

## ABUNDANCE AND DISTRIBUTION OF RAPTORS IN THE SIERRA DE SAN JAVIER BIOLOGICAL PARK, NORTHWESTERN ARGENTINA

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**Resumen.** – **Abundancia y distribución de aves rapaces en el Parque Biológico Sierra de San Javier, noroeste de Argentina.** – Presentamos los patrones de utilización de hábitat para 27 especies de aves rapaces del Parque Biológico Sierra de San Javier. Registramos en total 20 especies diurnas y 7 de hábitos nocturnos; 70% de ellas habitan con regularidad el área relevada. En los hábitat principales, realizamos un análisis cualitativo de la abundancia y de la distribución temporal estacional de las especies. Las especies más abundantes son residentes permanentes, ampliamente distribuidos en Sudamérica. La riqueza de especies fue mayor para los carnívoros y menor para los insectívoros en los tres hábitat principales del parque, mientras que los carroñeros fueron el grupo funcional más abundante en los tres casos. Discutimos la contribución del parque para la conservación de especies de aves rapaces susceptibles de extinguirse a escala local. El Milano pico garfio (*Chondrobierax uncinatus*) y el Taguató negro (*Buteo leucorhous*) poseen alto riesgo de extinción local, debido a su disminución numérica, susceptibilidad a la alteración del hábitat y al progresivo aislamiento del parque. Ocho especies utilizan con regularidad el tipo de hábitat donde su abundancia es mayor [Jote real (*Sarcorambus papa*), Aguilucho cola corta (*Buteo brachyurus*), Halcón montés chico (*Micrastur ruficollis*) y Lechucita canela (*Aegolius harrisi*) en el bosque montano subtropical; Milano blanco (*Elanus leucurus*), Chimango (*Mihago chimango*), Halconcito colorado (*Falco sparverius*) y Lechucita vizcachera (*Speotyto cunicularia*) en los bosques alterados]. Estas especies son potencialmente útiles como indicadores de la calidad del hábitat y para evaluar el impacto de la modificación y fragmentación de los hábitat naturales sobre la vida silvestre del parque. *Aceptado el 10 de Mayo de 2004.*

**Abstract.** – We describe patterns of habitat use for 27 species of raptors in the Sierra de San Javier Biological Park in northwest Argentina. Twenty diurnal and seven nocturnal species were recorded; 70% of them regularly inhabit the area. For the main habitats, we present a qualitative analysis of species seasonal distribution and abundance during the dry and wet seasons. The most abundant species were permanent residents that are widely distributed in South America. Species richness was highest among carnivores and lowest among insectivores in the three main habitats of the park, while scavengers were the most abundant functional group in all habitats. We discuss the importance of the park for the conservation of species susceptible to local extinction. The White-rumped Hawk (*Buteo leucorhous*) and the Hook-billed Kite (*Chondrobierax uncinatus*) seem to be at high risk of local extinction because of their decrease in number, susceptibility to forest degradation, and the progressive isolation of the park. Eight species regularly used the habitat where their abundance was highest [King Vulture (*Sarcorambus papa*), Short-tailed Hawk (*Buteo brachyurus*), Barred Forest-Falcon (*Micrastur ruficollis*), and Buff-fronted Owl (*Aegolius harrisi*) in the mature subtropical montane forest; and White-tailed Kite (*Elanus leucurus*), Chimango Caracara (*Mihago chimango*), American Kestrel (*Falco sparverius*), and Burrowing Owl (*Speotyto cunicularia*) in disturbed forests]. These spe-

cies are potentially useful as indicators of habitat quality and in assessing the impact of habitat fragmentation and modification on the park's wildlife.

