Meyburg, B.-U. & R. D. Chancellor eds. 1989
Raptors in the Modern World
WWGBP: Berlin, London & Paris

Some Ecological Aspects of Two Primary Evergreen Forest Raptor Communities compared with Cultivated Tropical Areas in Southern Mexico

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Tropical forests encompass about 6,495 million ha in Africa, Asia, and Latin America (Ofori *et al.* 1986). However, the current annual rate of deforestation in the tropics is estimated to be from 3.3 to 20 million ha per year (Hartmans 1986; Lal 1986; Palm *et al.* 1986). It is estimated that 1,000 million ha of once-forested tropical areas have been turned into semidesert during recorded history (Bene *et al.* 1977). In Mexico, Rzedowski (1978) estimated that the original area of tropical evergreen forest was approximately 11% (2,159,446 ha) of the whole country. He further estimated that Mexico has already lost at least 90% of its original tropical evergreen forest. The Mexican "Instituto Nacional de Investigaciones Forestales" (I.N.I.F.) current estimates are that over 400,000 ha of woodlands are felled each year in the country (Gonzalez 1983).

Approximately 80% of the world's plant and animal species are concentrated in tropical regions. The Neotropics in particular have the richest bird fauna, with many more species known than in any other biogeographic region. At least 2,930 species (over 34% of all known bird species) are confined to this region (Darlington 1957; Blake 1977). Currently, very limited biological information is available for most Neotropical species of birds, especially forest raptors (Ramos 1985a; Kennedy 1986).

Of the 287 known falconiform species, 258 (90%) live in the tropics. The majority of these (91.5%) are residents; only 22 species (8.5%) are migrants. Moreover, 121 species (46.9%) occur in tropical forests, 85 of them in the Neotropics (Kennedy 1986). Moreover Brown and Amadon (1968) recognized 23 genera and 67 species endemic to the Neotropics. The diversity of falconiforms is much higher in tropical American forest than in similar forest of other continents (Thiollay 1984). Most published references on Neotropical raptors are short observations of feeding (Haverschmidt 1962; Boyce 1980; Fontaine 1980), descriptions of nests, eggs and chicks (Wolfe 1954; Harrison & Kiff 1977; Smith 1982), or breeding behaviour (Laughlin 1952; Bierregaard 1984; Lyon & Kuhnigk 1985). Very few are long-term studies of migratory or wintering behaviour (Smith 1980; Dominguez 1984; Albuquerque 1984) or general ecology (Jaksic *et al.* 1981; Hector 1981; Hector 1985; de Vries *et al.* 1983; Albuquerque *et al.* 1986).

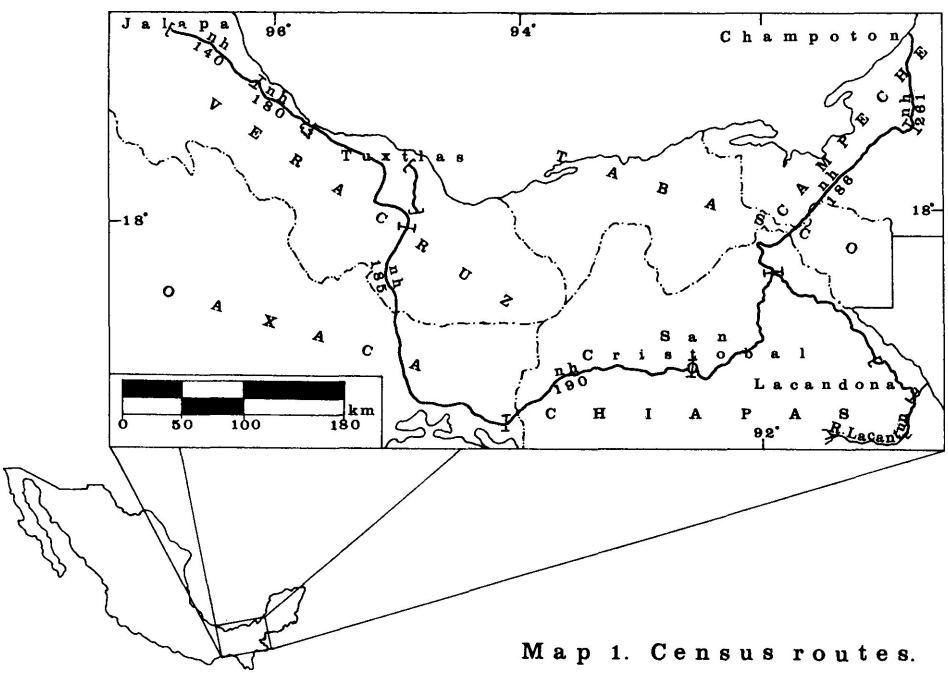
In temperate habitats, particularly in North America, roadside surveys are frequently used to determine relative raptor abundance, to examine raptor habitat use and to evaluate perch type

preferences (Enderson 1965; Marion & Ryder 1975; Mills 1976; Woffinden & Murphy 1977; Craig 1978; Bauer 1982; Gessaman 1982; Hubbard 1983; Bohall & Collopy 1984; Fischer *et al.* 1984; Sferra (1984). Few studies of raptor habitat use exist for the Neotropics (Jaksic *et al.* 1981; Albuquerque *et al.* 1986). Roadside surveys are a convenient method for sampling widely dispersed populations of conspicuous raptors to evaluate long-term population trends, distribution and seasonal abundance, particularly on open land or where there are scattered trees (Fuller & Mosher 1981; Bohall & Collopy 1984).

