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ROADSIDE RAPTOR SURVEYS IN THE ARGENTINEAN PATAGONIA

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Abstract.—Roadside raptor surveys were conducted in November 1991 along 1224 km in the northern Argentinean Patagonia. Twelve species and 477 individuals were observed. The most common species were Chimango Caracaras (*Milvago chimango*) (N = 243) and Black Vultures (*Coragyps atratus*) (N = 72). Raptor abundance and diversity index were highest in lowland valleys and in grassy hills near the Andean cordillera. Shrubsteppe zones near other habitats had higher raptor abundance and lower diversity than inner steppe areas. The Andean woodlands had the lowest raptor abundance. We suggest that deforestation of Andean woodlands and other human-induced alterations may have had positive effects on raptor open land abundance.

Conteos de aves rapaces por carretera en la Patagonia argentina

Resumen.—En noviembre de 1991 se recorrieron 1224 km en el norte de la Patagonia argentina y se registraron 12 especies de aves rapaces diurnas y un total de 477 individuos. Las especies más comunes fueron el Chimango (*Milvago chimango*) (N = 243) y el Jote de Cabeza Negra (*Coragyps atratus*) (N = 72). Los índices de diversidad y abundancia de rapaces fueron máximos en las zonas de mallines (fondos húmedos de valle) y en las colinas herbosas del piedemonte andino. En las estepas arbustivas, la abundancia de rapaces fue máxima en las zonas de borde cercanas a otros hábitats. Los bosques presentaron las menores abundancias. Se sugiere que la abundancia de aves rapaces se ha visto incrementada por la deforestación en la cordillera andina y por el incremento de las actividades humanas.

Roadside surveys have been widely employed to determine relative abundances of raptors in many regions of the world (see review in Ellis et al. 1990). In some cases, surveys have been used to compare relative abundances and diversities between broad regions and/or biomes (Meyburg 1973, Reichfold 1974, Ellis et al. 1990), and to assess the impact of human-induced habitat transformations on raptor species richness (Ellis et al. 1990).

Here, we report the results obtained in three raptor roadside surveys carried out in the northern Argentinean Patagonia. Previous raptor roadside surveys in this region were made by Olrog (1979) and by Ellis et al. (1990). Olrog (1979) did not provide any reference about the habitats surveyed, but Ellis et al. (1990) considered a single habitat—the desert scrub. Northern Patagonia, however, is crossed by extensive valleys where rivers and streams favor the occurrence of a very different kind of landscape dominated by wet grasslands ("mallines"), small woodlots, and some agriculture. In other arid regions of the world the existence of isolated humid zones promotes changes in the avian community composition and richness (Valverde 1957, Newton 1979). We hypothesized, therefore, that raptor diversity and abundance indices in the northern Patagonia are not uniform, being influenced by local habitat differences within the biome. Additionally, we recorded data on raptor relative abundance in other marginal habitats in northwestern Patagonia: Andean woodlands, Andean grassy hills, and villages.

Study Area and Methods

The weather in northern Argentinean Patagonia (provinces of Chubut, Río Negro and Neuquén) is dry and cold, with frost almost throughout the year and frequent snowfall in winter. Topographically, the area consists of great plains at 800–900 m above sea level, dissected by steep rugged areas and valleys with large rivers. Mountains occupy the west part of the study area. Physiographically, from west to east, this area can be subdivided into the main Andean cordillera, the precordilleran foothills, and the Patagonian plains.

Within this area, we recognized the following habitats:

Shrubsteppe (Desert) of the Patagonian Plains. The vegetation was characterized by a mixed steppe of bunchgrasses (*Stipa* spp. and *Festuca* spp.) and spiny shrubs. Trees were absent.

Valleys with Wet Zones. These were flat areas situated at the bottom of the valleys and in lowlands (river, mallines). The vegetation was primarily herbaceous with a high productivity. Trees were concentrated along rivers and in plantations around ranches.

Andean Woodlands. This area was characterized by temperate rainforests dominated by 50 m tall *Nothofagus* spp. with a dense bamboo understory of *Chusquea culeou.* This woodland occupies rugged areas on the foothills and the Andean cordillera. In some parts logging and fire have degraded the forest opening clearings and reduced the age of the stands.