**Key words:** Argentina, conservation, ecological indicator, raptor, subtropical montane forest, Tucumán.

## INTRODUCTION

Subtropical montane forests of northwestern Argentina are subject to ongoing degradation resulting from deforestation followed by agricultural use (Kappelle & Brown 2001). National and provincial parks and reserves (Brown *et al.* 2001) currently protect less than 10% of these forests. Lack of information on the biology of species that inhabit these forests, and on factors affecting them, limits any serious attempt to manage subtropical montane forests. Due to increasing pressure of human activities on these areas, it is imperative to document species' occurrence and population status in natural environments, data that will be useful in park management.

Raptors that depend on undisturbed forests to complete their life cycles are believed to be especially sensitive to habitat modification and fragmentation (Thiollay 1985, Jullien & Thiollay 1996, Bildstein *et al.* 1998). Other raptors, however, appear to be favored by disturbed habitats (Reichholf 1974, Whitacre *et al.* 1990, Jullien & Thiollay 1996) and may benefit from increased forest clearing and cattle ranching (Olrog 1985). These observations suggest that raptor species may be used as indicator species to accurately assess both quality and quantity of habitats available for others species of interest (Landres *et al.* 1988, Vides Almonacid 1991).

Present knowledge about population status and habitat requirements of raptor species in northwestern Argentina is rudimentary, as it is for most forest-dwelling raptors of South America (Bierregaard 1998). Olrog (1985) qualitatively described the effects of deforestation on raptor populations inhabiting the humid forests of northern Argentina, but no

quantitative data were given. Vides Almonacid (1989) made a preliminary analysis of bird conservation in the Sierra de San Javier Biological Park, including raptors.

At present time, the biodiversity of this park is at high risk of reduction because of progressive isolation due to modification of the surrounding forest, combined with the narrow shape of the park and its small size, making more difficult the persistence of species with low population size and large territorial requirements (Vides Almonacid 1991, 1992). In this context, raptors are predicted to be one of the most threatened groups. We present information on abundance and habitat use of raptor species of the Sierra de San Javier Biological Park in northwestern Argentina, obtained during 11 years of fieldwork in the area.

## STUDY AREA

The study was conducted in a 14,000-ha protected area, the Sierra de San Javier Biological Park (26°45'S, 65°23'W), Tucumán Province, Argentina. The park occupies about 70% of the Sierra de San Javier, between 600 and 1875 m in elevation. The climate is warm and wet in summer, and temperate and dry in winter; intermediate seasons are short. The mean annual temperature in the humid forest varies from 18.8°C in the mountain foothill (420 m) close to the park to 13.9°C at 1400 m. Mean annual rainfall is about 1200 mm in the humid forest (Vides Almonacid 1992), although horizontal precipitation resulting from passing low clouds increase as much as 40% the annual precipitation (Hunzinger 1995). Rainfall is considerably lower in the northern sector of the sierra, with a mean annual of 485



FIG. 1. Xerophytic woodland or montane chaco in the Sierra de San Javier Biological Park.



FIG. 2. Subtropical mountain forest in the Sierra de San Javier Biological Park.

mm in the foothill (Vides Almonacid 1992).

Three main plant communities can be distinguished based on vegetation structure and

composition. The first one is the montane chaco (Fig. 1), a xerophytic woodland in the northwestern sector of the sierra, covering



FIG. 3. Mesophytic grassland growing above the timberline in the Sierra de San Javier Biological Park.

close to 20% of the study area. The tree layer is characterized by *Schinopsis haenkeana*, associated with *Caesalpinia paraguayensis*, *Tipuana tipu*, *Aspidosperma quebracho-blanco* and *Ruprechtia* spp. The second community is represented by the yungas or “selva tucumano-boliviana”, a subtropical montane forest (Fig. 2) covering most of the sierra between 600 and 1300–1500 ma.s.l. *Cinnamomum porphyria*, *Blepharocalix salicifolius*, *Anadenanthera macrocarpa*, *Parapiptadenia excelsa*, and *Terminalia triflora* are the main tree species. The temperate cloud forest, dominated by alder (*Alnus acuminata*) and pine (*Podocarpus parlatorei*), replaces the subtropical montane forest at higher altitudes (1300 to 1800 m). The subtropical montane forest and temperate cloud forest are jointly dealt with. The third community corresponds to mesophytic grasslands (Fig. 3), composed primarily of *Festuca* bunch grass, occurring at higher altitudes above the timberline, and covering less than 10% of the sierra.