This paper is a preliminary report of roadside counts conducted in Mexico from 1984 to 1985 to determine the relative abundance and habitat use of diurnal raptor species and to examine the impact of loss of large areas of primary tropical evergreen forest on raptor populations. The intrinsic ecological requirements of many tropical forest falconiforms (rarity, large home ranges, specialized hunting strategies, occupation of a specific stratum in the forest, low reproductive rates, etc.) make these birds the best avian "bio-indicators" of the quality and equilibrium in tropical forest ecosystems.

STUDY AREAS

Our study areas included five states of southern Mexico (Veracruz, Oaxaca, Chiapas, Tabasco and Campeche). Two tropical evergreen forest communities were studied. One was the east part of the "Lacandona" jungle ("Reserva de la Biosfera Montes Azules") in Chiapas (16°05' - 17°28'N, 90°20'-90°28'W), a hot and humid area at 80-300m elevation (S.P.P. 1908d). The second was the Tuxtlas mountains in Veracruz (18°15' - 18°30'N, 94°41' - 94°55'W), with a hot and humid climate (Af m) at 250-1,250m (Soto 1976) (Map 1).



Map 1. Census routes.

The road surveys were in disturbed areas (including various man-made habitats): Route 1 was San Cristobal de las Casas to Jalapa (national highway 190, 185, 180, and 140). Route 2 was San Cristobal to Champoton (Ocosingo-Palenque, national highway 186 and 261) (Map 1).

In the "Lacandona" jungle the most abundant habitat surveyed (76 km; 53%) was tropical evergreen forest at the edge of the Lacantun River. The most common tree species known for the area are: *Terminalia amazonica, Swietenia macrophylla, Brosimum alicastrum, Calophyllum brasiliensis* and *Cedrela mexicana*; most are about 30m tall (Rzedowski 1978), and there were 66km (46%) of tropical evergreen forest. In the Tuxtlas mountains there were 44km (55%) of primary tropical evergreen forest (*S. macrophylla, Manilkara zapota, Astronium graveolens, B. alicastrum*) (Rzedowski 1978), 30km (38%) of evergreen forest mixed with pasture and 5km (6%) of cloud forest.

On Route 1 the most abundant habitat (441km; 51%) was pasture and arable farmlands, followed by 168 km (19.5%) of disturbed tropical deciduous forest, and 114km (13%) of modified tropical evergreen forest. Less common habitats along Route 1 included 33km (4%) of altered savanna and wetlands, 32km (4%) of pine (*Pinus* sp.) - oak (*Quercus* sp.) woodland, 29km (3%) of urban areas, and 26km (3%) of disturbed tropical semi-evergreen forest (Table 1). Pasture and arable farmlands were also the most abundant habitat on Route 2 (182km; 36%) followed by 144km (29%) of disturbed tropical semi-evergreen forest, 63km (12%) of altered savanna, and 50km (10%) of modified tropical evergreen forest. Other habitats included 25km (5%) of pine-oak forest, 25km (5%) of pine-oak forest, 25kmm (5%) of urban areas, and 12km (2%) of swamps (Table 1).

METHODS

The first author was present on each survey; the second and third varied. We initiated surveys about 1/2 hour after sunrise (0600-0700) and finished at 1800. We drove 85-100km/h, and stopped to identify birds sighted with 10x40 binoculars. We used a spotting scope at the edge of forest areas. The forest raptor counts included direct observations on birds and calling censuses. All route counts were on clear days or with less than 40% cloud cover.

We used the actigram concept (Walter 1983) to record habitat use (19 types), behaviour (perching, flying or soaring), perch types (8), time and km (on roadside counts) for each observed raptor. We recorded raptors seen within 0.5km of the roadsides. Natural perches (e.g. bare trees, live tree-tops, middle part of a tree, etc.) were common in both forest surveys and Route 1 and 2 counts, whereas manmade perches (e.g. telegraph poles, wires, fence posts, etc.) were most abundant during roadside counts.

In the Lacandona jungle, we travelled 284km (53.3% by boat, 42.4% by car and 4.3% on foot) with more than 160 observer-hours in two major habitats. In the Tuxtlas mountains we travelled 224km (60.1% by car and 39.9% on foot), with over 294 hours in three major habitats. The Lacandona jungle was surveyed during November 10-16, and 20-27 1984, and the Tuxtlas mountains during November 4-14 in 1984 and March 3-20 in 1985.

