven (Virginia Institute of Marine Science, unpubl. data).
[e] From St. Pierre and Davis (1972).
[f] From Lux and Porter (1966).
[g] From Jachowski and Schwartz (1965).
[h] From Swartz and van Engel (1968).
[i] From Mercer (1983).
[j] From Dupaul and McEachran (1973).

most large fish were American Eel (*Anguilla rostrata*), White Perch (*Morone americana*), White Catfish (*Ictalurus catus*), Atlantic Croaker (*Micropogonias undulatus*), or Spotted Seatrout (*Cynoscion nebulosus*).

Conversions of fish lengths to weights revealed that Atlantic Menhaden accounted for nearly 75% of the diet (Table 2). White Perch represented over 7% of the diet, whereas Atlantic Croaker, Oyster Toadfish (*Opsanus tau*), and American Eel each comprised about 3% of the diet. During the 10 wk of observation, we recorded 15 species delivered to the nest (Table 2). The mean weight of fish delivered during the nestling period was 156.9 g (SD = 167.1, N = 246). Diet composition varied among broods, however, nearly all broods received at least 50% Menhaden.

Analysis of prey remains indicated that Menhaden constituted almost 65%, whereas Oyster Toadfish, Atlantic Needlefish, White Perch, Croaker, and Sunfish together comprised 23%. Menhaden, in the form of opercula, pectoral and caudal fins, and scales, predominated in the remains taken at each nest. Mandibles, craniums, and bills of Needlefish and jaws of Oyster Toadfish were particularly well represented at two nests. The few American Eel remains reflected a bias in determining diet composition from prey remains; some prey (e.g., eel) were eaten more easily and had fewer bones and hard parts which would be rejected by the feeding Osprey. Also, food items found in the nest may have been nest material. The large Bluefish (*Pomatomus saltatrix*) cranium found in one of the nests was probably collected from the shore nearby. In other parts of the bay, Ospreys have been observed gathering Bluefish remains from the beach (P. Spitzer, pers. comm.).

The diet of Ospreys in southwestern Chesapeake Bay appears to reflect local prey availability; these results are similar to those of a recent study of Florida Ospreys (Edwards 1988). In Chesapeake Bay, Menhaden are plentiful and represent over 80% of the commercial catch (Thompson 1984). Because Menhaden school near the water's surface, they make attractive prey. On two occasions, we observed a male Osprey clutching two Menhaden, one in each set of talons. American Eels were hunted primarily over shallow water. Though a significant diet item in this study, they reputedly are unimportant in the diet of Osprey populations elsewhere (P. Spitzer, pers. comm.). Needlefish (*Strongylura marina*), Oyster Toadfish, Summer Flounder (*Paralichthys dentatus*) and Hogchokers (*Trinectes maculatus*) are typically bottom dwellers but also are found occasionally in the shallows, especially at high tide. Under these conditions, Ospreys can effectively capture these fish about 0.5 m beneath the water's surface (pers. observation). In Florida, Edwards (1988) demonstrated that Ospreys preferred Sunfish (*Lepomis* spp.)

Table 2. The diet of Ospreys in southwestern Chesapeake Bay based on the mean weight of fish delivered to the nest.

SPECIES	WEIGHT (g)[a]	% OF DIET
Menhaden (*Brevoortia tyrannus*)	152.5 (134.4, 255)	74.69
White perch (*Morone americana*)	290.0 (366.0, 13)	7.24
Atlantic croaker (*Micropogonias undulatus*)	185.9 (117.2, 11)	3.93
Oyster toadfish (*Opsanus tau*)	133.7 (52.8, 13)	3.34
American eel (*Anguilla rostrata*)	93.0 (90.6, 16)	2.86
Hogchoker (*Trinectes maculatus*)	120.5 (68.8, 8)	1.85
Summer flounder (*Paralichthys dentatus*)	82.0 (82.2, 11)	1.73
White catfish (*Ictalurus catus*)	223.2 (17.82, 4)	1.71
Spotted seatrout (*Cynoscion nebulosus*)	410.0 (278.6, 2)	1.58
Harvestfish (*Peprilus alepidotus*)	228.8 (—, 1)	0.44
Butterfish (*Peprilus triacanthus*)	222.8 (—, 1)	0.43
Needlefish (*Strongylura marina*)	54.6 (—, 1)	0.10
Cutlassfish (*Trichiurus lepturus*)	22.9 (25.0, 2)	0.09
Sunfish (*Lepomis macrochirus*)	15.2 (—, 1)	0.03
Spanish mackerel (*Scomberomorus maculatus*)	45.7 (—, 1)[b]	—
Unknown	32[c]	—
	Total	100.02

[a] Mean (SD, *N*).
[b] Length (cm); uncertain of length–weight relationship.
[c] Total number of unidentifiable species.

when they were more abundant and Shad (*Dorosoma* spp.) when Sunfish abundance declined.

In terms of fish size and the average number of fish delivered daily, our findings are consistent with some others' (Stinson 1978, Hakkinen 1977, Prevost 1982, Henny 1988). In an earlier study of Chesapeake Bay Ospreys, Stinson (1978) reported a mean fish size of 237.1 g (SD = 160.0). Prevost (1982) observed African Ospreys with fish as large as 740 g, though most fish generally weighed between 200 and 400 g. In Finland, Hakkinen (1977) found that 5.2 (SD = 1.0) fish were delivered per day.

It is likely that the Ospreys' impact on a fishery is insignificant. Hakkinen (1977) calculated that the Osprey population in Finland consumed 0.6% of the total Finnish freshwater fish catch. In the Chesapeake Bay, Ospreys consume 5.4 fish/d per breeding pair including young. Given a mean fish weight of 156.9 g, the Chesapeake Bay Osprey population (estimated at 3000 breeding pairs) would be expected to eat approximately 132 171 kg of fish over the 52-d nestling period. This Osprey "harvest" represents 0.004% of the annual Chesapeake Bay commercial harvest of nearly 300 million kg (Thompson 1984). Clearly, the Ospreys' influence on the bay's fishery is negligible.

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LITERATURE CITED

DAWSON, C.E. 1962. Length-weight relationship of South Carolina Hogchokers, *Trinectes maculatus*. *Trans. Am Fish Society* 91:89–90.

DUPAUL, W.D. AND J.D. MCEACHRAN. 1973. Age and growth of the butterfish *Peprilus tricanus*, in the lower York River. *Chesapeake Science* 14:205–207.

EDWARDS, T.C., JR. 1988. Temporal variation in prey preference patterns of adult Ospreys. *Auk* 105:244–251.

HAKKINEN, I. 1977. Food catch of the Osprey (*Pandion haliaetus*) during the breeding season. *Ornis Fenn.* 54·166–169.

HARRELL, R.M. AND H.A. LOYACANO, JR. 1980. Age, growth, and sex ratio of the American eel in the Cooper River, South Carolina. *Proceedings of the Annual Con-*

ference of the Southeastern Association of Fish and Wildlife Agencies 34:349–359.

HENNY, C.J. 1988. Osprey. Pages 73–101 *in* R.S. Palmer, [ED.], Handbook of North American birds. Yale University Press, New Haven, CT.

JACHOWSKI, R. AND F.T. SCHWARTZ. 1965. The age, growth and length weight relationships of the Patuxent River, Maryland Ictalurid white, catfish *Ictalurus catus*. *Chesapeake Science* 6:226–237.

LUX, F.E. AND L.R. PORTER, JR. 1966. Length-weight relationship of the summer flounder, *Paralichthys dentatus*. U.S. Department of the Interior Burr. Comm. Fish. 55 R-Fish. 531:1–5, Washington, D.C.

MCLEAN, P.K. 1986. The feeding ecology of the Chesapeake Bay Ospreys and the growth and behavior of their young. M.A. thesis, College of William and Mary, Williamsburg, VA.

MERCER, L.P. 1983. A biological and fisheries profile of weakfish, *Cynoscion regalis*. Report No. 39, North Carolina Development of Natural Resources and Community Development. Morehead City, NC.

PREVOST, Y.A. 1982. The wintering ecology of Ospreys in Senegambia. Ph.D. thesis, University of Edinburgh, Edinburgh, Scotland.

STINSON, C.H. 1978. The influence of environmental conditions on aspects of the time budgets of breeding Ospreys. *Oecologia* 36:127–139.

ST. PIERRE, R.A. AND J. DAVIS. 1972. White perch in the James and York Rivers. *Chesapeake Science* 13: 272–281.

SWARTZ, R.C. AND W.A. VAN ENGEL. 1968. Length-weight and girth relations in the toadfish, *Opsanus tau*. *Chesapeake Science* 9:249–253.

THOMPSON, B.G. 1984. Fishery Statistics of the United States 1977. Statistical Digest No. 71, U.S. Department of Commerce, Washington, DC.

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REPRODUCTIVE INVESTMENT AND ANTI-PREDATOR BEHAVIOR IN COOPER'S HAWKS DURING THE PRE-LAYING PERIOD

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ABSTRACT.—Based on marked intersexual behavioral differences during the pre-laying period in the Cooper's Hawk (*Accipiter cooperii*), and contrary to theory, we suggest that prior to fertilization male Cooper's Hawks, not females, make a greater investment in reproductive effort. Male Cooper's Hawks provided most of the food for the pair, they did most of the nest building, and males more frequently attacked potential predators.

Esfuerzo reproductivo y conducta contra predadores del Gavilán Pechirrojo Mayor (*Accipiter cooperii*), durante el período anterior a la puesta de los huevos

EXTRACTO.—Basados en marcadas diferencias de conducta intersexual del Gavilán Pechirrojo Mayor (*Accipiter cooperii*), en el período anterior a la puesta de los huevos, y contrariando la teoría, sugerimos que antes de la fertilización son los Gavilanes Pechirrojos machos y no las hembras, los que contribuyen mayormente en los esfuerzos reproductivos. Los machos proveyeron la mayor parte de los alimentos para la pareja, son ellos también los que pusieron más trabajo en la construcción del nido, y fueron los que con más frecuencia atacaron a potenciales predadores.

[Traducción de Eudoxio Paredes-Ruiz]

Males and females make unequal energetic investments in gametes: females produce large (relative to male gametes) energy-rich eggs, while males only produce small sperm with negligible energy costs. This disparity ("anisogamy") has led to the prediction that reproductive effort up to the time of fertilization usually will be greater for females than males (Trivers 1972, 1985, Wilson 1975, Dawkins 1976). Beissinger (1987) claimed to have found the first empirical evidence of an exception to this prediction in his study of the pre-laying behavior of the Snail Kite (*Rostrhamus sociabilis*). Male Snail Kites did most of the nest building, chased predators and conspecifics more often than did females, and performed most of the foraging for their mates and themselves during the pre-laying period. Considering time and energy expenditures of these intersexual differences in pre-laying behavior, Beissinger (1987) proposed that female Snail Kites had overcome the effects of anisogamy because males had made a greater investment in reproductive effort than females.

While recognizing that time and energy expenditures are not the only currency of reproductive investment, researchers have usually relied on such measures because these are readily quantified (Sordahl 1990). Antipredator behavior, for example, is a form of parental investment that often involves considerable risk, but such behavior is not readily observed and consumes only small amounts of energy, while the real costs of risk are difficult to measure (Sordahl 1990).

Here we summarize observations of intersexual behavioral differences in Cooper's Hawks (*Accipiter cooperii*) during the pre-laying stage (see Rosenfield et al. 1991) that parallel those reported by Beissinger (1987) and thus appear to represent another example of female raptors overcoming the effects of anisogamy. We also present data on anti-predator behavior of Cooper's Hawks in the pre-laying pe-

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riod, and suggest that intersexual differences in risk are likewise consistent with a pattern of greater male investment.

Our observations on pre-laying behavior of Cooper's Hawks come from an intensive study in Waukesha County, southeastern Wisconsin (42°53′N 88°29′W). We watched Cooper's Hawks from ground blinds erected within 5–70 m of uncompleted nests during late March to early May 1986–89. For a detailed description of the study area and observation techniques, see Rosenfield (1990) and Rosenfield et al. (1991).

There is marked asymmetry in the behavior of male and female Cooper's Hawks during the pre-laying period. Females exhibit reduced locomotor activity and remain near nests prior to egg laying (Rosenfield et al. 1991). Males are more active than females: they do twice as much nest building as females and most of the hunting for the pair (Rosenfield et al. 1991). That males are more active than females is accentuated by the fact that males must leave the vicinity of the nest to procure food (Rosenfield et al., 1991).

During the pre-laying period, male Cooper's Hawks also engaged in anti-predator behavior more frequently than females. On 14 occasions at 13 nests, when both male and female hawks were present, various intruders (including one or more American Crows (*Corvus brachyrhynchos*) on six occasions, one Red-tailed Hawk (*Buteo jamaicensis*), a Raccoon (*Procyon lotor*), and an Eastern Gray Squirrel (*Sciurus carolinensis*) on each of six occasions) were attacked and/or chased within 30 m of uncompleted nests, or, in two instances, when squirrels climbed onto the nests. Males chased these potential predators (and probably struck the Raccoon and at least two squirrels) significantly more often than did females (12 attacks by 12 individually-marked males and two by the same female; $G = 10.9$, $P < 0.001$; for statistical independence, only one of the attacks by the female is considered). In two of these instances, males also perched within 1–3 m of squirrels and exhibited threat postures (raised crests and outstretched wings). Gray Squirrels were only attacked when they were in trees, never while they were on the ground, even though at these and many other times we saw squirrels on the ground beneath nests and/or perched hawks. In all cases only one member of a mated pair of hawks attacked a potential nest predator; the other bird remained silently perched nearby. One female eventually flew out of view toward the area where her mate had attacked some crows, while another female approached the Raccoon's location but did not attack it. Except for the Raccoon, which probably denned in the tree where it was attacked, all other intruders left the area of the hawk nest within 2 min after attacks began.

We suggest that the marked differences in behavior between the sexes during the pre-laying period, which are similar to the differences in activity exhibited by male and female Snail Kites (Beissinger 1987), make it likely that our results offer another example of females overcoming the effects of anisogamy. Moreover, it may be that the intersexual disparity in reproductive effort is accentuated in Cooper's Hawks because the pre-laying period is longer than that of Snail Kites (about 30 d; Rosenfield et al. 1991) versus 11–20 days.

By reducing activity (especially the energetically demanding activity of flight) and depending on males to provide most of their food during egg production, female Cooper's Hawks are presumably able to enhance energy assimilation and reduce the relative level of energy depletion during egg laying (Beissinger 1987). Female Cooper's Hawks are indeed heavier at the pre-laying stage than at the incubation or nestling stages (R.N. Rosenfield and J. Bielefeldt unpubl. data). Beissinger (1987) suggested that a female Snail Kite that withholds energy investments and builds endogenous reserves may be better able to replace clutches soon after nest failures, which were common in his study. He speculated that a high nest failure rate could have selected for male reproductive effort (through courtship feeding) to exceed female reproductive effort before laying. Reproductive failure, however, may not explain why female Cooper's Hawks have adopted a strategy so similar to that of female Snail Kites. Although many Cooper's Hawk nest failures occur during the egg stage and renesting typically occurs if nests fail early in incubation, in accord with Beissinger's (1987) hypothesis, only about 25% of all nests fail each year (R.N. Rosenfield and J. Bielefeldt unpubl. data) versus about 68% in the Snail Kite. Regardless of reproductive failure, egg production is energetically demanding (Walsberg 1983), and a complement of various strategies (e.g., increasing dietary intake, using stored nutrient reserves, reducing activity) could be used simultaneously to offset the energy demand of egg production (King and Murphy 1985). It also

may be that female Cooper's Hawks are inactive during the pre-laying period to protect developing eggs. Walter (1979:359) suggested that raptors, particularly those that hunt birds (as do Cooper's Hawks), encounter a considerable danger to developing eggs that could be damaged when a hawk chases and subdues prey.

Recent studies have investigated investment strategies of the sexes during the breeding season by dividing reproductive effort into mating effort (activities used to secure copulations) and parental effort (the sum of parental investments in each offspring) (Beissinger 1987, Brunton 1988). Females invest in offspring (eggs and young), whereas males are required to do likewise (through anti-predator behavior and courtship feeding, for example) and also to guard against cuckoldry (Trivers 1972). Under this categorization, investments by female Cooper's Hawks take the form of parental effort. During the pre-laying period, however, males must also invest much in mating effort, in an attempt to assure paternity through frequent copulations, building of the nest (perhaps a pre-coital display, Rosenfield et al., 1991) and courtship feeding (also associated with copulatory behavior in the Cooper's Hawk, Rosenfield et al., 1991). Burger (1981) suggested that because of the potential for cuckoldry, monogamous males must invest more rather than less in reproductive effort prior to egg laying, and her results on Black Skimmers (*Rynchops nigra*), and our own on Cooper's Hawks support this hypothesis. Also, the pre-laying behavior of many members of Falconiformes appears similar to that of the Cooper's Hawk and Snail Kite (Newton 1979:156-157); perhaps the behavior of numerous species in this order may be interpreted as overcoming the effects of anisogamy.

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LITERATURE CITED

BEISSINGER, S.R. 1987. Anisogamy overcome: female strategies in Snail Kites. *Am. Nat.* 129:486–500.

BRUNTON, D.H. 1988. Energy expenditure in reproductive effort of male and female Killdeer (*Charadrius vociferus*). *Auk* 105:553–564.

BURGER, J. 1981. Sexual differences in parental activities of breeding Black Skimmers. *Am. Nat.* 117:975–984.

DAWKINS, R. 1976. The selfish gene. Oxford University Press, Oxford, U.K.

KING, J.R. AND M.E. MURPHY. 1985. Periods of nutritional stress in the annual cycles of endotherms: fact or fiction? *Am. Zool.* 25:955–964.

NEWTON, I. 1979. Population ecology of raptors. Buteo Books, Vermillion, ND.

ROSENFIELD, R.N. 1990. Pre-incubation behavior and paternity assurance in the Cooper's Hawk (*Accipiter cooperii*). Ph.D. thesis, North Dakota State University, Fargo, ND.

———, J. BIELEFELDT AND J. CARY. 1991. Copulatory and other pre-incubation behaviors of Cooper's Hawks. *Wilson Bull.* 103. In press.

SORDAHL, T.A. 1990. The risks of avian mobbing and distraction behavior: an anecdotal review. *Wilson Bull.* 102:349–352.

TRIVERS, R.L. 1972. Parental investment and sexual selection. Pages 136–179 *in* B. Campbell, [ED.], Sexual selection and the descent of man, 1871–1971. Aldine, Chicago, IL.

———. 1985. Social evolution. Benjamin/Cummings, Menlo Park, CA.

WALSBERG, G.E. 1983. Avian ecological energetics. Pages 161–220 *in* D.S. Farner, J.R. King and K.C. Parkes, [EDS.], Avian biology. Vol. 7. Academic Press, New York.

WALTER, H. 1979. Eleonora's Falcon. University of Chicago Press, Chicago, IL.

WILSON, E.O. 1975. Sociobiology. Harvard University Press, Cambridge, MA.

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FOOD HABITS OF GURNEY'S BUZZARD IN PRE-ANDEAN RANGES AND THE HIGH ANDEAN PLATEAU OF NORTHERNMOST CHILE

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ABSTRACT.—We examined 381 pellets that yielded 1764 prey items for Gurney's Buzzards (*Buteo poecilochrous*) at a pre-Andean (3600 m elevation, non-breeding season) and a high-Andean plateau site (4500 m elevation, breeding season) of northernmost Chile. We compared mammalian prey in the diet with mammals trapped in the field. Gurney's Buzzards preyed extensively on invertebrates (57 and 72% of items), but considering the invertebrates' small biomass, the buzzards likely relied on vertebrates (primarily on small mammals) as their staple prey. The number of small mammals in the diet versus that obtained in the field agreed better at the pre-Andean than at the high-Andean plateau site. Differences in diet between sites were apparently related to the seasons when the sampling occurred.

Hábitos alimentarios del aguilucho de la puna en la precordillera andina y el altiplano del extremo norte de Chile

EXTRACTO.—Examinamos 381 egagrópilas que rindieron 1764 presas del aguilucho de la puna (*Buteo poecilochrous*) en un sitio precordillerano (3600 m altura, estación no reproductiva) y en uno altiplánico (4500 m altura, estación reproductiva) del extremo norte de Chile. Comparamos la composición de mamíferos en la dieta con aquella obtenida por trampeos de terreno. El aguilucho de la puna predó extensamente sobre invertebrados (entre 57 y 71% de la dieta, numéricamente), pero considerando la pequeña biomasa de estos invertebrados, es más probable que el aguilucho dependiera más de los vertebrados (principalmente de los micromamiferos) como elementos estables de su dieta. La incidencia numérica de micromamíferos en la dieta versus la obtenida en el terreno se correspondió mejor en el sitio precordillerano que en el altiplánico. Las diferencias entre las dietas en los distintos sitios aparentemente se deben a las distintas estaciones del año en que se hicieron las colectas.

Gurney's, or Red-naped, Buzzard (*Buteo poecilochrous*), is a medium-sized (about 1000 g), high altitude buteo found along the Andean ranges from Colombia south to neighboring Chile, Argentina and Bolivia. In this extreme of its distribution, the Andean mountain ranges enclose a high-altitude plateau (>4000 m elevation). Little information exists on Gurney's Buzzard, the most recent being a description of its food habits in the high-Andean plateau of northernmost Chile (Jiménez and Jaksić 1990). These authors reported breeding season diet based on a sample of 27 pellets and 45 prey remains found in a nest. Here we document both breeding and non-breeding season diets of Gurney's Buzzard at two physiognomically and altitudinally different sites. We also compare mammalian prey with trapping results to estimate whether this raptor takes its mammalian prey in proportion to their estimated field abundance.

STUDY AREAS AND METHODS

At the pre-Andean locality of Patapatane (3600 m elevation, 18°05'S 69°43'W, 110 km E of Arica, Chile) we collected 229 fresh pellets below a cliff on 12 May 1990. This is autumn in the southern hemisphere, and consequently the pellet contents reveal non-breeding season diet of Gurney's Buzzard. To the best of our knowledge the

pellets belonged to this buzzard and not to the broadly sympatric but much scarcer Carunculated Caracara (*Phalcoboenus megalopterus*). We actually saw at least two different buzzards perching at the cliff or soaring above. We are not familiar with Carunculated Caracara pellets, but if those are similar to the pellets of the closely related Chimango Caracara (*Milvago chimango*; see Yáñez et al. 1982), then the pellets we collected were those of buteos and not of caracaras.

From 13 to 18 May 1990, for a total of 480 trap nights, we placed traps in two grids of 6 by 8 configuration, 15 m apart. We used Sherman traps 8 by 10 by 23 cm, set during 5 nights. Vegetation at this pre-Andean site was mixed. The shrub *Parastrephia lepidophylla* dominated on sandy soils on flat areas lacking a herbaceous plant layer. The dwarf shrubs *Fabiana* sp., *Chuquiraga rotundifolia*, and *Baccharis boliviensis* dominated on rocky slopes, where a scant cover of bunchgrasses (*Festuca* sp.) was also present.

At the high-Andean plateau, in Ancachalloane Valley (4500 m elevation, 18°10′S 69°20′W, 180 km E of Arica, Chile), we collected another sample of 152 fresh pellets below a cliff on 20 and 24 October 1989. This corresponds to the austral spring, and thus the beginning of the breeding season for local raptors. Again, we only saw Gurney's Buzzards in the area, and among the pellets we found molted feathers of this species, with the typical dark ochraceous coloration. Feathers of the broadly sympatric but rarely seen Carunculated Caracara are either white or black.

We did not sample small mammals at Ancachalloane Valley, but we did so in two neighboring and altitudinally, physiognomically and vegetationally similar sites. These were Tacora (4100 m elevation, 17°46′S 69°43′W, 156 km E of Arica, Chile) and Surire (4245 m elevation, 18°50′S 69°09′W, 200 km E of Arica, Chile). Between 10–15 January 1990 at Tacora, and between 24–29 January 1990 at Surire, we used two adjacent grids in each area as described above for a total of 480 trap nights in each. Vegetation at these high-Andean sites was dominated by dwarf shrubs of *Parastrephia lucida, P. lepidophylla* or *Baccharis santelices*, which grew together with bunchgrasses (*Festuca orthophylla*) interspersed with cushions of *Pycnophyllum molle, Azorella compacta, Werneria weddelli* and *W. aretioides*.

All pellets were labeled by locality and date, carefully teased apart and prey identified to species when possible using keys (Reise 1973) and museum specimens collected locally. The minimum number of individual prey present in the pellets was based on the number of known double or single anatomical elements such as crania, mandibles, teeth rows, beaks, feet, elytra, antennae and stings (Marti 1987). Mammalian nomenclature follows Honacki et al. (1982).

RESULTS AND DISCUSSION

Invertebrates (composed of insects mainly) accounted for 72 and 57% of prey individuals in the diet at the pre-Andean and at the high-Andean site, respectively. The lower incidence of insects at the latter site may be attributed to the pellets having been obtained in fall versus spring. The increased abundance of larger prey such as mammals during spring (F.M. Jaksić, pers. observation) may result in decreased predation on invertebrates. The same explanation may be offered for the lower incidence of reptiles at the high-Andean site. However, it is intriguing that the consumption pattern for amphibians went in the opposite direction. Mammals, and particularly birds, were more frequent as prey at the high-Andean site. Increased vulnerability of dispersing juvenile mammals, and of nesting birds during spring may account for their higher incidence as prey at this site.

At a finer level of resolution (Table 1), the most prevalent insect prey were curculionid and tenebrionid beetles. These were also the most abundant beetles at the two study sites (F.M. Jaksić, pers. observation). The hymenopterans found at the pre-Andean site were wasps, which were commonly seen there. Amphibians were found as prey only at the high-Andean site. These were Spiny Toads, the most terrestrial of the three species commonly found in the region (Jiménez and Jaksić 1990, F.M. Jaksić, pers. observation). The lizards found as prey at the two study sites were apparently iguanids in the genus *Liolaemus*. Three common *Liolaemus* species are found in the region (Jiménez and Jaksić 1990), but we could not separate them by species in our diet samples. That the relatively thermophilic snakes were only found among prey at the pre-Andean site speaks to the higher temperatures prevailing in that area (F.M. Jaksić, pers. observation). We could not identify avian prey to species; the Furnariidae could be any of the 10 species locally observed and the Fringillidae could be any of seven species (Jiménez and Jaksić 1990). It is interesting that 10 bird eggs were recorded among pellets at the high-Andean site, where pellets were collected during the breeding season. It had not previously been reported (Jiménez and Jaksić 1990) that Gurney's Buzzard raided bird nests. But it may well be that buzzards consume their own eggshells after their young hatch.