## METHODS

Accounts are based on a combination of sampling methods. Between May 1994 and June 1995, we recorded birds via transects along streams and foot trails. Thirty four transects were walked during daytime at a slow and steady pace. Transect length varied depending on site accessibility. The largest sampling effort (46 observation hours) was made in the montane subtropical forest (67%); the sampling effort was lower in the mesophytic grassland (12%) and montane chaco (21%), and was proportional to the area covered by each plant community. The sampling effort was similar during wet and dry seasons. We also covered five transects at dawn and dusk, though most observations of nocturnal raptors were made during non-systematic samplings. For each transect, we registered the number of all individuals seen or heard, their activity and habitat. Additionally, we included several non-systematic observations made

between 1985 and 1995, when species presence and number of sightings per habitat were recorded when we visited the park. Although the usefulness of partial counts of birds and detection by indirect methods is limited (Fuller & Mosher 1981), this approach to make inventories of raptor species of forest environments is pertinent when little information is available (Whitacre & Turley 1990).

More than 660 raptor sightings were recorded during the study. Species accounts given here are supplemented with observations by Vides Almonacid (1989, 1992), and with specimens of the bird collection at the Instituto Miguel Lillo (IML). According to their frequency of occurrence in the transects and to the overall number of sightings, species were classified into four semi-quantitative categories of relative abundance: (1) abundant, observed during at least 50% of the transect counts; (2) common, regularly seen, but on less than 50% of the transect counts; (3) uncommon, fewer than 10 sightings during the study; and (4) occasional, observed only once. Occurrence and seasonal variation in abundance were evaluated for wet (October–March) and dry seasons (April–September), for each habitat considered. Raptors were classified as residents, summer migrants, or winter migrants. We considered as summer migrants those species observed only during the rainy season, as winter migrants, those observed in the dry season, and as residents those observed in both seasons. Raptors were classified as insectivores, carnivores or scavengers, according to their main food type in the diet (Jullien & Thiollay 1996, P. G. Blendinger pers. observ.). Correspondence analysis (CA) was used for exploring the relationships between raptor assemblages in habitat use.

RESULTS

Twenty diurnal and seven nocturnal raptor species were recorded. Considering the park

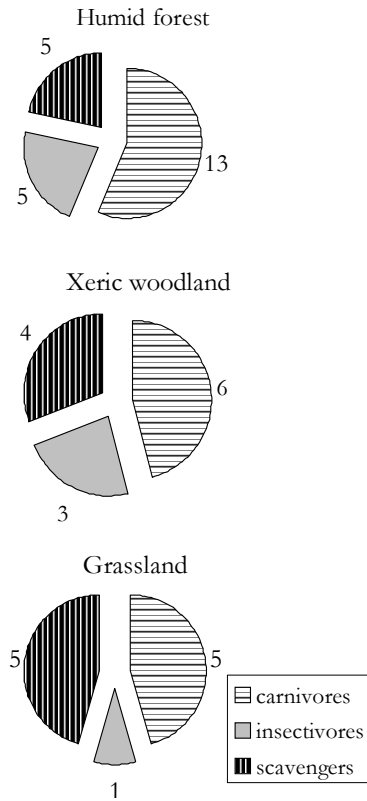


FIG. 4. Species richness in raptor functional groups in the three main habitats of the Sierra de San Javier Biological Park, based on 660 raptor sightings. The figures represent the number of individual species.

