Local density, behaviour, food and moult of the Fox Kestrel *Falco alopex*

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Summary

During short visits to central Mali (between Sévaré and Somadougou) in Febuary 2004 and Febuary 2005, territorial Fox Kestrels *Falco alopex* were found on two rocky outcrops of 4 km² and 5.5 km², which held respectively one pair, and six pairs plus two solitary birds. At the latter site, nearest-neighbour nest distances averaged 586 ± 407 m ($\bar{x}$ ± SD) and occupied nesting sites averaged 830 ± 285 m from the nest site of a Lanner Falcon *Falco biarmicus*. Nests were not in use at the time, but pairs displayed territorial behaviour. Approach by humans (on foot) and a Pied Crow *Corvus albus* elicited alarm-calling and flight, but Lanner Falcons were avoided silently or ignored. Alert and flight initiation distances at the approach of a person averaged 71 m and 43 m. Hunting was observed up to 1.5 km away from both rocky outcrops, in harvested rice and millet fields riddled with rodent burrows. Food (based on pellets and observations) consisted almost entirely of Orthoptera (Acrididae), but also included Coleoptera. Fox Kestrels foraged via sallies from exposed perches (trees and rocks) to capture locusts on the ground, then dismembered them back at the sitting post or in flight. A short bout of hovering was noted once. Five out of nine Fox Kestrels showed moult in primaries and/or rectrices.

Résumé

Densité locale, comportement, nourriture et mue de la Crécerelle renard *Falco alopex*. Durant de courtes visites au centre du Mali (entre Sévaré et Somadougou) en février 2004 et février 2005, deux affleurements rocheux de 4 km² et 5,5 km² se sont avérés héberger des Crécerelles renard *Falco alopex*, dont respectivement un couple et six couples plus deux solitaires. Dans ce dernier site, les distances des nids par rapport à leur plus proche voisin étaient en moyenne de 586 ± 407 m ($\bar{x}$ ± DS) et les nids occupés à une distance moyenne de 830 ± 285 m du nid d'un Faucon lanier *Falco biarmicus*. Les nids n'étaient pas en usage au moment de la visite, mais les couples affichaient un comportement territorial. Des appels d'alarme ont été suscités par des humains s'approchant à pied et par un Corbeaux pie *Corvus albus*, mais les Faucons lanier étaient évités en silence ou ignorés. Les distances d'alerte et d'envol à

l'approche d'une personne étaient respectivement de 71 m et 43 m en moyenne. La chasse a été observée jusqu'à 1,5 km des deux affleurements, sur des champs récoltées (riz, mil) criblés de terriers de rongeurs. Les aliments (sur la base des pelotes et d'observations) étaient presque entièrement constitués d'orthoptères (acridiens), mais aussi de coléoptères). Les Crécerelles renard se nourrissaient principalement en jaillissant à partir de perchoirs exposés (arbres, rochers) pour attraper les locustes au sol puis les démembraient à leur retour sur le perchoir ou en vol. Un vol stationnaire de courte durée a été noté une fois. Cinq Crécerelles renard sur neuf étaient, au vu de leurs primaires et/ou rectrices, en train de muer.

Introduction

The Fox Kestrel has been little studied in the past century, perhaps partly because of its familiarity as exemplified by this quote from Brown (1971): "I had splendid chances of watching it but never seized them because I thought the bird commonplace." The texts in handbooks contain little or no quantitative information (Brown & Amadon 1968, Brown *et al.* 1982, Cade 1982, Hoyo *et al.* 1994, Ferguson-Lees & Christie 2001), and measurements have been copied from handbook to handbook, lacking sample size and measures of variation. Their origin appears to be Brown & Amadon (1968 p. 10), who described their data as "measurements … often from standard works, such as Friedmann and Hartert." Many common Sudano-Sahelian raptors are still poorly known, although the breeding biology of African Swallow-tailed Kite *Chelictinia riocourii* and Grasshopper Buzzard *Butastur rufipennis* has been studied in detail (Buij *et al.* 2012, Buij *et al.* 2013, Mullié *et al.* 2014). Recent information on Fox Kestrel is limited to snippets, *e.g.* on eggs, chicks, diet, moult and taxonomy (Brouwer & Mullié 2000), hovering (Londei 2002, Buij & Croes 2014), flocking and attending grass fires to catch fleeing insects (Van Zyl *et al.* 2006).