Before comparing mammalian composition in the buzzard's diet with that in the field, some cautionary notes must be stated. The traps used were not adequate for sampling the fossorial Puna Tucotuco, the large Mountain Viscacha, and the trap-shy Smoky Chinchilla-rat. In addition, the trapping grids were not properly placed for sampling the semicolonial Highland Cavy or Puna Cavy, which inhabit bogs. Except for the Smoky Chinchilla-rat, the

Table 1. Percent of prey in the diet of Gurney's Buzzard at pre-Andean ranges and at the high-Andean plateau. Subtotals for prey classes are in parentheses.

	PRE-ANDES		HIGH-ANDES	
PREY CATEGORIES	DIET	TRAPS	DIET	TRAPS
Mammals	(15.3)	(100.0)	(19.5)	(100.0)
Smoky Chinchilla-rat (*Abrocoma cinerea*)	0.3	0.0	0.3	0.0
White-bellied Field Mouse (*Akodon albiventer*)	0.3	31.3	0.0	43.0
Andean Field Mouse (*Akodon andinus*)	1.4	0.0	0.2	0.0
Field mice (*Akodon albiventer* or *A. andinus*)	1.6	0.0	1.2	0.0
Shrub Andean-rat (*Andinomys edax*)	0.1	0.0	0.0	0.0
Bolivian Greater Mouse (*Auliscomys boliviensis*)	0.1	0.0	0.2	0.0
Andean Vesper-mouse (*Calomys lepidus*)	0.0	0.0	0.0	5.1
Puna Tucotuco (*Ctenomys opimus*)	0.0	0.0	3.1	0.0
Silky-foot Mouse (*Eligmodontia typus*)	1.4	6.2	0.7	35.4
Highland Cavy (*Galea musteloides*) or Puna Cavy (*Microcavia niata*)	0.1	0.0	0.5	0.0
Mountain Viscacha (*Lagidium viscacia*)	0.1	0.0	0.5	0.0
Darwin's Leaf-eared Mouse (*Phyllotis darwini*)	3.8	62.5	1.5	16.5
Cricetidae: unidentified	4.2	0.0	5.0	0.0
Rodentia: unidentified	1.9	0.0	6.3	0.0
Birds	(0.4)		(7.2)	
Furnariidae	0.1		0.0	
Fringillidae	0.0		0.3	
Passeriformes: unidentified	0.2		0.7	
Aves: unidentified	0.1		4.5	
Bird egg: unidentified	0.0		1.7	
Reptiles	(12.7)		(8.1)	
Long-tailed snake (*Philodryas chamissonis*)	2.8		0.0	
Iguanidae	9.9		8.1	
Amphibians	(0.0)		(8.1)	
Spiny Toad (*Bufo spinulosus*)	0.0		8.1	
Insects	(69.9)		(56.2)	
Buprestidae	0.4		0.3	
Carabidae	0.1		0.3	
Curculionidae	31.9		18.9	
Scarabaeidae	2.5		6.3	
Tenebrionidae	22.7		18.4	
Coleoptera: unidentified	1.9		11.1	
Hymenoptera	9.8		0.0	
Orthoptera	0.3		0.0	
Insect larva: unidentified	0.0		0.9	
Insect adult: unidentified	0.3		0.0	
Arachnids	(1.7)		(0.9)	
Aranea	0.1		0.0	
Scorpionida	1.6		0.9	
Total prey/captures	1181	16	583	79
Total pellets/trap-nights	229	480	152	960

presence of the remaining four rodents was evident from sightings and field marks, particularly at the high-Andean site.

At the pre-Andean site, Darwin's Leaf-eared Mouse was taken about in the proportion expected from their relatively high abundance estimated by trapping (Table 1). The White-bellied Field Mouse was taken by the buzzards less than expected, and the Silky-foot Mouse more than expected, from their respective field abundances (Table 1). The remaining mammalian species in the diet that were not trapped (disregarding unidentified species) represented less than 4% of the prey taken by the buzzards. Results from the high-Andean site were more disparate. Both the most (White-bellied Field Mouse) and least frequently trapped species (Andean Vesper-mouse) were not found at all among pellets. The Silky-foot Mouse was preyed upon below, and the Darwin's Leaf-eared Mouse above, their estimated abundances in the field (Table 1). The mammalian species not trapped (disregarding unidentified species) accounted for only 6% of the buzzards' diet.

In comparison to the breeding season diet, reported by Jiménez and Jaksić (1990) for Gurney's Buzzards at a high-Andean site close to ours, our current data indicate fewer arthropods (57 vs. 80%), more mammals (20 vs. 8%), amphibians (8 vs. 0%) and birds (7 vs. 4%), and about the same proportion of reptiles (8%). The same four mammalian prey species (Andean Field Mouse, Darwin's Leaf-eared Mouse, Tschudi's Cavy, and Puna Tucotuco) were reported by Jiménez and Jaksić (1990), but we did not find White-bellied Field Mouse as prey although it was trapped. We detected four additional prey species: Smoky Chinchilla-rat, Bolivian Greater Mouse, Silky-foot Mouse, and Mountain Viscacha. This is not surprising, as our sample size for pellets was almost six times larger than that reported by Jiménez and Jaksić (1990).

In conclusion, Gurney's Buzzard in northernmost Chile preys extensively on insects, but considering this prey's small biomass, it may be said to rely on vertebrates as its staple prey. Most differences in prey composition between the two sites studied apparently were the result of the different seasons when the sampling took place.

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LITERATURE CITED

HONACKI, J.H., K.E. KINMAN AND J.W. KOEPPL (EDS). 1982. Mammal species of the world: a taxonomic and geographic reference. Allen Press Inc. and Association of Systematics Collections, Lawrence, KS.

JIMÉNEZ, J.E. AND F.M. JAKSIĆ. 1990. Diet of Gurney's Buzzard in the puna of northernmost Chile. *Wilson Bull.* 102:344–346.

MARTI, C.D. 1987. Raptor food habits studies. Pages 67–80 *in* B.A. Giron Pendleton, B.A. Millsap, K.W. Cline and D.M. Bird [EDS.], Raptor management techniques manual. National Wildlife Federation, Washington, DC.

REISE, D. 1973. Clave para la determinación de los cráneos de marsupiales y roedores chilenos. *Gayana (Zoología)* 27:1–20.

YÁÑEZ, J.L., H. NÚÑEZ AND F.M. JAKSIĆ. 1982. Food habits and weight of Chimango Caracaras in central Chile. *Auk* 99:170–171.

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DISTRIBUTION OF BOREAL OWL OBSERVATION RECORDS IN WYOMING

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ABSTRACT.—From 1927–89, 50 observations of Boreal Owls (*Aegolius funereus*) have been documented in Wyoming from records which include museum specimens, photographs, limited surveys and incidental observations. Observations were primarily in high elevation coniferous forests in the northwestern and southeastern portions of Wyoming.

Distribución del buho de la especie *Aegolius funereus* en Wyoming.

Extracto.—Desde 1927 hasta 1989, se han documentado cincuenta observaciones hechas a buhos de la especie *Aegolius funereus* en Wyoming. Esta documentación se hizo de registros que incluyen muestras de museo, fotografías, inspecciones limitadas y observaciones incidentales. Las observaciones fueron primariamente hechas en elevadas forestas de coníferas en las zonas noroeste y sudeste de Wyoming.
[Traducción de Eudoxio Paredes-Ruiz]

The Boreal Owl (*Aegolius funereus*) was recently confirmed as nesting in the Rocky Mountain region of the western United States (Palmer and Ryder 1984, Ryder et al. 1987). It has been documented as breeding in states surrounding Wyoming including Montana (Holt and Ermatinger 1989), Idaho (Hayward and Garton 1983) and Colorado (Palmer and Ryder 1984). Previously mentioned records from Wyoming have included 3 observations reported by Palmer and Ryder (1984) and 27 additional observations reported by Hayward and Hayward (in Clark et al. 1989). These authors primarily reported records of incidental observations. In this paper, we present a comprehensive review of Boreal Owl records in Wyoming which include the above records, records from preliminary surveys (call-playback), museum specimens and additional incidental observations.

METHODS

Observation records for Boreal Owls in Wyoming were compiled and entered into The Nature Conservancy's Biological and Conservation Database for analysis. Information was obtained from preliminary field surveys conducted by R. Wallen and K. Duffy in Grand Teton National Park and surveys conducted by staff from the U.S. Forest Service Rocky Mountain Forest and Range Experiment Station in the Medicine Bow National Forest, Carbon County, Wyoming. Additional observations were obtained from Yellowstone National Park, the Wyoming Department of Game and Fish, literature reviews and a review of requests to 91 museums in the United States and Canada for museum specimen records.

RESULTS

We compiled a total of 50 observations for Wyoming from the above sources from 1927–89. These 50 records represent 73 individual owls at 50 sites (Fig. 1). Observations of Boreal Owls in Wyoming have primarily been in Grand Teton National Park (24 records) and in southeastern Carbon County in the Snowy Range and Sierra Madre Range within Medicine Bow National Forest (12 records). Observations were concentrated in these areas since these are the only areas in Wyoming where preliminary surveys have been conducted.

Thirty-one (62%) of all of the Wyoming records were recorded between 1 March through 1 September during the probable breeding season for Boreal Owls in Wyoming. Repeated observations have been made of Boreal Owls in areas surveyed during the breeding season. There is one probable breeding record in the Coon Creek drainage of the Encampment River in the Sierra Madre Mountains of south-central Wyoming. Repeated observations were made here of two adults occupying a hole in a snag but

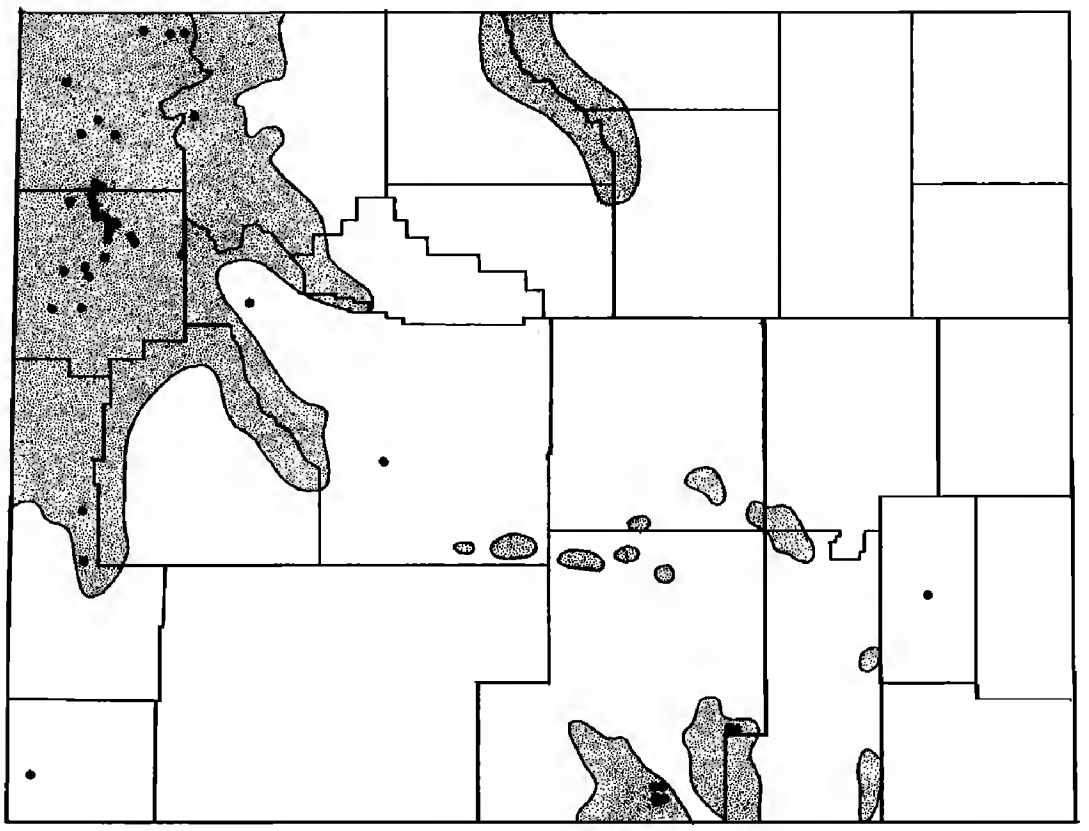

Figure 1. Distribution of Boreal Owl records in Wyoming. Stippled areas represent the distribution of Subalpine Fir, Engelmann Spruce and Lodgepole Pine forest types after Little (1971). All dots outside of stippled area represent winter records. Some dots represent more than one record.

no young were confirmed (H. Henry, pers. comm.). Another probable breeding record is known from the vicinity of Medicine Bow Peak, Snowy Range Mountains in south-central Wyoming where an adult was observed to bring a vole (*Microtus* sp.) to a recently fledged juvenile (S. Fitton, pers. comm.). Both of these areas are contained within the Medicine Bow National Forest.

In addition, courtship was observed at a potential nest cavity located in Grand Teton National Park in 1989, but the adults did not produce any young. Also, juvenile Boreal Owls were photographed in the interior of Grand Teton National Park in 1985. Consequently, circumstantial evidence indicates that this species breeds in following areas: Snowy Range/ Sierra Madre mountains, Grand Teton National Park, and possibly in Yellowstone National Park.

The 50 records range in elevation from 1770 m to 3240 m with a mean of 2490 m. The 31 Boreal Owl observations recorded during the breeding season ranged in elevation from 2000 m to 3240 m with a mean elevation of 2650 m. Habitat recorded for breeding season records in Wyoming are comprised of high-elevation coniferous forests; dominant tree species include Engelmann Spruce (*Picea engelmannii*), Subalpine Fir (*Abies lasiocarpa*) and Lodgepole Pine (*Pinus contorta*).

In the Rocky Mountain region, Boreal Owl observations have primarily been in high-elevation mixed coniferous forest. In Colorado, of four published accounts of Boreal Owl nest sites, two were in Engelmann Spruce snags, and two were in Lodgepole Pine. Roost sites used by Boreal Owls in Colorado were in Engelmann Spruce, Subalpine Fir and Lodgepole Pine (Ryder et al. 1987). In Idaho, Hayward (1989) found Boreal Owls primarily in the spruce-fir forest zone for nesting, foraging and roost habitats. Some use has also been observed in stands of mature Aspens (*Populus tremuloides*) interspersed with the above coniferous forest types.

DISCUSSION

From a review of the above literature on Rocky Mountain Boreal Owl observations and the Wyoming records presented here, it appears that habitats used by Boreal Owls in the Rocky Mountain region and Wyoming, are primarily subalpine forests of Engelmann Spruce, Subalpine Fir, and mature Lodgepole Pine with some use of mature Aspen stands which are interspersed with the above coniferous forest types.

Considering this information, the conifer distribution map for these three tree species, as represented in Figure 1, probably roughly represents po-

tential Boreal Owl habitat within Wyoming. However, it must be emphasized that systematic surveys have yet to be conducted in other forest types, and that additional surveys need to be conducted before any conclusions can be firmly made about habitat use. Also, the smaller disjunct areas of these forest types represented in Figure 1 should be surveyed to determine if Boreal Owl distribution is contiguous throughout these habitat types in Wyoming.

The Engelmann Spruce/Subalpine Fir forest types which are used by Boreal Owls are the largest and most valuable timber resources in Colorado and Wyoming, accounting for over 90% of the saw-timber volume in this area (Alexander et al. 1983, U.S. Department of Agriculture, Forest Service 1980 *in* Raphael 1987). There is no information on the effects of clear-cutting, habitat fragmentation, and other forest practices on Boreal Owls in the U.S. Consequently, the Boreal Owl is listed, or proposed for listing, by the U.S. Forest Service as a "Sensitive species" across its entire range of distribution in the lower 48 states. In addition, the Boreal Owl is also listed as a species of concern by state Natural Heritage or nongame programs in its entire breeding season range in the lower 48. Listing by these agencies reflects both the threat to the above mentioned habitat and a general lack of information. We hope that the information presented in this paper will be useful to resource managers and serve as an incentive for further investigations.

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LITERATURE CITED

CLARK, T.W., A.H. HARVEY, R.D. DORN, D.L. GENTER AND C. GROVES [EDS.]. 1989. Rare, sensitive and threatened species of the greater yellowstone ecosystem. Northern Rockies Conservation Cooperative, Montana Natural Heritage Program, The Nature Conservancy and Mountain West Environmental Services, Jackson, WY.

HAYWARD, G.D. AND E.O. GARTON. 1983. First nesting record for Boreal Owl in Idaho. *Condor* 85:501.

HAYWARD, G.D. 1989. Habitat use and population biology of Boreal Owls in the Rocky Mountains, USA. Ph.D. thesis, University of Idaho, Moscow, ID.

HOLT, D.W. AND D. ERMATINGER. 1989. First confirmed nest site of Boreal Owls in Montana. *Northwestern Naturalist* 70:27–31.

LITTLE, E.L. 1971. Atlas of United States trees. Vol. 1. Conifers and important hardwoods. Misc. Publication No. 1146, U.S. Department of Agriculture, Forest Service, Washington, D.C.

PALMER, D.A. AND R.A. RYDER. 1984. The first documented breeding record of the Boreal Owl in Colorado. *Condor* 79:215–217.

RAPHAEL, M.G. 1987. The Coon Creek Wildlife Project. effects of water yield augmentation on Wildlife. Pages 173–179 *in* C.A. Troendle, M.R. Kaufman, R.H. Hamre and R.P. Winokum [EDS.], Management of subalpine forests: building on 50 years of research. General Technical Report RM-149. U.S. Department of Agriculture, Forest Service, Ft. Collins, CO.

RYDER, R.A., D.A. PALMER, AND J.J. RAWINSKI. 1987. Distribution and status of the Boreal Owl in Colorado. Pages 169–174 *in* R.W. Nero, R.J. Clark, R.J. Knapton and R.H. Hamre, [EDS.], Biology and conservation of northern forest owls. General Technical Report RM-142. U.S. Department of Agriculture, Forest Service, Fort Collins, CO.

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PEREGRINE FALCONS AND MERLINS IN SINALOA, MEXICO, IN WINTER

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ABSTRACT.—Peregrine Falcons (*Falco peregrinus*) and Merlins (*F. columbarius*) were observed on the west coast of Mexico near Culiacan, Sinaloa, in fall 1989 and 1990. The vast marsh attracted several million waterfowl and shorebirds, and in turn many peregrines. In the marsh, we saw 2.0 and 2.3 peregrines per hour in 1989 and 1990, respectively, when we corrected for re-sightings. Sightings on a barrier beach were far fewer, and an average of one peregrine was seen each 39 km traveled. No migration of peregrines was evident. Three female peregrines were radiotagged and resulting locations for each bird had maximum diameters of 4, 8, and 19 km for up to 24 d. About 77% of all peregrines were adult females and all three North American subspecies may have been present. Teal were the most common prey of peregrines in the marsh, but other species were taken on the flats and beaches. Merlins were over three times more common than peregrines on the beach; one was seen for every 12 km of travel. We believe this region is a major wintering area for peregrines and merlins. A banded peregrine was trapped that had originated in Grand Teton National Park.

Halcónes de las especies *Falco peregrinus* y *Falco columbarius* en Sinaloa, México, en invierno

EXTRACTO.—Halcones de las especies *Falco peregrinus* y *F. columbarius* fueron observados en la costa oeste de México cerca a Culiacán, Sinaloa, en los otoños de 1989 y 1990. El amplio pantano atrajo muchos millones de aves acuáticas y aves de las orillas, y en su turno muchos Halcones Peregrinos. En el pantano, vimos 2.0 y 2.3 Halcones Peregrinos por hora en 1989 y 1990 respectivamente, cuando hicimos los ajustes para probables repeticiones de observaciones. Observaciones en la playa de la península fueron muy pocas, y un promedio de un Halcón Peregrino fue visto por cada 39 km de viaje. Migraciones de Halcones Peregrinos no fueron evidentes. Tres Halcones Peregrinos hembras fueron radio-controladas, y en las resultantes áreas habitadas por cada ave la dispersión máxima fue de 4, 8, y 19 km de diámetro, para períodos de hasta 24 días. Cerca del 77% de todos los Halcones Peregrinos fueron hembras adultas; y todas las tres sub-especies norteamericanas puede que hayan estado presentes. Cercetas (*Anas crecca, A. discors, A. cyanoptera*) fueron la presa más común de los Halcones Peregrinos en el pantano, pero otras especies fueron cogidas en los llanos y las playas. En la playa, los halcones de la especie *F. columbarius* fueron comunes en más del triple que los halcones de la especie *F. peregrinus*; se vio uno por cada 12 km de viaje. Creemos que esta región es una área de mayor importancia para los halcones de ambas especies en el invierno. Se atrapó un Halcón Peregrino anillado originado en Parque Nacional Grand Teton.

[Traducción de Eudoxio Paredes-Ruiz]

Migration of Peregrine Falcons (*Falco peregrinus*) on the Gulf Coast of Mexico is well known (Enderson 1965, Hunt et al. 1975, Yates et al. 1988). The majority are of high latitude origin and winter in Central and South America, but some winter as far north as Texas and Florida. Migrant or wintering peregrines on the west coast of Mexico have not been studied. The presence of a wintering population near Culiacán, Sinaloa, was first suggested by P. Widener (pers. comm.) based on observations of duck hunters.

We visited the area from 28 December 1989 to 14 January 1990 and from 10 October to 6 November 1990 to determine the abundance, distribution and behavior of peregrines. By capturing banded individuals we hoped to determine their origin. Telemetry was used to ascertain migration and use of habitat.

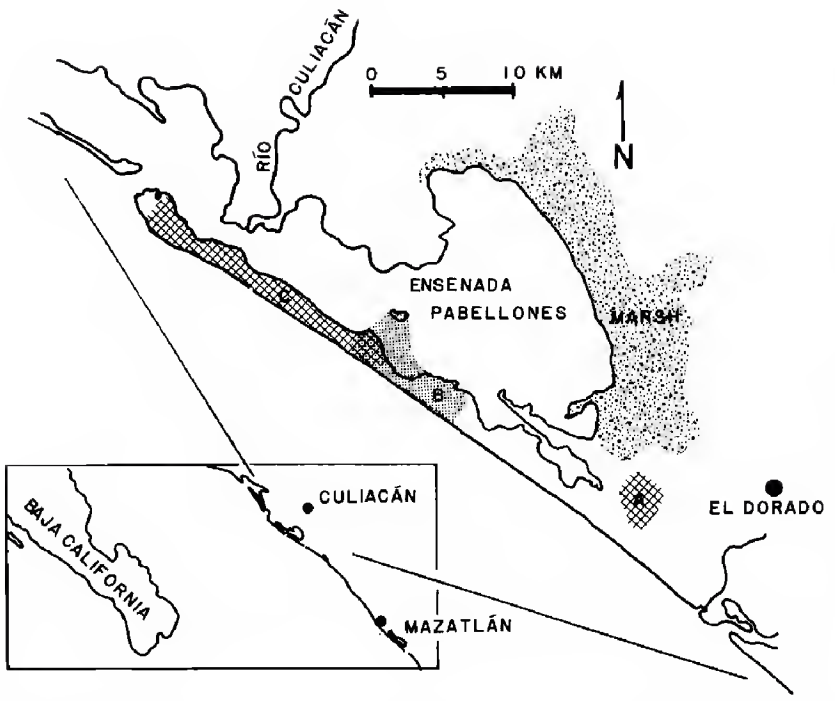

Figure 1. Areas used by radio-tagged adult female peregrines in winter 1989–90 (A on sand flat), and in fall 1990 (B and C on Península de Lucenilla).

STUDY AREA AND METHODS

The Culiacán area, east of southern Baja California (Fig. 1), is a coastal plain 40 km wide and 130 km long used for irrigated farming. The Gulf of California there is bordered by barrier beaches. Extending 8–17 km inland are salt water bays and farther east, fresh water marshes. Where crops are not cultivated, low scrub woodland occurred on the high ground. Near sea level, shallow pools in vast open sand flats with little vegetation attracted shorebirds and waterfowl. In the first period, winter 1989–90, we searched for peregrines on such flats, and in a freshwater marsh 6 km wide and 20 km long on the mainland side of a bay, Ensenada del Pabellones (Fig. 1). In the second period, fall 1990, we also searched a 43 km long barrier beach, Península de Lucenilla, seaward of the bay and marsh.

The marsh was open water, usually less than 1 m deep, except for about 25% coverage by cattails (*Typha* sp.). Several hundred thousand each of Northern Pintails (*Anas acuta*), Cinnamon Teal (*A. cyanoptera*), Green-winged Teal (*A. crecca*), and American Coots (*Fulica americana*) were present. Yellow-headed Blackbirds (*Xanthocephalus xanthocephalus*) were the most conspicuous icterid. Blackbirds of several species, important prey of peregrines nesting in the western United States, numbered in the millions.

We traveled on the marsh by airboat, recording the age-group and sex of peregrines attracted to thousands of waterfowl flushed from our path. Sex was determined by relative size and wing-beat rate. In the first period, we searched flats only from roads, but in the second period we used all-terrain vehicles to reach the flats and outer barrier beach. Peregrines were captured using Rock Doves (*Columba livia*) with noose harnesses. Tail-mounted transmitters, 216 mHz, were placed on three adult females, and locations determined for up to 24 d afterward, often by searching until the bird was seen.

RESULTS

Habitat Use. In 24 hr of searching the marsh by airboat over 10 d in the first winter period, we saw 58 peregrines (2.4/hr). In the second period, 9 were seen in 3.5 hr (2.6/hr). When we adjusted for probable repeat sightings and omitted trips when resightings could not be determined based on plumage characteristics or location, 31 individuals were seen in 15.5 hr in the first period (2.0/hr) and 8 in 3.5 hr (2.3/hr) in the second period. One peregrine seen in the second period bore an anodized black band on the left leg, of the type used in the western United States. In the first period, five of the searches exceeded 2.5 hr and between 5 and 11 individuals were seen in each period.

In the second period, we made 10 complete and 2 partial trips on the 43 km barrier beach on Peninsula de Lucenilla. Peregrines seen on the first legs of the round trips, totaling 473 km, were recorded. We saw a peregrine for every 39 km of travel. Generally the outer beach had few peregrines. No more than six individuals were thought present in the period between 12 October and 6 November 1990.

In the first period, on 31 December 1989, we radiotagged an adult female on the largest flat 9 km west of the town of El Dorado (Fig. 1). This female bore a band attached in 1982, in Teton Park, Wyoming, where the bird was released. This bird was subsequently found on the flats three times in the presence of an adult male. In the second period, two adult females used the same flat and were seen in view of each other several times. One was wearing a black band on the left leg.

Dispersion. The adult female caught on the flat in the first period, and the two adult females caught on Peninsula de Lucenilla in the second period were equipped with transmitters and tracked for periods of 14, 23 and 24 d, respectively, until we left the region. The first falcon was located on each of six days when we searched, in an area smaller than 4 km in diameter. The bird was on the ground in the open, on posts, or twice in trees less than 3 m high.

