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# LONG-TERM CHANGES OF RAPTOR POPULATIONS IN NORTHERN CAMEROON

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ABSTRACT.—Comparative mid-dry-season counts of diurnal raptors (42 species) were performed in similar conditions along nine road transects (total = 1359 km) in 1973 and 2000 in representative areas of northern Cameroon to assess changes in abundance of species over the last three decades. The transects covered Sudanian and southern Sahelian woodlands, savannas, cultivated areas, and wetlands. Additionally, in 2000, three protected woodlands and one new artificial wetland were censused to document the raptor community of these habitats.

All four broad categories of raptors (vultures, other resident species, Afrotropical, and Palearctic migrants) exhibited a decline in numbers, and only two species increased significantly, against 14 which decreased and 24 which did not show population changes. Overall, vultures declined by 67%, notably the formerly abundant Hooded (*Necrosyrtes monachus*) and White-backed (*Gyps africanus)* Vultures and Rüppell's Griffons (*Gyps rueppellii*). Their decrease was striking in every habitat and area. All large eagles (seven residents and three Palearctic migrants) also decreased significantly (83%). Only the two smaller migratory Wahlberg's (*Aquila wahlbergi*) and Booted Eagles (*Hieraaetus pennatus*) remained fairly stable or increased. Nine of the 11 smaller African residents did not change markedly; only the Black-shouldered Kite (*Elanus caeruleus*) increased three-fold and the Dark Chanting Goshawk (*Melierax metabates*) decreased significantly (62%). The five medium-size African migrants either decreased or increased, but not significantly, especially when differences in ecological conditions between years were taken into account. Among nine Palearctic migrants, kestrels decreased dramatically, whereas harriers remained at least stable. The new Maga Lake and associated rice fields were decidedly poorer in most Palearctic migrants than were the former natural humid grasslands which they replaced. Habitat modification due to the rapidly increasing human pressure explained most changes. However, the collapse of vulture populations cannot be accounted for by these changes or by persecution.

KEY WORDS: *Raptors; population changes; savanna; Cameroon.*

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Cambios poblacionales de rapaces a largo plazo en el norte de Camerún

RESÚMEN.—Comparamos los conteos de rapaces diurnas a mediados de la estación seca (42 especies) los cuales fueron realizados en condiciones similares a lo largo de nueve transectos de carretera (total = 1.359 km) en 1973 y en el 2000; en áreas representativas del norte de Camerún, con el fin de evaluar los cambios de abundancia de las especies en las ultimas tres décadas. Los transectos cubrían bosques sudaneses y sur–sahelianos, sabanas, áreas cultivadas y humedales. Adicionalmente en el 2000, se hicieron censos en bosques perturbados protegidos y en un nuevo humedal artificial con el fin de documentar la comunidad de aves rapaces de estos hábitats. Las cuatro categorías de rapaces (buitres, otras especies residentes y las migratorias afrotropicales y palearcticas) mostraron una disminución en sus números, solo dos especies tuvieron un incremento significativo en contraposición de las 14 que disminuyeron y 24 que no mostraron cambios de población. En general los buitres disminuyeron en un 67%, de los cuales sobresalen notablemente los anteriormente abundantes *Necrosyrtes monachus, Gyps rueppellii.* Su disminución fue alarmante en cada área de hábitat. Todas las grandes águilas (siete residentes y tres migratorias palearcticas) también disminuyeron significativamente (83%). Solo dos pequeñas rapaces migratorias *Aquila wahlbergi* y *Hieraaetus pennatus* permanecieron estables o aumentaron.

Nueve de la 11 especies residentes africanas no cambiaron significativamente; solo *Elanus caeruleus* incrementó tres veces mientras que *Melierax metabates* disminuyó significativamente (62%). Las cinco migratorias africanas de tamaño mediano disminuyeron o aumentaron pero no en forma drástica, especialmente cuando las diferencias en las condiciones ecológicas entre años fueron tenidas en cuenta. Entre las nueve migratorias palearcticas, los cernícalos disminuyeron dramáticamente, mientras que los aguiluchos permanecieron por lo menos estables. La nueva represa Maga y los cultivos asociados de arroz fueron definitivamente mas pobres (en cuanto a migratorias palearticas respecta), que los pastizales húmedos que reemplazaron. La modificación de hábitats debido al rápido aumento de la presión humana explica la mayoría de los cambios. Sin embargo el colapso de las poblaciones de buitres no puede ser atribuido a estos cambios o a la persecución humana.

[Traducción de César Márquez]

Raptors are usually conspicuous, at the top of food chains and sensitive to contaminants and disturbance (Newton 1979). They have often substantial ecological requirements in terms of foraging habitats, nest sites, and abundance, or diversity of food resources. Therefore, they may be suitable indicators of the quality of ecosystems, e.g., large scale degradation, changes in land use, or insidious environmental contamination. When such changes come from climate change or human population growth, they may occur slowly and become apparent after long periods of time. Long-term monitoring of raptor communities is rare in Africa (Thiollay 1998) or involves only eagles (Brown 1952, 1955, Gargett 1990). I had the opportunity to do extensive raptor surveys at a 27-yr interval in an area of West Africa where substantial landscape changes occurred under a combination of human population growth and large-scale development programs. Such an evolution is common to many tropical countries and these results may be indicative of a widespread situation. The aim of this study was to assess the long-term changes, or stability, in abundance of diurnal raptors (Falconiformes), both African species and Eurasian migrants, along the same transects recensused in similar conditions (observer, methods, season) nearly three decades after the first survey. The area harbored a rich raptor community and was an important wintering zone for Palearctic species (Thiollay 1978a). These broad counts over large areas (6036 raptors on 2636 km) give a general picture likely to be representative of regional trends, but they do not provide information about mechanisms and underlying factors involved such as habitat changes, shifts in habitat selection, or dynamic of local populations.

## STUDY AREA

During the last 30 years, i.e., between our two censuses, the human population of Cameroon has tripled, from about 5 to 15 million. The northern part of the country has always been the most densely populated and, as a result, a region with a high deforestation rate and the highest proportion of cultivated lands (Encyclopaedia Universalis 1974, Encyclopaedia Britannica 1998). Deforestation data are inaccurate for northern Cameroon because the natural vegetation is not moist forest but open canopy deciduous woodlands that are often heavily degraded rather than cleared, and cultivated areas may retain numerous large trees (WCMC 1994, Igemonger et al. 1997).