In Mali, the Fox Kestrel has been described as "commun et répandu dans toutes les zones de roches et de falaises … des Monts Mandigues à l'Adrar des Ifoghas, et même sur l'île de Taguilem (Faguibine). Nidification décembre à février; rarement, mars–avril." (Lamarche 1980). Using road counts, Thiollay (1977) observed Fox Kestrels in central Mali westwards as far as Bandiagara (14°25′N, 3°19′E). Later observations within this range do not seem to substantiate Lamarche's "commun et répandu", as Fox Kestrels have mostly been recorded in very small numbers only, or not at all, in suitable rocky habitats (Balança & de Visscher 1993, Moulin *et al.* 2001, Clouet & Goar 2003, Clouet *et al.* 2009).

In light of this scarcity of information, we report on behaviour, disturbance distance, moult, density and food of Fox Kestrels in Mali. Albeit based on limited observations, we present new information on the ecology of this species.

Study area

We surveyed two sites in the Sudano-Sahelian zone of central Mali: near Pérempé (centred around 14°28′N, 4°4′W, just south of Sévaré), and Hamdallaye (14°18′N,

4°5′W), which lies *c.* 25 km south of Sévaré and 2 km NNW of Somadougou. This semi-arid region at an altitude of 270 m comprises small rocky outcrops amidst flatlands. These eroded inselbergs are outliers of the Bandiagara Escarpment (up to 400–500 m altitude) 60 km to the east. Most of the rocky outcrops in the study plots consisted of weathered quartzite without cliffs. Some larger rock formations had cliffs up to 50 m high, with small ravines and gorges.

The Pérempé site, part of a larger rocky outcrop extending eastwards, consisted of a rock formation 2 x 2 km in surface area, with a small cliff. It was surrounded by savanna and dry farmland cropped with millet, and rice fields closer to the Niger River. The isolated rock formation of Hamdallaye, 5 km to the east of the River Niger, is partly surrounded by farmland with millet on the drier ground and rice in wetter fields closer to the River Niger. Although thoroughly eroded (Fig. 1), the formation still has gorges and cliff faces of 10–50 m height, exposed to the west and northwest.

Figure 1. View from the east of the rocky formation of Hamdallaye near Somadougou, central Mali, 11 Nov 2013.

The region has a long dry season, with a single rainy season mainly in July–August). Annual rainfall in 2003 and 2004 was 662 and 457 mm, *i.e.* a wet and a dry year compared to the 2001–2014 average of 557 mm (data from Sévaré airport, with missing values substituted by L. Zwarts using satellite-derived estimates). The vegetation was open savanna with scattered *Acacia nilotica* and *Balanites aegyptiaca* trees, some *Calotropis procera* and many small *Combretum glutinosum*. Near villages

and temporary lakes, small fields were cultivated with millet, sorghum and rice. In February 2005, the harvested fields abounded with rodents: apart from the many burrows observed to be in use, rodents were commonly seen and heard. In the wake of an outbreak of Desert Locust *Schistocerca gregaria* in West Africa from October 2003 (Ceccato *et al.* 2007), many adults of this species were present during our stay in 2004, but numbers nowhere reached swarm densities. In 2005, only non-migratory grasshoppers were present, frequently encountered in fields with millet stubble. These were mostly species typical of sandy soils and rain-fed farmland (Lecoq 1988, Popov 1988), such as *Acorypha clara*, *Oedaleus senegalensis*, *Kraussaria angulifera* and *Diabolocatantops axillaris* (Legg & Togola 1993).