The other two peregrines were captured on 14 and 15 October 1990. They were found 12 and 10 times, with maximum dispersion less than 19 and 8 km in extent, respectively (Fig. 1). Signals from the latter bird sometimes came from a small island in the bay inland of the peninsula. Both birds were located whenever we searched and were actually seen in several searches. They unpredictably moved in

the areas they frequented and showed no trend to move over days in a given direction. All three birds appeared to be established winter residents.

Age and Sex Ratios. Most peregrines identified were adult females. Combined totals for both periods in the marsh were 41 adult females, 2 adult males, 6 hatch-year females, and 4 hatch-year males. On the beach in the second period nine adult females, one hatch-year female, one hatch-year male, and a yearling female mid-way in the molt to adult plumage were seen.

Prey. Ducks flushed by airboats in the marsh attracted peregrines. We saw nine ducks caught when falcons rushed large flocks in near-level flight, but some attacks were from below. Once a pintail was caught and then released when the load seemed too heavy to carry; the falcon caught a teal soon afterward and flew inland. Fourteen teal, seen caught or identified from remains included a Blue-winged Teal (*A. discors*), two Cinnamon Teal and two Green-winged Teal (*A. carolinensis*). Nine teals were not identified to species. Other fresh prey remains, abandoned by peregrines at our approach, included a White-winged Dove (*Zenaida asiatica*), a Cattle Egret (*Bubulcus ibis*), and three unidentified shorebirds.

Merlins. Merlins (*F. columbarius*) were recorded on 11 trips on the beach in fall 1990. Sightings on the return trip were omitted to avoid repeat counts. In all, 36 Merlins were seen in 430 km of travel (1 individual/12 km). Many others were seen on the flats. Merlins attacked flocks of small shorebirds but most often were seen eating or carrying small passerines. Several were seen chasing small birds among the dunes. Very dark Merlins resembling *F. c. suckleyi,* typical of the North American Pacific Northwest, and pale birds, typical of the *F. c. richardsonii* from the Northern Prairie were seen.

DISCUSSION

The enormous prey resource attracted large numbers of peregrines to the Sinaloa area. The 130 km^2 marsh was probably hunted regularly by an estimated 10–20 peregrines based on the portion we searched and the rate of sightings. Some were seen on the few dead trees in the otherwise open marsh, but most hunted from perches on the perimeter and returned to perches with prey. Ducks larger than teal were probably not often taken because they are difficult to carry and there was little dry ground in the marsh where a falcon could land and feed.

The open flat with shallow pools near El Dorado was regularly used by one peregrine in the first period and by two in the second. These birds usually fed by 0700 H, suggesting conditions conducive to easy hunting. We saw several attacks where the peregrine climbed steeply to 100–200 m and then flew powerfully in an increasingly high speed dive. Prey was usually hit near the ground.

The barrier beach had few peregrines compared to Merlins, and seemed to have few prey birds in the size range taken by either falcon. No peregrine was seen hunting there, although an adult female was seen eating a medium-sized shorebird. Most peregrine prey was probably caught on the bay side of the peninsula, perhaps over water. Merlins probably hunted inland from the beach where large open grassland areas were present. When flushed on the beach, Merlins nearly always flew inland. The wide, open beach was seemingly attractive to both species because it offered numerous perching places on driftwood clear of vegetation.

In contrast to the eastern coast of Mexico, no peregrine migration was evident in this study. In the second period, when the migration was at its peak on the east coast (T. Maechtle, pers. comm.), we never saw more than three peregrines on the beach in one day. Furthermore, on 4 of 12 trips no peregrine was seen, although the positions of radio-tagged falcons were found. If a migration typical of the coast along the Gulf of Mexico had been in progress we might have encountered several times more peregrines each trip and those would have been replaced by others of different plumages and sexes within a few days, revealing a turnover of individuals.

We believe only 1–2 individuals in addition to the two radio-tagged birds were resident on the 43 km long peninsula. Peregrines apparently use coastal areas in winter in other regions. Of 10 banded peregrines from Canada recovered in winter in Central and South America, seven were within 30 km of coasts (Schmutz et al. 1991).

Some of the peregrines wintering near Culiacán are from the western United States. Besides the evidence provided by the three banded birds encountered, plumages of many were like those nesting in the Rocky Mountains or the Colorado Plateau. The warm climate, and very abundant prey resource of the study area sharply contrast with the cold montane nights and relatively sparse prey resource encountered by these birds in the breeding season. Curiously, only 1 of 45 peregrines, most banded in

western Canada, was recovered on the Pacific coast (Schmutz et al. 1991).

Apparently not all peregrines in Sinaloa in winter are of inland, temperate origin. One of the captured females was in mid-molt in mid-October (4 of 12 tail feathers were fully grown), typical of peregrines from the arctic. The captured hatch-year male was typical of *F. p. pealei* from Pacific maritime regions.

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LITERATURE CITED

ENDERSON, J.H. 1965. A breeding and migration survey of the Peregrine Falcon. *Wilson Bull.* 77:327–339.

HUNT, W.G., R.R. ROGERS AND D.J. SLOWE. 1975. Migratory and foraging behavior of Peregrine Falcons on the Texas coast. *Can. Field-Nat.* 89:111–123.

SCHMUTZ, J.K., R.W. FYFE, U. BANASCH AND H. ARMBRUSTER. 1991. Routes and timing of migration of falcons banded in Canada. *Wilson Bull.* 103:44–58.

YATES, M.A., K.E. RIDDLE AND F.P. WARD. 1988. Recoveries of Peregrine Falcons migrating through the eastern and central United States, 1955–1985. Pages 471–483 *in* T. Cade, J.H. Enderson, C.G. Thelander and C.M. White [EDS.]. Peregrine Falcon populations. The Peregrine Fund, Inc., Boise, ID.

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NOTE ADDED IN PROOF:

We recently learned that Bird C (Fig. 1) was identified by our marker-band on 8 July 1991, nesting 50 km downstream of Eagle, Alaska. She had two young and her transmitter was still in place.

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HUNTING TECHNIQUES AND SUCCESS RATES OF URBAN MERLINS (*Falco columbarius*)

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ABSTRACT.—Hunting techniques and success rates are described for urban Merlins (*Falco columbarius*). Attack from a perch was the most common technique (58% during breeding, 95% during winter) and cruising flights the second most common (37% and 5%, respectively). Hunting success of breeding Merlins was significantly higher (28%) than wintering birds (11%).

Modalidades de caza y sus proporciones de éxito en los halcones de la especie *Falco columbarius*

EXTRACTO.—Describimos las modalidades de caza y sus correspondientes proporciones de éxito en los halcones de la especie *Falco columbarius*. El ataque desde una percha fue la modalidad más frecuente (58% durante la época de reproducción y 95% durante el invierno). En segundo lugar se observó la cacería al vuelo (37% y 5% respectivamente). Estos halcones tuvieron más éxito en sus cacerías durante la época de reproducción (28%) que durante el invierno (11%).

[Traducción de Eudoxio Paredes-Ruiz]

The hunting techniques used by raptors depend upon the type of prey, habitat, weather, and characteristics of the hunting bird such as age, sex and experience (Balgooyen 1976, Wakeley 1978, Cade 1982). Merlins (*Falco columbarius*) feed primarily on small birds (Oliphant and McTaggart 1977, Becker 1985, James and Smith 1987, Sodhi et al. 1990). Most published information on hunting techniques of this species has been obtained from migrating or wintering birds (Rudebeck 1951, Page and Whitacre 1975, Boyce 1985, Buchanan et al. 1988, Dekker 1988, Warkentin and Oliphant 1990). Similar data obtained during the breeding season are generally based on few observations (Armitage 1932, Craighead and Craighead 1940, Roberts 1962, Kermott 1981). Here, we describe the hunting techniques and success rates of Merlins from an intensively studied urban breeding population in Saskatoon, Saskatchewan (Oliphant and Haug 1985, James 1988) and make comparisons to the hunting behavior of Merlins wintering there.

METHODS

Breeding Merlins (*F. c. richardsonii*) were trapped at their nests in Saskatoon and fitted with radiotransmitters Between May and July 1987–90, observations of hunting behavior were made on 16 males and 11 females that were tracked for a total of 1200 hr. Only one bird was tracked at a time, generally for 4-hr periods during the first and last four daylight hours. The methodology employed in radio tracking is presented by Sodhi et al. (1991).

From 1983–88, Merlins were trapped each winter. Most of the wintering Merlins at Saskatoon are derived from the local breeding population (Warkentin et al. 1990). Individuals were fitted with radiotransmitters and detailed information was gathered throughout the day from six females and three males during 542 hr of direct visual contact. A detailed description of methodology for the collection of data in winter is presented by Warkentin and Oliphant (1990).

In addition, we present other observations of hunting Merlins, made on an urban wintering population of Black Merlins (*F. c. suckleyi*) in Seattle, Washington, from 1968–70 and on the Saskatoon population (both breeding and wintering) from 1971–90. These observations are difficult to quantify in terms of hours but conservatively represent about 200 separate attacks on prey. Generally only in-

Table 1. Hunting techniques used by breeding Merlins in Saskatoon, Canada. Most data (n = 73) were collected from 26 radio-tagged adults. Data are presented as number of hunting attempts made. Hunting success rate on species on which ≥3 attempts were observed is also reported. AP = attack from perch, CF = cruising flights, and OHF = other hunting flights.

SPECIES	AP	CF	OHF	TOTAL	SUCCESSFUL	% SUCCESS[a]
House Sparrow (*Passer domesticus*)	16	7	—	23	13	56
American Robin (*Turdus migratorius*)	6	2	—	8	1	11
Brewer's Blackbird (*Euphagus cyanocephalus*)	4	—	1	5	1	20
Horned Lark (*Eremophila alpestris*)	—	2	1	3	1	33
Cedar Waxwing (*B. cedrorum*)	1	—	1	2	0	0
Chipping Sparrow (*Spizella passerina*)	4	—	—	4	2	50
Tree Swallow (*Tachycineta bicolor*)	—	1	—	1	0	0
Common Grackle (*Quiscalus quiscula*)	1	—	—	1	0	0
Eastern Kingbird (*Tyrannus tyrannus*)	—	2	—	2	0	0
Unidentified	14	16	1	31	3	30
Total	46	30	4	80	21	28

[a] Values are based on hunting attempts of known outcome only.

stances where kills were observed were recorded, making it impossible to generate success rates from these observations. Observations were also recorded of the hunting flights of seven falconry-trained Merlins.

A hunting attempt was considered as one or more strikes at potential prey (Page and Whitacre 1975, Dekker 1988, Warkentin and Oliphant 1990). Even when the bird disappeared from view, radiotracking facilitated, based on radio signal amplitude, in determining whether it had changed the hunting technique when out of view.

RESULTS

Description of Hunting Techniques. Merlins used three main hunting techniques which are listed separately below although they were at times used in conjunction.

Attack from perch (AP). Merlins often (58% in summer and 95% in winter; Tables 1 and 2) initiated attacks directly from perches such as conifers, utility poles, deciduous trees, and even the ground. When hunting from high perches, prey sighted at considerable distances were attacked by strong direct flights. The falcon at times initially glided down to near ground level from the perch, which may allow greater acceleration and provide concealment when approaching potential prey. The final approach toward prey was often a fixed-wing glide.

Ground perches were used by Merlins while hunting in open country. These perches possibly made Merlins less detectable and enabled them to attack flying birds from below, forcing the prey away from cover. On one occasion, we observed a Merlin landing in a spruce tree that had House Sparrows in it, about 1 m from the ground. The falcon started hopping down until it chased the sparrows out and then it followed them. Out of 45 attacks of known outcome initiated from a perch, 12 (27%) were successful in summer. In winter, Merlins were successful in 30 (11%) of 273 attempts from a perch.

Cruising flights (CF). This was the second most common hunting technique used (37% in summer and 5% in winter; Tables 1 and 2). The hunting Merlins flew at high speed and at varying altitudes, close to the ground or just over or below the canopy in wooded areas. Birds already in flight or flushed at the approach of the Merlin were attacked. Low fast flights were frequently used while hunting in open country. This behavior was efficient in capturing prey such as Horned Larks that flushed from ground cover. In urban areas, Merlins often used streets as relatively open paths along which they flew at high speed below the arched canopy of trees. House Sparrows that flushed from beside or under parked vehicles were particularly vulnerable to attack. Birds such as Bohemian Waxwings (*Bombycilla garrulus*) and Cedar Waxwings were caught after flushing ahead of the Merlin, or were taken directly off their perches.

On one occasion, we observed a flying Merlin attack a blackbird that had been flushed by a Swainson's Hawk (*Buteo swainsoni*). On another occasion, a Merlin took a quarry flushed by a dog. We also observed one attack on a nest of an Eastern Kingbird. The Merlin took a nestling from the nest while

Table 2. Hunting techniques used by wintering Merlins in Saskatoon, Canada. Data presented were collected from radio-tagged birds. For abbreviations of hunting techniques see Table 1.

SPECIES	AP	CF	TOTAL	SUCCESSFUL	% SUCCESS
House Sparrow	260	11	271	25	9.2
Waxwings	12	2	14	5	35.7
Common Redpoll (*Carduelis flammea*)	1	0	1	1	—
Total	273	13	286	—	—

passing over, without landing. Of 28 cruising attacks of known outcome during the breeding season, six (21%) were successful. In winter, only one of 13 (8%) attempts were successful using this technique.

Other hunting flights (OHF). Merlins also used three other types of hunting flights (5% in summer and 0% in winter; Tables 1 and 2) to capture their prey. Some of these behaviors were not used by radio-tracked birds.

a) Ringing flights. Certain prey species (e.g., Horned Lark and Bohemian Waxwing) attempted to outfly attacking Merlins resulting in rising aerial chases. The term "ringing" denotes the tendency for both prey and pursuer to fly in circles as they climbed. Typically, the quarry flew in tighter circles as was described by Williamson and Williamson (1953). Merlins climbed in larger circles, often at such a distance that it was not always evident that it was actually in pursuit. If the Merlin succeeded in outclimbing its prey, it then stooped; forcing its quarry to do likewise to avoid being caught. Prey were typically taken after one or more stoops or were able to successfully find cover. Both flocks and solitary birds were attacked by this technique.

b) Straight aerial pursuit. Birds such as swallows attempted to outfly the Merlin by sheer speed and maneuverability. These flights consisted of a series of rapid, short stoops and direct aerial chases over a relatively long period of time but did not vary much in altitude.

Native sparrows (e.g., the Clay-colored Sparrow, *Spizella pallida*) and juncos that flushed from sparse cover were often capable of dodging several attacks by a pursuing Merlin. These attacks took the form of a series of twisting swoops in rapid succession, the Merlin rising less than 1 m above its quarry.

c) Attack from high soar. Similar to the hunting technique described by Walter (1979) for Eleonora's Falcon (*F. eleonorae*), soaring Merlins stooped at birds flying at considerable distance below. Soaring flights were observed near the height of spring migration when greater numbers of birds passed through at moderately high altitudes.

Hunting Success Rates. The success rate of the AP was slightly, but insignificantly higher than CF both in summer ($Z = 0.6$, $P > 0.05$) and winter ($Z = 0.4$, $P > 0.05$). Merlins were observed to attack nine and three species of passerines during summer and winter, respectively (Tables 1 and 2). The percent of successful hunting attempts was highest on House Sparrows during the breeding season. During winter, hunting Merlins were more successful when attacking waxwings. Overall, 28% (21/75) and 11% (31/286) of hunting attempts of known outcome (observed from start to finish) were successful during summer and winter respectively, a significant difference ($Z = 5.6$, $P < 0.05$).

DISCUSSION

Both wintering and breeding Merlins most frequently attacked prey from a perch. However, breeding Merlins more frequently attacked prey while in cruising flight than wintering Merlins ($\chi^2 = 66.8$, $P < 0.01$). While wintering Merlins made relatively more attacks from a perch. These differences may be dependent upon seasonal differences in prey behavior (e.g., flocking), prey species attacked, energetic constraints and habitat used by Merlins.

In contrast to our results, it has been documented previously that while hunting shorebirds, wintering Merlins use aerial attacks more frequently than other hunting techniques (Page and Whitacre 1975, Boyce 1985, Buchanan et al. 1988, Dekker 1988). It is possible that the urban setting may have made aerial attacks less feasible or that extended aerial chases are more conspicuous in rural settings and therefore more often recorded. These differences could

also be due the different prey species (e.g., shorebirds versus passerines).

The hunting success of Merlins during the breeding season was significantly higher than during winter in Saskatoon. These differences could be due to the fact that radio-tagged breeding Merlins were only observed when actively hunting. Other studies on wintering or migrating Merlins report hunting success rates between 5–22% for Merlins (Rudebeck 1951, Page and Whitacre 1975, Buchanan et al. 1988, Dekker 1988, Dickson 1988). Dekker (1988) reported a hunting success rate of 40% for breeding Merlins. Thus, the available information indicates that hunting success of Merlins during the breeding season is higher than in winter or migration. Some of the possible reasons for this include: a) only efficient foragers breed, b) prey vulnerability might be higher during the breeding season due to an influx of fledged birds in prey populations, and c) migrant and winter populations of Merlins include higher numbers of juvenile birds, which may be less experienced hunters.

Most hunting techniques reported here have been previously documented (Armitage 1932, de Lawrence 1949, Rudebeck 1951, Williamson and Williamson 1953, Roberts 1962, Sperber and Sperber 1963, Page and Whitacre 1975, Kermott 1981, Buchanan et al. 1988, Dekker 1988). However, Merlins landing in cover and then flushing and attacking prey, and attacking from high soar have not been reported earlier. Although Merlins have been observed attempting to capture prey flushed by other objects (both living and nonliving; Jenkins 1972, Bjorkman 1978, Cudworth and Massingham 1986, Dekker 1988), we document the first such hunting with prey flushed by a Swainson's Hawk and a dog. Some hunting behaviors previously reported in literature, were not observed by us (e.g., Haug 1985).

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LITERATURE CITED

ARMITAGE, J. 1932. Merlins taking young from nests. *Brit. Birds* 25:303–304.

BALGOOYEN, T.G. 1976. Behavior and ecology of the American Kestrel (*Falco sparverius*) in the Sierra Nevada of California. *Univ. Calif. Publ. Zool.* 103:1–83.

BECKER, D.M. 1985. Food habits of Richardson's Merlin in southeastern Montana. *Wilson Bull.* 97:226–230.

BJORKMAN, G. 1978. Hunting association between Merlin, *Falco columbarius*, and Hen Harrier, *Circus cyaneus*. *Var Fagelvarld* 37:259.

BOYCE, D.A. 1985. Merlins and the behavior of wintering shorebirds. *Raptor Res.* 19:94–96.

BUCHANAN, J.B., C.T. SCHICK, L.A. BRENNAN AND S.G. HERMAN. 1988. Merlin predation on wintering Dunlins: hunting success and Dunlin escape tactics. *Wilson Bull.* 100:108–118.

CADE, T. 1982. The falcons of the World. Cornell University Press, Ithaca, New York.

CRAIGHEAD, J. AND F. CRAIGHEAD. 1940. Nesting Pigeon Hawks. *Wilson Bull.* 52:241–248.

CUDWORTH, J. AND C. MASSINGHAM. 1986. Hen Harrier and Merlin hunting together. *Brit. Birds* 79:340.

DEKKER, D. 1988. Pergerine Falcon and Merlin predation on small shorebirds and passerines in Alberta. *Can. J. Zool.* 66:925–928.

DICKSON, R.C. 1988. Habitat preferences and prey of Merlins in winter. *Brit. Birds* 81:269–273.

HAUG, E. 1985. Merlin feeding on road-kills. *Raptor Res.* 19:103.

JAMES, P.C. 1988. Urban Merlins in Canada. *Brit. Birds* 81:274–277.

——— AND A.R. SMITH. 1987. Food habits of urban-nesting Merlins, *Falco columbarius*, in Edmonton and Fort Saskatchewan, Alberta. *Can. Field-Nat.* 101:592–594.

JENKINS, M.A. 1972. Opportunistic hunting tactics of the Merlin. *Bird-Banding* 8:40–41.

KERMOTT, L.H. 1981. Merlins as nest predators. *Raptor Res.* 15:94–95.

DE LAWRENCE, L.K. 1949. Notes on nesting Pigeon Hawks on Pimisi Bay, Ontario. *Wilson Bull.* 61:15–25.

OLIPHANT, L.W. AND E. HAUG. 1985. Productivity, population density and rate of increase of an expanding Merlin population. *Raptor Res.* 19:56–59.

——— AND S. MCTAGGART. 1977. Prey utilized by urban Merlins. *Can. Field-Nat.* 91:190–192.

PAGE, G.W. AND D.F. WHITACRE. 1975. Raptor predation on wintering shorebirds. *Condor* 77:73–83.

ROBERTS, E.L. 1962. Merlins taking newly hatched passerines. *Scot. Birds* 2:245.

RUDEBECK, G. 1951. The choice of prey and modes of hunting of predatory birds with special reference to their selective effect. *Oikos* 3:200–231.

SODHI, N.S., A. DIDIUK AND L.W. OLIPHANT. 1990. Differences in bird abundance in relation to proximity of Merlin nests. *Can. J. Zool.* 68:852–854.

———, I.G. WARKENTIN, P.C. JAMES AND L.W. OLIPHANT. 1991. Effects of radiotagging on breeding Merlins. *J. Wildl. Manage.* 55:in press.

SPERBER, I. AND C. SPERBER. 1963. Notes on the food consumption of Merlins. *Zool. Bidrag. Uppsala* 35:263–268.

WAKELEY, J.S. 1978. Hunting methods and factors affecting their use by Ferruginous Hawk. *Condor* 80: 327–333.

WALTER, H. 1979. Eleonora's Falcon. University of Chicago Press, Chicago, IL.

WARKENTIN, I.G. AND L.W. OLIPHANT. 1990. Habitat use and foraging behavior of urban Merlins (*Falco columbarius*) in winter. *J. Zool., Lond.* 221:539–563.

———, P.C. JAMES AND L.W. OLIPHANT. 1990. Body morphometrics, age structure, and partial migration of urban Merlins. *Auk* 107:25–34.

WILLIAMSON, K. AND E. WILLIAMSON. 1953. Hoopoe pursued by a Merlin. *Scot. Nat.* 65:56–57.

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NESTING PHENOLOGY, SITE FIDELITY, AND DEFENSE BEHAVIOR OF NORTHERN GOSHAWKS IN NEW YORK AND NEW JERSEY

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ABSTRACT.—Eleven Northern Goshawks (*Accipiter gentilis*) were detected on territory during midwinter suggesting that most nesting pairs are permanent residents along the New York-New Jersey border. The onset of incubation occurred primarily (80%) during the second through fourth weeks in April at 20 nests monitored. Only two of 35 nesting attempts were made by immature-plumaged females and all breeding males observed were in adult plumage. Goshawks built from one to five nests in the nesting area and an occupancy of 18 sites averaged 3.8 years. Nest defense was scored at 20 nests but no significant correlation between aggression and habituation to human habitation was apparent. Extreme aggressive attacks on ground observers occurred only during single observer visits. Aggressive attacks by the female were most intense during the early nestling stage. Males participated on only 18% of nest defense encounters and were usually less aggressive.

Época reproductiva, fidelidad al nido, y conducta de defensa en el Gavilán Azor, en Nueva York y Nueva Jersey

EXTRACTO.—Once Gavilanes Azor (*Accipiter gentilis*) fueron detectados en su territorio durante la mitad del invierno, lo que sugiere que la mayoría de las parejas reproductoras son residentes permanentes a lo largo de la frontera entre Nueva York y Nueva Jersey. En 20 nidos observados, los inicios de la incubación ocurrió primariamente (80%) desde la segunda a la cuarta semana de abril. Solo dos de los 35 intentos de nidificar fueron hechos por hembras con el plumaje que es típico de aves aún inmaduras, mientras que todos los gavilanes machos observados estaban ya en su plumaje de adultos. Los gavilanes construyeron de uno a cinco nidos en el área de reproducción y la ocupación en 18 sitios promedió 3.8 años. La intensidad de defensa del nido fue registrada en 20 nidos. No hubo aparente correlación entre la agresión y la habituación a zonas pobladas por personas. Ataques de agresión extrema, a quien hace la observación desde el suelo, ocurrió sólo durante visitas de observación individuales. Los ataques agresivos por las hembras fueron más intensos durante el período de las crías en el nido. Los machos participaron en sólo 18% de los encuentros de defensa del nido y fueron usualmente menos agresivos.

[Traducción de Eudoxio Paredes-Ruiz]

There are few accounts on the nesting behavior of Northern Goshawks (*Accipiter gentilis*) in North America. Sutton (1925), Bent (1937), Bailey and Niedrach (1938), Todd (1940), Schnell (1958), and Bartelt (1977) provided qualitative accounts of nesting behavior. Allen (1978) observed prey deliveries and development of young from a blind at two nests in the Adirondack Mountains of New York. Hennessy (1978) reported increased "aggression" by adult goshawks toward human intruders from March through August in Utah. Lee (1981) observed two nests in Utah and speculated on relationships between human activity, nest defense, and habituation by goshawks to disturbance. Reynolds and Wight (1978) reported information on nest site tenacity and nesting phenology of goshawks in Oregon.

Since the mid-1970s, we have studied the nesting ecology of Northern Goshawks in northern New Jersey and southeastern New York. Most of this research has focused on population status, habitat selection, and nest site characteristics (Speiser and Bosakowski 1984, 1987, 1989, Bosakowski 1990). Here, we present some details of goshawk nesting biology and behavior in the northeastern United States where little information has been previously reported.

STUDY AREA AND METHODS

Goshawks were studied at nest sites in northern New Jersey (Morris, Passaic, and Sussex Counties) and southeastern New York (Orange County). This area is comprised of rolling hills and valleys (41 north latitude) with nests ranging between 250–400 m in elevation. The study area was extensively forested excepting occasional suburban housing developments, reservoirs, and rights-of-way. Forest composition and physiognomy have been previously described in detail (Speiser and Bosakowski 1987).

Observations of incubating or protesting goshawks were made at nest sites found from 1977–89. A "nest site" is defined as an active nest and the forest area immediately surrounding the nest. A "traditional nest site" is defined as a nest which is used for at least two nesting seasons. A "nest area" is defined as a traditional nesting area which contained one or more nests and was used over a period of several nesting seasons, presumably by the same male and/or female. Reynolds and Wight (1978) estimated goshawk nest areas as 8–10 ha in extent.

All observations were made by observing nests, goshawks, and their young with binoculars from the ground without blinds. The nest tree was not climbed at any nest site. A total of 35 nesting attempts were studied from 20 different nest areas. The onset of incubation was monitored by repeated visits to nest sites during 20 nest attempts. At 18 nest areas, signs of nesting activity (i.e., greenery, incubating or protesting birds, young) were monitored from initiation of the first nest to final abandonment of nest areas to determine the duration of "nest site fidelity." Aggression to a single human intruder was ranked at 16 different nest sites as: high (actual strike or diving within striking distance), medium (diving outside of striking range), and low (flyovers and/or protesting only). Reactions were summarized from one or more visits by a single observer during visits when nestlings were estimated to be between 2–3 wk of age.