The study area extends across the transition from the Sudanian to the Sahelian woodlands (9°10–11°30′N), along a south-north gradient of decreasing annual rainfall (900–700 mm). Accordingly, the length of the rainy season decreases from May–October to July–September Mean annual temperature reaches 28°C, the hottest months being March–May and the lowest mean temperatures in January ranging 19–13°C from south to north.

The main vegetation zones (see Letouzey 1968, Louette 1981) include the Benue river plains in the south, the Mandara mountains along Nigeria (northernmost extension of the Cameroon mountains ridge, highest peak = 1442 m), the Sahel in the central northern part and the inundation zone of the Logone river along the Chad border (Fig. 1). The southwestern corner of our study area (west and north of Garoua, mostly transect A, Fig. 1) was the northernmost extension of the rather dense, now fragmented, Sudanian woodlands. Elsewhere, the first three protected areas surveyed (see below) were the only significant, forest-like patches within a mostly cultivated landscape.

Cultivated areas are now a dominant feature of most

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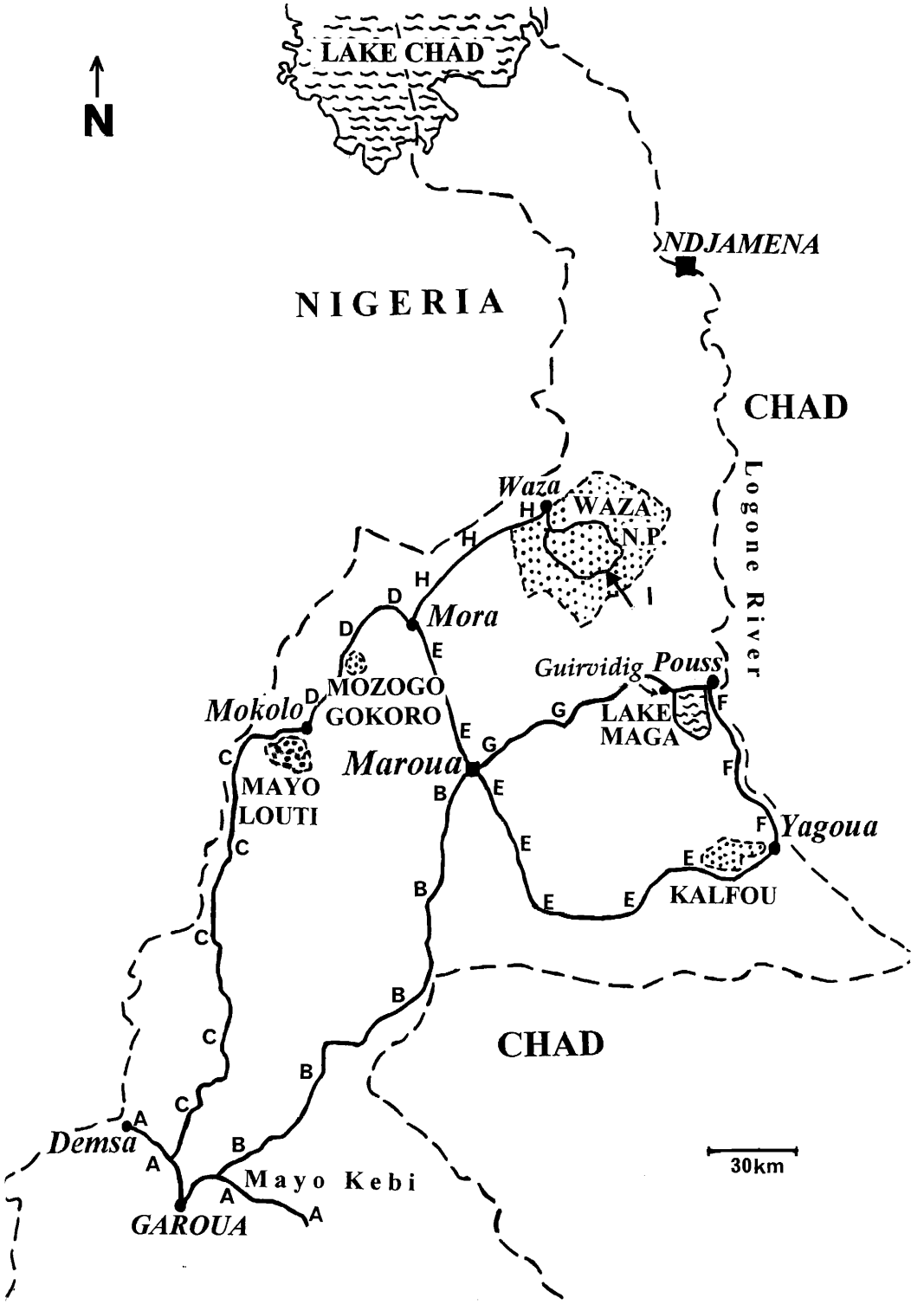
Figure 1. Road counts and survey areas in northern Cameroon. Dashed lines are international borders, black dots are main towns and dotted areas are protected areas surveyed. Solid lines are roads where raptor counts have been done and letters along them refer to the transect identification (see Study Area and Appendix).


N
LAKE CHAD
NDJAMENA
NIGERIA
CHAD
Logone River
Waza
WAZA N.P.
Mora
MOZOGO
GOKORO
Mokolo
MAYO LOUTI
Maroua
Guirvidig
Pouss
LAKE MAGA
Yagoua
KALFOU
CHAD
Demsa
Mayo Kebi
GAROUA
30km

landscapes. Main crops are millet (rainy season), cotton, sorghum (dry season in wet lowlands) and locally maize or onions (irrigated). Traditional fields are dotted with isolated trees (e.g., *Adansonia, Bombax, Butyrospermum, Khaya, Acacia*), often regularly pruned for fodder. Trees tend to disappear from large cropland plantations (cotton, sorghum). The original vegetation was dry woodland, so-called savanna woodland because of its high grass cover, dominated by broadleaf trees in the Sudanian zone and thorny *Acacia* or *Balanites* in the Sahel. Natural woodlands are now much reduced, fragmented, and severely degraded by fires, cattle grazing, and wood cutting, even in protected areas. Additionally, hunting pressure has largely depleted, if not eliminated, large and medium size wild mammals, and game birds to a lesser extent (Ground Hornbill [*Bucorvus abyssinicus*], bustards [*Eupodotis* sp. and *Neotis* sp.], Guineafowl [*Numida meleagris*]).