area as a whole, 6 species were abundant [e.g., Black Vulture (*Coragyps atratus*), Tropical Screech-Owl (*Otus choliba*)], 11 common [e.g., King Vulture (*Sarcoramphus papa*), Bicolored Hawk (*Accipiter bicolor*), Short-tailed Hawk (*Buteo brachyurus*)], 7 uncommon [Great Black Hawk (*Buteogallus urubitinga*) and Stygian Owl (*Asio stygius*) among others], and 3 occasional [Andean Condor (*Vultur gryphus*), Sharpshinned Hawk (*Accipiter striatus*), and Bat Falcon (*Falco rufigularis*)]. Seventeen species were residents, six were winter migrants [Cinereus Harrier (*Circus cinereus*), Red-backed Hawk

(*Buteo polyosoma*), Great Black Hawk, Black-chested Buzzard-Eagle (*Geranoaetus melanoleucus*), Tucuman Pygmy-Owl (*Glaucidium tucumanum*), and Burrowing Owl (*Speotyto cunicularia*), and one, Peregrine Falcon (*Falco peregrinus anatum*), a migrant from the Northern Hemisphere, seen only in summer.

Transects were walked for 68 h during daytime, period during which 240 birds of 17 species were observed; during the 5 h of nocturnal observation, six species were recorded for a total of 15 sightings. Four species accounted for 79% of the diurnal records: Black Vulture (39%), Roadside Hawk (*Buteo magnirostris*) (21%), Turkey Vulture (*Cathartes aura*) (12%), and Crested Caracara (*Caracara plancus*) (7%). Each of the remaining species accounted for less than 5% of the observations.

Based on the total raptors recorded, carnivores were the most speciose functional group in all three main habitats (Fig. 4). However, in the grasslands, the number of scavenger species was similar to that of carnivores. Insectivores had the lowest species richness in all three habitats.

Scavengers were the most abundant functional group in the humid forest and in the xeric woodland while, in the grassland, most of the individuals were carnivores (Fig. 5). Insectivores represented less than 5% of all raptors in humid forest and xeric woodland; no insectivorous species were recorded in the grassland.

The first two axes in the correspondence analysis explained 60% of the variation in species composition from different habitats and seasons (Fig. 6). Three groups of species were defined. The Andean Condor characterized the first group corresponding to wet season occurrence in grassland; only few other species were recorded at the same time in this habitat. Species composition of wet and dry season samples from humid forest was similar based on their proximity in the

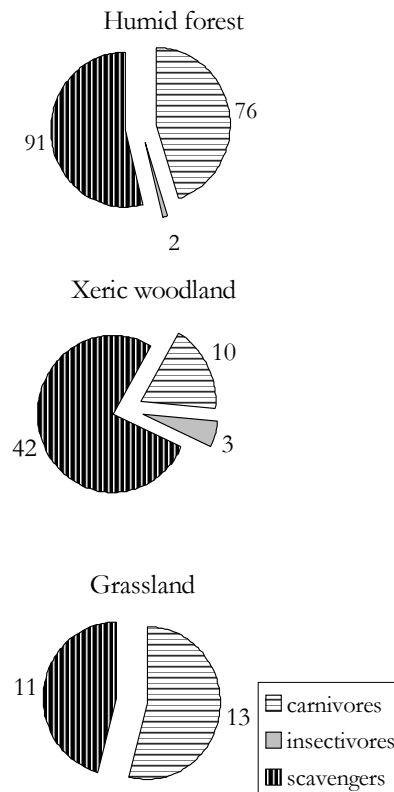


FIG. 5. Raptor abundance in three functional groups of species recorded during 73 h of transects walked in xerophytic woodlands, humid forests and mesophytic grasslands. The figures represent the number of raptors.

ordination diagram. They were defined by the presence of Barred Forest-Falcon, Bicolored Hawk, Great Black Hawk, Buff-fronted Owl, Stygian Owl, Short-eared Owl (*Asio flammeus*), Barn Owl (*Tyto alba*) and Peregrine Falcon. Finally, samples from both seasons in xerophytic woodlands and the dry season in grassland were close together in the ordination space, mostly because of the presence of Cinereus Harrier, Red-backed Hawk, Aplomado Falcon (*Falco femoralis*), and Burrowing Owl, among other species in the three samples.