RESULTS AND DISCUSSION

Nesting Phenology. In our region, most goshawks appear to be permanent residents. Mid-winter observations of goshawks were made at or near several traditional nest sites ($N = 6$) and others were lured-in near nest sites with broadcasts or imitations of various raptor calls ($N = 5$). The majority of breeding goshawks probably begin regular visits to the nest site in late February as we usually observed fresh greenery and newly added sticks on the nest by mid-March. In one exceptional case, during an unusually mild winter, a new, almost completed nest with a protesting adult (sex undetermined) was discovered on 1 January 1990. This nest was defended vigorously in late May and was located about 300 m from the previous year's nest which was successful.

Observations of incubating goshawks were made at 20 closely monitored nests. Along with back-dating from the age of young, we estimated that incubation commenced primarily (80%) during the second through fourth week in April with a mean of 23 April (Fig. 1). Henny et al. (1985) reported a similar mean date (24 April) for clutch completion in eastern Oregon at elevations ranging from 500–1600 m. However, Reynolds and Wight (1978) reported a later mean date (6 May) for goshawks initiating incubation in Oregon which was apparently a result of higher elevation 1430–2130 m.

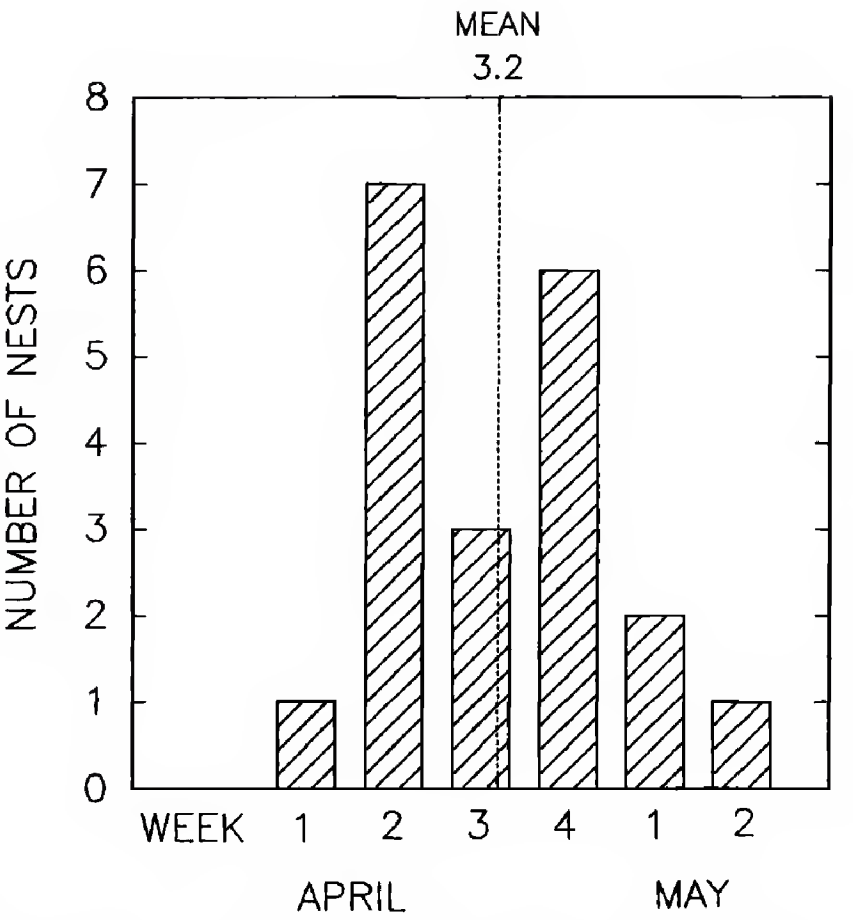

Figure 1. Onset of incubation at 20 Northern Goshawk nests found along the New Jersey-New York Border.

Of 35 nesting attempts studied in total, we observed only two females breeding in immature plumage and all males observed ($N = 18$) were in adult plumage. Similar frequencies of nesting by immature-plumaged females have been reported in the literature, but immature males have not been reported to attempt breeding (Henny et al. 1985, Palmer 1988).

Nest Site Fidelity. Nest areas were occupied from one to eight years with an average occupancy of 3.83 (SD = 3.05) years. Reynolds and Wight (1978) reported occupancy of nest areas only up to five years for goshawks nesting in Oregon. A nest area in Washington has been continuously occupied for at least 10 years (D. Bates, R. Speiser, T. Bosakowski, pers. observation).

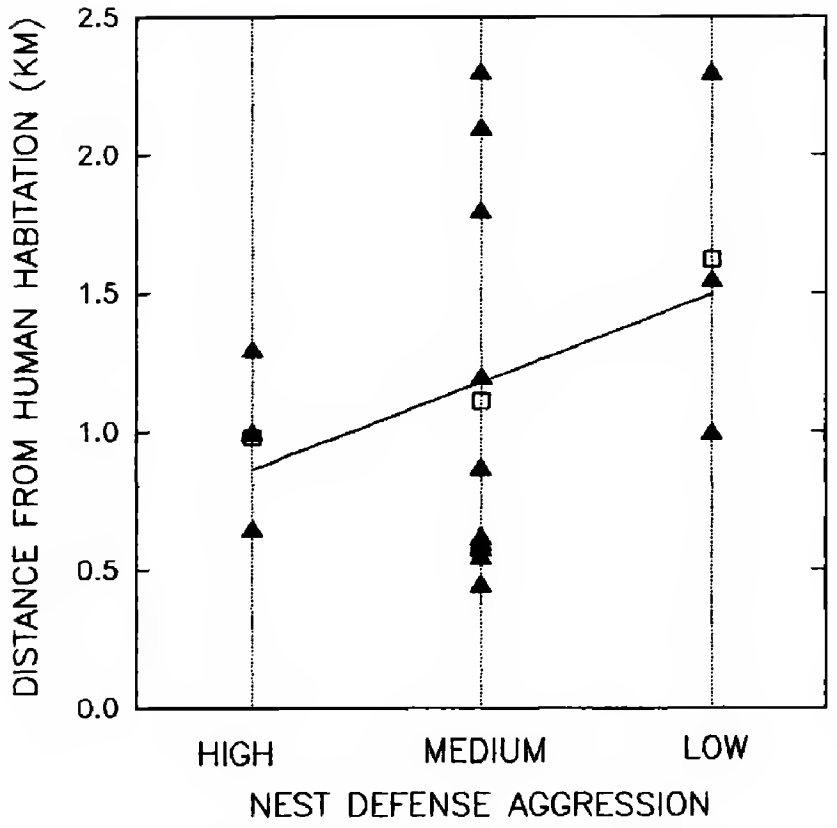

Figure 2. Nest defense aggression rank at 16 Northern Goshawk nests versus distance to human habitation. Squares represent mean for each rank. The least squares correlation was extremely weak (r = 0.005) and was not significant by ANOVA (P = 0.788).

During their occupancy, goshawks built and/or nested in one to five nests in the nest areas investigated in the study area. Each year, goshawks often used different nests in their nest area regardless of the nesting success or failure of the previous year. All nests, except one, were originally constructed by the nesting goshawks. The one exception was of unknown origin (probable goshawk nest) and was vacant for eight years prior to its use.

Once abandoned, traditional nest areas were not rapidly reoccupied for nesting. Only one reoccupation of a nest area in our region is known; this was following a period of seven years vacancy. These results support previous conclusions (Speiser and Bosakowski 1984, Bosakowski 1990) that the number of nesting pairs are below saturation levels and densities are considerably lower compared to other regions (see review by Reynolds 1983).

Nest Defense Behavior. The goshawk is a secretive forest raptor throughout the year, except during the breeding cycle, when adults respond aggressively to human intruders with loud vocalizations, aggresive fly-bys, and aerial attacks (Sutton 1925, Bent 1937, Todd 1940, Lee 1981, this study). During incubation we found that females usually sat tight on the nest and rarely flushed even if the observer stood beneath the nest tree. At that time the male was secretive. However, during the early brood period (nestlings less than two weeks in age) the female became most aggressive and was occasionally supported by protesting vocalizations of the male who only participated in 18% of cases of nest defense. Schnell (1958) also noted that nest area defense was not characteristic of the male goshawk.

Nest defense usually began with protracted "cackle" alarm calls described as "cac, cac, cac" in Bent (1937). These calls were uttered by both adults if present. The cackling was quickly followed by repeated flyovers, then direct diving at the intruder primarily by the female. When young were more than three weeks old, adults rarely attacked an observer which was also noted by Julian (1971). At this time, the young were sometimes left unattended for up to a few hours. After the young fledged, aggression was greatly reduced to an occasional protest alarm call as the family unit quickly retreated away from the nest area.

The most aggressive aerial attacks were initiated by the female if an intruder came within about 100 m of the nest during the early nestling stage. Furthermore, attacks became more vigorous if an observer moved in the direction of the nest. We noticed that occasional solitary hikers on nearby trails (<60 m) were not usually attacked. Stopping and watching the nest from the same trail was not tolerated and usually provoked aggressive attacks. Ground observers were struck on only two occasions in this study, partially because we often flailed our arms and yelled, causing the bird to break its attack or retreat. In North America, ground observers have been occasionally struck by goshawks (Bent 1937, Lee 1981, this study), but the habit is not apparent in European goshawks (*A. g. gentilis*) presumably because they have long been persecuted (Newton 1979, R.E. Kenward, pers. comm.).

We also observed a direct relation between the magnitude of aggressive encounters and the number of observers in the party. Goshawks were noticeably less bold and aggressive when more than one observer was present. Visits to active nest sites have shown at least 15 extreme aggressive attacks during at least 80 single observer visits in comparison to no aggressive attacks during some 30 multiple observer visits (these numbers are estimates and refer strictly to attacks upon ground observers). Sutton (1925) also noted that a female goshawk became much more

bold and aggressive when other members of his party left him alone to study the nest. Hennessy (1978: 51) stated that "a large number of people would elicit a milder protest and less likelihood of an actual attack than fewer people." During our study, a minimum group size of two was always sufficient to prevent extremely aggressive attacks. In addition, adults tended to leave the nest area within a matter of minutes if a group of two or more people were present, but would continue protesting from a distance.

The possible relationship of distance to human habitation and the extent of aggressive nest defense behavior was also examined. However, no significant correlation was observed (Fig. 2). Thus, there is no clear indication that goshawks nesting closer to development have habituated to human disturbance (and have become less aggressive) or that less-aggressive goshawks will tolerate closer human habitations. In our study area, goshawks typically selected remote habitats, significantly farther from human habitation than random sites (Speiser and Bosakowski 1987), even though nest site selection always precedes the period of aggressive nest defense behavior. Lee (1981) believed that goshawks habituated to human disturbance, but this assumption was based on only two nests. Our data do not support such an hypothesis from a "normal" population of 20 nest sites that was not excessively disturbed during the nesting season (i.e., only two nests were on frequently used hiking trails). Thus, we suspect that nest defense by goshawks is a fairly inflexible response which is rarely modified by habituation to disturbance or proximity to human habitation.

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LITERATURE CITED

ALLEN, B.A. 1978. Nesting ecology of the goshawk in the Adirondacks. M.S. thesis, State University of New York, Syracuse, NY.

BAILEY, A.M. AND R.J. NIEDRACH. 1938. A day with a nesting goshawk. *Nature Magazine* 31:38–40.

BARTELT, P.E. 1977. Management of the American goshawk in the Black Hills National Forest. M.A. thesis, University of South Dakota, Vermillion, SD.

BENT, A.C. 1937. Life histories of North American birds of prey. Part 1. Bull. No. 167, U.S. National Museum.

BOSAKOWSKI, T. 1990. Community structure, niche overlap, and conservation ecology of temperate forest raptors during the breeding season. Ph.D. thesis, Rutgers University, Newark, NJ.

HENNESSY, S.P. 1978. Ecological relationships of accipiters in northern Utah—with special emphasis on the effects of human disturbance. M.S. thesis, Utah State University, Logan, UT.

HENNY, C.J., R.A. OLSEN, AND T.L. FLEMING. 1985. Breeding chronology, molt, and measurements of Accipiter Hawks in northeastern Oregon. *J. Field Ornithol.* 56:97–112.

JULIAN, L.T. 1971. Some observations on a goshawk nest. *Colo. Field Ornithol.* 10:4–5.

LEE, J.A. 1981. Habituation to human disturbance in nesting Accipiters. *Raptor Res.* 15:48–52.

NEWTON, I. 1979. Population ecology of raptors. Buteo Books, Vermillion, SD.

PALMER, R.S. [ED.]. 1988. Handbook of North American birds. Diurnal Raptors, Part 1. Yale University Press, New Haven, CT.

REYNOLDS, R.T. 1983. Management of western coniferous forest habitat for nesting *Accipiter* hawks. General Technical Report RM-102, Rocky Mountain Forest and Range Experiment Station, U.S.D.A. Forest Service, Fort Collins, CO.

——— AND H.M. WIGHT. 1978. Distribution, density, and productivity of *Accipiter* hawks breeding in Oregon. *Wilson Bull.* 90:182–196.

SCHNELL, J.H. 1958. Nesting behavior and food habits of goshawks in the Sierra Nevada of California. *Condor* 60:377–403.

SPEISER, R. AND T. BOSAKOWSKI. 1984. History, status, and future management of Northern Goshawk nesting in New Jersey. *Records of New Jersey Birds* 10:29–33.

——— AND ———. 1987. Nest site selection by Northern Goshawks in Northern New Jersey and Southeastern New York. *Condor* 89:387–394.

——— AND ———. 1989. Nest trees selected by Northern Goshawks along the New York-New Jersey border. *Kingbird* 39:132–141.

SUTTON, G.M. 1925. Notes on the nesting of the goshawk in Potter County, Pennsylvania. *Wilson Bull.* 37: 193–199.

TODD, W.E.C. 1940. Birds of Western Pennsylvania. University of Pittsburgh Press, Pittsburgh, PA.

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Short Communications

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Injury to a Merlin (*Falco columbarius*) from Discarded Fishing Tackle

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Commercial and recreational fishing activities have been reported to cause fatalities in raptors (Knight et al. 1980, Meyers 1989, Watson 1989), as well as other species (Tarshis 1971, Trapp 1973, Schreiber 1975, Bartel 1984, Coe 1986 in NOAA 1988, Atkins and Henemann 1987, NOAA 1988, Croxall and Prince 1990), even to the extent of being implicated as the primary cause in some avian population declines (Weimerskirch and Jouventin 1987). Monofilament fishing line has been used to control bird predation near fish hatcheries (Ostergaard 1981), but of particular concern is the entanglement of birds in discarded monofilament fishing line (Tarshis 1971, Trapp 1973, NOAA 1988). Entanglement is probably common near lakes and reservoirs that support resident waterfowl populations and are used regularly for recreational fishing (W. Harris, pers. comm.). Typically, wings and/or feet of birds become entangled or wrapped with discarded monofilament line preventing escape and ultimately result in death from exhaustion or starvation (Tarshis 1971, Knight et al. 1980, Meyers 1989). We report an incident of a Merlin (*Falco columbarius*) found impaled on a fish hook attached to discarded monofilament fishing line.

On 16 September 1988, approximately 2 km south of Utah Lake State Park, Utah, a female Merlin was discovered hanging approximately 7 m above the ground from the end of a branch of a dead cottonwood (*Populus* sp.) tree. Shortly thereafter, the bird fell to the ground exhausted and did not struggle when picked up. There was 97 cm of fishing line still attached to a size 6 fishing hook that was imbedded in the bird's left wing near the radius and ulna (Fig. 1). A small lead weight was located 48 cm from the end of the line. Several meters of line remained on the branch from which the Merlin fell. Apparently, the bird was perched on the branch and became impaled when attempting to take flight.

A great deal of blood was present on left wing and body feathers. Some additional bleeding occurred when the hook was moved. An X-ray revealed that the hook had torn a portion of both the *extensor metacarpi radialis* and *pronator superficialis* muscles (Redig and Duke 1980) of the left wing (Fig. 2). Presumably, branches of the brachial artery and vein had been severed.

The hook was removed by Merrill Shupe, a veterinarian in the College of Biology and Agriculture at Brigham Young University. Afterward, the Merlin was transferred to a local falconer for rehabilitation. On 17 September the bird weighed 168 g, which is below average (e.g., 190–225 g; K. Tuttle, pers. comm.) for winter resident female Merlins in Utah. A topical antibiotic was applied because the wing injuries became swollen and bruised. On 19 September an infection was apparent, and 25 mg of cephalexin hydrochloride was administered orally twice daily for 7 d.

By 26 September the Merlin appeared stronger and displayed good movement in the injured left wing. Administration of oral antibiotic was discontinued. By 3 October, the Merlin weighed 175 g and injuries appeared to have healed. However, the bird held the injured wing away from the body when perched.

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Figure 1. Top: General condition of injury to a Merlin by discarded fishing line. Note matting of feathers from considerable blood loss. Note also length of the fishing line. Bottom: Hook location in the left wing. The point of the hook (arrow) appeared to be imbedded in muscle.

Figure 2. X-ray of the left wing of a Merlin due to imbedding of a fish hook in muscle. A tear in the muscle tissue (arrow) indicates the path that the point of the hook traveled after breaking through the skin.

A daily exercise program utilizing traditional falconry techniques (see Beebe 1984) was begun. On 1 November the Merlin was released to hunt and made 6 unsuccessful hunting attempts within 1 hr before finally taking a small unidentified bird as prey. By 8 November, weight had increased to 185 g, and the Merlin was again released to hunt. The bird perched temporarily on a nearby power pole, and the injured wing was still held noticeably away from the body. The Merlin flew from the power pole in a southerly direction, flew out of sight and was not seen again.

No laws currently exist to protect wildlife in such instances, except for litter regulations that are seldom enforced. The State of Utah currently has no regulations governing discard of fishing tackle, which would be virtually impossible to enforce (D. Shirley, pers. comm.). The incident reported here underscores the need for regulations and public education concerning discarded fishing tackle. Agencies that manage areas used for recreational fishing that are critical for wildlife should engage in public information campaigns aimed at reducing the incidence of needless and careless discard of fishing tackle. With help from informed and conscientious fishermen, injury and death to non-target wildlife can be reduced.

RESUMEN.—En septiembre 16, 1988, un Esmerejón (*Falco columbarius*) hembra fue descubierta, cerca del Utah Lake State Park, Utah County, Utah, a 7 metros de altura, colgada en un hilo de pescar de un árbol seco de álamo (*Populus* sp.). Un gancho de pescar, tamaño 6, conectado al hilo estaba incrustado en el ala izquierda del ave, cerca del radio y cúbito. Aparentemente el ave estaba posada en la rama y resultó cogida cuando intentaba volar. Una radiografía de la zona lesionada reveló que el gancho había desgarrado una parte de los músculos del ala (extensor metacarpi radialis y pronotor superficialis). Había sangrado considerablemente y se supone que las ramificaciones de las arteria y vena braquiales han sido también afectadas. El gancho ha sido removido, y el ave fue transferida a un halconero local para su rehabilitación diaria usando las técnicas tradicionales de cetrería. En noviembre 8, 1988, mientras estaba siendo sometido a entrenamiento

y ejercicios por el halconero, el halcón voló en dirección sur hasta que se perdío de vista. En el presente no hay leyes que protejan la vida silvestre en tales circunstancias. El incidente reportado aquí sugiere la necesidad de regulaciones y educación pública.

[Traducción de Eudoxio Paredes-Ruiz]

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LITERATURE CITED

ATKINS, N. AND B. HENEMANN. 1987. The dangers of gill netting to seabirds. *Am. Birds* 41:1395–1403.

BARTEL, K.E. 1984. Barn Swallow fatalities due to monofilament fish line. *N. Am. Bird Bander* 9:8.

BEEBE, F.L. 1984. A falconry manual. Hancock House Publ., Blaine, WA.

COE, J.M. 1986. Derelict fishing gear: disaster or nuisance? M.Sc. thesis, University of Washington, Seattle, WA.

CROXALL, J.P. AND P.A. PRINCE. 1990. Recoveries of Wandering Albatrosses *Diomedea exulans* ringed at South Georgia 1958–1986. *Ring. and Migra.* 11:43–51.

KNIGHT, R.L., J. SKRILETZ AND D.C. RYAN. 1980. Owl mortality and abandoned fishing line. *Raptor Res.* 14: 40.

MEYERS, J.M. 1989. Plastic causes death of Osprey (*Pandion haliaetus*). *Alabama Birdlife* 36(2):17.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA). 1988. Report of the interagency task force on persistent marine debris. U.S. Dept. of Commerce Report, Washington, DC.

OSTERGAARD, D.E. 1981. Use of monofilament fishing line as a gull control. *Prog. Fish Cult.* 43(3):134.

REDIG, P.T. AND G.E. DUKE. 1980. Medical management of birds of prey. Dept. of Veterinary Biology, College of Veterinary Medicine, University of Minnesota, St. Paul, MN.

SCHREIBER, R.W. 1975. Bad days for the Brown Pelican. *Natl. Geog. Mag.* 147(1):111–123.

TARSHIS, I.B. 1971. An unusual fatality of a yearling Canada Goose. *Jack-Pine Warbler* 49:128.

TRAPP, J.L. 1973. Mute Swans entangled in fishing line. *Jack-Pine Warbler* 51:91–92.

WATSON, J.W. 1989. Bald Eagle dies from entanglement in fish net. *J. Raptor Res.* 23:52–53.

WEIMERSKIRCH, H. AND P. JOUVENTIN. 1987. Population dynamics of the wandering albatross, *Diomedea exulans,* of the Crozet Islands: causes and consequences of the population decline. *Oikos* 49:315–322.

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Food Habits of the Great Horned Owl (*Bubo virginianus*) in the Cape Region of Lower California, Mexico

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On 4 May 1989 we discovered a Great Horned Owl (*Bubo virginianus*) nest with two young. The nest was located on the arms of a Cardon (*Pachycereus pringlei*) at 4.3 m above the ground. Since little is known about Great Horned Owls in Baja California, we studied the food habits of this pair.

Study Area and Methods

The nest was in an alluvial prairie (24°08′N 110°26′W) 17 km West of La Paz, Baja California Sur, Mexico, 635 m from the coast line and 6 m above sea level. Vegetation consisted of fleshy stemmed shrubs about 2 m in height with Mesquite (*Prosopis articulata*), Sweet Mangrove (*Maytenus phylantoides*), Torote and Copals (*Bursera* spp.), Adam's tree (*Fouquieria diguetii*), Dagger Cactus (*Machaerocereus gummosus*), Cholla Cactus (*Opuntia* sp.), and Cardons as high as 7 m.

We collected 49 pellets and prey remains from the ground below the nest Cardon (Fig. 1) and eleven other locations in a 50 m radius on 16 and 24 May, and 3 and 9 June. Fledglings left the nest in the first week of June. Skeletal remains were identified using the bird and mammal collection of Centro de Investigaciones Biológicas de Baja California Sur. Invertebrates were identified according to Chu (1949) and Borror et al. (1981). Identified prey were classified into seven groups, according to their phylogenetic affinities: lagomorphs, rodents, birds, Coast Horned Lizards, ophidia, insects and centipedes, spiders and scorpions.

Results and Discussion

Mammals (rodents and lagomorphs) formed the bulk of prey consumed (Table 1). Jackrabbits (*Lepus californicus*). Desert Cottontail (*Sylvilagus auduboni*), pocket mice (*Peronathus* spp.) and Darkling Beetles (Tenebrionidae) were the most frequently consumed prey species. Few rats (*Neotoma lepida* and *Dipodomys merriami*) and White-Footed mice (*Peromyscus eva*) were recorded. Crickets (Grillidae), Horned Beetles (Cerambicidae) and some unidentified coleopterans, comprised the second major group (insects and centipedes). Coast Horned Lizards (*Phrynosoma coronatum*) and ophidia were the most frequent reptiles. Arthropods, such as arachnids (mainly scorpions), chilopods and insects, including Darkling Beetles, were also present. The least frequent prey were birds, spiders and scorpions. Rodents, insects and chilopods were dominant at the nest Cardon; rodents and lagomorphs were dominant at the Cardon occupied by adults as main feeding perches.

The greatest variety of prey in owl pellets was observed at the nest Cardon, followed by a Cardon occupied by adults as the main feeding perch. Judging from the position where pellets and prey remains where found, adult owls consumed mainly large prey, but weights ranged between 16.5 (pocket mice) and 1703 g (jackrabbits). On the contrary, young owls apparently received mainly small and medium-sized prey, such as Darkling Beetles (0.24 g) and Wood Rats (125 g).

Our results based on a single pair differ from those reported for Great Horned Owls at other Mexican deserts where the greatest proportion of the owls' diets included rodents (42.7%), insects (19.0%) and arachnids (17.2%); Donázar et al. 1989). In our study lagomorphs (24.3%), rodents (22.7%) and insects (16.5%) were the primary prey. Rodents and lagomorphs were abundant in our study

Figure 1. Vegetation showing a Great Horned Owl nest in a Cardon at El Comitán, Baja California Sur, México.

Table 1. Prey (N = 115) recorded from 49 pellets of the Great Horned Owl, collected in the locality El Comitán, Baja California Sur, May–June 1989.

PREY	NUMBER OF ITEMS	PERCENT
Mammals		
Lagomorphs		
Lepus californicus	19	16.5
Sylvilagus spp.	7	6.1
Unidentified	2	1.7
Rodents		
Perognathus spp.	13	11.3
Peromyscus eva	1	0.9
Neotoma lepida	4	3.5
Dipodomys merriami	1	0.9
Unidentified	7	6.1
Total	54	47.0
Birds	6	5.2
Reptiles		
Lizards and toads		
Phrynosoma coronatum	6	5.2
Sceloporus sp.	1	0.9
Snakes	8	7.0
Unidentified	3	2.6
Total	18	15.7
Arachnids		
Scorpions	8	7.0
Spiders		
Lycosa sp.	1	0.9
Olios sp.	1	0.9
Total	10	8.7
Centipedes		
Scolopendromorpha	8	7.0
Insects		
Coleoptera		
Cerambycidae	3	2.6
Tenebrionidae	11	9.6
Unidentified	2	1.7
Hymenoptera		
Formicidae	1	0.9
Orthoptera		
Grillidae	2	1.7
Total	19	16.5

region (Arnaud and Acevedo 1990) and hence it is not surprising that the proportion of lagomorphs in the diet of the Great Horned Owls we studied is three times larger than the 6.1% reported by Donázar et al. (1989) for the desert zone of Durango and Sonora, Mexico.