**Road Transects** (see Fig. 1). (A) Garoua area. From the main town of Garoua (9°18′N–13°24′E), two tracts were censused, twice each, by vehicle and by foot: to the northwest (Gashiga–Demsa) a hilly area with cliffs, disturbed Sudanian woodlands and millet-cotton fields, and to the east (Pitoa-Mayo Kebi), a plain whose former seasonally flooded zones are now mostly cultivated (sorghum) and where the last shallow wetlands are overgrazed by cattle.

(B) Garoua–Maroua (10°36′N–14°20′E): flat or hilly degraded savanna woodlands, fragmented by many fields and villages.

(C) Garoua–Rhumsiki–Mokolo. From the Benue Plain, the dirt road enters the Mandara Mountains up to 800–900 m, through valleys and plateaus that are densely cultivated with few remaining patches of woodlands. Only the numerous *Isoberlinia* seedlings in fallow fields suggest that the area must have been covered with Sudanian dry forest. Between Rhumsiki and Mogodé, the picturesque volcanic plateau landscape of Kapsiki is dominated by isolated rocky towers, but is otherwise densely cultivated.

(D) Mokolo (10°45′N–13°48′E)–Koza–Mora (11° 03′N–14°09′E). From the northeastern rocky slopes and terraced fields of the Mandara Mountains, down to the Sahelian Plain of the lower Logone Catchment. The few non-cultivated areas are lightly wooded, grazed, and represent degraded *Acacia* savanna (with *Guiera, Commiphora* or *Salvadora* bushes).

(E) Mora–Maroua–Lara–Yagoua (10°20′N–15°14′E). Patches of northern Sudanian dry woodlands remain within a largely cultivated plain, dominated by occasional rocky outcrops (Mindif).

(F) Yagoua–Pouss (10°51′N–15°03′E)–Guirvidig. This area changed drastically between the two surveys. The track follows the River Logone along which former seasonally inundated grasslands (yaérés) are now densely populated and almost completely cultivated (rice) after an embankment had been built all along the river to prevent floods. A large dam has also turned the lowest part into Lake Maga. Palm stands (*Borassus, Hyphaene*) around villages are a typical feature of the landscape.

(G) Maroua–Bogo–Guirvidig (10°53′N–14°50′E). Sahelo-Sudanian savanna woodland, degraded, grazed, and now mostly cultivated. The first half was artificially reforested (exotic trees) in the 1980s.

(H) Mora–Waza (11°25′N–13°34′E). Cultivated fields were still the dominant habitat along the first half of this road transect, these fields then gave way to the woodland of the Waza National Park fringes and finally to the treeless inundation zone, south-west of the village of Waza, where an additional foot sample transect was done. Pools along the paved road probably attracted some raptors.

(I) Waza National Park. This 170 000 ha protected area was formerly one of the richest in West Africa for large mammals, and also for raptors (Thiollay 1978a). The building of a dam and dikes, to canalize the Logone floods, dramatically changed the vegetation of the former grasslands (yaérés) in the early 1980s, resulting in a crash of the ungulate populations. Later on, the seasonal flooding was partly restored, thereby improving the ecological situation. However, the adjacent *Acacia seyal* woodlands and little flooded plains were overgrown by an unpalatable spiny annual plant (*Monecma ciliata*) that further impoverished both mammal and bird populations. Following good rains, pools were still numerous in February 2000 all over the park, contrary to the drought that affected the area in 1973.

**Protected Areas.** Mayo Louti Forest Reserve (10°42′N–13°44′E), between Mogodé and Mokolo, is the last forested remnant of significant size (about 3000 ha) on the Kapsiki Plateau (800–850 m) in the Mandara Mountains It is a dry Sudanian broad leaved woodland (including *Isoberlinia, Piliostigma, Parkia, Combretum, Cussonia*) with few *Acacia* (but many *Balanites*). The area is entirely grazed by cattle and regularly burned. Rocky outcrops and a sandy riverbed lined with large trees (*Khaya, Bombax*) provide additional habitat diversity and nest sites for eagles. During the survey (20–22 January 2000) 112 non-raptor bird species were identified.

The 1400 ha Mozogo-Gokoro National Park (10°58′N–13°55′E), between Koza and Mora, is a dense sahelian forest isolated within largely-cultivated areas of the densely-inhabited northern plain (≤ 400 m). It is crossed by the dry sandy bed of a river. *Acacia, Erythrina,* and *Balanites* are dominant trees with a few scattered sudanian trees. Temporary pools become grassy sites in the dry season. Poaching and woodcutting probably have negative impacts. During the survey (23–25 January 2000), 94 non-raptor bird species were also found.

Kalfou-Yagoua forest reserve (10°20′N–15°14′E) is a 4000 ha disturbed sudano-sahelian woodland in the low plain of the Logone (300 m), and is also completely surrounded by cultivated areas and severely affected by woodcutting and cattle grazing throughout. Numerous flowering *Erythrina* trees and grassy dry pools ringed by *Acacia seyal* woodlands were typical features of the landscape. During the survey (29–31 January 2000), 104 non-raptor bird species were recorded.

The Lake Maga area (10°50′N–15°00′E), formerly a grassy inundation zone, has been turned, since 1979–80, into a large artificial lake providing water for 12 000 ha of irrigated rice fields where reed beds (*Typha*) and bushes (*Acacia, Mitragyna*) along ditches are the only wild vegetation, together with some grassy fallow areas and palms around villages. Most fields were dry and harvested in February. The lake itself (13 000 ha) has a continuous belt of *Typha* or locally *Acacia,* except along the 22 km earth dam wall.

## METHODS

Daily raptor counts were performed along the main dirt and tarred roads of northern Cameroon from 1–20 February 1973 and from 17 January–6 February 2000. Additional counts in April 1973 and September 1975 were only referred to for the presence of additional wet-season migrants. In 2000, four specific areas, not previously investigated, were surveyed because they had been tentatively identified as potential Important Bird Areas to be included in the African network being designed by Birdlife International (M. Languy pers. comm.). All counts took place in the middle of the dry season, which extends from October to May. At that time, the level of the water courses was already low, pools were beginning to dry, most trees were losing their leaves, many *Acacia* trees were flowering, the grass cover was at its minimum, millet fields were bare, whereas cotton was being harvested and sorghum was still green and ripening. However, the two years were different: 1973 followed one of the lowest rainy seasons on record, while 2000 came after an above-average rainy season. So, there was more green vegetation, more water available (especially pools) and probably more insects and rodents in 2000 than in 1973.