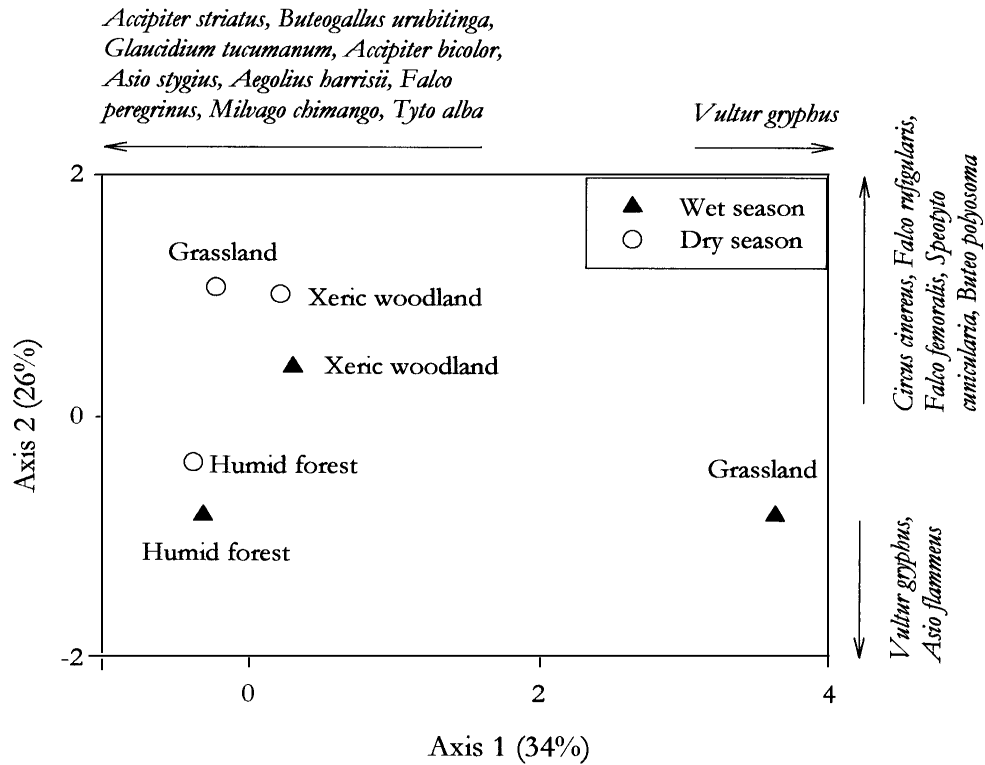


FIG. 6. Ordination diagram of raptor assemblages of the three main habitats in the Sierra de San Javier Biological Park observed during the wet and dry seasons.

SPECIES ACCOUNTS

We include only those species observed in the park between 1985 and 1995.

*Turkey Vulture* (*Cathartes aura*). An abundant resident in forest and an abundant winter visitor in the high montane bunch grass. It was rarely observed in groups of more than two individuals.

*Black Vulture* (*Coragyps atratus*). An abundant resident in all habitats of the park. Usually seen in small groups of two or three individuals, although groups of up to 20 individuals were seen flying over the lowest slopes (600 to 800 m).

*King Vulture* (*Sarcoramphus papa*). A common resident species. It is regularly seen in the temperate cloud forest of *Podocarpus* and *Alnus*. It is less abundant in the foothills with secondary forest and in areas outside the park. Both young and adults were seen flying over mesophytic grasslands.

*Andean Condor* (*Vultur gryphus*). Occasional in the park. A single adult was seen in December flying over the Sierra de San Javier at 1650 m.

*White-tailed Kite* (*Elanus leucurus*). A common species in open habitats. It is a permanent resident in clearings and cultivated fields lower than 700 m in elevation. The species also uses the outer areas of the park where a fledgling

was seen in a cropland. It was also observed in the montane grassland and flying over the subtropical montane and the temperate cloud forest.