RESUMEN.—Se analizaron 49 egagrópilas arrojadas por una familia de Tecolotes Cornudos (*Bubo virginianus*) en un sitio de la región del Cabo, Baja California Sur, a mediados de 1989. Los tecolotes jóvenes consumieron principalmente roedores, insectos y cienpiés; los adultos comieron, sobre todo, lagomorfos y roedores. Esta dieta, basada principalmente en lagomorfos (24,3%) y roedores (22,7%), difiere mucho de aquella reportada para los tecolotes cornudos de los desiertos de Durango y Sonora, México, donde los lagomorfos solo llegan al 6,1%, y en cambio los roedores alcanzan el 42,7%. Esto puede indicar la gran selectividad de presas que estos tecolotes pueden realizar localmente, favorecidos por la mayor diversidad en la flora del área, respecto a los otros desiertos mexicanos, donde su dieta es más diversa.

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LITERATURE CITED

ARNAUD, G. AND M. ACEVEDO. 1990. Hábitos alimenticios de la zorra gris, *Urocyon cinereoargenteus* (Carnivora: Canidae) en la Región Meridional de Baja California, México. *Revista de Biología Tropical* 32(28): 499–502.

BORROR, D.J., D.M. DE LONG AND CH.A. TRIPLEHORN. 1981. An introduction to the study of insects. Saunders College Publishing Co., Philadelphia, PA.

CHU, F.H. 1949. The immature insects. Wm. C. Brown Co. Publishers. Dubuque, IA.

DONÁZAR, J.A., F. HIRALDO, M. DELIBES AND R.R. ESTRELLA. 1989. Comparative food habits of the Eagle Owl *Bubo bubo* and the Great Horned Owl *Bubo virginianus* in six Paleartic and Nearctic biomes. *Ornis Scandinavica* 20:298–306.

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NOTES ON THE FOOD HABITS OF THE BAT FALCON (*Falco rufigularis*) IN TAMAULIPAS, MEXICO

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The Bat Falcon (*Falco rufigularis*) is a small falcon of the New World Tropics. It has a range covering the Neotropical region from Mexico south to Peru, Bolivia, Paraguay, and Argentina and most of the eastern portion of South America in between (Brown and Amadon 1968, Cade 1982). In Mexico the Bat Falcon reaches its northernmost distribution along the coasts in the northern third of the country. On the Gulf coast it occurs as far north as the State of Tamaulipas whereas on the western coast it occurs as far north as southern Sonora. In the central and southern Mexico at approximately 20° north latitude the two coastal distributions merge to form a continuum extending south and east to Central America. The Bat Falcon is well-known for its crepuscular hunting habits. Though being very conspicuous and tolerant of observers, little information has been published on its foraging habits. All the available information on prey items taken by this falcon has been collected in the southern portions of its range, in southern Mexico (Falxa et al. in Cade 1982), Central America (Wetmore 1965), and South America (Beebe 1950, Haverschmidt 1962, Kirven 1976). To our knowledge no food habit data are available from the northern part of its range.

The diet of this falcon has been described as consisting of mainly small birds and bats but large insects are also taken (Brown and Amadon 1965, Cade 1982). More specifically Beebe (1950) reported a pair of Bat Falcons ate 163 individual birds of 56 species, mainly swifts (Apodidae, $N = 26$), hummingbirds (Trochilidae, $N = 34$), and swallows (Hirundinidae, $N = 17$), as well as five species of mammals. Kirven's (1976) data indicate that the composition of the diet varies for different individuals in different localities depending on the type and availability of prey species. In one area Kirven observed one Bat Falcon preying primarily on birds (90.4% of prey by numbers) while at a different site another individual preyed primarily on bats (76% of its prey) and very few birds (5%). Insects made up less than 20% of the prey by numbers taken by all the falcons he observed. This information may suggest that bat falcons are opportunistic concentrating their hunting efforts on the most abundant prey type or species in the area.

We studied a pair of Bat Falcons along the eastern coast of Mexico in the state of Tamaulipas at Rancho Los Colorados. The ranch is a large cattle breeding operation, 25 km east of Aldama and approximately 6 km from the Gulf of Mexico. More than 90% of the ranch land is in a condition called "tree pasture," pastures cleared of native vegetation and reseeded with introduced grasses. A few large trees are left standing interspersed in the pasture giving it a park-like appearance. Only small pockets of native vegetation remain, mostly in long narrow belts along the fences between pastures. This is deemed ideal habitat for Bat Falcons; most authors agree that areas where Bat Falcons have been most frequently observed are relatively open and altered to some degree by human intervention. Bat Falcon habitat has been variously described as a dense jungle in tropical lowlands (Beebe 1950), open country with scattered trees (Haverschmidt 1962), along or near woods in clearings and edges (Brown and Amadon 1965), dry tropical forest (Kirven 1976), and edge along closed forest (Cade 1982).

We watched the pair of Bat Falcons from the 10 through 15 of April 1991, at a feeding perch consisting of a large Ficus tree (*Ficus* spp.) approximately 25 m high and 50% of it dead. The falcons were on the perch daily during mornings from 0620–0855 H. Thereafter both falcons flew out of sight after feeding or perching on the Ficus tree, and returned to the same perch after 1800 H, leaving again before 1900 H. We do not know where the falcons spent the middle of the day or the night, but it is likely that the falcons spent the time in the small patches of undisturbed forests.

We recorded avian prey within 50 m of the perch as very common, common, uncommon, and rare. Species were classified depending on the number of individuals observed between 0700 and 0800 H during three mornings.

During six days of observation the falcons consumed nine birds of at least four species. None of these have been reported as Bat Falcon prey. Seven prey items were below the perch: two Mourning Doves (*Zenaida macroura*), two Brown-headed Cowbirds (*Molothrus ater*), one Cedar Waxwing (*Bombycilla cedrorum*), one Ladder-backed Woodpecker (*Picoides scalaris*), and one unidentified bird. In addition to these, two other birds were brought by the falcons to the perch but not eaten there. One was a Brown-headed Cowbird, the other bird could not be identified. The falcon's departure from the perch was precipitated

by an American Kestrel (*Falco sparverius*), that began mobbing the Bat Falcon as soon as it had alighted with its prey. This was the only incident of agonistic behavior by the kestrel towards the Bat Falcons despite kestrels being present in the area each day.

The birds caught by the falcons were uncommon or absent from the area immediately surrounding the perch tree. The most common prey species, the Brown-headed Cowbird, was never observed in the vicinity of the perch. The nearest location where cowbirds were observed was at the ranch headquarters approximately 2 km from the area of observation. We saw no prey captured in the vicinity of the perch, though both male and female attacked quarry within 30 m but without success. All but one of the attacks were at Red-billed Pigeons (*Columba flavirostris*), one attempt was made by both male and female together at a flock of Great-tailed Grackles (*Quiscalus mexicanus*). Red-billed Pigeons were common in the perching area and observed each day feeding on a tree approximately 10 m away. The grackles never perched or fed in the area but were common, flying over head.

Since Brown-headed Cowbirds were not observed in the area and the other prey species were uncommon around the perch site this suggests that the falcons travelled up to several kilometers from the perch to capture prey. Beebe (1950) also observed Bat Falcons flying several kilometers to capture their prey. Cade (1982) found that the distance Bat Falcons flew to capture prey was usually less than 100 m from the perch. Kirven (1976) found the maximum distance to be 660 m.

RESUMEN.—Estudiamos un par de halcones de la especie (*Falco rufigularis*) en el estado de Tamaulipas, México. Durante 6 días de observaciones los halcones se posaron diariamente de 0620 a 0855 y de 1800 a 1900 H en un higuerón (*Ficus* spp.) y consumieron nueve aves de por lo menos cuatro especies, dos *Zenaida macroura,* tres *Molothrus ater,* un *Bombycilla cedrorum,* un *Picoides scalaris,* y dos no identificados. Las aves consumidas nunca se observaron en los alrededores de la percha o se observaron raramente.

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LITERATURE CITED

BEEBE, W. 1950. Home life of the Bat Falcon, *Falco albigularis albigularis* Daudin, *Zoologica* 35:69–86.

BROWN, L. AND D. AMADON. 1968. Eagles, hawks, and falcons of the world. McGraw-Hill Book Company, New York.

CADE, T.J. 1982. The falcons of the world. Cornell University Press, Ithaca, NY.

HAVERSCHMIDT, F. 1962. Notes on the feeding habits and food of some hawks of Surinam. *Condor* 64:154–158.

KIRVEN, M.N. 1976. The ecology and behavior of the Bat Falcon, *Falco rufigularis*. Ph.D. thesis, University of Colorado, Boulder, CO.

WETMORE, A. 1965. The birds of the Republic of Panama. *Smithson. Misc. Collect.* 150:282–286.

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FOOD HABITS OF BREEDING SHORT-EARED OWLS IN SOUTHWESTERN BRITISH COLUMBIA

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Short-eared Owls (*Asio flammeus*) inhabit grasslands and marshes in both the old and new world. In southwestern British Columbia they are an uncommon resident and a local summer breeder (Campbell et al. 1990). The winter diet of Short-eared Owls is well-known because the use of communal roost sites facilitates the collection of pellets (e.g., Kirkpatrick and Conway 1947, Weller et al. 1955). However, pellets are more difficult to find in summer because they are scattered throughout hunting territories and do not accumulate around nests (Clark 1975). Field studies in Iowa (Errington 1937) and Manitoba (Clark 1975) are the only analyses of the summer diet of North American Short-eared Owls. Here I report the summer diet of Short-eared Owls in southwestern British Columbia based on an analysis of pellets.

STUDY AREA AND METHODS

Breeding Short-eared Owls were studied in the municipality of Delta, British Columbia from May to August 1987. At least three pairs and eight young used the grass

Table 1. Summer diet of breeding Short-eared Owls in British Columbia based on pellet analysis, 1987.

SPECIES	PERCENT OF PREY ITEMS	PERCENT OF TOTAL BIOMASS[a]
Microtus townsendii		
Adult	54.8 (62)[b]	62.3
Juvenile	15.0 (17)	9.2
Microtus spp.	13.3 (15)	15.1
Total *Microtus* spp.	83.2 (94)	86.6
Peromyscus maniculatus	5.3 (6)	2.1
Sylvilagus floridanus	1.8 (2)	9.3
Ondatra zibethicus	0.9 (1)	
Emberizinae spp.	6.2 (7)	1.9
Coleoptera spp.	2.7 (3)	trace

[a] Excluding *Ondatra zibethicus*.
[b] Numbers in parentheses.

fields and saltmarsh foreshore near Boundary Bay Airport (49°N 123°W) for hunting and nesting. Every second week I collected fresh pellets from an area of about 2 km^2 adjacent to the airport that was in the vicinity of two known nest sites. Thus, it is likely that I collected pellets from both adult and juvenile owls. No other raptors bred on this land or consistently used it while hunting, although Northern Harriers (*Circus cyaneus*) occasionally flew over the area. Short-eared Owl pellets can be distinguished from those of harriers by their length and high bone content (Clark 1972, Holt et al. 1987).

Regurgitated pellets are frequently used to study food habits of raptors and pellet contents are indicative of captive Short-eared Owls' diets (Chitty 1938, Clark 1975). Biases in pellet analysis may occur if the prey items cannot be eaten in a single meal (Marti 1974) but most prey of Short-eared Owls are smaller than 70 g. I moistened the pellets before teasing them apart by hand and determined the number of individual mammals based on the number of skulls. Some *Microtus* skulls could not be identified because teeth were missing, and so were classified "*Microtus* spp." Since Short-eared Owls may crush bird skulls and do not necessarily ingest the bill (Johnston 1956), one bird was counted even if the skull was absent when there were feathers in the pellet. To convert prey numbers into biomass, I used mass estimates of voles from Krebs et al. (1976) and of deer mice from a mean of 70 specimens in the Royal British Columbia Museum and the Vertebrate Museum, University of British Columbia. Masses of other mammals are from Banfield (1974). I assumed a mass of 18 g for the sparrows. Because muskrats are probably rare prey, I did not include them in the calculation of biomass in order to obtain a more representative analysis.

RESULTS AND DISCUSSION

Of the 90 pellets collected, 59% were found beneath fenceposts and large driftwood logs that owls used frequently when hunting from a perch or roosting. The remainder appeared to be randomly scattered throughout the fields. The mean number of prey items per pellet was 1.26 (SD = 0.51). This is similar to the 1.21 reported by Holt et al. (1987), but is lower than many of the 24 studies reviewed by Clark (1975) in which the average was 1.67 items per pellet (range 0.78–2.37). The number of prey items in a pellet is inversely related to prey size (Weller et al. 1963). Since *Microtus townsendii* are among the largest species of vole in North America (Banfield 1974) one would expect there to be fewer prey items in the pellets I found.

About 91% of prey items were mammals (Table 1), the most common species in both numbers and biomass being *Microtus townsendii*. A predominance of voles in the diet of Short-eared Owls has been found in most studies, especially in winter when the microtine component usually exceeds 90% (Kirkpatrick and Conway 1947, Clark 1975, Colvin and Spaulding 1983). In comparison with other summer diets, the proportion of voles in this study was between the 63% reported by Errington (1937) in Iowa and 90% reported by Clark (1975) in Manitoba. Other mammals comprised only a small fraction of the diet (Table 1). The adult-sized muskrat skull found in the pellet had a crushed occipital region which is characteristic of the way Short-eared Owls kill prey (Clark 1975). It was thus unlikely to have been scavenged. Although Short-eared Owls are known to eat juvenile lagomorphs (Errington 1937), a muskrat has never been previously reported as prey and probably represents an upper size limit around 800–1000 g. Two juvenile muskrats were eaten by Short-eared Owls in Massachusetts (D. Holt, pers. comm.).

Although the emberizid prey were not identified to species, Savanna Sparrows (*Passerculus sandwichensis*) and Song Sparrows (*Melospiza melodia*) were abundant in the area. Two pellets contained small, cream-colored eggshell fragments. Clark (1975) suggested that juvenile Short-eared Owls might eat passerine eggs while walking through the fields. Alternatively, Short-eared Owls may consume the shells of their own eggs after the chicks hatch or eat female passerines containing eggs.

The diet of Short-eared Owls in southwestern British Columbia is similar to that of the Barn Owl *Tyto alba* (Campbell et al. 1987) and Northern Harrier (Campbell et al. 1990) who are also *Microtus* specialists that use similar habitats. It is likely that these three species compete for the same resources, but crepuscular hunting by Short-eared Owls in this study may offer some degree of temporal separation from the nocturnal Barn Owl and the diurnal harrier.

RESUMEN.—La dieta de verano de buhos de la especie *Asio flammeus* no es bien conocida. Egagrópilas de estos buhos, que estaban en su época reproductiva en el sudoeste de Colombia Britanica, fueron colectadas durante el verano de 1986 y fueron analizadas para determinar la dieta. Las egagrópilas fueron analizadas para determinar el numero y el peso de las especies que fueron presas. La mayoría de los items fueron restos de ratones campestres (*Microtus* spp.) pero la proporción fue menos que aquella que se encontró muchos estudios de las dietas de invierno. Una egagrópila contenía la calavera de una rata amizclera ad-

ulta (*Ondatra zibethicus*), siendo la primera vez que un mamífero tan grande se ha registrado como presa de esta especie de buho.

[Traducción de Eudoxio Paredes-Ruiz]

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LITERATURE CITED

BANFIELD, A.W.T. 1974. The mammals of Canada. University of Toronto Press, Toronto, ON, Canada.

CAMPBELL, R.W., N.K. DAWE, I. MCTAGGART-COWAN, J.M. COOPER, G.W. KAISER, AND M.C.E. MCNALL. 1990. The birds of British Columbia. Vol. 2, Non-passerines. Royal British Columbia Museum, Victoria, BC, Canada.

———, D.A. MANUWAL AND A.S. HARESTAD. 1987. Food habits of the Common Barn-Owl in British Columbia. *Can. J. Zool.* 65:578–586.

CHITTY, D. 1938. A laboratory study of pellet formation in the Short-eared Owl (*Asio flammeus*). *Proc. Zool. Soc. Lond.* 108A:267–287.

CLARK, R.J. 1972. Pellets of the Short-eared Owl and Marsh Hawk compared. *J. Wildl. Manage.* 36:962–964.

———. 1975. A field study of the Short-eared Owl (*Asio flammeus*), in North America. *Wildl. Monogr.* No. 47.

COLVIN, B.A. AND S.R. SPAULDING. 1983. Winter foraging behavior of Short-eared Owls (*Asio flammeus*) in Ohio. *Am. Midl. Nat.* 110:124–128.

ERRINGTON, P.L. 1937. Summer food habits of the Short-eared Owl in northwestern Iowa. *Wilson Bull.* 49:121.

HOLT, D.W., L.J. LYON AND R. HALE. 1987. Techniques for differentiating pellets of Short-eared Owls and Northern Harriers. *Condor* 89:929–931.

MARTI, C.D. 1974. Feeding ecology of four sympatric owls. *Condor* 76:45–61.

JOHNSTON, R.F. 1956. Predation by Short-eared Owls on a *Salicornia* salt marsh. *Wilson Bull.* 68:91–102.

KIRKPATRICK, C.M. AND C.H. CONWAY. 1947. The winter foods of some Indiana owls. *Am. Midl. Nat.* 38:755–766.

KREBS, C.J., I. WINGATE, J. LEDUC, J.A. REDFIELD, M. TAITT AND R. HILBORN. 1976. Microtus population biology: dispersal in fluctuating populations of *Microtus townsendii*. *Can. J. Zool.* 54:79–95.

WELLER, M.W., I.C. ADAMS, JR. AND B.J. ROSE. 1955. Winter roosts of marsh hawks and short-eared owls in Central Missouri. *Wilson Bull.* 67:189–193.

———, L.H. FREDRICKSON AND F.W. KENT. 1963. Small mammal prey of some owls wintering in Iowa. *Wilson Bull.* 67:189–193.

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Letters

Sharp-shinned Hawk Predation of a Male American Kestrel

At 12:10 H on 8 May 1986, I observed from my vehicle a hunting male American Kestrel (*Falco sparverius*) in the Northwest Angle Provincial Forest of southeastern Manitoba, Canada. The kestrel was hunting from electrical power lines about 11 m above a 12 m-wide grassy right-of-way, parallel to a paved provincial highway. Southeast of the right-of-way was a dense mixed balsam fir (*Abies balsamea*) and black spruce (*Picea mariana*) forest interspersed with trembling aspen (*Populus tremuloides*).

The kestrel made four diving flights into the grass, returning immediately up to the wire where it had previously perched. At 12:30 H, as the kestrel flew toward the grass below, it was intercepted in mid-flight by another bird. The kestrel and its attacker grappled about 3–5 sec and then separated. After flying about 2 m toward the forest, the kestrel was overtaken by the attacking bird. The two equal-sized birds then tumbled together to the ground. The attacking bird, identified as a Sharp-shinned Hawk (*Accipiter striatus*), was on top of the kestrel. The sharp-shin's red eye and reddish-brown barred breast and abdomen indicated it was an adult (W.E. Godfrey 1986, The birds of Canada. National Museums of Canada, Ottawa, Canada). Furthermore, the sharp-shin was likely a male, as it did not appear much larger than the male kestrel (Godfrey 1986).

The kestrel was pinned down belly-up and faced the Sharp-shinned Hawk; the kestrel's wings flapped slowly on either side of the mantling Sharp-shinned Hawk. I did not observe the sharp-shin biting the kestrel. After 1.5 min the kestrel ceased flapping its wings. Soon thereafter, the sharp-shin flew into the forest carrying the limp carcass of the kestrel in its feet. A quick search of the immediate surroundings failed to locate a nest or plucking perch.

Agonistic encounters between American Kestrels and Sharp-shinned Hawks have been described previously, but I am not aware of reports of actual mortality resulting from these encounters. Early one August morning, C.W. Nash (*in* E.E. Thompson 1975, The birds of Manitoba. Premium Ventures Ltd., Winnipeg, MB, Canada) observed five or six kestrels and a Sharp-shinned Hawk chase each other "for over half an hour and (I) left them still at it." This suggests that the element of surprise is important to successful predation on kestrels by Sharp-shinned Hawks. However, W.E. Cram (*in* A.C. Bent, 1961, Life histories of North American birds of prey. Part 2. Dover Publications, Inc., New York) observed an aerial encounter between a female Sharp-shinned Hawk and an American Kestrel in which the former appeared to "have the advantage." The outcome of this "vigorous and spirited fight" was not recorded (Bent 1961).

D. Klem et al. (1985, *Wilson Bull.* 97:230–231) summarized observations and literature on the interspecific killing by raptors. Major motivational factors include self-defense, vulnerability and conspicuousness, annoyance, food, and defense of territory, nests or young. It is perhaps noteworthy that raptor species that regularly take avian prey are predisposed, both anatomically and behaviorally, to killing other raptors. Therefore, one would expect Peregrine Falcons (*Falco peregrinus*), Merlins (*F. columbarius*) and the accipiters to kill other raptors more frequently than do other raptors that typically feed on non-avian prey, such as buteos. Nine of 10 cases of raptors killing and chasing raptors reported by Klem et al. (1985) involved Peregrines, Merlins, and Sharp-shinned Hawks as the predators or aggressors. There are two records of the European Kestrel (*F. tinnunculus*) appearing in the diet of the European Sparrowhawk (*A. nisus*), but no observational details are given (Uttendörfer 1952 *in* I. Newton 1979, Population ecology of raptors. Buteo Books, Vermillion, SD).

While it is likely that a combination of motivational factors (listed above) often play a role in the interspecific killing of raptors, the observed killing of an American Kestrel by a Sharp-shinned Hawk may simply have been predation for food by a bird specialist. The early date may eliminate defense of a nest as a causal factor for the attack (C.J. Henny et al., 1985. *J. Field Ornithol.* 56:97–112). While the American Kestrel is probably not normal prey, the Sharp-shinned Hawk may have responded to the seeming vulnerability of the hunting kestrel intent on catching its own food.

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News and Reviews

Raptor Research Foundation, Inc. Life Members

Morlan W. Nelson
(Photo by Frank M. Bond)

Morlan W. Nelson, known as Morley by many, is one of the most recent life members of the Raptor Research Foundation, Inc. Morley became Honorary Life Member of the Foundation in 1990, but he has been a colorful member of the Foundation for many years.

Morley's interest in raptors started 65 years ago. His "world view" toward nature was influenced by a special ingredient which many great conservationists share, the hands on experience of nature. Morley "manned" a Red-tailed Hawk to hunt rabbits on the old home ranch along the Cheyenne River in North Dakota. He was fascinated with the speed of animals in his childhood. He felt the graceful speed of his old racing horse "Slim" through the seat of his pants, admired the coordination of his ball-catching dog "Buster." He watched in awe the fall of descending teals, wings folded—to him at the time the fastest action on the planet. One day, Morley's admiration for things natural reached a new plane. The hiss by a falcon extending its wings was audible split seconds before a powerful blow sent a teal reeling. The diving falcon rolled on its back at the short end of a hook in the sky, it took the falling teal and carried it off into the north wind.

Morley became professionally involved in raptor research and conservation in 1946, at a time when it was not fashionable to speak out for raptors. He worked under the tutelage of Angus M. Woodbury and William Bailey at the University of Utah. Once recovered from a battle wound incurred in the mountains of Italy, Morley joined the research arm of the U.S. Soil Conservation Service, in Boise, Idaho. He maintained his interest in raptors as an avocation while working as a snow surveyor.

Morley played an important role in natural history films produced by Walt Disney Productions, Wild Kingdom, Paramount, and films produced by his offsprings Norm, Suzie and Tyler. Since Morley retired 21 years ago, he has devoted his time to running the family ranch, producing nature films on his own, and to speaking on the topic of raptors to those who invite him and to all who would listen. In the 1960s he was instrumental in convincing the Secretary of the Interior, Rogers C.B. Morton, and the Governor of Idaho, Cecil Andrus, to establish the Snake River Birds of Prey Natural Area. There, much of his study and filming of Golden Eagles and Prairie Falcons took place. He is currently working on a book, "The cool north wind," in which he reveals the events in his life which have molded his personal views and philosophy.

1991 Annual Meeting. Nearly 250 members of the Raptor Research Foundation, Inc., from 35 U.S. states, 4 Canadian provinces, and the countries of Chile, United Kingdom, Mexico and Japan attended the 1991 Annual Meeting in Tulsa, Oklahoma on 6–10 November 1991. The Scientific Program Committee, chaired by M. Alan Jenkins, and the Local Committee, chaired by Keven Colbert, both at the G.M. Sutton Avian Research Center in Bartlesville, efficiently organized a board meeting, 2.5 d of scientific presentations (see below), a general business meeting, field trips and a banquet with award presentations.

The meeting was introduced by Peter Dunne, New Jersey Audubon Society, who hailed past accomplishments and identified future challenges in raptor conservation in a most stimulating and entertaining way. Field trip choices included visits to the G.M. Sutton Avian Research Center, the Oklahoma Nature Conservancy's Tallgrass Prairie, the Oxley Nature Center and the Tulsa Zoo, where a raptor show was conducted by Walter C. Crawford's Raptor Rehabilitation and Propagation Project at the Tyson Research Center of Eureka, MO.

The Saturday night banquet "took attendants to another continent." Traditional Arabian food was enjoyed by participants perched on Persian carpets. Hungry souls sat wide-eyed, listening attentively to Steve Sherrod's instructions on how to use one's thumb to move food in the proper direction through the palm of the right hand. The mood was further set by an Arabian desert tent and falcons on blocks. Entertainment was provided by a Turkish-American youth ensemble from New York City who performed Turkish folk music and dance.

At the banquet some very deserving award recipients were announced. Richard R. Olendorff, better known to his colleagues as Butch, received the Raptor Research Foundation, Inc., President's Award. This award had been given to only three other recipients in the 25 year history of the Foundation. Butch currently serves as Co-Leader for Applied Research and Governmental Affairs at the Raptor Research and Technical Assistance Center, and as the leader for the U.S. Department of the Interior Bureau of Land Management, birds of prey research. In addition to over 35 publications, Butch is well known among raptor researchers for his extensive bibliography on diurnal birds of prey, published in the 1970s. This bibliography has motivated other bibliophiles to produce bibliographies on raptors. Within the Foundation, Butch served as publications editor from 1971–76 and as secretary from 1975–76. He also served as president from 1977–81 and on the board of directors from 1980–82. He was the primary organizer for the megaconferences held in conjunction with the Raptor Research Foundation conference in Sacramento in 1985. This conference attracted over 1000 raptor researchers from many parts of the world.

The President's Award was not the first major honor Butch has received for conducting and guiding research on raptors. For example, in 1988, a $300 000 endowment fund was established in Butch's name at the Washington State University's College of Veterinary Medicine. The Richard R. Olendorff Raptor Endowment Fund is used to further the University's raptor research program. This includes studies of clinical techniques, causes of and cures for raptor diseases and raptor rehabilitation methods with provisions for the support of graduate students.