We travelled 2,377km (35 observer hrs) on Route 1, and 1,005km (47 hrs) on Route 2, with seven major habitats in each. Route 1 was surveyed four times, between December 10 1984, and June 6 1985. Route 2 was surveyed on three occasions between April 22 and 27 1985. Habitat types were assigned from vegetation and land-use maps (S.P.P. 1980a, b, c). Vegetation types are based on Rzedowski's (1978) classification.

TABLE 1. Habitat types along both forest communities and road surveys in southern Mexico

Habitat	Description
Primary Forest	
Lacandona	Tropical evergreen forest. Tropical evergreen forest at Lancantun River edge.
Tuxtlas	Tropical evergreen forest. Tropical evergreen forest (with pastures). Cloud forest.
Disturbed lands	
Route 1 San Cristobal-Jalapa	Pasture and arable farmlands (temporary agriculture, pastures and palm groves). Disturbed tropical deciduous forest (with temporary agriculture and secondary vegetation). Modified tropical evergreen forest (with temporary agriculture and secondary vegetation). Altered savanna and wetlands (flood grasslands, freshwater and marine marshes, and river margins). Pine-oak forest (with temporary agriculture and secondary vegetation). Urban areas (including approx. one km before and after villages, and small towns). Disturbed tropical semi-evergreen forest (with temporary agriculture and secondary vegetation).
Route 2 San Cristobal-Champoton	Pasture and arable farmlands (with temporary agriculture and pastures). Disturbed tropical semi-evergreen forest (with temporary agriculture and secondary vegetation). Altered savanna (grasslands and herbaceous vegetation). Modified tropical evergreen forest (with temporary agriculture and secondary vegetation). Pine-oak forest (with temporary agriculture and secondary vegetation, and nomad agriculture). Urban areas (including approx. one km before and after villages and small towns).

ANALYSIS

Habitat use, perch site, and relative raptor density were analyzed with a dBase III Plus programme. Our measure of species diversity was the number of resident species observed (the "species richness" of Krebs 1978). Relative abundance was estimated as the distance travelled/individual, using the index of Woffinden & Murphy (1977):

$$\frac{\text{Total number of species observed}}{\text{Total number of km travelled}} \times 1{,}000$$

In addition to these indices the calculations of species diversity and equitability were made for each survey using the Shannon-Wiener function (Krebs 1978).

RESULTS AND DISCUSSION

We accumulated 1,611 hrs of observations and travelled 3,883km. We recorded 26 species, of which 5 were migratory. In all, we sighted 2,185 raptors, of which 65.3% (n = 1,247) were flying or soaring (mainly vultures and migrating flocks; n = 1,116), and 24.3 % (n =532) were on perches.

The undisturbed areas of Lacandona jungle and the Tuxtlas mountains had the highest species richness, with 13 species in each. In the former we observed 327 individuals, and 517 in the latter. On Route 1, we counted only 12 species, although 1,407 individuals were observed, and 11 species on Route 2(n = 301).

Relative abundance

In the Lacandona jungle, Turkey Vultures (*Cathartes aura*), Black Vultures (*Coragyps atratus*) and Bat Falcons (*Falco rufigularis*) were the most commonly observed species (Table 2A).

In the Tuxtlas mountains, excluding the migratory mixed flocks of Broad-Winged Hawk (*Buteo platypterus*) and Swainson's Hawk (*Buteo swainsoni*), the most commonly seen resident raptors were Black Vultures, White Hawks (*Leucopternis albicollis*) and Barred Forest Falcons (*Micrastur ruficollis*). One important raptor observed was the Orange-Breasted Falcon (*Falco deiroleucus*), a very rare species (Cade 1982), with one individual sighted (Table 2B).

Along Route 1, Black Vultures were again the most common raptors, representing 57.1% of all sightings. Road-side Hawks (*Buteo magnirostris*) were the next most common resident species (Table 3A).

On Route 2, without counting the migratory flocks of Mississippi Kites (*Ictinia mississippiensis*), Turkey and Black Vultures were again common as was the Crested Caracara (*Polyborus plancus*)(Table 3B).

The diversity indices (H, Shannon-Wiener, and E = H / Hmax) showed that the primary forest of the Tuxtlas mountains had the highest diversity of raptors (H = 4,885; Hmax = 4.0; E = 1.221), followed by the Lacandona jungle (H = 3.716; Hmax = 3.90; E = 0.951). Counts along Route 2 (H = 3.311; Hmax = 3.70; E = 0.894), and Route 1 (H = 3.164; Hmax = 3.584; E = 0.894) were the least diverse.

TABLE 2. Numbers of raptors sighted and relative abundance indices.