**Roadside Counts.** Counting raptors from a vehicle along roads is a widespread method (Johnson 1978, Fuller and Mosher 1981, Bibby et al. 1992). It provides an abundance index that is sensitive to the behavior of the species involved, the habitat, speed of the vehicle, meteorological conditions, hour, season, and number and experience of observers. It allows one to cover large areas and to record a significant number of individuals, but it affords little comparability between species where their detectability may be different. Intraspecific comparisons, however, can be made between years because of the similarity of observer, season, and method. Local differences in habitats between the two periods (e.g., more cultivation) were in fact a critical component of the changes to be assessed.

All individuals seen perched or flying within <1 km on either side of the road were counted. Two experienced observers, always including the author, looked carefully for raptors when driving slowly (<50 km/h on average) and during frequent stops, from after sunrise to before sunset, avoiding cloudy, windy, or cool weather. The time spent on any transect and year was always ≥3 hr/100 km. Binoculars (10 × 42) were used during stops to search for birds systematically. The length of each transect was measured by the vehicle odometer. Village crossings were included, but not urban areas >1 km wide. All abundances were expressed in birds/100 km. Several transects (A, G, H) or part of them (D, I) were each censused twice in both years, on different days and/or hours, using the maximum number of birds of each species in either count. The minor and unavoidable sources of variation between years that may have been due to differences in conditions (hours, weather, time spent) on some road segments were minimized, counterbalanced between areas and averaged over such long distances. Therefore, I was reasonably confident that overall numbers of raptors recorded were representative and comparable between years.

**Local Surveys.** The censuses performed in 4 additional areas in 2000 were used to assess the local abundance of raptors in particular habitats, but not for comparisons with any roadside counts. They cannot be used as density estimates because areas were unequally surveyed and individual raptors also ranged outside the limits of these areas. Three protected forest reserves (see study areas) were surveyed by foot, during 3 days each. Slow, full-day walks covered all their main areas with multiple stops in all large gaps and vantage points to search for flying birds. The time was too short to detect every pair of raptors, let alone to estimate actual densities. So, the abundance index used (Table 2) was the maximum number of most likely different individuals of each species seen within any single day.

The last area, Lake Maga, included the reservoir, its reed belt, and associated large irrigated fields. The lake itself was censused by boat, moving along the swampy shores and by walking and searching around three bays of the lake. Careful searches of raptors were also done along >50 kilometers of line transects by vehicle, at slow speeds, on dikes and along ditches through two different areas of the rice fields, with frequent stops. Because habitats and surveys were distinct, I summed the minimum number of different individuals of each species seen in each zone. A few double counts could not be ruled out, but, on the other hand, many birds were probably missed. As a result, the figures obtained are likely to be conservative estimates of the overall number of migrants wintering in the region.

**Data Analysis.** To allow for comparison between transects, the number of birds recorded was expressed as the mean per 100 km (Table 1). Even when it was counted twice, each yearly transect gave a single value. Thus, there was no possibility to assess statistically the between-year difference within each transect separately. Therefore, I used for each species a nonparametric Wilcoxon signed-ranks test over all matched pairs of counts to assess the global between-year difference expressed in the last column of Table 1 by the sum of individuals seen over all transects (Siegel and Castellan 1988). Actual numbers that were recorded on each transect were used for computing the Wilcoxon test except for transect I, where mean values/100 km were used because of unequal transect length between years.

## RESULTS

Forty-one species of diurnal raptors were identified during these counts (Table 2 and Appendix), but only seven of them were seen, at least one year, on all nine transects and 16 other species on 5–8 transects. Several species were also recorded outside the actual counts. The Eurasian Honey-buzzard (*Pernis apivorus*) and Hobby (*Falco subbuteo*) were only Palearctic passage migrants observed in April–September 1973–75. Some Lesser Spotted Eagles (*Aquila pomarina*) in 1973, were misidentified (from photographs reexamined) and none were recognized in recent surveys. One Levant Sparrowhawk (*Accipiter brevipes*) was tentatively identified at Waza and 2 Ovampo Sparrowhawks (*Accipiter ovampensis*) near Yagoua in 2000. The

Table 1. General trends in raptor populations, from similar dry-season roadside counts in northern Cameroon conducted at a 27-yr interval. See Appendix for specific data.

| | No. of Individuals Recorded | | No. of Species | | |
|---|---|---|---|---|---|
| | 1973 | 2000 | Increasing (*) | Decreasing (*) | Not Significant |
| Vultures (resident) | 1300 | 433 | 0 | 3 | 3 |
| Other resident species[a] | 526 | 323 | 1 | 6 | 11 |
| Afrotropical migrants | 1562 | 981 | 0 | 1 | 4 |
| Palearctic migrants[b] | 571 | 340 | 1 | 4 | 6 |

[a] From large eagles to small falcons, including Red-necked Buzzard.

[b] No Black Kite, Egyptian Vulture, or Peregrine Falcon was included. Also includes Lesser Kestrel, together with Common Kestrel.

* at $< 0.10$ level.

Beaudouin's Snake-Eagle (*Circaetus beaudouini*), an African wet season migrant, was positively identified in the Waza grasslands only in April 1973. The Western Banded Snake-eagle (*Circaetus cinerascens*), a riparian forest specialist, was seen on a nearby transect in 1973 and possibly in Mozogo forest reserve in 2000. Other African migrants (Shikra, Grasshopper, and Red-necked Buzzards) were more abundant in the 1973–75 wet seasons than they were in February of either year because most of their populations spend the dry season at more southern latitudes (Thiollay 1978b).

Species were grouped into categories according to their taxonomy and the similarity of their population trends between years as suggested by comparative road counts (See Appendix and Table 1).