Andean Grassy Hills. Grassland areas are situated in rugged terrains of the foothills of the Andean cordillera. Trees are scarce because of soil characteristics and/or human pressure tending to expand areas suitable for livestock raising.

Villages. Urban areas, including the cities of Trelew, Esquel, San Carlos de Bariloche and Junín de los Andes, made up this category.

The surveys (Fig. 1) were conducted in 1991 on the following dates and localities: 15 November (0625–1930 H) at Trelew-San Carlos de Bariloche (920 km), 16 November (0825–1148 H) at San Carlos de Bariloche-Junín de Los Andes (221 km), and 25 November (1416–1726 H) at Junín de los Andes-Estancia Quemquemtreu (83 km).

Roadside counts were conducted by two experienced observers: the driver and another person sitting on the front seat of a car. A third person recorded information. The surveys were carried out in fine weather, without clouds and with a wind velocity lower than 20 km/hr. The average driving speed was 60–70 km/hr.

We recorded every raptor seen. In a few cases it was necessary to stop the vehicle to identify the birds. In this case, we did not take records on the new birds discovered during the stop. Relative abundance of raptors was estimated as the number of kilometers traveled per individual observed. The Shannon index was used to calculate diversity (Herrera 1974).

To determine whether raptor abundance and diversity indices varied within the main habitat (shrubsteppe) due to the vicinity of other habitats, we established two categories: "outer steppe" (the first or last 20 km after or before entering a different habitat) and "inner steppe" (the rest of the surveys).

Additionally, between 15 and 30 September 1991, one observer equipped with 10 × 40 binoculars conducted 15 point counts in the *Nothofagus* woodland of the Lanín National Park. The points had reduced visibility (approximately 50–150 m) but the radius of detection of raptor calls was greater. The weather conditions were appropriate (calm air and no rain).

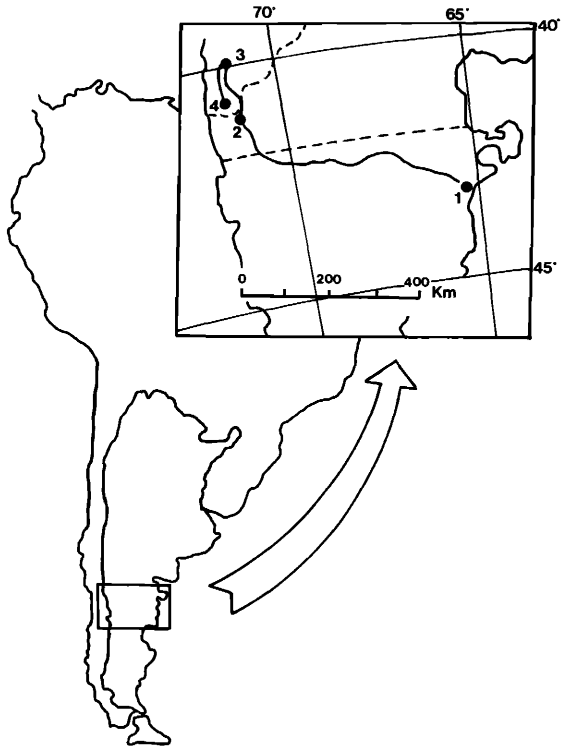

Figure 1. Location of roadside raptors surveys. 1. Trelew, 2. San Carlos de Bariloche, 3. Junín de los Andes, 4. Estancia Quemquemtreu.

RESULTS

Chimango Caracaras *Milvago chimango* ($N = 243$) and Black Vultures *Coragyps atratus* ($N = 72$) were the most common species, followed by American Kestrels *Falco sparverius* ($N = 45$), Grey Eagle-Buzzards *Geranoaetus melanoleucus* ($N = 26$), Turkey Vultures *Cathartes aura* ($N = 24$), Crested Caracaras *Polyborus plancus* ($N = 23$), and Red-backed Hawks *Buteo polyosoma* ($N = 20$; Table 1).