The following regular 1991 awards were also presented. The Tom Cade Award recognizes an individual who has made significant advances in the area of captive propagation and reintroduction of raptors. This year's award went to Jim Weaver, of New Mexico, for the leadership and dedication he exhibited in connection with the Peregrine Fund's Peregrine Falcon reintroduction program.

The first Fran and Frederick Hamerstrom Award recognizes an individual who has contributed significantly to the understanding of raptor natural history. The 1991 award went to Valerie Gargett for her long-term studies of the Black Eagle (*Aquila verreauxii*) in Zimbabwe. This work culminated in her recent 279 page book entitled "The Black Eagle," published jointly by Acorn Books, Randburg, South Africa and Russell Friedman Books, Halfway House, South Africa. Valerie currently resides in South Australia. The award was accepted on Valerie's behalf by Fran Hamerstrom.

The James R. Koplin Travel Award is given to a student who is the senior author on the paper to be presented at the meeting for which travel funds are requested. This year's award went to James R. Duncan for his paper, entitled "Breeding Dispersal of Great Gray Owls in Manitoba and Minnesota."

The William C. Anderson Memorial Award is given to the student who presents the best paper at the annual Raptor Research Foundation Meeting. This year's award was presented to David Plumpton of Texas Tech University for his paper entitled "Nest Site Selection by Burrowing Owls in Colorado."

The Stephen R. Tully Memorial Grant is given to support research, management and conservation of raptors, especially to students and amateurs with limited access to alternative funding. This year's grant of $600.00 was awarded to Neal D. Niemuth, of the University of Wyoming, and Keith J. Merkel, of Wisconsin, for their work on small mammal densities as an estimator of Saw-Whet Owl abundance. This award was accepted by Gerald R. Craig on the recipients' behalf.

The Leslie Brown Memorial Award is given to support research and/or the dissemination of information on raptors, especially to individuals carrying out work in Africa. The 1991 award was presented to John D. Foss, who is a graduate student at Boise State University studying the Rio Bio-Bio rainforest ecosystem in southern Chile. The

ecosystem and the resident Pehuenche Indians are threatened by a dam and associated hydroelectric developments. This award is traditionally given to workers in Africa but in 1991 no African proposal was received for this award This award was accepted by Fabian M. Jaksić on John's behalf.

The Dean Amadon Award recognizes an individual who has made significant contributions in the field of systematics or distribution of raptors. No award was made this year.

The Membership endorsed the following resolutions:

A) Whereas Geddes Resources Ltd. of Canada plans to develop a large open-pit copper mine at the confluence of the Tatsheninl and Alsek Rivers in British Columbia; and

Whereas the watershed supports some 15 raptor species as well as grizzly bears, wolves, wolverines, Dall sheep, mountain goats, and a variety of other wildlife; and

Whereas the mine could result in heavy truck traffic passing through the Chilkat Bald Eagle preserve, which supports thousands of eagles during the fall; and

Whereas the area is important as a recreational and wilderness area.

Therefore, be it resolved that the Raptor Research Foundation, Inc., Board Members, Officers, and General Membership request that the responsible authorities require a thorough study of the potential impacts of this project, and permit the project only if the wildlife, wilderness and recreational values of the area can be protected.

B) Whereas decisions made in Washington, DC may have profound effects on wild bird populations, and on the practice of bird conservation and ornithology; and

Whereas accurate information on the effects of these decisions can result in decisions which are better for wild birds, conservationists and ornithologists; and

Whereas there currently are no professional ornithologists in Washington, DC who represent the ornithological community and specialize in providing accurate ornithological information to decision-makers.

Therefore be it resolved that the Raptor Research Foundation, Inc., Board Members, Officers, and General Membership support the concept of joining with other ornithological groups in establishing an ornithological council (subject to procedural and financial details), with a Washington, DC office that will provide information to Washington, DC decision-makers.

C) Whereas forest alteration is depleting the remaining mature forests in the western United States; and

Whereas there is concern that populations of the Northern Goshawk may be declining in some of the altered areas

Therefore be it resolved that the Raptor Research Foundation, Inc., Board Members, Officers, and General Membership:

1. Support the efforts of the U.S. Department of Agriculture, Forest Service, as exemplified by the Southwestern Region, to maintain goshawk populations in the forests for which it is responsible.
2. Urge Congress to appropriate funds to assist federal and state agencies immediately to conduct further research to determine the status and requirements of goshawks.
3. Recommend the establishment of management guidelines to sustain viable populations of goshawks and all other native forest fauna and flora throughout the western United States.

D) Whereas the 1991 Raptor Research Foundation, Inc., annual meeting was a well planned and well attended conference; and

Whereas the local committee, chaired by Keven Colbert, did an excellent job of selecting accommodations, finding sponsors, and planning the banquet and field trips; and

Whereas the scientific committee, chaired by Alan Jenkins, selected and organized a well-rounded and informative collection of oral and poster papers.

Therefore be it resolved that the Raptor Research Foundation, Inc., Board Members, Officers, and General Membership give their thanks and appreciation to the members of the local and scientific committees for making the 1991 annual meeting a splendid event.

4th World Conference on Birds of Prey and Owls. This conference will be held from 10–17 May 1992 in Berlin. Up to 31 December 1991, the Registration Fee is US$110.00 (£75.00), and thereafter US$135.00 (£90.00). For further information, apply to the World Working Group on Birds of Prey (15b Bolton Gardens, London SW5 0AL, Great Britain or Wangenheimstr. 32, 1000 Berlin 33, Germany).

The Scientific Program will comprise the following paper sessions (and conveners): The Systematics and Taxonomy of Raptors: With Emphasis on Contemporary Methodology (C.M. White and A. Kemp), Population Studies: Aspects of Long-term Changes in Numbers and Distribution of Raptors and Owls (A. Kostrzewa and V. Galushin), Declining

Raptor Populations: Their Biology and Conservation (B.-U. Meyburg and R.D. Chancellor), Environmental Contaminants and Raptors (R.W. Risebrough), Biology and Conservation of the Large Falcons in the Subgenus *Hierofalco* (T.J. Cade, W. Baumgart and C.M. White), Population Ecology of Owls (E. Korpimäki and H. Pietiäinen), The Biology of Extirpated, Rare or Lesser Known Owls (R.J. Clark and H. Mikkola), Tropical Rain Forests and Raptors (J.-M. Thiollay), Reintroductions of Eagles, Vultures and Other Raptors (J. Love and M. Terrasse) and Trapping, Marking and Radio-tagging Techniques (R. Bögel and R. Kenward).

Due to the recent fundamental political changes, it is now possible to offer excursions from Berlin to the new federal states of Brandenburg and Mecklenburg-Vorpommern (in the former German Democratic Republic or "East Germany") which have hitherto been virtually inaccessible to ornithologists from the West and where there are good chances to observe White-tailed Sea Eagle, Osprey, Lesser Spotted Eagle, Hen Harrier, Montagu's Harrier, Red Kite, Peregrine Falcon, Great Bustard, Black Stork.

MANUSCRIPT REFEREES

The input of the referee in evaluating manuscripts submitted to a journal represents a fundamental aspect that is unique to the process of science. Referees rely on at least two of the Mertonian norms that characterize the behavior of scientists: universalism and disinterestedness. Referees make a concerted effort not to let the reputation of the author influence their judgement. Referees furthermore make an effort, as much as humanly possible, to remove their own personal beliefs and to judge a contribution based on its own merit in a professional manner.

The recommendations of the referee greatly influence the nature of the published material that appears in this journal. During my tenure as editor I have noted several times great similarity in the recommendations of a manuscript by different referees. Despite being geographically separated and having different educational backgrounds, the referees responded in a remarkably similar way to aspects of a manuscript. This suggests a convergence and consistency in biological thinking that is refreshing. I have furthermore been impressed by the care taken by referees to be constructive in their criticism. Referees, who are on the whole very busy people, allow additional work for which they receive too little credit creep into a primary position on their work list. The time lag from receipt of a manuscript to response by referees greatly influences a journal's publication delay. A review of the periods from submission to acceptance, published at the end of each manuscript, reveals that the referees mentioned below have done very well. The Foundation is indeed grateful for their selfless support in reviewing one or more (*) manuscripts for the *Journal* in 1991.

Thomas G. Balgooyen, Sam Barry, Alan D. Barth, Marc J. Bechard,* Steven R. Beissinger, Keith L. Bildstein,* David M. Bird, Pete Bloom,* Gary Bortolotti,* Tom Bosakowski, Reed Bowman, Joseph B. Buchanan, Evelyn L. Bull,* Tom Cade, Susan B. Chaplin,* Dick J. Clark, Jack Clinton-Eitniear, Charles T. Collins, Michael W. Collopy, Alison G. Cook, Walter Crawford, Gary E. Duke, Wade L. Eakle, David H. Ellis, Dave L. Evans, Paolo Fasce, Glen Fox, Alan Franklin, Jim Fraser,* David L. Goldstein, Dan N. Gossett, Fran Hamerstrom, Al H. Harmata, Floyd E. Hayes, Chuck J. Henny,* Fernando Hiraldo, Denver W. Holt, C. Stuart Houston,* David C. Houston, G. Chris Iverson, Ronald E. Jackman, Fabian M. Jaksić,* Paul C. James, Jaime E. Jiménez, Paul Kerlinger, J. Tim Kimmel,* D. W. King, John S. Kirkley, Mike N. Kochert, Josef Kösters, Eduardo Lander, Jeffrey S. Marks, Carl D. Marti, W. Bruce McGillivray, Carol L. McIntyre, Brian A. Millsap, Vicky J. Meretsky, Jim A. Mosher, Joe R. Murphy, Juan José Negro, R. Wayne Nelson,* James R. Phillips, Sergej Postupalsky, Charles R. Preston, Patricia P. Rabenold,* Pat T. Redig,* Paul M. Roberts, Ricardo Rodriguez-Estrella, Robert N. Rosenfield, James L. Ruos, C. Hoagy Schaadt, John A. Smallwood, Neal G. Smith, Mark Stalmaster, Dan E. Varland, Clay White.*

J. Raptor Res. 25(4):151–164

Abstracts of Presentations Made at the Annual Meeting of the *Raptor Research Foundation, Inc.*, Held at Tulsa, Oklahoma, on 6–10 November 1991

Acknowledgments

The Raptor Research Foundation, Inc., gratefully acknowledges financial and other support which helped immensely in making the meeting a success. Support was provided by: Mohamed Al-Salhi, Amir's Persian Imports, The Bartlesville Audubon Society, The Indian Nations Audubon Society, Nature Conservancy Oklahoma Chapter, Oklahoma Biological Survey, Connors State College Biology Club, Tim Jessell Artist, Oklahoma Department of Wildlife Conservation, Oklahoma Falconer's Association, Mary K. Oxley Nature Center, Phillips Petroleum Foundation, Public Service Company of Oklahoma, Ken Riddle, Sutton Avian Research Center, The Tulsa Audubon Society, The Tulsa World, The Tulsa Zoo, The U.S. Fish and Wildlife Service, Tulsa office, West of Boston, The Williams Companies, Inc., and Sally Ann Wormley.

Organizing Committee Chairpersons

M. Alan Jenkins, Scientific Program Chairperson, G.M. Sutton Avian Research Center, P.O. Box 2007, Bartlesville, OK 74005

Ms. Keven Colbert, Local Committee Chairperson, G.M. Sutton Avian Research Center, P.O. Box 2007, Bartlesville, OK 74005

Oral Papers

The Status Review and Reclassification Process of the Peregrine Falcons in North America

Ambrose, R.E. and T.R. Swem. *Endangered Species, U.S. Fish and Wildlife Service, 1412 Airport Way, Fairbanks, AK 99701*

The U.S. Fish and Wildlife Service is reviewing the status of the Arctic Peregrine Falcon (*Falco peregrinus tundrius*) and American Peregrine Falcon (*F. p. anatum*) in northern North America. The Arctic Peregrine Falcon is currently listed as threatened and the American Peregrine Falcon is listed as endangered. The Service published a Notice of Status Review in the Federal Register on 12 June 1991. Information and comments received to date indicate overwhelming support for the "delisting" of both populations. A review of all information and a decision on reclassification will be made by early 1992. Any proposed rule (status change) will be published in the Federal Register.

Feeding and Reproductive Ecology of Sympatric Buteonine Hawks in Southeastern Colorado

Andersen, D.E. *Minnesota Coop. Fish and Wildlife Research Unit, Dept. of Fisheries and Wildlife, University of Minnesota, St. Paul, MN 55108*

From 1983–88 I studied the feeding and reproductive ecology of Red-tailed (*Buteo jamaicensis*), Ferruginous (*B. regalis*), and Swainson's Hawks (*B. swainsoni*) in southeastern Colorado. Diet breadth was greatest for Red-tailed Hawks (B = 4.64) and lower for Ferruginous (2.82) and Swainson's (2.65) Hawks. Diet overlap was highest between Ferruginous and Swainson's Hawks (O = 0.729), intermediate between Red-tailed and Swainson's Hawks (0.290) and lowest between Red-tailed and Ferruginous Hawks (0.220). Reproductive success was highly variable for Ferruginous ($\bar{x}$ = 0.55, CV = 0.386) and Swainson's Hawks ($\bar{x}$ = 0.64, CV = 0.341) and less variable and higher for Red-tailed Hawks ($\bar{x}$ = 0.73, CV = 0.263). These observations reflect divergent life history strategies among these congeneric species.

Habitat Use by Breeding Goshawks in the Southern Cascades

Austin, K. *Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331*

Management of breeding Northern Goshawk (*Accipiter gentilis*) habitat in Region 5 of the U.S. Forest Service consists of retention of a 50–100 acre forested nest buffer, and research is needed to evaluate and expand management guidelines. Radiotelemetry conducted during the breeding season of 1988 and 1989 indicates an average home range area (95% minimum convex polygon) of 1891 ha (4670 ac) for 10 goshawks (5 males, 5 females). Analysis of vegetation data, from radio-telemetry sites and random sites in home range areas, indicates that goshawks selected the oldest, densest vegetation type available, and avoided the youngest, and most open vegetation.

Nestling Diet in Cooper's Hawk

Bielefeldt, J., R. Rosenfield and J. Papp. *Racine County DPW, Sturtevant, WI 53177*

Most studies of diet in Cooper's Hawks (*Accipiter cooperii*) have concluded that avian prey predominates, but methodological problems may compromise such results. We contrast tallies of prey deliveries to nestlings and prey remains found near nests in Wisconsin. Mammals accounted for a majority of biomass in 2 of 3 nest delivery samples, and reliance on prey remains probably overestimates the proportion of more conspicuous avian items. Prey brought to nestlings was mainly ground-foraging and sub-adult items. We suggest that seasonal, geographic, and

other limitations of existing data preclude generalizations about Cooper's Hawk diets or prey "agility."

EFFECTS OF *TRICHINELLA PSEUDOSPIRALIS* INFECTIONS ON THE PREDATORY BEHAVIOR OF AMERICAN KESTRELS (*FALCO SPARVERIUS*)

BOMBARDIER, M. AND M.E. RAU. *Institute of Parasitology,* D.M. BIRD. *Macdonald Raptor Research Centre, McGill University, Ste-Anne-de-Bellevue, PQ Canada H9X 1CO.* P.Y. JUI. *Agriculture Canada, Statistical Research Section, Ottawa, ON Canada K1A OC6*

T. pseudospiralis did not affect the attack rate or hunting success of kestrels in a modified open-field arena. Infection, however, altered the manner in which insect prey were taken. Thus, the frequency of flight-hunting declined with infection, and birds tended to hunt on foot. In flight, the frequency of wing beats and the horizontal distance travelled to regain the elevated perch increased, making aerial approaches less steep and individual wing beats less powerful. Concordance was found between intensity of infection, magnitude of change in flight activities and body weight. Fenbendazole was 99% effective in killing muscle larvae and treated birds showed signs of rehabilitation.

ARTIFICIAL NEST STRUCTURES FOR FERRUGINOUS HAWKS IN WYOMING

CALL, M.W. AND J.R. TIGNER. *Afton, WY 83110 and BLM, Rawlins, WY 82301*

Between the fall of 1987 and the fall of 1990, 65 artificial nest structures were erected for Ferruginous Hawks nesting in the Rawlins BLM District: 31 by the BLM, 30 by Energy International, Inc., and 4 by the U.S. Air Force. Twenty-six structures were available for nesting in 1988, 54 in 1989, 61 in 1990 and 65 in 1991. One hundred nineteen nests were used during the four nesting seasons of the 206 structures available during those years. Of the 119 active nests, 105 successfully fledged 280 young hawks, for an average over the four years of 2.7 young fledged per successful nest. Use of artificial nest structures is compared between the Rawlins BLM District and the structures erected and studied by Stalmaster (1988) in northern Utah and Colorado and those of Schmutz (1984) in Alberta, Canada.

BALD EAGLE SHORELINE PERCHING HABITAT ON THE NORTHERN CHESAPEAKE BAY, MARYLAND

CHANDLER, S.K., D.A. BUEHLER AND J.D. FRASER. *Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.* J.K.D. SEEGAR. *Chemical Research, Development and Engineering Center, Aberdeen Proving Ground, MD 21010*

We studied Bald Eagle (*Haliaeetus leucocephalus*) diurnal perching habitat on the northern Chesapeake Bay shoreline from July 1990 to May 1991. We investigated the differences between known eagle perch trees and randomly selected trees. We found that perch trees were larger than random trees in both DBH (54.31 cm and 34.80 cm respectively, $P < 0.0001$) and height ($\bar{x}$ = 19.94 m and 12.15 m respectively, $P < 0.0001$). Forested shoreline areas had significantly more potential perch trees than either developed or marsh shoreline ($\bar{x}$ = 42.63, 26.48 and 8.9 trees, respectively, and $P < 0.0001$ and $P < 0.0001$ respectively). Eagles selected marsh habitat less than expected when compared to unused areas ($\chi^2 = 15.33$, df = 4, $P = 0.004$).

PLASMA ENZYME LEVELS OF REHABILITATED RED-TAILED HAWKS FOLLOWING EXERCISE

CHAPLIN, S.B. AND S.T. KNUTH. *Department of Biology, University of St. Thomas, St. Paul, MN 55105*

Plasma levels of lactate dehydrogenase (LD) and creatine phosphokinase (CK) were assayed in four Red-tailed Hawks during their flight conditioning program as a means of assaying muscle damage and providing a measure of muscle fitness. Blood samples (0.5 ml) were taken before flight and at 4, 8, 12, 24, 48 and 72 hours after a standardized exercise of 1500 feet of flight. Unfit hawks sampled at the beginning of their flight conditioning program exhibited significantly higher levels of both LD and CK than well-conditioned individuals. There was a peak of CK activity about 24 hours after exercise in unfit hawks; however, LD levels increased gradually over 48 hours. The usefulness of enzyme assays as measures of flight fitness will be discussed.

POPULATION RECOVERY OF COLORADO PEREGRINES

CRAIG, G.R. AND J.H. ENDERSON. *Colorado Division of Wildlife, 317 W. Prospect, Ft. Collins, CO 80526, and Dept of Biology, Colorado College, Colorado Springs, CO 80903*

Since 1973, all documented peregrine nesting sites in Colorado have been monitored annually and potential breeding areas were surveyed as time permitted. The population increased from a low of 8 occupied breeding territories in 1975 to 58 occupied sites in 1991. Since 1976, 47 previously unknown breeding sites were documented. Population models suggest that the rapid expansion resulted from infusion of 406 young successfully released through fostering and hacking between 1976 and 1989. Productivity of wild pairs improved from 0.44 young per occupied territory during the period of population decline to 1.47 during the recovery phase. Given the rate of reoccupancy, productivity and reduced eggshell thinning, it appears that the Colorado population is secure.

DYNAMICS OF A YEAR-ROUND COMMUNAL ROOST OF BALD EAGLES

CURNUTT, J.L. *South Florida Research Center, Everglades National Park, Box 279, Homestead, FL 33030*

I observed a year-round communal roost of Bald Eagles in southern Florida from April 1990 to February 1991.

Over 77% of eagles observed were subadults. The proportion of adult eagles changed from 5% during the breeding season to 26% during the non-breeding season. Numbers of eagles peaked in July and in December. The number of eagles arriving at the roost was negatively correlated with wind speed and positively correlated with mean temperature. Arrival time correlated with sunset and was not affected by cloud cover. Adults tended to leave the roost later than subadults but the difference was not significant. There were 14 observed displacements and 20 pursuits; all pursuits were between subadults. Unlike most Bald Eagle communal roosts, the Everglades National Park roost is not located near available prey, nor does it offer any obvious advantage in climate. The roost may serve as a social integration mechanism.

LIFE HISTORY OF THE WHITE HAWK IN GUATEMALA

DRAHEIM, G. *Raptor Research Center, Boise State University, Boise, ID 83725*

Initial observations were made on White Hawks during the 1991 breeding season in Tikal, Guatemala. Three nests were located. The mean dbh of the nest trees was 67.3 cm and nest height averaged 23.1 m above the ground. Mean width of nests was 54.4 × 90.8 cm with a vertical dimension of 31 cm. Two eggs were weighed and measured, mean dimension was 44.3 × 53.4 mm and average weight was 55.7 g. Fifty-four prey items were observed; 48% were reptiles, 33% unidentified, 9% mammals, 7% birds and 1% amphibians. Three breeding adult hawks were trapped and measurements were taken. Home range for one breeding adult male was 208 ha.

DEMOGRAPHY OF ARIZONA BALD EAGLES

DRISCOLL, D. AND G. HUNT. *BioSystems Analysis Inc., 303 Potrero 29-203, Santa Cruz, CA 95060*

The number of known Bald Eagle breeding areas in Arizona has grown from 2 in 1970 to 28 by 1990; however, much of this gain may be a result of increased nest search efforts, rather than population expansion. Productivity does not differ significantly from that of other Bald Eagle populations in North America. However, there appears to be a high rate of mortality in some areas. Sixty-one percent of known replacements of missing mates were by eagles in near-adult, rather than full-adult plumage, a rate greatly exceeding those reported for other populations. Whether the high frequency of near-adults as members of pairs results from an expanding population or one experiencing high overall mortality rates is unknown. This study was funded by the U.S. Bureau of Reclamation.

INTESTINAL CECA: WHY OWLS BUT NOT HAWKS?

DUKE, G.E. AND S.B. CHAPLIN. *Department of Veterinary Biology, University of Minnesota, St. Paul, MN 55108, and Biology Department, University of St. Thomas, St. Paul, MN 55105*

All strigiforms have large, well developed ceca yet no falconiforms have them. The major functions of the ceca or cecal flora are believed to be: fiber breakdown, water conservation, metabolism of urinary nitrogen and bacterial competition with gut pathogens. Raptors don't eat fiber and they have little need for additional protein via urinary recycling. Hawks and owls may both benefit, however, from water conservation and being better able to cope with pathogens. We found that cecectomized owls held at 15°C were able to maintain fluid balance eating only freshly killed lab mice with no drinking water. When held at 27°C, however, the cecectomized owls could not have survived without drinking water. Owls and hawks have similar diets and habitats, so if owls need ceca, why don't hawks need them too?

BREEDING DISPERSAL OF GREAT GRAY OWLS IN MANITOBA AND MINNESOTA

DUNCAN, J.R. *Zoology Department, University of Manitoba, Winnipeg, MB Canada R3T 2N2*

The influence of prey abundance and snow cover on the breeding dispersal of radio-marked Great Gray Owls (*Strix nebulosa*) was investigated from 1984 to 1990. Of 1545 prey items identified, 90% were meadow voles (*Microtus pennsylvanicus*). During increase and peak vole population phases, adult owls remained on their breeding home ranges and did not disperse. Breeding dispersal of owls was independent of snow cover and occurred following prey population crashes. On average, adult female owls dispersed farther (466 vs. 214 km, $P < 0.001$) and earlier (October vs. January, $P < 0.05$) than adult males. There was no difference between male and female mean dispersal azimuths (11° vs. 6°, $P < 0.05$) and these were significantly nonrandom ($P < 0.001$). Adult Great Gray Owls exhibited a breeding dispersal pattern best described as a female biased multi-annual migration, rather than nomadism, driven by prey population fluctuations.

DDE, EGGSHELLS AND PRODUCTIVITY IN A RECOVERING PEREGRINE POPULATION

ENDERSON, J.H. AND G.R. CRAIG. *Department of Biology, Colorado College, Colorado Springs, CO 80903, and Colorado Division of Wildlife, 317 W. Prospect, Fort Collins, CO 80526*

DDE in Peregrine egg contents collected 1973–90 declined to less than 10 ppm in 1990. Eggshell thickness increased 1977–82 from a low of 0.290 mm (19% thinner than pre-1947 mean of 0.359 mm) to 0.325 mm but no further improvement has occurred. Large within-clutch variation in thickness of eggshells and fragments greatly lowered their predictive value. Although thickness was inversely related to DDE in the egg contents, the correlation was poor. No trend in DDE or shell thickness was found in individual females over years. Territories in woodland/

brushland were associated with high nesting success compared to montane and subalpine sites, but young fledged per pair, eggshell thickness or DDE did not vary significantly with elevation. Thickness of shells or fragments did not relate to fledging success in a given nesting attempt. The practice of gathering egg or shell samples to determine the status of a population may be dubious.

DO DISPARATE SEX RATIOS IN NORTHERN HARRIERS INFLUENCE THE OCCURRENCE OF POLYGYNY?

ENGLAND, M.E. *National Audubon Society, Scully Science Center, 550 South Bay Avenue, Islip, NY 11751*

During a five year study of Northern Harrier breeding biology on a Long Island, New York, barrier beach, I found that female harriers significantly outnumbered males in nestling, fledgling and adult breeding populations. At the mid-nestling stage, 44% of harrier nests contained only female young, and female fledglings outnumbered males by 3:1. Among breeding harriers there were almost twice as many females as males. Reasons for this disparity were not determined in my study, which stressed fitness consequences for the individual arising from the inequality. The excess of harrier females may influence female breeding options, and indeed polygyny rates in the barrier beach nesting areas exceeded 50% over the course of the study years. I suggest that limited male numbers contributed to the occurrence of polygyny in the study population, and that multiple pairings may have enabled more females to breed when the "choice" was between polygyny and not breeding.

ARE OSPREYS SENSITIVE MONITORS OF CONTAMINANT LEVELS AND BIO-EFFECTS ON THE GREAT LAKES?