All together, vultures declined by 67% over all counts. The three uncommon species, Egyptian, Lappet-faced, and White-headed Vultures were too rare and local for any significant trend to stand out. Moreover, Egyptian Vultures may have included unknown proportions of both local breeding birds and European migrants. Conversely, the mostly urban Hooded Vulture and the widespread White-backed Vulture and Rüppell's Griffon declined, respectively, by 67, 60, and 87%. This was further confirmed by the lack, or small number, of vultures seen around carcasses occasionally encountered. An even more striking evidence was the much lower number of Hooded Vultures recorded during stops in villages and towns (outside road counts) between 1973 and 2000, often by an order of magnitude. In the Waza National Park, a stronghold of vultures, but where ungulates decreased dramatically after 1980, I counted 141 vultures on 158 km (89/100 km) in late January 2000, compared to 395 on 240 km (165/100 km) in early February 1973 and 1257 on 334 km (376/100 km) in April 1973 during a severe drought (i.e., abundance of carcasses). The seven large resident eagles (Fish-, Brown Snake-, Bateleur, Tawny, Hawk-, Martial and Long-crested Eagles) all declined significantly (83%, $P = 0.025$). Only the smaller Wahlberg's Eagle remained stable.

For 9 of the 11 smaller African resident species, there was no significant change between years, or at least their sample size was too small for any conclusive evidence: Lizard Buzzard (here on the northern edge of its distribution), Harrier-hawk (also at its northern dry-season limit), Gabar Goshawk (secretive, but still fairly common), Red-necked Buzzard (a migrant, rare elsewhere in the Sudanian zone during the dry season, Thiollay 1978b), Fox Kestrel (highest known population is in the Mandara Mountains, Thiollay 1977), Grey Kestrel (inconspicuous, local species), Red-necked and Lanner Falcons (bird predators often associated with palms and cliffs respectively as nesting sites) and Peregrine Falcons (including both the local breeding, *F. p. minor,* and the Palearctic wintering, *F. p. calidus,* subspecies).

The three-fold overall increase of Black-shouldered Kites in 2000 may have been explained by an increased area under intensive cultivation, to which the species is well adapted, but also, perhaps, by an increasing availability of rodents, following a much better rainy season than in 1973. The significant decrease (62%) of the Dark Chanting Goshawk, a generalist predator of small terrestrial vertebrates, may be an indicator of the general prey impoverishment of heavily exploited and degraded natural habitats.

Table 2. Raptor surveys of specific areas in 2000. The first three columns are forest reserve where the maximum number of different individuals seen within any full-day spent walking through the reserve is given. Maga includes both the lake and the extended rice fields to the north. Here, the total number of birds seen in the whole area is given (see Methods).

| | MAYO LOUTI | MOZOGO GOKORO | KALFOU YAGOUA | LAKE MAGA |
|---|---|---|---|---|
| Osprey** | | | | 5 |
| Black-shouldered Kite | | 1 | 2 | 21 |
| African Swallow-tailed Kite* | | 1 | 4 | 12 |
| Black Kite* | 2 | | 4 | 150 |
| African Fish Eagle | | | | 1 |
| Hooded Vulture | 1 | 1 | 1 | 67 |
| African White-backed Vulture | | | | 26 |
| Short-toed Snake-eagle** | | | 1 | 1 |
| Brown Snake-eagle | 2 | 1 | 2 | 1 |
| Bateleur | 1 | | | |
| Western Marsh Harrier** | | | | 258 |
| Pallid Harrier** | | | | 3 |
| Montagu's Harrier** | 1 | | 2 | 37 |
| African Harrier-hawk | | 1 | | |
| Lizard Buzzard | | 3 | | |
| Dark Chanting Goshawk | 3 | 1 | 6 | 11 |
| Gabar Goshawk | 1 | 2 | 5 | 3 |
| Shikra* | 2 | 3 | | |
| Grasshopper Buzzard* | | 1 | 8 | 3 |
| Long-legged Buzzard** | | | | 3 |
| Red-necked Buzzard* | 1 | | | |
| Greater Spotted Eagle** | | | | 2 |
| Tawny Eagle | 1 | | | |
| Steppe Eagle** | | | | 4 |
| Wahlberg's Eagle* | 1 | 2 | 2 | 1 |
| African Hawk-Eagle | 2 | | | |
| Booted Eagle** | | 1 | 1 | 9 |
| Martial Eagle | | | 1 | |
| Long-crested Eagle | 1 | | | |
| Common Kestrel** | 1 | | 2 | 1 |
| Lesser Kestrel** | | | 1 | |
| Fox Kestrel | 1 | | | |
| Grey Kestrel | 2 | 1 | | |
| Red-necked Falcon | | 2 | 2 | 5 |
| Lanner Falcon | 1 | 2 | 2 | 1 |

* African migrants.
** Palearctic migrants.

The main African migrants either decreased (Black Kite and Swallow-tailed Kite) or increased (Shikra, Grasshopper Buzzard) by about 40–50%, but the trend was significant only for the Black Kite. The differences in rainfall between years may have resulted in different proportions of the populations staying in February at this northern edge of their dry-season range (Thiollay 1978b). Such shifts may obscure any change in population size. Moreover, most Black Kites were of the African subspecies (*M. m. parasitus*), but a small, albeit unknown, proportion of them were Palearctic wintering birds, *M. m. migrans* (at least 7% in 1973).

Among the Palearctic migrants, the Short-toed Snake-eagle and the Steppe Eagles decreased significantly (84%, Table 1), and probably also the

Greater Spotted Eagle and the Long-legged Buzzard, whose numbers were too low for the trend to be significant. The Common + Lesser Kestrel complex, formerly widespread and easy to see, declined even more strongly (92%). The actual proportion of Lesser Kestrels and of African residents vs. Palearctic migrants among Common Kestrels could not be determined, for a lack of time to look carefully at every individual. In 1973, a sample of 80 birds well identified included at least 18 *F. naumanni,* 4 *F. t. rufescens,* and 58 *F. t. tinnunculus.* From occasional sightings in 2000, there was no evidence that the locally breeding *rufescens* (always uncommon) had declined, nor that the proportion of Lesser Kestrels had changed. So, most of the decline was ascribable to the European birds. The Saker Falcon is too rare a migrant to show a significant trend.

Surprisingly, the Booted Eagle increased strikingly (314%), although numbers were low. The harriers altogether increased by 69%, but, species by species, not significantly ($P = 0.182$). These wintering birds tended to use specific habitats: western Marsh Harrier in wetlands, Montagu's Harrier in humid lowlands and plateaus, Pallid Harrier in drier grasslands, and Booted Eagle often in hilly and rocky, cultivated, or open woodlands. Yet, they all may have benefited from the consequences of better rains in 2000 than in 1973, on prey availability (large insects and small vertebrates). This would further emphasize the decline of Common and/or Lesser Kestrels, which should have also been favored by these improved conditions. Therefore, the massive population decrease is more likely to have occurred on the kestrels' breeding grounds.