Turkey Vultures, Black Vultures and Crested Caracaras reached their highest abundances in valleys and Andean grassy hills. The Chimango Caracara abundance was maximum in villages, followed by shrubsteppes and valleys. American Kestrels and Cinereous Harriers (*Circus cinereus*) occurred mostly in valleys. The Grey Eagle-Buzzard was detected mainly in Andean grassy hills whereas *Buteo* species were observed more frequently in shrubsteppes. Most individuals were seen alone or in pairs (Table 2). Three species were clearly gregarious: Turkey Vul-

Table 1. Results of roadside raptor counts (S = shrubsteppe, V = valley, W = Andean woodland, H = Andean grassy hill, Vl = village).

	TOTAL 1234 km				
SPECIES	S	V	H	W	VL
Cathartes aura	91.4	30.0	19.0	0.00	0.0
Coragyps atratus	—	4.5	—	28.6	0.0
Vultur gryphus	640.0	300.0	—	—	—
Circus cinereus	640.0	60.0	133.0	143.0	—
Geranoaetus melanoleucus	80.0	60.0	12.1	71.5	—
Buteo albicaudatus	640.0	—	—	—	—
Buteo polyosoma	40.0	75.0	—	—	—
Buteo sp.	106.7	—	133.0	—	—
Polyborus plancus	71.1	42.9	19.0	—	—
Milvago chimango	4.2	5.2	8.3	11.9	1.3
Falco sparverius	58.2	10.7	33.2	71.5	—
Falco femoralis	640.0	—	—	71.5	—
Falco peregrinus	—	100.0	—	—	—
Total species	10	10	7	6	1
Total Individuals	212	188	47	24	6
Diversity	0.461	0.722	0.716	0.620	0.000
km/individual	3.0	1.6	2.8	6.0	1.3

ture (maximum group size of 5 birds), Black Vulture and Chimango Caracara.

Raptor diversity was highest in valleys and Andean grassy hills (Table 1). These two habitats were also those having the highest raptor abundances. The abundance index was least in Andean woodlands. The habitats lowest in raptor diversity were shrubsteppes and villages.

There were important variations in raptor abundance in counts carried out in similar habitats but in different places. The values obtained in the three surveys made in shrubsteppes were uneven (Table 1). In contrast, the diversity values were very similar. When we compared the results obtained in inner shrubsteppe surveys with those obtained in outer shrubsteppe (Table 3), the latter had higher raptor abundances. On the other hand, diversity was higher in inner steppes.

Surveys carried out in different zones of valleys also demonstrated important differences (Table 1). All the valley zones were of small size. As a consequence, an analysis similar to that made for the shrubsteppe habitat was not possible. The main differences between surveys seem to be determined by the presence of scavenger species. When Turkey Vultures, Black Vultures and Andean Condors were excluded from the counts, the abundance indices for the three valleys became more similar, changing from 3.6, 0.6, and 1.2 to 3.7, 2.0, and 1.6, respectively.

We conducted 15 point counts in the *Nothofagus* woodland of the Lanín National Park totaling 13 hours of observation. Eight individuals were detected: one *Buteo* sp., one Crested Caracara, five Chimango Caracaras, and one American Kestrel. These raptors were seen in small clearings within the forest, none inside the woodland.

DISCUSSION

Our results showed that high abundances and diversities of raptor species occur in valleys and Andean grassy hills. These two habitats also had low raptor richness. This may have been influenced by the variety of potential nest-sites: sparse trees, woodlots, flooded and dry prairies, rivers, cliffs, and by the primary productivity which determines a high density of wild and domestic herbivores whose carcasses are exploited by vultures and facultative scavengers. The villages had the greatest abundance index and the lowest diversity due to the important number of Chimango Caracaras that visit urban areas for foraging and nesting. This species has been observed breeding in San Carlos de Bariloche, Junín de los Andes, and San Martín de los Andes (author's unpubl. data). Finally, the low abundance obtained

Table 2. Group sizes of the species observed throughout the surveys.

SPECIES	NO. INDIVIDUALS 1	2	3–10	>10
Cathartes aura	7	4	2	–
Coragyps atratus	2	1	2	1
Vultur gryphus	2	—	–	–
Circus cinereus	6	1	–	–
Geranoaetus melanoleucus	14	4	1	–
Buteo albicaudatus	1	—	–	–
Buteo polyosoma	18	1	–	–
Buteo sp.	5	1		
Polyborus plancus	19	2	–	–
Milvago chimango	113	10	8	3
Falco sparverius	39	3	–	–
Falco femoralis	1	1	–	–
Falco peregrinus	1	1	–	–

in the Andean woodlands could be partly due to the lower probability of detecting raptors in forested areas (Fuller and Mosher 1987). We think, however, that this apparent low abundance was real. The roads normally cross the mountain slopes, so the detection band was broad enough. In addition, the point counts made in the *Nothofagus* woodland of the Lanín National Park yielded only eight observations in 13 hours. The impoverished avifauna of the *Nothofagus* woodlands was also noted by Darwin (1839).