*Cinereus Harrier* (*Circus cinereus*). A common winter migrant in the montane grassland; this is a non-breeding migrant in the lower montane areas of northwestern Argentina.

*Bicolored Hawk* (*Accipiter bicolor*). A common resident in the subtropical montane forest. In winter, it was observed hunting in open areas close to forest or flying over secondary forests and agricultural fields.

*Sharp-shinned Hawk* (*Accipiter striatus*). A single individual was observed in a clearing in the foothills bordering the montane forest.

*Great Black Hawk* (*Buteogallus urubitinga*). In winter, an uncommon migrant along streams and rivers of the park's wet forest. Recorded between 700 and 1000 m in elevation.

*Black-chested Buzzard-Eagle* (*Geranoaetus melanoleucus*). A common winter migrant in the temperate cloud forest and montane grasslands above 1500 m. Non-breeding individuals visit the lowlands and low montane areas, migrating both latitudinally and altitudinally from their breeding grounds in southern and western Argentina.

*Red-backed Hawk* (*Buteo polyosoma*). This common species is a winter migrant in high montane grassland and foothill clearings. It is an uncommon migrant in the montane chaco. In the subtropical montane forest, it was only observed flying high over the canopy. Non-breeding individuals visit the lower montane areas of northwestern Argentina.

*Short-tailed Hawk* (*Buteo brachyurus*). Resident in the subtropical montane forest, this

species is common in winter and uncommon in summer. During winter, it can also be found in foothill secondary forests. Only one individual was observed in the montane chaco. Out of 16 sightings, 11 were in light color morph and 4 were in dark color morph.

*Roadside Hawk* (*Buteo magnirostris*). An abundant resident species occupying all main habitats at all elevations; it is more abundant in lowland forests near clearings. Usually alone or in pairs, Roadside Hawks use to occupy the same area the year-round, even in the ecotone between the temperate cloud forest and high grasslands at 1700 m.

*Crested Caracara* (*Caracara plancus*). An abundant resident in the subtropical montane forest, where it is seen most frequently in clearings and ravines. It is a winter visitor in the montane chaco and high elevation grasslands. Regularly observed in clearings bordering the park.

*Chimango Caracara* (*Milvago chimango*). Not observed inside the park, but is an uncommon resident in foothill clearings and agricultural fields outside the park.

*Barred Forest-Falcon* (*Micrastur ruficollis*). An abundant resident in the subtropical montane forest, and less abundant in lowland secondary forests. It is an uncommon winter visitor in the *Alnus* and *Podocarpus* temperate cloud forest. In the montane chaco, it was recorded only in the most humid forest.

*American Kestrel* (*Falco sparverius*). An uncommon resident; observed only in clearings near the edge of the park, mostly below 900 m.

*Bat Falcon* (*Falco ruficularis*). Occasional in the montane chaco. Uncommon species in



the entire region where it reaches its southern distribution limit.

*Aplomado Falcon* (*Falco femoralis*). An uncommon species, occurring in the edges of the subtropical montane forest and in the montane chaco.

*Peregrine Falcon* (*Falco peregrinus*). Common in the park; mainly seen in disturbed areas. *Falco p. cassini*, a winter migrant from southern Argentina, is seen only between May and June. *F. p. anatum*, a regular summer migrant from the northern hemisphere, is seen in clearings and fields from November to March.

Barn Owl (*Tyto alba*). Common in the park, regularly observed in old buildings. Seen in clearings in the subtropical montane forest (600 to 1200 m) and secondary forests.

*Tropical Screech-Owl* (*Otus choliba*). An abundant resident in many habitats. One pair was observed breeding in May and June in the subtropical montane forest.

*Tucuman Pygmy Owl* (*Glaucidium tucumanum*). An uncommon winter migrant in the temperate cloud forest and lowland secondary forests.