**Other Surveys.** The three forest reserves studied (Mayo Louti, Mozogo, and Kalfou; Table 2) are the only protected areas between the latitudes of Garoua and Waza (225 km) and the last significant patches of woodlands in that part of northern Cameroon. So, they should be representative of a formerly widespread raptor community. They included not only forest, but patches of open woodlands, grasslands, seasonal wetlands, and some cultivated areas.

In these areas, however, only 27 raptor species were recorded (64% of the regional pool). Only six of them were seen in all three reserves and 17 were found in a single site. The species abundance distribution matches that of roadside counts. Especially striking was the lack of vultures, except an occasional Hooded Vulture coming from a nearby village, and also the rarity of eagles, except the Brown Snake-eagle and the smaller Wahlberg's and Booted Eagles. Both vultures and eagles are conspicuous birds that could not be missed. The low number of kites, harriers, and kestrels may be due to unsuitable habitats for species mostly associated with fields or large grasslands. The abundance of Chanting, and Gabar Goshawks, Shikras, Rednecked, and Lanner Falcons was indicative of still healthy populations, as already suggested by road counts.

It was interesting to see how raptors were using the lake Maga area, a new, artificial wetland, intensively cultivated. During a survey of about two-thirds of the lakeshores, river banks, villages and irrigated fields, at least 625 individuals of 23 species were counted, including eight species not recorded in any forest reserve. However, 61% of the species and 78% of all individuals were either European (10) or African (4) migrants, 41% of which were Marsh Harriers. In 1973, when the area was still covered with seasonally inundated grasslands, I did only a linear transect through the area and not a census. Yet, along this transect (F in Appendix), the number of species recorded in 2000 had decreased by 38% and the total number of raptors by 65%. This supported the impression that the new habitat was decidedly poorer and less suitable for many species than the former natural grasslands. While harriers and a few uncommon species remained stable, the vulture numbers declined from 360 to 101, large eagles from 130 to 8, kestrels from 131 to 0 and even kites (except the black-shouldered) from 765 to 291. Although external factors may be partly responsible, habitat degradation must be involved in these dramatic declines, through prey reduction, either large insects (kestrels, kites), large mammals (vultures) or smaller vertebrates (eagles). A lack of large trees around the lake may explain the rarity of the Fish Eagle, in spite of the introduction of fishes (*Tilapia*).

## DISCUSSION

We must be cautious in interpreting such counts in terms of population dynamics. Roadside count data are highly sensitive not only to weather, visibility, hour and season, but also to number, experience or attentiveness of observers, and to speed, type of vehicle, and frequency of stops. However, in several respects, the counts of 2000 were done under better conditions than in 1973, which may suggest the magnitude of the decline as more se-

vere than indicated by the data. Additionally, in 1973, because of the drought, both Afrotropical and Palearctic migrants may have shifted their dry season ranges southward (Thiollay 1977, 1978a) and the breeding success of some resident species may have been reduced, except for the vultures. Therefore, the density of a number of taxa in the study area was likely to be lower than usual in 1973.

It is delicate to infer a general trend from only two points along such a time period without intermediate data. Nevertheless, most changes in raptor populations recorded in 2000 were consistent with what was expected from the general modification of ecosystems during the past decades. Even if many specific results were not significant because of low sample size and variability between transects, the overall picture (Table 1) is that of a net decrease in raw numbers in all four broad categories, with only two species increasing, against 14 species decreasing and 24 species apparently stable.

**Habitat Changes.** There are no accurate regional data about the modification of vegetation cover or areas under cultivation. From the comparison of my descriptions of habitats along road transects, from the huge increase in human population size, and from the observed current pressure on natural resources, trends toward ecosystem impoverishment were all too obvious. Not only has much of the forest been cleared during recent decades, but most remaining woodlands were heavily degraded by widespread firewood cutting and charcoal production. The area under cultivation had increased locally, but also there were more areas, previously under a system of long fallows, that were now under permanent cultivation. Sorghum planting on wetlands had also expanded dramatically at the expense of former grasslands. However, the most drastic change was the damming of the Logone River and the conversion of $>1000$ km$^2$ of grasslands, teeming with wildlife, into rice fields, densely populated by humans, and a large reservoir. Meanwhile, cattle have not noticeably changed and overgrazing of woodlands and savannas was apparent almost everywhere. Moreover, the last supposedly protected forests were heavily exploited for firewood and hunted without effective control. In the countryside, even small rodents and birds are routinely killed for food, and hunting may have played a role in the disappearance of larger game species.

Among other possible factors, pesticide use, that was extremely limited 30 years ago, is now very widespread and sometimes massive, especially in cotton fields and against locusts. There are no data documenting the impact of contaminants on nontarget species. Locust control operations also occur on a large scale in years when locust density is high and they have probably reduced the average maximum abundance of this critical and seasonal source of food.

**Resident Species.** Increasing human pressure can affect predators through prey and nest site availability and disturbance. Only small raptors adapted to cultivated and human inhabited areas were found stable (e.g., Gabar, Shikra, resident kestrels, Lanner) or even increasing (Black-shouldered Kite). These were rodent, bird, or lizard specialists, favored by clearings, open ground, and croplands. Larger, albeit generalist species (e.g., Black Kite, Chanting Goshawk) were significantly decreasing but the underlying factors were unclear.

The consistent decline of all resident eagles may be explained by the probable decrease of their food supply and of large nest trees on overgrazed and cleared natural habitats, as well as by increased disturbance. Forest reserves are too small and scattered to allow, by themselves, the maintenance of viable eagle populations. Yet, a majority of eagles were recorded in or around such reserves. The long-term fate of these eagle species is uncertain.

**Vulture Decline.** The significant decrease of vulture populations has no obvious explanation. Vultures are traditionally not molested by humans. Cattle, goats, sheep, and donkeys were still abundant in 2000. Methods of cattle raising and seasonal movements had changed little and poisoning carcasses for predator control was reported to be rare. Urban sanitation, however, may have increased a little, but refuse and open-air slaughterhouses still were plentiful and food availability alone could not explain why many Hooded Vultures had vanished from towns. The dramatic decline of wild ungulates in the Waza National Park area may have affected the number of vultures locally, but not outside where domestic ungulates had long been the main source of carcasses. However, the much better rainy season, prior to the year 2000 counts, than in 1973 may have not favored the vultures as it probably did for predators.