SPECIES	NUMBER OBSERVED	KMS TRAVELLED PER INDIVIDUAL	INDEX OF RELATIVE ABUNDANCE
A: LACANDONA JUNGLE, CHIAPAS FROM NOVEMBER 10 TO NOVEMBER 27, 1984:-			
Cathartes aura[a]	137	2.07	482.39
Coragyps atratus[a]	64	4.43	225.35
Falco rufigularis	54	5.25	190.14
Sarcoramphus papa	12	23.66	42.25
Pandion haliaetus[b]	12	23.66	42.25
Buteo magnirostris	11	25.81	38.73
Elanus caeruleus	11	25.81	38.73
Herpetotheres cachinnans	7	40.57	24.64
Spizaetus tyrannus	3	94.66	10.56
Falco sparverius[a]	3	94.66	10.56
Buteogallus anthracinus	2	142.00	7.04
Geranospiza caerulescens	2	142.00	7.04
Micrastur ruficollis	1	284.00	3.52
Leucopternis albicollis	1	284.00	3.52
Buteo nitidus	1	284.00	3.52
B: IN THE TUXTLAS MOUNTAINS, VERACRUZ FROM NOVEMBER 4-14, 1984 AND MARCH 3-20, 1985:-			
Buteo platypterus[c]	279	0.80	1,245.5
Buteo swainsoni[c]	70	3.2	312.5
Coragyps atratus	45	4.97	200.89
Leucopternis albicollis	35	6.4	156.25
Micrastur ruficollis	22	10.18	98.21
Falco sparverius[a]	13	17.23	58.03
Buteo nitidus	9	24.88	40.17
Spizaetus ornatus	9	24.88	40.17
Cathartes aura[a]	8	28.00	35.71
Buteo magnirostris	7	32.00	31.75
Falco rufigularis	5	44.8	22.32
Spizaetus tyrannus	5	44.8	22.32
Buteogallus urubitinga	5	44.8	22.32
Herpetotheres cachinnans	2	112.00	8.92
Pandion haliaetus[b]	1	224.00	4.46
Harpagus bidentatus	1	224.00	4.46
Falco deiroleucus	1	224.00	4.46

a Migratory and resident populations.
b Exclusively migratory.
c Primarily flocks migrating through the study area.

TABLE 3. Numbers of raptors sighted and relative abundance indices.

SPECIES	NUMBER OBSERVED	KMS TRAVELLED PER INDIVIDUAL	INDEX OF RELATIVE ABUNDANCE
A: ON ROUTE 1 (S. CRISTOBAL - JALAPA) FROM DEC. 10, 1984 TO JUNE 6, 1985:-			
Coragyps atratus[a]	598	3.97	251.57
Cathartes aura[a]	225	10.56	94.65
Falco sparverius[a]	134	17.35	56.37
Buteo magnirostris	45	52.82	18.93
Polyborus plancus	15	158.46	6.31
Elanus caeruleus	13	182.84	5.46
Buteo nitidus	8	297.12	3.36
Buteo albicaudatus	3	792.33	1.26
Rosthramus sociabilis	2	1,188.5	0.84
Pandion haliaetus[b]	2	1,188.5	0.84
Buteo jamaicensis[a]	1	2,377.0	0.42
Buteogallus anthracinus	1	2,377.0	0.42
B: ON ROUTE 2 (S. CRISTOBAL - CHAMPOTON) FROM APRIL 22 - 27, 1985:-			
Cathartes aura[a]	82	12.25	81.59
Ictinia mississippiensis[c]	76	13.22	75.62
Coragyps atratus	55	18.27	54.72
Polyborus plancus	29	34.65	28.85
Buteo magnirostris	23	43.69	22.88
Elanus caeruleus	18	55.83	17.91
Buteo nitidus	9	111.66	8.95
Falco rufigularis	2	502.5	1.99
Pandion haliaetus[b]	2	502.5	1.99
Rosthramus sociabilis	2	502.5	1.99
Falco sparverius[a]	2	502.5	1.99
Buteo albicaudatus	1	1,005.0	1.00
Chondrohierax uncinatus	1	1,005.0	1.00
Herpetotheres cachinnans	1	1,005.0	1.00

a Migratory and relatively resident populations.
b Exclusively migratory.
c Primarily flocks migrating through the study area.

Habitat Use

In the Lacandona Jungle, Turkey Vultures were observed most frequently soaring over tropical evergreen forest along the Lacantun river (500m wide), perhaps because they find their food more easily in open lands along the river than in dense forest. The Bat Falcon also was observed primarily in tropical evergreen forest along rivers, because aerial prey (birds and insects) are most available and more easily captured in the large open area of the Lacantun River. This falcon was also seen in tropical evergreen forest away from clearings, over the forest canopy (Table 4).

In the Tuxtlas mountains, the White Hawk was the most common raptor in primary tropical evergreen forest, followed by the Barred Forest Falcon. The Black Vulture generally was observed soaring over tropical evergreen forest with some pasture lands. The Barred Forest Falcon and the Ornate Hawk-eagle (*Spizaetus ornatus*) were the most frequently observed species in cloud forest (Table 5).

Along Route 1, the greatest number of raptor species (n = 8) was seen on the edge of deciduous forests. Turkey Vultures were the most abundant (n = 80). In evergreen forest, we found only five species, with the Road-side Hawk the most abundant. In pasture and arable lands, we sighted only seven raptor species, although this was the habitat with the highest total of individual sightings (51.4%). Black Vultures were found most in urban areas, as has been reported by Wetmore (1943) and Iñigo (1987) (Table 6). On Route 2, most raptor species (n = 9) were seen in or flying over evergreen forest, although this habitat had only 10% of the individual sightings. Turkey Vultures and

Road-side Hawks were the most abundant in this habitat. On pasture and arable lands, where most individuals were observed (36%), we only sighted five species (Table 7).