EWINS, P.J. AND M.E. BARKER. *Canadian Wildlife Service, Canada Centre for Inland Waters, P.O. Box 5050, Burlington, ON Canada L7R 4A6*

In 1991 we initiated a study of Ospreys in two areas of Lake Huron (Georgian Bay and the St. Mary's River) and in a reference area 100 km to the east (the Kawartha Lakes). In these respective study areas 80%, 38% and 59% of active nests occurred on man-made structures. Overall breeding success was 46% in Georgian Bay, 58% in the St. Mary's River and 53% in the Kawartha Lakes, with means of 1.1, 1.8 and 1.3 young fledged per active nest. Aerial coverage of a larger sample of nests provided comparable figures of 1.1, 1.4 and 1.1 respectively. Egg predation by raccoons was important in two areas. In the absence of reliable population counts, or data on age of recruitment or mortality rates, it is difficult to evaluate these productivity figures in relation to the "health" of these populations, even though they are within the range of published values for most stable populations elsewhere in North America. Levels of mercury, 18 organochlorines (OCs) and 41 PCB congeners were determined for 14 fresh and 12 unhatched eggs. These were compared with residues of OCs, total PCBs and mercury in 21 chick blood samples, and with mercury levels in mantle feathers of 23 chicks and feathers molted by 11 adults. These data were also compared amongst study areas and related to reproductive statistics, as well as to previous contaminant levels for Ospreys in Ontario and elsewhere in North America.

BALD EAGLE ACTIVITY ALONG THE UPPER MISSISSIPPI RIVER

GALLI, J.M. *Minnesota Department of Natural Resources, Nongame Wildlife Program, Box 7, 500 Lafayette Road, St. Paul, MN 55155*

This presentation reviews recent efforts to monitor, manage and protect Minnesota's recovering Bald Eagle population. The Bald Eagle is a year-round resident in Minnesota. There are currently 437 occupied breeding areas in the state, with an estimated wintering population of 100–200 eagles occurring primarily along the major river corridor. Results of a four year effort to 1) document eagle winter activity and identify and protect roost sites along the Mississippi River north of Iowa, and 2) monitor and manage a formerly disjunct breeding subpopulation in southeast Minnesota are discussed.

BLOOD PARAMETERS IN WILD GOLDEN EAGLES

GIBSON, M.J. AND D.C. GIBSON. *N2160 W. Rollwood Road, Antigo, WI 54409.* P.T. REDIG. *The Raptor Center, 1920 Fitch Ave., St. Paul, MN 55108.* P.H. BLOOM. *Western Foundation for Vertebrate Zoology, 13611 Hewes Ave , Santa Ana, CA 92705*

Standard hematological and a panel of 21 serum chemical parameters were obtained from 150 Golden Eagles (*Aquila chrysaetos*) trapped in Kern County, California, between September 1985 and January 1987. Body weights, all hematological parameters and several serum chemical parameters associated with nutritional status (e.g., albumin, total protein) showed seasonal variation with low points occurring during summer months. No differences in these parameters were seen as a function of age or sex. Seasonal variation of serum enzymes was also seen. These annual variations affect interpretation of blood data for clinical and toxicological studies.

MORPHOLOGICAL DIFFERENCES OF FERRUGINOUS HAWKS IN ALBERTA AND IDAHO

GOSSETT, D.N. AND M.J. BECHARD. *Raptor Research Center, Department of Biology, Boise State University, Boise, ID 83725*

Preliminary results are described from the first year of a study of morphological differences between subpopulations of Ferruginous Hawks. Measurements of feeding apparatuses were of particular interest due to ecological differences in prey selection in these study areas.

BLOOD CONTAMINANTS OF MIGRANT GOLDEN AND BALD EAGLES IN MONTANA WITH NOTES ON CAPTURE, SIZE AND GENDER ASSIGNMENT

HARMATA, A. *Department of Biology, Montana State University, Bozeman, MT 59717*

Between 1984 and 1990, 85 Golden Eagles and 67 Bald Eagles were captured as migrants, weighed, measured and blood analyzed for heavy metals, hematozoa, pesticide residues and cholinesterase (ChE) levels. Mean Pb levels tended to increase with age, were at or above those considered toxic in both species and tended to be higher in female Golden Eagles. Poor plumage and foot lesions were related to higher blood Pb levels and incidence of Leucocytozoon in Golden Eagles. Mean Se levels tended to decrease with age in Golden Eagles but remained constant in Bald Eagles. Hg was detected only at low levels in Golden Eagles and As overall. DDE was detected in most Bald Eagles and some Golden Eagles. ChE levels were higher in Golden Eagles than Bald Eagles and indicated recent organophosphate or carbamate poisoning in some eagles. Mensural data suggest selection for larger female and smaller male Golden Eagles but larger Bald Eagles. Gender differences in plumage of adult Golden Eagles were noted.

AN OSPREY STUDY AT LOON LAKE, SASKATCHEWAN

HOUSTON, C.S. *863 University Drive, Saskatoon, SK Canada S7N 0J8.* F. SCOTT. *RR #3, Saskatoon, SK Canada S7K 3S6*

Since 1975 we have banded 277 nestling Ospreys in 139 successful nests near Loon Lake. Alpha-numeric colorbands have been used since 1988 on the other leg of all nestlings and on 23 adults, including 5 males. Only one of the trapped adults had been banded as a nestling at Loon Lake 14 years earlier; the rest immigrated from elsewhere. There have been eight retrappings of six adults in subsequent years. Nests in dead trees have been moved to man-made platforms, which now account for more than half the nests. Twelve recoveries to date include two from Columbia and one each from Panama, Costa Rica, Veracruz, Louisiana and New Mexico.

FORAGING STUDIES OF NESTING BALD EAGLES IN ARIZONA

HUNT, G., E. BIANCHI, D. DRISCOLL AND R. JACKMAN. *BioSystems Analysis Inc., 303 Potrero 29-203, Santa Cruz, CA 95060*

In a study funded by the U.S. Bureau of Reclamation, we tracked the daily movements of radio-tagged adult Bald Eagles at seven breeding areas while simultaneously observing prey deliveries to the nest. In riverine habitats, eagles mainly took live fish, while on reservoirs they found carrion. Ecology and life history events of fish, particularly spawning, influenced their availability to eagles on both rivers and reservoirs. Comparing habitat availability with use, we found that eagles foraging in riverine habitats selected riffles over runs and pools. At breeding areas containing reservoirs, eagles tended to use them as much or more than river sections, and to prefer the areas where free-flowing rivers entered the reservoirs.

PESTICIDE LEVELS AND EGGSHELL THICKNESS IN FOUR SYMPATRIC NEOTROPICAL RAPTORS IN SOUTHEASTERN MEXICO

IÑIGO-ELIAS, E.E. *Department of Wildlife and Range Sciences, 118 Newins-Ziegler Hall, University of Florida, Gainesville, FL 32611-0304.* L.A. ALBERT. *Consultores Ambientales Asociados S.C., Ap. Postal 474, Xalapa, Veracruz 91000, Mexico.* A.F. NAVARRETE. *Martires 28 de Agosto #155-2, Xalapa, Veracruz 91020, Mexico.* L.F. KIFF. *Western Foundation of Vertebrate Zoology, Suite #1400-1100 Glendon Avenue, Los Angeles, CA 90024*

We studied the types and levels of organochlorine pesticides and eggshell thickness in eggshells of four sympatric neotropical raptors (*Elanus caeruleus, Buteogallus anthracinus, Buteo magnirostris, Herpetotheres cachinnans*) in four states in Mexico. Eggs were collected from 1952 through 1969. Between 5–9 organochlorine residues were found in all samples. Eggshells from the four species showed a reduction from pre-DDT era thicknesses.

EFFECTS OF FOREST FRAGMENTATION ON A TROPICAL FOREST RAPTOR COMMUNITY IN THE SELVA LACANDONA REGION OF CHIAPAS, MEXICO

IÑIGO-ELIAS, E.E. AND M.W. COLLOPY. *Department of Wildlife and Range Sciences, 118 Newins-Ziegler Hall, University of Florida, Gainesville, FL 32611-0304*

We studied the effects of forest fragmentation on a community of forest raptors in the Montes Azules Biosphere Reserve and Marques de Comillas area in the Selva Lacandona region of Chiapas, Mexico. During September 1989 to August 1990 we conducted 12 monthly surveys using two different sampling methods: walking line transects (N = 24, 282 replicates) and river transects (N = 11, 126 replicates). Two principal objectives were tested: 1) the effectiveness of different survey methods and 2) to document what changes occurred at the community and species levels due to forest fragmentation. Significant changes occurred in the raptor assemblage (species richness and diversity) and at the species level due to forest fragmentation.

FOREST HABITAT DIMENSIONS OF THE FLAMMULATED OWL

JOHNSON, E.D. AND P.J. ZWANK. *U.S. Fish and Wildlife Service, Cooperative Fish and Wildlife Research Unit, New Mexico State University, Las Cruces, NM 88003*

During the first of two field seasons, 132 Flammulated Owl territories were identified in a surveyed aural landscape of 26 700 ha on the Lincoln National Forest, New Mexico. Average density of Flammulated Owls was estimated to be 0.20/40 ha. Groups of territories contained

2 to 9 males; group territory size ranged from 78 to 628 ha. We will further report on distribution and abundance data collected during the second field season and distribution and abundance relationships to measurements of habitat dimensions.

A HIGH SCHOOL HAWK WATCH PROJECT

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This TAPESTRY Award winning hawk watch project offers students a real and immediate project rather than a simulation to study and discuss the issues of raptor ecology. As an interdisciplinary expression through math and verbal avenues students are expected to sharpen scientific skills. Students summarizing their conclusions in a scientific paper is an exercise in organizational and critical thinking. Using Bernice McCarthy's 4MAT system to Learning Styles, the hawk watch activities address all four learning styles exhibited by students as well as left-right brain hemisphericity modes of learning. This project can easily be expanded and coordinated with other schools across the country. It is hoped that contacts can be made and ideas shared to accomplish this task. As a result, students involved will discover an exciting and challenging vocational avenue, ornithological research.

THE DIET OF NORTHERN GOSHAWKS AND COOPER'S HAWKS DURING THE NESTING SEASON IN NORTH-CENTRAL NEW MEXICO

KENNEDY, P.L. *Department of Fishery and Wildlife Biology, Colorado State University, Ft. Collins, CO 80523.* J.A. GESSAMAN. *Biology Deptartment, Utah State University, Logan, Utah 84322.* R. WARREN. *Environmental Sciences Group MS J495, Los Alamos National Lab., Los Alamos, NM 87545.* B.A. GILROY. *U.S. Fish and Wildlife Service, National Fish and Wildlife Forensics Lab., 1490 E. Main St., Ashland, OR 97520*

During 1984–88 we assessed diet of Cooper's Hawks (*Accipiter cooperii*) and Northern Goshawks (*A. gentilis*) nesting in north-central NM by direct observation of 203 prey deliveries, and analyzing 420 prey remains and 214 pellets collected at nests, perches or plucking posts. Ranking of prey eaten by both *Accipiter* species, categorized by taxon, did not differ between three dietary sampling methods. Results support assumption that periodic samples of prey remains at nests characterize species composition of diet of breeding raptors. In interspecific comparison, no differences were found in ranking of prey taxa used by the two *Accipiter* species in NM. These results indicate sympatric nesting populations of Northern Goshawks and Cooper's Hawks do not necessarily feed on different prey species during nesting season.

USING SOFTWARE IN RADIO-TAG PROJECTS: NOT THE FINAL DECISION

KENWARD, R.E. *Institute of Terrestrial Ecology, Wareham BH20 5AS, U.K.*

Radio-tagging projects often produce neither quantitative results nor analyze data rigorously. This is partly a result of poor planning, and can be overcome by using pilot projects to develop efficient field techniques. Ideally, the data collection technique should maximize the number of animals which can be tracked by minimizing the number of fixes needed for each movement record or home range. Assumptions of fix independence can then be avoided by treating each collection of fixes as a single record in robust tests of differences between individuals, areas, seasons and experimental treatments. This approach requires access to suitable software from the start of a project, with final analyses of multi-animal data sets relying heavily on the programs available. The process is illustrated by using RANGES IV to analyze data from radio-tagged goshawks, buzzards and squirrels.

DISTRIBUTION, DENSITY AND STATUS OF THE GOSHAWK IN PENNSYLVANIA

KIMMEL, J.T. AND R.H. YAHNER, *School of Forest Resources, The Pennsylvania State University, University Park, PA 16802*

We studied the Northern Goshawk (*Accipiter gentilis*) in Pennsylvania from 1988–91 to determine the distribution, abundance and status of this raptor in the state. Information from various sources contributed to identifying 91 locations statewide where goshawks were confirmed to nest in the past 15 years (64 in the past 5 years). The primary breeding range of the goshawk in Pennsylvania is the northern half of the state, excluding the extreme northwestern counties. Censuses conducted in the Allegheny National Forest and the Bald Eagle State Forest yielded minimum densities of 1.17 and 0.73 active nests/100 km^2 of forest in these two areas, respectively. We estimated the statewide population using three relatively independent techniques; point estimates were 144, 201 and 348 nest sites.

A COMPARATIVE EXAM OF GOLDEN EAGLE NEST SITES IN BOULDER COUNTY, COLORADO

KING, D.W., N. LEDERER AND M. FIGGS. *Boulder County Nature Association, Boulder, CO 80302*

Since first discovered in 1907 by Denis Gale and later evaluated by Malcolm Jolley (1943), nine Golden Eagle nest sites have added a surprising number of young eagles to Colorado's eagle population. This paper will compare a site within the city limits of Lyons to the remaining six nest sites of Colorado's Front Range within the confines of Boulder County.

HOME RANGE AND HABITAT USE OF THE MEXICAN SPOTTED OWL IN SOUTHERN NEW MEXICO

KROEL, K.W. AND P.J. ZWANK. *U.S. Fish and Wildlife Service, Cooperative Fish and Wildlife Research Unit, New Mexico State University, Las Cruces, NM 88003*

We determined home range size and habitat use characteristics of the Mexican Spotted Owl (*Strix occidentalis lucida*) on the Lincoln National Forest, NM. Radiotransmitters were placed on 9 owls (4 pairs and 1 female) in October 1990. The owls were tracked until their transmitters failed, they died or project termination in August 1991. Home range estimates (minimum convex polygon method) of individual owls ranged from 237 ha to 1168 ha with an average of 703 ha. Home range sizes for pairs ranged from 790 ha to 1410 ha with an average of 1121 ha.

MANAGING BALD EAGLES AT THE LOCAL LEVEL: A PROTOTYPICAL ORDINANCE

LINCER, J.L. *BioSystems Analysis Inc., 5355 Mira Sorrento Place, Suite 100, San Diego, CA 92121*

Throughout most of the United States, federal and state regulations deal with impacts to Bald Eagles only after they have been documented. To take a more proactive approach, Sarasota County (Florida) is developing a local Bald Eagle Protection Ordinance. Because of the obvious transferability to other local governments throughout the United States, a prototypical ordinance was produced for further distribution. This ordinance provides for duties of the ordinance administrator, designation and regulation of protective zones, management plans, cease and desist orders, transferrable development rights, variances, a Bald Eagle protection fund, eagle habitat acquisition, penalties and enforcement.

PREDATION OF BLACK-LEGGED KITTIWAKE CHICKS BY COMMON RAVENS ON BACCALIEU ISLAND, NEWFOUNDLAND

MACCARONE, A.D. *Biology Department, Friends University, Wichita, KS 67213*

Baccalieu Island, Conception Bay, Newfoundland, supports several hundred thousand pairs of seabirds, including alcids, gannets and Black-legged Kittiwakes. Common Ravens also breed on this tiny island and prey extensively on the breeding seabirds. Ravens patrol singly or in pairs along the cliff face and attempt to flush adult birds in order to steal eggs and chicks. I describe the predatory strategy and success of the ravens and kittiwake anti-predatory behavior.

TROPHIC CHARACTERISTICS AND GUILD STRUCTURE OF VERTEBRATE PREDATORS

MARTI, C.D. *Department of Zoology, Weber State Univ., Ogden, UT 84408.* K. STEENHOF, M.N. KOCHERT AND J.S. MARKS. *U.S. Bureau of Land Management, Boise, ID 83725*

We examined trophic characteristics of 17 coexisting predators (12 raptors) in southwestern Idaho. Mammalian prey was most important in diets of all the predators. Mean prey mass ranged from 2.2 to 711 g and was correlated with predator mass. Ratios of prey mass/predator mass ranged between 0.4% and 22.5%. Diet overlaps between predators ranged from 1–90%. No significant differences were detected in food niche breadth or mean prey mass between diurnal and nocturnal predators. Dietary overlap between predators with the same diel activity was significantly greater than that between asynchronously-active predators. Mean diet overlap was significantly greater between nocturnal predators than between diurnal predators ($P < 0.004$). Four feeding guilds were present. One owl and one hawk were not members of guilds.

COMMUNAL ROOSTS OF VAGRANT RAVENS ARE MOBILE INFORMATION CENTERS

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Vagrant Common Ravens in western Maine roost communally and accumulate into groups of 40 or more at food bonanzas during the winter. Three observations on free ranging birds confirm that communal roosts are information centers. 1) Ravens arrive at roosts from a variety of directions, but leave as a group in one or two directions the next morning. 2) Birds, naive of a bonanza's location and experimentally implanted into a roost, follow their roost mates to food, but naive birds, not introduced into a roost, rarely located the bonanza. 3) Significantly more ravens arrive at bonanzas the morning after discovery than can be accounted for by independent discovery and/or local enhancement. Conspicuous social soaring displays facilitate information transfer among members of ephemeral roosts.

GOSHAWK NEST SITE ATTRIBUTES IN NORTHERN NEVADA

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In April, 1991, a 3-year study of Northern Goshawks in the Independence Mountains of northern Nevada was initiated as a cooperative effort involving Independence Mining Co. Inc., Boise State University, the U.S. Fish and Wildlife Service, and Nevada Department of Wildlife. During 1991, we determined attributes of 14 occupied goshawk nest sites, utilizing field data and a geographic information system. Nest sites were consistently in mature stands of aspen and specifically in relatively larger aspen trees ($\bar{x}$ height = 7.6 m), located 45–90 m from the edge of the stand. Nest trees had the following characteristics: (1) relatively mild terrain ($\bar{x}$ slope = 21%), (2) distance

to water of 49 m, and relatively open understory vegetation. Eventual abandonment of six nests was not correlated with proximity of habitat disturbance.

THE STATUS OF THE MEXICAN SPOTTED OWL

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In 1989, the U.S. Fish and Wildlife Service received a petition to list the Mexican Spotted Owl (*Strix occidentalis lucida*) under the Endangered Species Act. The maximum potential habitat within the U.S. appears to be 5.6 million acres with 99% on public lands. The known population in 1990 was 804 and the maximum estimated population 2160, about one-third the population size of the Northern Spotted Owl subspecies. Considering habitat fragmentation and projected habitat trends, the population may not provide assurance of the species' future security.

USING SATELLITE RADIO TELEMETRY TO TRACK LOCAL AND LONG DISTANCE MOVEMENTS OF AN ALASKAN GOLDEN EAGLE

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An 85 gram satellite radio transmitter was attached to a nestling Golden Eagle using a backpack-style harness in Denali National Park and Preserve on 2 August 1990. The eagle's movements were monitored by satellite in Alaska, during migration and throughout the winter. The eagle left Denali on 23 September 1990 and arrived in northern Idaho on 15 October 1990. Local winter movements in eastern central Idaho and western Montana were monitored via satellite until March 1991, when the transmitter batteries expired.

GENETIC AND DEMOGRAPHIC STATUS OF PEREGRINE FALCONS IN THE UPPER MIDWEST

MOEN, S. AND H.B. TORDOFF. *Bell Museum of Natural History, University of Minnesota, Minneapolis, MN 55455.* P.T. REDIG. *The Raptor Center, University of Minnesota, St. Paul, MN 55108*

Out of 549 Peregrine Falcon eyasses released over the past 10 years, less than 40 have bred and produced 96 fledglings in the upper Midwest. The reintroduced peregrines differ both genetically and demographically from those which occupied the Midwest prior to extirpation in the 1950s. Genetically, the new population is composed of at least five subspecies which, because of the species' rarity and the nature of the captive breeding programs, show a high level of inbreeding. The three wild-produced peregrines now breeding in the midwest are also inbred; all three share the same mother. Through DNA and pedigree analyses, we assess the levels of inbreeding and outbreeding of the new population. A banding program of wild young has allowed us to monitor the movements and age distribution of the known wild population. The population is partially migratory and includes birds released from as far away as New Brunswick. The new peregrines are roughly 65% urban. Historical eyries along the Mississippi River remain unoccupied.

BREEDING BIOLOGY OF LAUGHING FALCONS IN RAINFOREST AND AGRICULTURAL LANDS OF THE PETEN, GUATEMALA

PARKER, M. *Department of Biology, Boise State University, Boise, ID 83725*

The breeding biology of Laughing Falcons (*Herpetotheres cachinnans*), has been studied for the breeding seasons of 1990 and 1991 within the primary forest of Tikal National Park. Data were collected in 1991 on birds nesting in man-altered, agricultural habitat outside the park and comparisons made between the two groups as to diet, prey delivery rates, home range and habitat use. Nesting success was 56% (N = 16) over the two years and growth curves for this species were established.

A STUDY OF FACTORS AFFECTING FORAGING HABITAT SELECTION OF OSPREYS (*PANDION HALIAETUS*) AT CASCADE RESERVOIR, IDAHO

PHELPS, J.M. AND M.J. BECHARD. *Department of Biology, Raptor Research Center, Boise State University, Boise, ID 83725*

This two year study involved describing and quantifying physical features critical to Osprey foraging habitat. During the 1990 and 1991 field seasons radio telemetry was used to locate home ranges and foraging habitats of seven nesting male Ospreys. Physical features were described and measured in order to ascertain the significance of these characteristics. Preliminary results indicate the most important factors were those affecting prey (fish) availability, such as water parameters.

NEST SITE SELECTION BY BURROWING OWLS IN COLORADO

PLUMPTON, D. AND R.S. LUTZ. *Department of Range and Wildlife Management, Texas Tech University, Lubbock, TX 79409*

Physical attributes of Burrowing Owl nesting sites were studied in north-central Colorado during 1990 and 1991. In 1990, Burrowing Owls selected burrows in areas of greater burrow density ($P = 0.006$, $\bar{x} = 29$ burrows/0.2 ha) than available ($\bar{x} = 21$). The distance to the nearest

above ground perch at selected burrows was significantly greater than control burrows in 1990 ($P = 0.015$, $\bar{x} = 14.2$ and 7.1 m for selected and control burrows respectively). Orientations did not differ between used and available burrows ($\chi^2 = 11.07$, $P > 0.05$, df = 7); both were oriented randomly. Burrowing Owls apparently did not select burrows based on the physical attributes we measured.

ULTRASTRUCTURE OF RED-TAILED HAWK (*BUTEO JAMAICENSIS*) SPERMATOZOA

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The ultrastructure of Red-tailed Hawk spermatozoa was characterized by transmission electron microscopy. The structure was similar to that reported for domestic fowl. The cells were vermiform in shape and apically bounded by a conical acrosome. Spermatazoa also possessed a dense spine under the acrosomal cap that was surrounded by a granular matrix. The nuclear chromatin also appeared to be less dense than that seen in other species.

UNCONVENTIONAL RELEASE METHODS FOR PEREGRINE FALCONS

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In this paper, we describe methods used for release of Peregrine Falcons where efficiency, differential rates of maturity of various subspecies of peregrines, or the vagaries associated with weather, logistics, disease and injury necessitated substantial deviation from conventional hacking methods. Described are: 1) sequential, multiple releases at one site, 2) release at advanced age, 3) short duration pre-release residence in the hack box, 4) trapping and translocation of liberated falcons after attack by adult falcons, and 5) repair, recovery and release within the same release season or in a subsequent year by "re-hacking" of falcons that have sustained fractures.

NEST-BOX USE AND REPRODUCTIVE SUCCESS OF AMERICAN KESTRELS IN SOUTHEASTERN PENNSYLVANIA

ROHRBAUGH, R.W. AND R.H. YAHNER. *School of Forest Resources, Pennsylvania State University, University Park, PA 16802*

We monitored the activity of 131 American Kestrel (*Falco sparverius*) nest boxes during 1990 and 1991. Our objectives were to determine kestrel nest box use patterns and reproductive success. The nest boxes were spaced approximately 0.81 km apart throughout the 1000 km^2 study area. Habitat of the study area was predominantly agricultural interspersed with fencerows, woodlots and gallery type forests. We characterized 35 breeding attempts in 1990 and 55 in 1991. The mean clutch size was 4.39, mean number of nestlings per pair was 2.20, yielding a hatchability rate of 51%. Mean number of fledglings per successful pair was 3.59, however the number of fledglings produced per breeding pair was only 2.28. Predation and desertion each contributed equally to the 48 (53%) failed breeding attempts.

PREY OF PEREGRINE FALCONS IN GREENLAND: TAKE THE YOUNG, THE STUPID, AND THE MANY

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We recorded 455 prey items delivered to two Peregrine Falcon eyries during 492 hours of observation from blinds on a 2590 km^2 study area in west Greenland, 1989–90. Lapland Longspurs, the most abundant prey species available near both nests, contributed the most to the nestlings' diet both in terms of frequency of occurrence and biomass. There were local differences in prey use between the two nests. A minimum of 65% of all longspurs delivered as prey were nestlings and/or fledglings. Analyses of prey items (N = 676) found as remains at 159 eyries in the study area are also discussed.

BIAS IN DETECTING AMPHIBIANS AND REPTILES IN THE DIETS OF NORTH AMERICAN FALCONIFORMES

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A literature review of seven species of North American raptors revealed that those food habit studies conducted by direct observation detected amphibians and reptiles more efficiently than did those studies using indirect observation. A combination of indirect and direct study is recommended for some species.

GEOGRAPHIC VARIATION IN THE GROWTH OF NESTLING OSPREYS

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Thirty-one nestling Ospreys evaluated for sex-specific growth performance within a sedentary population in Sonora, Mexico were compared with nestlings from a migratory population in Nova Scotia, Canada. Comparisons of geographic variation by sex showed that Ospreys in the Sonoran Desert had significantly higher weight asymptotes, reduced growth rates, longer nesting periods and later emergence of flight feathers than temperate migratory birds. I present a hypothesis that invokes phenotypic responses to external environmental conditions, namely mi-

gratory habits and climate, as possible factors accounting for differences in morphological features observed between the two populations.

AGE-RELATED DIFFERENCES IN REPRODUCTIVE SUCCESS AMONG FERRUGINOUS AND SWAINSON'S HAWKS IN ALBERTA

SCHMUTZ, J.K. *Department of Biology, University of Saskatchewan, Saskatoon, SK Canada S7N 0W0*

Color-banded Ferruginous and Swainson's Hawks varied greatly in the number of young reared to fledging over several years. A highly successful male Ferruginous Hawk contributed to the fledging of 20 young in seven years. An unsuccessful female Swainson's Hawk raised only one young in eight years. Site and mate fidelity was pronounced. There was no evidence that the hawks changed territories or mates in years after reproductive failures. In both species the youngest known breeder was two years old. The oldest known breeder, a male Swainson's Hawk, is at least 17 years old.

ARE INITIAL OBSERVATIONS ADEQUATE TO DESCRIBE THE BEHAVIOR OF RAPTORS?