The spectacular collapse of Southeast Asian, and more recently, Indian vultures, is suggestive of a widespread disease (Rahmani 1998, Watson 2000). In this context, I report the following observation

During the two days in the Waza National Park, a former stronghold of vultures, 93% of the vultures recorded were seen sitting near a single pool where there was no carcass. Vultures, all six species together, with empty crops, were gathered on the ground, in spite of an abundance of trees around where a few birds perched. They were not seen flying, even in the afternoon. They were immobile, often crouched, reluctant to move ahead of the vehicle, and then just flying a short distance to sit again on the ground. Some of them were drinking in the afternoon, but none were seen bathing. The weather was clear and moderately hot and windy, i.e., good flight conditions. Such an unusual gathering and behavior were not observed elsewhere.

**Palearctic and African Migrants.** Large Palearctic eagles (Snake-, Steppe or Spotted) were too rare or local to convincingly indicate a decline. However, this trend was consistent with that of their African counterparts and with the known change in their status in Europe (Tucker and Heath 1994). Conversely, the stability (if not increase) of the small African (Wahlberg's) and European (Booted) migrant eagles was well established.

Locusts (and orthopteras in general) are known to be a major source of food for many migrant raptors and to be fairly reliable indicators of the abundance of other prey (large insects, small vertebrates) of these raptors (Thiollay 1978b). The average level of locust populations probably decreased both because of habitat changes and of recurrent chemical control operations (use of Dieldrin and organophosphates). Nevertheless, among species mostly dependent on this prey base, the Eurasian harriers (notably Montagu's) and small African migrants (especially Grasshopper Buzzard) did not decrease appreciably during recent decades, whereas the Common and Lesser Kestrels suffered a very significant decline. Therefore, this decline can be attributed primarily to factors affecting the population on their breeding grounds rather than to drought, habitat degradation, or pesticide use in the wintering areas. The decline of Lesser Kestrel populations has been widely documented, especially in Europe (Tucker and Heath 1994) and this species may have made a substantial proportion of the kestrels in the 1973 counts.

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Appendix. Comparative dry-season, roadside counts of diurnal raptors in northern Cameroon in 1973 (first value) and 2000 (second value). Mean number of individuals recorded per 100 km from transects A to I.

| TRANSECTS[a]: LENGTH (km): | A 104 | B 190 | C 210 | D 60 | E 205 | F 158 | G 124 | H 68 | I 240/158 | TOTAL[b] | P[c] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Black-shouldered Kite *Elanus caeruleus* | 12.5/18.3 | 1.1/1.6 | 1.9/1.0 | 3.3/13.3 | 1.0/2.0 | 1.9/8.2 | 1.6/12.9 | 4.4/60.3 | 4.2/13.3 | 41–127 | 0.017 |
| African Swallow-tailed Kite *Chelictinia riocouri** | 1.0/1.0 | 2.6/0.0 | | 6.7/30.0 | 0.0/1.0 | 47.5/7.0 | 1.6/11.3 | 17.6/10.3 | 9.2/5.1 | 121–61 | NS |
| Black Kite *Milvus migrans** | 24.0/2.9 | 30.5/3.7 | 18.1/14.8 | 15.0/0.0 | 15.6/2.9 | 436.7/177.2 | 60.5/20.2 | 72.1/69.1 | 167.5/256.3 | 1378–804 | 0.015 |
| African Fish Eagle *Haliaeetus vocifer* | | | | | | 22.2/0.0 | | 2.9/0.0 | 4.6/2.5 | 48–4 | (0.108) |
| Egyptian Vulture *Neophron percnopterus*** | | | 1.0/1.0 | | | | | | 2.1/18.4 | 7–31 | NS |
| Hooded Vulture *Necrosyrtes monachus* | 37.5/32.7 | 30.0/21.6 | 26.7/15.2 | 15.0/6.7 | 39.0/6.8 | 149.4/40.5 | 79.0/25.0 | 95.6/2.9 | 19.2/4.4 | 686–229 | 0.007 |
| African White-backed Vulture *Gyps africanus* | 2.9/0.0 | 6.8/0.0 | 4.8/2.4 | | 4.9/0.0 | 49.4/23.4 | 8.9/0.8 | 19.1/5.9 | 55.8/39.2 | 272–109 | 0.011 |
| Rüppell's Griffon *Gyps rueppellii* | | | 24.3/5.7 | | 5.4/2.9 | 26.6/0.0 | 4.0/0.0 | 14.7/1.5 | 71.3/12.0 | 290–38 | 0.027 |
| Lappet-faced Vulture *Torgos tracheliotos* | | | | | | 1.3/0.0 | | 2.9/2.9 | 12.1/12.0 | 33–21 | NS |
| White-headed Vulture *Trigonoceps occipitalis* | | | | | | 1.3/0.0 | | | 4.2/3.2 | 12–5 | NS |
| Short-toed Snake-eagle *Circaetus gallicus*** | | | 1.4/0.5 | | 0.0/0.5 | 15.8/0.6 | 0.8/0.0 | 7.4/0.0 | 12.1/4.4 | 63–10 | 0.046 |
| Brown Snake-eagle *Circaetus cinereus* | 1.0/1.9 | | | | 2.0/1.0 | 5.1/0.6 | | 2.9/0.0 | 2.1/0.0 | 20–5 | 0.078 |
| Bateleur *Terathopius ecaudatus* | | 0.5/0.0 | 1.0/0.5 | | | 12.7/0.0 | 1.6/0.0 | 4.4/0.0 | 27.9/10.1 | 95–17 | 0.027 |
| Western Marsh Harrier *Circus aeruginosus*** | 4.8/11.5 | 0.5/0.0 | | | | 41.8/39.2 | | 2.9/13.2 | 0.8/19.0 | 75–113 | NS |
| Pallid Harrier *Circus macrourus*** | 1.0/1.0 | | | | 0.0/0.5 | 5.1/1.9 | | 2.9/4.4 | 2.1/1.9 | 16–11 | NS |
| Montagu's Harrier *Circus pygargus*** | 3.8/3.8 | | 1.0/0.5 | | 1.5/2.4 | 22.8/21.5 | 1.6/4.8 | 8.8/32.4 | 5.0/42.4 | 65–139 | NS |
| African Harrier-hawk *Polyboroides typus* | 1.0/2.9 | | | | | 1.3/0.0 | | | 4.2/0.6 | 13–4 | NS |
| Lizard Buzzard *Kaupifalco monogrammicus* | 1.9/2.9 | | | | | | | | | 2–3 | NS |