Tropical evergreen forest areas (both Lacandona and Tuxtlas) had a total of 18 resident species, while only nine occurred in tropical evergreen forest patches with disturbed areas (agricultural fields, grasslands, abandoned plantations). Of the total resident raptor species observed in virgin evergreen forest, nine were absent from similar habitats along Routes 1 and 2, particularly the species sensitive to forest disturbance, like the Barred Forest Falcon and Ornate Hawk-eagle.

Perch Types

In the virgin Lacandona Jungle lands, the Bat Falcon was the species most frequently observed at the top of bare trees and snags, as has been reported by Cade (1982), and also in the mid part of trees (Table 8A). Of these falcons, 20 were seen in pairs during November 21-27; perhaps they were forming breeding pairs to lay eggs between February and April. Turkey Vultures were observed soaring most frequently. Bat Falcons were also found perching on bare trees or snags in the Tuxtlas mountains. The Barred Forest Falcon was observed perching in the middle part of trees. The Broad-winged Hawk was the most frequently observed raptor soaring (Table 8B).

Power and telephone poles were used more frequently as perches than the cables between them, particularly by the Road-side Hawk. Among the natural perches, bare trees and snags were used most frequently, particularly by Black Vultures and Road-side Hawks. The latter also perched in the tops of live trees (Table 9). The Black Vulture was the most common species seen soaring along Route 1.

Although along Route 2 utility poles were present on one side of the road, no raptors were observed perching on these. Among the natural perches, bare trees and snags were again the most used, particularly by Road-side Hawks and White-tailed Kites (*Elanus caeruleus*). The high use of bare trees and snags was also observed in Florida by Bohall and Collopy (1984), because raptors on an open perch can spot their prey more easily. Turkey Vultures and Mississippi Kites were the species observed soaring most often along Route 2. In virgin and cultivated areas, American Kestrels (*Falco sparverius*) were observed more often on bare trees, snags and live tree tops. They also used utility poles more than wires along Route 1. A similar preference by Kestrels for utility poles was found by Craig (1978) in southern Idaho. Nevertheless, other studies in temperate habitats show a high preference for power and telegraph lines (Mills 1976; Craig 1978; Bauer 1982).

TABLE 4. Habitat use of raptor species sighted in Lacandona Jungle, Chiapas from November 10 to November 27, 1984.

SPECIES	TROPICAL EVERGREEN FOREST AT LACANTUN RIVER EDGE		TROPICAL EVERGREEN FOREST[1]	
	n	%	n	%
Cathartes aura	137	100.0	-	-
Coragyps atratus	10	21.28	37	78.72
Falco rufigularis	44	81.48	10	18.52
Sarcoramphus papa	4	33.33	8	66.66
Pandion haliaetus	12	100.0	-	-
Buteo magnirostris	7	63.63	4	36.36
Elanus caeruleus	2	18.18	9	81.81
Herpetotheres cachinnans	6	85.71	1	14.29
Spizaetus tyrannus	-	-	3	100.0
Falco sparverius	-	-	3	100.0
Buteogallus anthracinus	2	100.0	-	-
Geranospiza caerulescens	2	100.0	-	-
Leucopternis albicollis	1	100.0	-	-
Buteo nitidus	-	-	1	100.0
Micrastur ruficollis	-	-	1	100.0

1 Includes open lands.

TABLE 5. Habitat use of raptor species sighted in Tuxtlas Mountains, Veracruz from November 4-14, 1984 and March 3-20, 1985.

SPECIES	TROPICAL EVERGREEN FOREST		TROPICAL EVERGREEN FOREST WITH PASTURE LANDS		CLOUD FOREST	
	n	%	n	%	n	%
Buteo platypterus	-	-	279	100	-	-
Buteo swainsoni	-	-	70	100	-	-
Coragyps atratus	10	22.22	35	77.77	-	-
Leucopternis albicollis	34	97.14	-	-	1	2.85
Micrastur ruficollis	16	72.72	-	-	6	27.27
Falco sparverius	3	25.0	9	75.0	-	-
Buteo nitidus	8	88.88	1	11.11	-	-
Spizaetus ornatus	5	55.55	-	-	4	44.44
Cathartes aura	2	25.0	6	75.0	-	-
Buteo magnirostris	1	14.28	6	85.71	-	-
Falco rufigularis	5	100.0	-	-	-	-
Spizaetus tyrannus	5	100.0	-	-	-	-
Buteogallus urubitinga	5	100.0	-	-	-	-
Herpetotheres cachinnans	2	100.0	-	-	-	-
Pandion haliaetus	1	100.0	-	-	-	-
Harpagus bidentatus	-	-	-	-	1	100.0
Falco deiroleucus	1	100.0	-	-	-	-

TABLE 6. Habitat use of raptor species sighted on Route 1 (S. Cristobal - Jalapa) from December 10, 1984 to June 6, 1985.