*Burrowing Owl* (*Speotyto cunicularia*). An uncommon winter migrant in the park. Burrowing Owls were observed in open areas such as agricultural fields and high montane grasslands at 1800 m.

*Stygian Owl* (*Asio stygius*). An uncommon resident in the subtropical montane forest. Observed in mature forests, at forest edges, and in exotic *Eucalyptus* woodlands, at 700 m elevation. A single individual was observed in the montane chaco near the park.

*Short-eared Owl* (*Asio flammeus*). Observed once in secondary forests in the park at 700 m. Short-eared Owls are uncommon in the foothills and clearings near the park.

*Buff-fronted Owl* (*Aegolius harrisi*). A common resident species in the subtropical montane and *Alnus* and *Podocarpus* cloud forests; recorded between 900 and 1600 m.

## DISCUSSION

The four most abundant raptor species in the Sierra de San Javier Biological Park (in order of abundance, Black Vulture, Roadside Hawk, Turkey Vulture, and Crested Caracara) are residents that use all main habitats in the park and are widely distributed in South America. Most of them are scavengers, the prevailing functional group in all habitats. Several other species (e.g., White-tailed Kite, Red-backed Hawk, American Kestrel, and Burrowing Owl), occasionally seen in the park, preferred clearings, secondary forests, and pastures, just outside the Park boundaries. These species also were present in the park's *Festuca* grasslands.

Several species from wet forests, such as Bicolored Hawk, Great Black Hawk, Barred Forest-Falcon, Stygian Owl and Buff-fronted Owl, were rarely, if ever, recorded in the other habitats sampled. Most of these species are carnivores, the most speciose functional group in the park. Species composition changed less seasonally in forested than in grassland areas. Without taking in account the occasional record of the Andean Condor, the grassland wet season assemblage was characterized by few widely distributed species, whereas the dry season assemblage was defined by the presence of winter migrants (i.e., Cinereus Harrier, Red-backed Hawk and Black-chested Buzzard-Eagle).

The main habitat found in the park, the subtropical montane forest, was the most

thoroughly sampled; as a consequence, the species list of the humid forest is better documented (Vides Almonacid 1991, 1992; N.P. Giannini pers. com.; P.G. Blendinger & P. Capllonch pers. observ.). The other habitats were less intensively covered and other raptors could be recorded there in the future, mainly in the xerophytic woodland. Some species are probably more widely distributed in the park than our data suggest. For example, Vides Almonacid (1992) observed Tucuman Pigmy Owls in all forested areas and Barred Forest-Falcon, in both *Podocarpus* and *Alnus* forests. In addition, Burrowing and Tucuman Pigmy owls are common year round in areas outside the park. Our sightings, however, include 27 of the 31 species recorded for the park. The following species were not seen: Swallow-tailed Kite (*Elanoides forficatus*) (Vides Almonacid 1989), Hook-billed Kite (*Chondrobierax uncinatus*) (IML Collection; Vides Almonacid 1989, 1992), Crowned Eagle (*Harpyhaliaetus coronatus*) (Budín 1976), and White-rumped Hawk (*Buteo leucorrhous*) (IML Collection).

Nineteen species regularly use the park forests, provided that occasional (Andean Condor, Crowned Eagle, Sharp-shinned Hawk, Swallow-tailed Kite, Bat Falcon and Short-eared Owl) and open-area species (White-tailed Kite, Cinereus Harrier, Red-backed Hawk, American Kestrel, Chimango Caracara and Burrowing Owl) are not included. We did not record two (White-rumped Hawk and Hook-billed Kite) of these 19 forest species. The White-rumped Hawk was recently recorded in the *Podocarpus* forests of the park (N.P. Giannini pers. com.); additionally, three (one male, two female) specimens collected in the park between 1901 and 1930 are preserved in the IML Collection. The presence of Hook-billed Kites in the park was documented by Vides Almonacid (pers. com.) and by two (one male, one female) specimens in the IML Collection, col-