Appendix. Continued.

| TRANSECTS[a]: | A | B | C | D | E | F | G | H | I | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LENGTH (km): | 104 | 190 | 210 | 60 | 205 | 158 | 124 | 68 | 240/158 | TOTAL[b] | P[c] |
| Dark Chanting Goshawk *Melierax metabates* | 5.8/6.7 | 3.2/0.5 | 5.2/2.4 | 1.7/1.7 | 0.5/0.0 | 8.9/7.0 | 9.7/1.6 | 44.1/7.4 | 15.4/8.2 | 118–45 | 0.021 |
| Gabar Goshawk *Micronisus gabar* | 1.9/1.9 | 0.5/0.0 | 0.0/0.5 | 1.7/3.3 | 0.0/0.5 | 1.3/1.3 | | 10.3/2.9 | 1.7/1.9 | 17–13 | NS |
| Shikra *Accipiter badius** | 0.0/1.9 | | 0.5/2.4 | | | | | | | 1–7 | NS |
| Grasshopper Buzzard *Butastur rufipennis** | 11.5/14.4 | 5.8/1.1 | 3.8/6.7 | 3.3/3.3 | 2.0/2.9 | 0.6/1.9 | 0.8/2.4 | 13.2/38.2 | 1.7/17.7 | 52–99 | (0.091) |
| Long-legged Buzzard *Buteo rufinus*** | 1.9/0.0 | | | | | 3.8/1.9 | | 2.9/0.0 | 0.4/0.6 | 11–4 | NS |
| Red-necked Buzzard *Buteo auguralis** | 1.9/1.9 | | 2.4/2.4 | | | | | | | 7–7 | NS |
| Greater Spotted Eagle *Aquila clanga*** | | | | | | 1.3/1.3 | | | 0.8/0.0 | 4–2 | NS |
| Tawny Eagle *Aquila rapax* | 1.0/0.0 | | 1.0/1.0 | | 0.5/0.0 | 5.1/0.0 | 1.6/0.0 | 7.4/0.0 | 13.3/6.3 | 51–12 | 0.027 |
| Steppe Eagle *Aquila nipalensis*** | | | | | | 14.6/2.5 | | 4.4/0.0 | 5.0/0.6 | 38–5 | (0.102) |
| Wahlberg's Eagle *Aquila wahlbergi** | 1.9/0.0 | | 0.0/0.5 | | | 1.9/0.6 | | 1.5/5.9 | 2.5/1.3 | 10–10 | NS |
| African Hawk-Eagle *Hieraaetus spilogaster* | | | 0.5/0.0 | | | | | | 0.4/0.0 | 2–0 | NS |
| Booted Eagle *Hieraaetus pennatus*** | 0.0/1.0 | 0.5/0.5 | 0.5/1.0 | 1.7/15.0 | 0.0/0.5 | 1.9/5.7 | 0.0/1.6 | 0.0/2.9 | 0.4/1.3 | 7–29 | 0.012 |
| Martial Eagle *Polemaetus bellicosus* | | | 0.5/0.5 | | | | 0.8/0.0 | | 0.4/0.0 | 3–1 | NS |
| Long-crested Eagle *Lophaetus occipitalis* | 1.0/1.9 | | | | 0.5/0.0 | 5.7/0.0 | 0.8/0.0 | 5.9/0.0 | 4.6/0.0 | 27–2 | 0.071 |
| Common Kestrel[d] *Falco tinnunculus*** | 8.7/1.9 | 2.6/0.0 | 14.8/2.9 | 11.7/1.7 | 5.4/1.0 | 82.3/0.0 | 6.5/2.4 | 58.8/5.9 | 20.0/3.8 | 289–24 | 0.007 |
| Fox Kestrel *Falco alopex* | 5.8/15.4 | | 17.1/19.0 | | | | | 2.9/0.0 | | 44–56 | NS |
| Grey Kestrel *Falco ardosiaceus* | 1.9/0.0 | | 0.5/0.5 | 0.0/1.7 | | 0.6/0.0 | | 2.9/0.0 | 1.3/0.0 | 9–2 | NS |
| Red-necked Falcon *Falco chicquera* | | | | | | 1.3/2.5 | | 2.9/0.0 | 1.3/0.0 | 7–4 | NS |
| Lanner Falcon *Falco biarmicus* | | | 1.9/2.9 | 1.7/3.3 | 1.0/1.0 | 1.3/0.6 | | 2.9/1.5 | 1.7/1.3 | 15–14 | NS |
| Saker Falcon *Falco cherrug*** | | | | | | 0.6/0 0 | | 1.5/1 5 | 0.4/1.3 | 3–3 | NS |

Appendix. Continued.

| TRANSECTS[a]: | A | B | C | D | E | F | G | H | I | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LENGTH (km): | 104 | 190 | 210 | 60 | 205 | 158 | 124 | 68 | 240/158 | TOTAL[b] | P[c] |
| Peregrine Falcon *Falco peregrinus*** | | | 1.9/1.4 | | 0.5/0.5 | 0.6/0.0 | | 0.0/1.5 | 1.3/1.3 | 7–7 | NS |
| – Species number | 21/20 | 12/6 | 22/23 | 10/10 | 14/15 | 32/20 | 15/10 | 28/19 | 35/28 | 42–39 | 0.049 |
| – Individuals/100 km | 133/127 | 85/29 | 131/86 | 62/89 | 80/26 | 973/345 | 180/83 | 420/271 | 478/491 | 3959–2077 | 0.038 |

[a] Transect locations shown in Fig. 1.

[b] Actual number of individuals counted each year.

[c] Statistical significance of between-year quantitative differences. NS = nonsignificant; in parentheses: near significant.

[d] Also includes some Lesser Kestrels, *Falco naumanni,* in both years.

* African migrants (likely to be more abundant in the rainy season).

** Palearctic migrants (rare or absent in June–August).