SPECIES	PASTURE & FARM-LANDS		DECIDUOUS FOREST		EVERGREEN FOREST		SAVANNA/ WETLANDS		PINE-OAK FOREST		URBAN AREAS		SEMI-EVERGREEN	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Coragyps atratus	109	18.2	6	1.0	-	-	14	2.3	6	1.0	457	76.4	6	1.0
Cathartes aura	102	45.3	80	35.5	9	4.0	6	2.6	15	6.6	3	1.3	10	4.4
Falco sparverius	104	77.4	8	5.9	2	1.4	-	-	4	2.9	14	10.4	2	1.4
Buteo magnirostris	26	57.7	7	15.5	10	22.2	2	4.4	-	-	-	-	-	-
Polyborus plancus	10	55.5	5	27.7	3	16.6	-	-	-	-	-	-	-	-
Elanus caeruleus	9	69.2	4	30.7	-	-	-	-	-	-	-	-	-	-
Buteo nitidus	-	-	5	62.5	3	37.5	-	-	-	-	-	-	-	-
Buteo albicaudatus	-	-	3	100.0	-	-	-	-	-	-	-	-	-	-
Rosthramus sociabilis	-	-	-	-	-	-	2	100.0	-	-	-	-	-	-
Pandion haliaetus	-	-	-	-	-	-	2	100.0	-	-	-	-	-	-
Buteo jamaicensis	1	100.0	-	-	-	-	-	-	-	-	-	-	-	-
Buteogallus anthracinus	-	-	-	-	-	-	1	100.0	-	-	-	-	-	-

Of the 452 Turkey Vultures observed in the virgin and disturbed areas, 58.1% were soaring very close to the ground (approximately › 50m) as solitary individuals or in flocks of no more than five individuals. In contrast, Black Vultures soared in groups of more than 15 individuals (range 7-76) at high altitudes (100m to 1,000m).

Migration and Wintering

In the Lacandona jungle the 12 Ospreys (*Pandion haliaetus*) observed were fishing and soaring over the Lacantun River on 22 November (Table 4). Several flocks of Broad-winged Hawks, with a few Swainson's Hawks, were observed on migration on 20 March 1985 (Table 2A). Several flocks of the Mississippi Kite were sighted on migration during 22 and 27 April along Route 2 (Table 3B) on hills covered with evergreen forest and the ecotone of pine-oak woodlands and deciduous forest.

The Kestrels were found in low numbers in both forest study areas and always in small clearings (Table 2B). They were observed more frequently along Route 1 than Route 2 (two birds on April 27). Along Route 1, we sighted 49 Kestrels on 10 December 1984, 85 on 2 and 21 March 1985 and none on 6 June 1985 (Table 3A). Route 2 was surveyed only in mid-April, when most Kestrels had already migrated out of the area (Table 3B). On Route 1, they were found more often on pasture and arable land and in urban areas than in other habitat (Table 3A). This is similar to reports from North America (Craig 1978; Bauer 1982; Fischer *et al.* 1984; Sferra 1984; Bohall-Wood & Collopy 1986).

Neotropical raptor populations, including those in Mexico, differ significantly from those in most of North America in that the arrival of the high numbers of migrating and wintering birds may stress resident populations which presumably already have strong intra- and inter-specific competition for resources, such as food, habitat, perches, etc. (Iñigo pers. obs.). This phenomenon needs to be well understood for the conservation of both migrant and resident raptors.

TABLE 7. Habitat use of raptor species sighted in Route 2 (S. Cristobal - Champoton) from April 22 to April 27, 1985.

SPECIES	PASTURE & FARM-LANDS		SEMI-EVERGREEN		SAVANNA		EVERGREEN FOREST		PINE-OAK FOREST		URBAN AREAS		SWAMP VEGETATION	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Carthartes aura	12	14.6	37	45.1	-	-	25	30.4	1	1.2	1	1.2	6	7.3
Ictinia mississippiensis	-	-	25	32.8	-	-	49	64.4	2	2.6	-	-	-	-
Coragyps atratus	33	60.0	-	-	22	40.0	-	-	-	-	-	-	-	-
Polyborus plancus	22	75.8	-	-	-	-	5	17.2	-	-	-	-	-	-
Buteo magnirostris	-	-	-	-	-	-	23	100.0	-	-	-	-	-	-
Elanus caeruleus	10	55.5	3	16.6	-	-	1	5.5	-	-	4	22.2	-	-
Buteo nitidus	-	-	-	-	-	-	9	100.0	-	-	-	-	-	-
Falco rufigularis	-	-	-	-	-	-	2	100.0	-	-	-	-	-	-
Pandion haliaetus	-	-	-	-	-	-	-	-	-	-	-	-	2	100.0
Rosthramus sociabilis	-	-	-	-	-	-	-	-	-	-	-	-	2	100.0
Falco sparverius	2	100.0	-	-	-	-	-	-	-	-	-	-	-	-
Buteo albicaudatus	-	-	-	-	-	-	1	100.0	-	-	-	-	-	-
Chondrohierax uncinatus	-	-	1	100.0	-	-	-	-	-	-	-	-	-	-
Herpetotheres cachinnans	-	-	-	-	-	-	1	100.0	-	-	-	-	-	-