SCHUECK, L. AND J. MARZLUFF. *Greenfalk Consultants, 8210 Gantz, Boise, ID 83709*

Initial observations of behavior are statistically independent and often are preferred over continuous observations. However, we compared initial and subsequent behavioral observations of raptors in the Snake River Birds of Prey Area and found that initial observations inadequately describe the full range of behavior exhibited by these species. Using only the first activity observed underestimates the occurrence of rare behaviors and overestimates the occurrence of common behaviors. Studies designed to document rare behaviors such as prey pursuit and capture or inter/intra-specific interactions require continuous observations, but statistical analyses must account for the inherent dependency of such observations.

DNA ANALYSIS OF RED-TAILED HAWK POPULATIONS IN CALIFORNIA AND NEVADA

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Blood samples were taken from groups of nestling and parent Red-tailed Hawks in widely separated locations in California and Nevada and from apparent migrants at the Golden Gate. DNA fingerprints were generated from each sample and compared. Although bird band recovery data suggest these birds return to their natal areas to nest, no DNA markers were unique to the locations sampled. This is not an unexpected result considering that this Red-tailed Hawk population is probably contiguous and given the very high level of genetic diversity that has commonly been detected by DNA fingerprint probes. Immatures flying together in December appeared unrelated. Additional findings will be reported.

THE RESPONSES OF SOUTHEASTERN AMERICAN KESTRELS TO INCREASED AVAILABILITY OF NESTING SITES IN TWO HABITATS

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Florida populations of the Southeastern American Kestrel (*Falco sparverius paulus*), currently listed as threatened, have declined severely in recent decades due to the loss of natural nesting cavities. A principal objective of this ongoing study is to examine the effect that providing large numbers of nest boxes has on the size of local populations, as determined by a standardized roadside census conducted each August in experimental and control areas in north-central Florida. Prior to the 1991 breeding season, 355 nest boxes were erected in two habitats, longleaf pine/turkey oak sandhills and hardwood hammocks, both of which had been altered by logging and grazing. Kestrels laid eggs in 65 (18.3%) nest boxes, suggesting the presence of a substantial "floater" population. The occupancy rate for nest boxes in sandhills was over twice that for those in hammocks. Clutch size was inversely proportional to laying date in both habitats. Nesting success was greater in the sandhills (67% vs. 36%). The number of fledglings per breeding attempt was inversely correlated with laying date in nests in hammocks, but not in sandhills. Preliminary results of the 1991 census suggest that kestrel numbers are increasing in sandhills where nest boxes have been introduced.

INFLUENCE OF SPATIAL AND TEMPORAL DYNAMICS OF PREY POPULATIONS ON PATCH SELECTION BY BROAD-WINGED HAWKS

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Broad-winged Hawks were radio-tracked to assess if foraging patches were selected based on criteria consistent with central-place models of foraging activity. Factors that were examined included distance from the foraging site to the nest, amount of prey cover, and variation in composition, abundance and biomass of the prey community at potential foraging sites. Seven hawks were tracked on breeding territories. All major habitat types were surveyed seasonally and annually for mammals, amphibians and reptiles. An index of prey availability was developed that incorporates the abundance and biomass of each prey species and the amount of protective cover. Digital vegetation maps were created and weighted for prey availability, which allowed testing of use versus availability of habitat types by foraging hawks. Broad-winged Hawks demon-

strated significant preference for sites high in prey availability (mature to old-growth forests, forest streams and forest roads). A compensatory relationship was also observed between distance and quality of foraging patches; only high quality sites were hunted in regions distant to the nest.

WINTERING BALD EAGLE POPULATION TRENDS IN IDAHO, 1980–1991

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We used route-regression methods (Geissler and Noon 1981) to analyze 11 years of mid-winter eagle count data from Idaho. The route-regression techniques allowed us to account for unequal survey effort among years and among regions of the state, a common problem in winter eagle surveys. Statewide counts ranged from 433 in 1980 to 839 in 1991. Trends estimated from adjusted data indicated that populations were stable or slightly increasing. Annual counts in areas where eagles are abundant were less variable than in areas where eagles are rare, but counts from both types of areas correlated positively as did counts from different habitat types. We present recommendations for sampling and analysis of wintering populations in Idaho and elsewhere, based on our findings.

STATUS OF RED-SHOULDERED HAWKS IN IOWA AND POSSIBLE EFFECTS OF INCREASING CROW POPULATIONS ON THEIR NESTING SUCCESS

STRAVERS, J. *Iowa Raptor Foundation, P.O. Box 32, Pella, IA 50219*

Between 1983–91, Red-shouldered Hawks nesting within a three county driftless (unglaciated) area of northeastern Iowa maintained high nest site fidelity and suitable reproductive rates (39 attempts, 29 successful, 2.17 fledged per successful nest, 1.62 per nesting attempt). However, only five nesting attempts were documented during this same period in eight counties in southeastern Iowa, where Red-shouldered Hawk nest site fidelity and reproductive success were poor. We found higher numbers of crows in flood-plain forests in southeastern Iowa and we feel increasing crow populations have a negative impact on Red-shouldered Hawk attempts to re-establish traditional nesting sites or pioneer new territories.

THE CURRENT STATUS OF ARCTIC AND AMERICAN PEREGRINE FALCONS IN ALASKA

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Both Arctic and American Peregrine Falcons continue to increase in numbers in Alaska. Surveys in four "index areas" have indicated about a 3-fold increase in the number of nesting peregrines since the mid-1970s. More peregrines are found in these areas now than were found in the 1950s and 1960s, and populations are still expanding. It is therefore difficult to predict the levels at which populations will stabilize. Productivity in all areas in Alaska remains high, and there is no evidence of pesticide-caused reproductive failure. The pesticide content of eggs is gradually decreasing, and values are currently well below those found associated with nesting failures.

TURNOVER RATES AND DISPERSAL OF NESTING PEREGRINE FALCONS IN THE NORTHEASTERN UNITED STATES

TELFORD, E. *Raptor Research Center, Department of Biology, Boise State University, Boise, ID 83725*

A study to assess turnover rates and dispersal of cliff nesting Peregrine Falcons (*Falco peregrinus*) was conducted during the 1990 and 1991 nesting seasons. Seventeen nests were visited, and vocal recordings were made of at least 19 different falcons. Band information indicated turnover in three of eight individuals identified. An assessment of the use of sonographic analysis in the identification of individual birds is in progress.

USING A GIS TO INTEGRATE RAPTOR DATA INTO AN AIRCRAFT BIRD AVOIDANCE MODEL

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Red-tailed Hawks, Turkey Vultures and Black Vultures account for 33% of the U.S. Air Force's damaging birdstrikes. A Geographical Information System is being used to integrate biological and geophysical data to predict the relative risk of an aircraft collision with a bird. Migration count, banding recovery, Breeding Bird Survey, Christmas Bird Count and research data are being analyzed to monitor raptor altitudinal, temporal, migration and population distributions. Satellite tracking of Turkey Vultures is one example of proposed Air Force sponsored research to determine migration and altitude distribution. A review of analyses will be presented.

FORAGING EFFICIENCY IN SMALL AND LARGE BROODS OF POST-FLEDGING AMERICAN KESTRELS

VARLAND, D.E. *U.S. Fish and Wildlife Service, Iowa Cooperative Fish and Wildlife Service Research Unit, Iowa State University, Ames, IA 50011*

Presumably, young kestrels learn foraging skills during the first 4–6 weeks after fledging. Imitative social foraging during this period may provide an adaptive advantage to individuals later in the juvenile period, if there is strong selection for learned efficiency in foraging. To test the hypothesis that imitative social foraging increases foraging efficiency, I compared foraging efficiency in experimentally adjusted broods of two and five American Kestrels (*Falco sparverius*) after fledging. No differences in foraging efficiency were detected during the four weeks that birds were observed. However, sample sizes were reduced be-

cause of high mortality or signal failure among radiotracked birds.

EFFECTS OF RADIO TRANSMITTERS ON BREEDING PRAIRIE FALCONS

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We examined the effects of backpack radiotransmitters on 26 Prairie Falcons nesting in Idaho's Snake River Canyon during 1991. One member of each pair was fitted with a 13 g radio and the pair's productivity was compared to 43 control pairs. Instrumented (I) and control (C) pairs did not differ significantly in productivity (% of occupied sites successful: I = 73, C = 79; fledglings/pair: I = 2.7, C = 3.0; weight [g] of male nestlings: I = 600, C = 558; weight of female nestlings: I = 839, C = 830). Within 13 instrumented pairs, birds wearing radios did not deliver prey items at significantly different rates than birds not wearing radios (prey delivery rate [items/h] of males I = 0.27, C = 0.15; prey delivery rate of females: I = 0.15, C = 0.24).

USE OF WEIGHT TO PREDICT AGE FOR SOUTHERN BALD EAGLES

WALBORN, C. AND B. MASTERS. *Department of Statistics, Oklahoma State University, Stillwater, OK 74078*

A growth curve for Southern Bald Eagles was estimated with weighted least squares nonlinear regression based on age and weight data collected on 190 eagles at the Sutton Avian Research Center. Reliable prediction bands cannot be generated for inverse regression to predict age based on weight from a nonlinear model. Therefore, a linear model was fitted to the data associated with eaglets between 12 and 42 days old. Body weight of eaglets in this subspecies within this age range seems to increase about 101.4 grams per day. Prediction intervals associated with 95% confidence were constructed for the range of ages for which a linear model is appropriate.

USE OF MORPHOMETRIC MEASUREMENTS IN DETERMINING THE SEX OF SOUTHERN BALD EAGLES

WALBORN E. AND B. MASTERS. *Department of Statistics, Oklahoma State University, Stillwater, OK 74078*

A gender prediction equation was estimated with logistic regression to predict the sex of a Southern Bald Eagle. The model was based on foot pad length and bill depth. Although many morphometric measurements were recorded by Sutton Avian Research Center on eagles of this subspecies, these two variables were able to produce an estimated model with 97.9% accuracy.

PRELIMINARY INVESTIGATIONS OF THE ALTAI FALCON IN THE SOVIET UNION

WALTON, B.J. *The Peregrine Fund, c/o Santa Cruz Predatory Bird Research Group.* C.M. WHITE. *Brigham Young University.* S. SHERROD. *Sutton Avian Research Center.* R. PFEFFER. *Institute Soivjetskaja Kazakstan.* K.E. RIDDLE. *Abu Dhabi Falcon Research Hospital.* J. L. LONGMIRE. *Los Alamos National Laboratory, Los Alamos, NM*

The Altai Falcon (*Falco altaicus*) of central Asia is surrounded by mystery and confusion with regard to nesting range, phylogenetic classification, and even with regard to its existence as an independent species from *Falco cherrug* or *Falco rusticolus*. In June 1991, three of the authors visited the Soviet Union and examined museum specimens, held preliminary discussions and exchanged cultural ideas with Soviet scientists, and conducted field investigations in the Tien Chen Mountains of Kazakstan. Results from DNA fingerprinting for blood samples from Sakers, Gyrfalcons, and Altai Falcons are pending. Future plans for further investigations are discussed.

ENVIRONMENTAL CONTAMINANTS IN BALD EAGLE EGGS

WIEMEYER, S.N., C.M. BUNCK AND C.J. STAFFORD *U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20708*

Bald Eagle eggs (1968–84) were analyzed for organochlorine pesticides, PCBs and mercury. DDE declined in WI, ME and the Chesapeake Bay. DDE was most closely related to shell thickness and reproduction at sampled breeding areas. Sixteen ppm DDE (wet weight) was associated with 15% shell thinning. Reproduction was normal when eggs at sampled breeding areas contained <3.6 ppm DDE; success was nearly halved between 3.6 and 6.3 ppm and halved again when concentrations exceeded 6.3 ppm. Other contaminants were associated with poor reproduction and eggshell thinning; however, their impact appeared secondary to that of DDE.

HISTORICAL DISTRIBUTION AND STATUS OF THE MEXICAN SPOTTED OWL IN MEXICO

WILLIAMS, S.O., III. *New Mexico Department of Game and Fish, Santa Fe, NM 87503*

Specimen and sight records of Mexican Spotted Owls (*Strix occidentalis lucida*) obtained in Mexico over the past 120 years provide an initial understanding of the species' general distribution and relative abundance there. Spotted Owls were reported from 23 locations in 9 Mexican states, the sites being generally confined to the high western, southern, and eastern edges of the Mexican Plateau. Of the total 23 locations, 70% are in Sonora and Chihuahua, with large gaps in the known distribution south and east of there. Available evidence suggests the species was never abundant in Mexico and, based on current and projected rates of habitat alteration, it may be in jeopardy there.

THE HISTORY OF THE NAMING OF THE FERRUGINOUS HAWK

WOFFINDEN, N.D. *Division of Natural Sciences, University of Pittsburgh at Johnstown, PA 15904*

The largest, finest and most colorful of the North American hawks of the genus *Buteo* is the Ferruginous Hawk, *Buteo regalis*. Endemic to a limited area of North America and Mexico, and until recently, poorly known even throughout its range, the species was first collected and named by British and German nationals. One specimen, collected by F. Deppe in 1836, was made the type of *Falco ferrugineus* by H. Lichtenstein, but the name was preoccupied. Another was assigned the name *Buteo regalis* by G.R. Gray of the British Museum in 1844. A.J. Grayson, an American painter and naturalist, named the species *B. californica* in 1857. It is unfortunate that this name was preceded by Gray's, as Grayson was the only worker who knew the species from the wild.

HABITAT USE AND MOVEMENT PATTERNS OF SUBADULT BALD EAGLES IN FLORIDA

WOOD, P.B. *Department of Wildlife and Range Sciences, University of Florida, Gainesville, FL 32611*

Very little was known about seasonal movements or habitat requirements of the various age classes in subadult Bald Eagle populations, particularly in an area such as Florida where resources are widely scattered and eagles do not form large winter concentrations. Consequently, I conducted a radio-tracking study of nestling eagles from spring 1987 to spring 1991. Locations of radio-tagged eagles allowed examination of specific habitat requirements and movement patterns. Landscape level habitat use and distance to various features of the landscape was examined with a Geographic Information System based on a LandSat satellite image.

WHAT DO SWAINSON'S HAWKS REALLY EAT?

WOODBRIDGE, B. *U S. Forest Service, Klamath National Forest, 1312 Fairlane Rd., Yreka, CA 96097*

I examined the diet and prey base relationships of Swainson's Hawks during the course of a long-term population study in northern California. Results of pellet analysis, observations at nest sites and feeding experiments with captive birds were compared. Belding's ground squirrels were strongly overrepresented in pellets and remains in nests whereas montane voles and other small prey were underrepresented. Dramatic seasonal variation in availability and body composition of certain prey species resulted in temporal shifts in prey selection by nesting hawks. Belding's ground squirrels may have been important in increasing body condition of hawks prior to egglaying, but were not selected by hawks that were feeding young.

POSTER PAPERS

THE ARIZONA BALD EAGLE NESTWATCH PROGRAM

BEATTY, G. *Arizona Game and Fish Department, 2221 W. Greenway, Phoenix, AZ 85023*

Arizona supports 28 Bald Eagle (*Haliaeetus leucocephalus*) breeding areas mostly along the Salt and Verde Rivers in central Arizona. Coordinated by the Department and funded by the Southwestern Bald Eagle Management Committee, the Nestwatch Program places 20 nestwatchers at sites where human disturbance may impact breeding success. Nestwatchers collect biological information, enforce seasonal closures surrounding the nests, and educate the public about desert nesting Bald Eagles. Our display describes the Bald Eagle's adaptations to the desert, impacts that threaten the bird's breeding success, and the Nestwatch Program's place in the State's efforts to manage the species.

THE RAPTOR RESEARCH FOUNDATION. INC.—25 YEARS

CLARK, RICHARD J. *Department of Biology, York College of Pennsylvania, York, PA 17403-3426*

The Raptor Research Foundation first met on 2 September 1965 in Madison, Wisconsin with 12 members from three countries attending. The Foundation has grown to 1059 members from 46 countries. The Raptor Research News was first published in January 1967 at a cost of $0.25 per issue while *The Journal of Raptor Research* in 1991 costs $5.50 per issue. Comparing this cost with 32 other publications indicates the cost is third from the lowest with the mean for the journals compared being $13.63. Membership dues of $18.00 compared with the average of $72.10 are extremely low. This poster plots the geography of its membership and the location of its annual conferences. The Foundation's historical background is presented as a basis for planning the Foundation's future.

FIELD OBSERVATIONS ON THE STYGIAN OWL *ASIO STYGIUS* IN BELIZE, CENTRAL AMERICA

FRANZ, MARK. *New College, Sarasota, FL 34243*

A pair of adult owls was observed for one month in June of 1989 on a 1700 acre tract adjacent to the Belize Zoo in Belize, Central America. Observations were made concerning roosting, hunting, and nesting. The observation area consisted of savannah and pine flatwood habitat. During the observation period, the pair utilized the savannah for nesting and hunting and the pine flatwoods for roosting. Hunting was active, and consisted of aerial captures of bats, birds, and large insects primarily at dawn and dusk; pellets collected were composed mainly of bat remains. The nest location was found in savannah habitat at ground level. Very little is known about the Stygian Owl, and the information yielded from these observations, including rare film footage of the subject pair, will serve as a prelude to further study.

WHAT FACTORS CONTROL LAKE SUPERIOR BALD EAGLE PRODUCTIVITY?

MEYER, M.W. AND D.E. ANDERSEN. *Bureau of Research, Wisconsin Dept. of Natural Resources, Madison, WI 53716 and Minnesota Coop. Fish and Wildlife Research Unit, Dept. of Fisheries and Wildlife, University of Minnesota, St. Paul, MN 55108*

The number of Bald Eagles nesting on Wisconsin's Lake Superior shoreline increased from two pairs in the 1970s to 17 pairs in 1991. Reproductive success and productivity of these eagles has improved, although reproductive rates are lower than at inland Wisconsin sites. Prey items and eagle tissues collected along the Wisconsin Lake Superior shoreline have higher concentrations of organochlorines (PCBs and pesticides) than at inland nesting sites, indicating that prey contamination may continue to be a cause of reduced productivity. In addition, climatic data, observations of nest behavior, and nestling lipid levels indicate that the environmental/physical factors may also impact the Lake Superior Bald Eagle population.

NOTES ON RARE AND UNCOMMON BIRDS OF PREY IN QUINTANA ROO, MEXICO

RANGEL-SALAZAR, J.L., P.L. ENRIQUEZ AND E. ESCOBEDO. *Departamento de Ecologia Terrestre, CIQRO, Ap. Postal 424, 77000 Chetumal, Quintana Roo, Mexico*

Quintana Roo State supports a large number of raptor species; however, not all of these have been described. In this paper we present our observations on the nest and food habits of the Black Hawk-Eagle (*Spizaetus tyrannus*); food habits of the Black-and-white Owl (*Ciccaba nigrolineata*); and the current distribution records of several birds of prey within the state, such as the Ornate Hawk-Eagle (*Spizaetus ornatus*), Collared Forest-Falcon (*Micrastur semitorquatus*) and the Lesser Yellow-headed Vulture (*Cathartes burrovianus*) among others. The state of Quintana Roo has recently been incorporated into the national development program and the threats to raptor habitats are increasing.

FILMS AND VIDEOS

"ON A WING AND A PRAYER"—G.M. SUTTON AVIAN RESEARCH CENTER'S SOUTHERN BALD EAGLE RESTORATION PROGRAM

COLBERT, K.V., S.K. SHERROD, M.A. JENKINS AND A.E. BESKE. *G.M. Sutton Avian Research Center, P.O. Box 2007, Bartlesville, OK 74005*

This 30-minute video was filmed by award winning video photographer Tim Yoder and is narrated by reporter Rick Peterson of Tulsa's CBS affiliate, Channel 6. The photographer accompanied Sutton Research Center personnel during all phases of the 1990/91 Bald Eagle Restoration Program field season. The video explains the need and rationale behind the restoration program in a popular and dramatic way while showing all the steps from egg removal to the final success of hacked eagles fledging young in the wild.

TUNKURUCHU

DURING, C. AND J.L. RANGEL-SALAZAR. *Departamento de Difusion, CIQRO, Ap. Postal 424, Chetumal, 77000 Quintana Roo, Mexico*

Conservation of Neotropical raptor communities and species is an important issue in Latin America. In this video, we feature research on the Black-and-white Owl (*Ciccaba nigrolineata*), a threatened species which inhabits the state of Quintana Roo, Mexico. The main goals of the video are to teach raptor study techniques and to relate the importance of the owl in the natural ecosystem. Tunkuruchu is the common name for owls used by Mayan people. They believe that owls are symbols of darkness and death.

INTIMATE NESTING BEHAVIOR OF DAMAGED, WILD, GREAT GRAY, BARRED AND SNOWY OWLS

MCKEEVER, K. *The Owl Rehabilitation Research Foundation, R.R. 1, Vineland Station, ON Canada L0R 2E0*

Video coverage, with pan, tilt and zoom, of successful breeding of these species, among eight others, at the Vineland facility. The tape demonstrates that if damaged, wild owls have access to very large areas, in appropriate vegetation, with choice of mate, territory and nest site, new bonds can be formed and brought to natural fruition. Offspring are raised entirely by their wild parents, protected from human view, pursuing live rodents, and are psychologically releasable whence one parent originated.

GOLDEN EAGLES IN JAPAN—BE AS THE WIND FOREVER

YAMAZAKI, TORU AND M. IWASAKI. *The Society for Research of the Golden Eagle in Japan, 482-57, Yukihata, Yasi-cho, Yasu-gun, Shiga Prefecture 520-23, Japan*

Japanese people and Golden Eagles have maintained a close relationship for a long time. But until recently, Golden Eagles existed mainly in legends, and there was no documentation of their ecology. The Society for Research of the Golden Eagle brought to light that there are only 118 pairs in Japan which are moreover threatened with extinction. It took ten years to complete this film in the steep mountains. We have filmed three "Fortresses," the Cliff Nest, the Valley Nest and the Nest in the Wind. This film introduces the ecology and the endangered situation of Golden Eagles in Japan. We have produced this film in the hope that it may raise public consciousness so that Golden Eagles may "Be as the Wind Forever."

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The Journal of Raptor Research is distributed quarterly to all current members. Original manuscripts dealing with the biology and conservation of diurnal and nocturnal birds of prey are welcomed from throughout the world, but must be written in English. Submissions can be in the form of research articles, letters to the editor, thesis abstracts and book reviews. Contributors should submit a typewritten original and three copies to the Editor. All submissions must be typewritten and double-spaced on one side of 215 by 280 mm (8½ × 11 in.) or standard international, white, bond paper, with 25 mm (1 in.) margins. The cover page should contain a title, the author's full name(s) and address(es). Name and address should be centered on the cover page. If the current address is different, indicate this via a footnote. Submit the current address on a separate page placed after the literature cited section. A short version of the title, not exceeding 35 characters, should be provided for a running head. An abstract of about 250 words should accompany all research articles on a separate page.

Tables, one to a page, should be double spaced throughout and be assigned consecutive Arabic numerals. Collect all figure legends on a separate page. Each illustration should be centered on a single page and be no smaller than final size and no larger than twice final size. The name of the author(s) and figure number, assigned consecutively using Arabic numerals, should be pencilled on the back of each figure.

Names for birds should follow the A.O.U. Checklist of North American Birds (6th ed., 1983) or another authoritative source for other regions. Subspecific identification should be cited only when pertinent to the material presented. Metric units should be used for all measurements. Use the 24-hour clock (e.g., 0830 H and 2030 H) and "continental" dating (e.g., 1 January 1990).

Refer to a recent issue of the journal for details in format. Explicit instructions and publication policy are outlined in "Information for contributors," *J. Raptor Res.*, Vol. 24(1–2), which is available from the editor.

1992 ANNUAL MEETING

The Raptor Research Foundation, Inc. 1992 annual meeting will be held on 11–15 November at the Red Lion Inn in Bellevue (Seattle suburb), Washington. Details about the meeting and a "call for papers" will be mailed to Foundation members in summer, and can be obtained from Mark Stalmaster, Scientific Program Chairperson, Stalmaster and Associates, 209 23rd Avenue, Milton, WA 98354; Tel. (206)922-5435. For further information about the meeting, or the associated Spotted Owl Symposium and art show, contact Lenny Young, Local Committee Chairperson, 5010 Sunset Dr. NW, Olympia, WA 98502; Tel. O(206)753-0671 H(206)866-8039, FAX (206)586-6126.

RAPTOR RESEARCH REPORTS

#1, R.R. Olendorff. 1971. *Falconiform Reproduction: A Review Part 1. The Pre-nestling Period.* $10.00 members, $12.50 non-members.

#2, F.N. Hamerstrom, B.E. Harrell and R.R. Olendorff [Editors]. 1974. *Management of Raptors. Proceedings of the Conference on Raptor Conservation Techniques, Fort Collins, CO, 22–24 March 1973.* $10.00 members, $12.50 non-members.

#3, J.R. Murphy, C.M. White and B.E. Harrell [Editors]. 1975. *Population Status of Raptors. Proceedings of the Conference on Raptor Conservation Techniques, Fort Collins, CO, 22–24 March 1973. (Part 6).* $10.00 members, $12.50 non-members.

#4, R.R. Olendorff, A. Miller and R. Lehman [Editors]. 1981. *Suggested Practices for Raptor Protection on Powerlines: State of the Art in 1981.* $5.00 members, $20.00 non-members.

#5, S.E. Senner, C.M. White and J.R. Parrish [Editors]. 1986. *Raptor Research Conservation in the Next Fifty Years. Proceedings of a Conference held at Hawk Mountain Sanctuary, Kempton, PA, 14 October 1984.* $3.50 members, $4.50 non-members.

#6, D.M. Bird, and R. Bowman [Editors]. 1987. *The Ancestral Kestrel. Proceedings of a Symposium on Kestrel Species, St. Louis, MO, 1 December 1983.* $10.00 members, $12.50 non-members.

#7, R.R. Olendorff [Editor]. 1989. *The Raptor Research Foundation, Inc. Bibliographic Index (1967–1986).* $2.50 members, $5.00 non-members.

#8, R.R. Olendorff, D.D. Bibles, M.T. Dean, J.R. Haugh and M.N. Kochert. 1989. *Raptor Habitat Management under the U.S. Bureau of Land Management Multiple-Use Mandate.* $5.00 members, $6.50 non-members.

Add $2.50 for postage and handling, and $1.00 each for additional reports.

BOOKS

Biology and Management of Bald Eagles and Ospreys. Proceedings of the First International Symposium, Montreal, Canada.
D.M. Bird [Editor]. 1983.
$15.00 members, $18.00 non-members plus $5.00 shipping.

JOURNAL BACK ISSUES

Journal Back Issues are available. For details see page 73 of *the Kettle* or write: Jim Fitzpatrick, Treasurer, Raptor Research Foundation, Inc., Carpenter St. Croix Valley Nature Center, 12805 St. Croix Trail, Hastings, MN 55033.