lected between 1960 and 1970. According to Olrog (1985), populations of both species seem to have decreased in wet forests of northwestern Argentina between 1960 and 1980, presumably because of extensive deforestation. Hook-billed Kites tend to use primary forests in French Guiana (Jullien & Thiollay 1996), although they also occurred in forest edges and slight fragmented forest. As the Sierra de San Javier forests are becoming increasingly isolated from the remaining montane forests, it is expected that some more sensitive species might disappear from the area (Vides Almonacid 1991). Of the forests surrounding the Sierra de San Javier, one third was foothill forest, which has been completely replaced by croplands and human settlements with a population larger than 500,000 habitants. On the remaining borders of the park, continuous deforestation and replacement of forested areas by agriculture and the advance of urbanization contribute to isolate the forests of the park from others forested areas. It has been suggested that some tropical forest raptors, including the Hook-billed Kite, are susceptible to habitat fragmentation (Whitacre *et al.* 1991, Alvarez-López & Kattan 1995, Jullien & Thiollay 1996). The paucity of records for the White-rumped Hawk and the Hook-billed Kite for the last 30 years in the Sierra de San Javier, coupled with the possible effect of forest degradation and progressive isolation of the park's habitats, suggests that both species might be highly susceptible to local extinction.

Three additional species, Bicolored Hawk, Short-tailed Hawk and Stygian Owl, were considered by Vides Almonacid (1989) to be in danger of local or regional extirpation. However, there is not enough historical information to establish trends in their population levels. These species are residents of the subtropical montane forest, are present in the montane chaco, and have been recorded in

clearings and plantations of *Eucalyptus* and *Pinus* outside the protected area, mostly during the winter. Thus, we predict that these species might be more abundant than suggested by Vides Almonacid (1989). Jullien & Thiollay (1996) found that the Bicolored Hawk was restricted to continuous and little disturbed primary forest in tropical rain forests. However, in subtropical montane forests of NW Argentina, we often saw Bicolored Hawks perching or chasing small birds in forest-edges and logged forests, soaring or flying high over the canopy, or crossing wide gaps in fragmented forests. Year round presence of Bicolored Hawks, Short-tailed Hawks and Stygian Owls in the park and their use of disturbed habitats are possible indications of their plasticity and ability to tolerate partial habitat modifications.

Because of their large area requirements and trophic specialization, raptors have been proposed as indicator species of habitat quality. It is thought that an area of habitat sufficient to maintain a viable population of all members of a raptor assemblage should be large enough to maintain many other species as well. Most species with narrow habitat preferences can be considered as potential indicators for monitoring ecological changes in biotic communities (Jullien & Thiollay 1996). In the Sierra de Jan Javier, a more complete study is needed to determine which species would be most useful as indicators. We proposed that King Vultures, Short-tailed Hawks, Barred Forest-Falcons, and Buff-fronted Owls could be used as indicators of undisturbed subtropical montane forest conditions. The Short-tailed Hawk was proposed to serve as an indicator species of undisturbed forests in southeastern Brazil (Albuquerque 1995) although, for northwestern Argentina, the presence or absence of this species does not seem to provide enough evidence of forest suitability for wildlife. On the other hand, White-tailed Kites, Chimango Caracaras,

American Kestrels, and Burrowing Owls are possible indicator species of a high degree of modification of forested habitats in the Sierra de San Javier. All eight species are regularly present in their preferred habitats, contributing to their potential use as indicator species.

#### ACKNOWLEDGMENTS

We are grateful to Janet Braun, Rubén Barquez and David Whitacre whose comments and criticisms improved an early draft of the manuscript. We thank Raymond McNeil and two anonymous reviewers for their valuable comments on the manuscript, and to Roberto Vides Almonacid, who provided us with valuable information. Thanks to Alfredo Grau and Ana Levy for the pictures of the montane chaco and mountain forest.

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