CONCLUSIONS

Many tropical forest birds, including diurnal and nocturnal birds of prey, are uncommon. Their rarity is presumably a result of large species having large home ranges, using specialized hunting techniques, laying only one or two eggs per clutch, having a lengthy chick development period, and having a complex coevolution with the whole tropical evergreen forest community (Karr 1977, 1981; Leck 1979; Ramos 1985a). Tropical forests are disappearing at high rates, approximately 11 million ha per year (Hartmans 1986; Lal 1986) and because of their position at the top of trophic levels, raptors disappear almost immediately following forest removal (Ramos 1985a).

TABLE 8. Number of observations of raptor species on various perch types and in flight.

SPECIES	FLYING OR SOARING	NATURAL PERCH TYPES: BARE TREE/ SNAG	MIDDLE PART OF TREES	TOP OF LIVE TREE	GROUND
A: IN LACANDONA JUNGLE, CHIAPAS.					
Cathartes aura	94	16	-	-	27
Coragyps atratus	61	-	-	3	-
Falco rufigularis	5	29	20	-	-
Sarcoramphus papa	12	-	-	-	-
Pandion haliaetus	8	-	-	-	-
Buteo magnirostris	1	10	-	-	-
Elanus caeruleus	3	8	-	-	-
Herpetotheres cachinnans	1	5	-	1	-
Spizaetus tyrannus	1	-	-	1	-
Falco sparverius	-	3	-	-	-
Buteogallus anthracinus	2	-	-	-	-
Geranospiza caerulescens	-	-	2	-	-
Micrastur ruficollis	-	-	1	-	-
Leucopternis albicollis	1	-	-	-	-
Buteo nitidus	-	1	-	-	-
B: IN THE TUXTLAS MOUNTAINS, VERACRUZ:-					
Buteo platypterus	-	279	-	-	-
Buteo swainsoni	70	-	-	-	-
Coragyps atratus	43	2	-	-	-
Leucopternis albicollis	28	2	3	2	-
Micrastur ruficollis	-	-	13	-	-
Falco sparverius	11	-	1	1	-
Buteo nitidus	5	-	1	3	-
Spizaetus ornatus	9	-	-	-	-
Cathartes aura	8	-	-	-	-
Buteo magnirostris	4	1	-	-	-
Falco rufigularis	-	4	1	-	-
Spizaetus tyrannus	4	-	1	-	-
Buteogallus urubitinga	5	-	-	-	-
Herpetotheres cachinnans	-	2	-	-	-
Pandion haliaetus	1	-	-	-	-
Harpagus bidentatus	-	-	1	-	-
Falco deiroleucus	1	-	-	-	-

TABLE 9. Number of observations of raptor species on various perch types and in flight.

SPECIES	FLYING OR SOARING	MAN-MADE		NATURAL			
		UTILITY POLE	WIRE[1]	BARE TREE/SNAG	MIDDLE OF TREE	TOP LIVE TREE	GROUND
A: ON ROUTE 1 (S. CRISTOBAL - JALAPA):-							
Coragyps atratus	496	26	-	53	-	2	21
Cathartes aura	221	2	-	-	-	1	1
Falco sparverius	3	96	23	1	-	11	-
Buteo magnirostris	8	13	2	8	2	12	-
Polyborus plancus	5	-	-	4	2	1	3
Elanus caeruleus	11	-	-	2	-	-	-
Buteo nitidus	1	2	1	4	-	-	-
Buteo albicaudatus	2	-	-	-	-	-	-
Rosthramus sociabilis	-	-	-	-	-	-	2
Pandion haliaetus	2	-	-	-	-	-	-
Buteo jamaicensis	1	-	-	-	-	-	-
Buteogallus anthracinus	-	-	-	1	-	-	-
B: ON ROUTE 2 (S. CRISTOBAL - CHAMPOTON):-							
Cathartes aura	76	-	-	5	-	-	1
Ictinia mississippiensis	76	-	-	-	-	-	-
Coragyps atratus	52	-	-	3	-	-	-
Polyborus plancus	7	-	-	7	13	-	2
Buteo magnirostris	6	-	-	13	2	2	-
Elanus caeruleus	7	-	-	11	-	-	-
Buteo nitidus	6	-	-	3	-	-	-
Falco rufigularis	-	-	-	2	-	-	-
Pandion haliaetus	-	-	-	-	-	2	-
Rosthramus sociabilis	-	2	-	-	-	-	-
Falco sparverius	-	-	-	2	-	-	-
Buteo albicaudatus	-	-	-	-	-	1	-
Chondrohierax uncinatus	-	-	-	-	1	-	-
Herpetotheres cachinnans	-	-	-	1	-	-	-

[1] Power and telegraph lines.