The heterogeneity of results obtained in surveys carried out in similar habitats may be due to different factors. In the shrubsteppe, raptor abundance seems reinforced by the proximity to other habitats. This proximity could stimulate raptors breeding in deserts to utilize other habitats for foraging and vice versa. In other arid zones, raptor richness increases when areas are irrigated (Newton 1979). In our study area, only the *Buteo* species maintain similar abundances in inner and outer steppes. This may be due to the high density of small mammals living in this habitat (up to 200/ha during summer; A. Travaini et al. unpubl.). A similar trend could be expected for the American Kestrel, because the most abundant rodents inhabiting the steppe have small body sizes (Pearson 1986): *Eligmodontia typus* (6–12 g) and *Akodon* spp. (10–15 g). American Kestrels, however, seem to be scarcer in the steppe zones than in the valleys.

The differences observed between valley surveys may be due to local fluctuations in food availability, especially of carrion: raptor abundance indices increased when vultures were excluded from the counts.

Table 3. Number of contacts (times each species was detected) and number of individuals observed at outer (<20 km from other habitats) and inner (>20 km) shrubsteppes.

	OUTER STEPPE 237 km		INNER STEPPE 414 km	
	CONTACTS	*N*	CONTACTS	*N*
Cathartes aura	3	7	—	—
Coragyps atratus	—	—	—	—
Vultur gryphus	1	1	—	—
Circus cinereus	1	1	—	—
Geranoaetus melanoleucus	4	7	1	1
Buteo albicaudatus	—	—	1	1
Buteo polyosoma	7	8	8	8
Buteo sp.	2	3	3	3
Polyborus plancus	6	6	2	3
Milvago chimango	40	138	12	13
Falco sparverius	8	8	2	3
Falco femoralis	1	1	—	—
Falco peregrinus	—	—	—	—
Total species		9		6
Total individuals		180		32
Diversity		0.405		0.596
km/individual		1.3		12.9

It is known that vultures concentrate near predictable feeding places (Brown and Amadon 1968), and 60 of the 72 observed Black Vultures were detected near a communal roost located in a zone with a high food availability. Additionally, scavenger species showed the largest group sizes.

The global abundance index found in our Patagonian surveys (1 individual/0.39 km) is half that found in March 1979 by Ellis et al. (1990; 1/0.69 km) but five times higher than that found by Olrog (1979) in January 1976 (1/10 km). It is difficult to make comparisons among these results because the three surveys were carried out at different stages of the breeding season and we do not know the habitat proportions in the surveys made by the other authors. Olrog (1979) argued that the numbers he found were low due to raptor extirpation through human persecution and pesticide treatments. Perhaps our higher abundance indices may result from the progressive respect shown to raptors by human populations (raptors have been legally protected in Argentina since 1975). In any case, certain groups of raptors seem to have benefited from human-induced alterations in the Patagonian habitats. Before European colonization, the Patagonian drylands and woodlands were very poor in raptors; Darwin (1839) observed only three species, all of them vultures in the steppe and two in the forest. With European settlements, the Andean woodlands were largely destroyed to expand the area of grassland suitable for livestock (Veblen et al. 1992). As has occurred in other American regions (Reichfold 1974, Wilbur 1983), the shift from wild herbivores (guanaco) to domestic livestock herds (sheep and cattle) undoubtedly favored vultures and other scavengers. Later, around 1950–60, the European hare (*Lepus europaeus*) was introduced and seems to have benefited large eagles that maintain very dense populations with high reproductive success (Travaini et al. unpubl.), and also small and medium-sized scavengers that exploit the carcasses of road-killed hares. These scavenging species have also benefited from the growth of human settlements and the ensuring increase in number and size of refuse dumps (Donázar et al. unpubl.).

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