The restrictive ecological requirements of many tropical falconiforms combined with human pressures, e.g. high loss of suitable tropical woodlands (Ramos 1985a) the pet and falconry trade (Iñigo 1986), hunting of large eagles (Iñigo *et al.* 1987) and high use of pesticides like DDT (Kiff *et al.* 1980), have resulted in the loss of many Neotropical raptor populations. In our study, we found that at least nine raptor species had disappeared from tropical evergreen forest areas that had any type of human disturbance. Species sensitive to forest fragmentation or disturbance were the Ornate Hawk-eagle, King Vulture and the Barred Forest Falcon.

At least 25 Neotropical raptor species are in danger of extinction (King 1981; Burton 1983; Ramos 1985a) and most of these birds depend on large blocks of primary tropical evergreen forest.

Recommendations for birds of prey conservation, habitat management as well as for the conservation of whole tropical communities include:

- The establishment of adequate parks and reserves, incorporating the requirement of extensive home ranges for many large raptors such as the Harpy Eagle *(Harpia harpyja).*
- If forest felling is necessary, this should be done gradually, not by massive deforestation. The remaining forest patches will promote natural regeneration and sustain forest wildlife. Reforestation of cut areas also should be encouraged.
- Develop integrated strategies for local people to use all the natural resources in an area. For example, use all available species of trees for wood (not only the valuable species, but also the less valuable woods, e.g. for making tool handles); growing native fruit; aqua-culture; wildlife management; tourism; etc. (IUCN 1980; Ramos 1985b). Do not depend only on agriculture and extensive cattle ranching, which do not resolve the economic and social problems of the local human populations and only benefit a select upper class group (Fernandez & Tarrio 1983).
- Prohibit or restrict the use of many pesticides that poison the environment and reduce populations of both resident and migrant raptors, as well as other wildlife species and human beings.

ACKNOWLEDGEMENTS

We wish to offer thanks to Lloyd Kiff and the Western Foundation of Vertebrate Zoology, Jim Brett and the Hawk Mountain Sanctuary Association, and Yossi Leshem from the Israel Raptor Information Center for supporting our participation in this conference. To Lloyd Kiff, Dr. Robert Kenward and Petra Bohall Wood for critically reviewing the manuscript. To Jon Fisher for his assistance in the computer. To Dr. Ian Newton for his comments. To Dr. John Rappole who participated with us during the surveys in the Tuxtlas mountains. To Cathy Ritchie and Lonel Segars for their assistance doing the tables.

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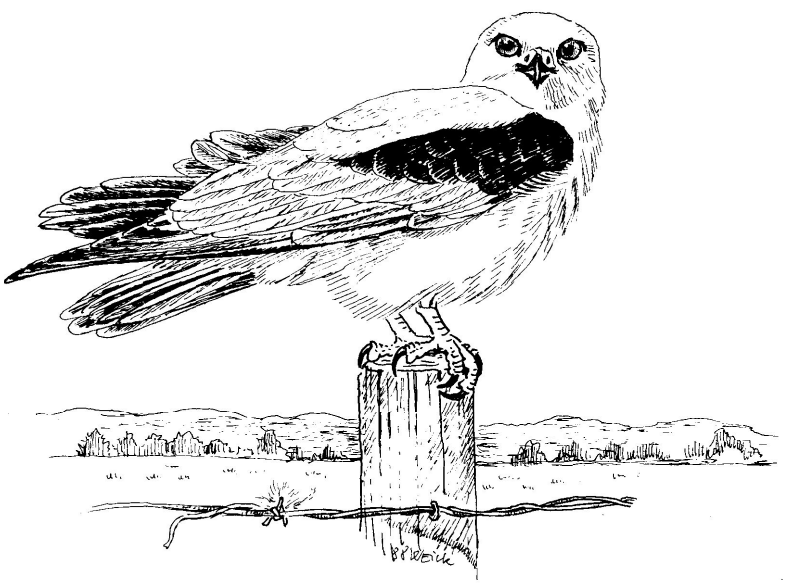

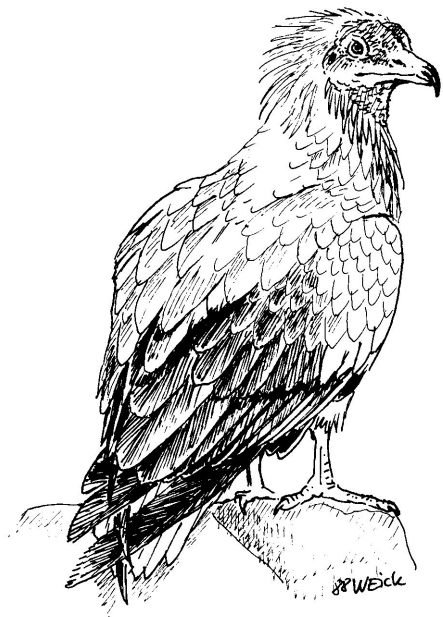
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