The cliffs were home to small mammalian predators, including African Striped Weasels *Poecilogale albinucha*, whose skulls were found in Barn Owl *Tyto alba* pellets and on nearby Yellow-billed Kite *Milvus migrans parasitus* nests (Bijlsma *et al*. 2005). Two adult Olive Baboons *Papio anubis* were seen and photographed at Hamdallaye on 3 Feb 2005. Both baboons and kites sometimes take eggs or chicks. Other raptors recorded at the Hamdallaye site on 2 and 3 Feb 2005, some of which may have been competitors (for nest sites or food) or predators of fully grown Fox Kestrels, included an adult Short-toed Eagle *Circaetus gallicus*, five adult Booted Eagles *Aquila pennatus* (two dark morph, three light morph), an adult female and a juvenile Montagu's Harrier *Circus pygargus*, a Common Kestrel *Falco tinnunculus* and a territorial pair of Lanners *Falco biarmicus*. An adult Lanner was also seen at the small cliff at Pérempé, on 15 Feb 2004. Sightings, pellets and/or moulted feathers of Barn Owl and Spotted Eagle Owl *Bubo africanus* were obtained at both sites.

Methods

The Sévaré site was visited on 15 Feb 2004 (9h15–15h30). The Hamdallaye farmland was visited on 2 Feb 2005 (11h00–17h30 h), and on 3 Feb 2005 (9h30–17h00), the rock formation itself, covering 2.5 x 2.2 km², was surveyed. At each site we systematically surveyed on foot a plot of 4 x 4 km, centred on each of the rocky outcrops. We checked trees and rock formations for raptor nests, mapped nests and birds with a Global Positioning System, and recorded intra- and inter-specific interactions, foraging, moult, nest sites and roosts. Nest sites were defined as occupied cavities with pellets on ledges, streaks of fresh and discoloured whitewash of uric acid and/or alarm-calling falcons nearby. For birds (including raptors) sitting in exposed positions, we recorded upon approach the detection distance (when the bird was noted), alert distance (AD: bird obviously taking note of the approaching observer) and flight initiation distance (FID: bird taking flight), following the methodology of Blumstein (2006). These distances were measured by the same observer (RGB) pacing (validated against a measured distance) in a straight line towards the target (distance *a*). Height of the sitting post was also recorded and observer's height subtracted from it (= *b*), allowing the flight initiation distances in metres (*c*) to be calculated using Pythagoras's theorem $a^2 + b^2 = c^2$. Heights were estimated by eye, and for trees higher than 6 m sometimes validated with a laser rangefinder.

On 3 Feb 2005, we collected 37 intact pellets and a handful of fragments of pellets, below a daytime roost of a Fox Kestrel, close to a nest site on a cliff in the Hamdallaye mountain range. The pellets were quite fresh, and the bird was seen on the roosting site. Pellets were measured and provisionally assigned to main prey species, but were lost before full identification of prey remains could be made.

Moulting of flight feathers was recorded whenever possible. Of the 16 individual Fox Kestrels observed, seven eluded close observation and were excluded from comments on moult. Remiges and rectrices are numbered descendantly (outwards) in primaries and rectrices, and ascendantly (inwards) in secondaries.

Means are given ± 1 SD.

Results

Habitat and density

In both plots, Fox Kestrels were always recorded near rocky outcrops, either roosting on the cliffs or in trees nearby. The Hamdallaye site held six pairs and two single Fox Kestrels, concentrated in the southern section of the mountain range where cliffs were steepest. Each pair had exclusive occupation of a gully with a cliff face (Fig. 2). Nearest-nest distances at Hamdallaye were 156, 156, 518, 561, 771 and 1352 m (six pairs). The heights of nesting cliffs varied between 11 and 33 m (mean 20.8 ± 6.6 m, n = 6), with all nests situated on ledges in the upper third of the cliff face. The pair of Lanners used one of the steepest cliffs in the central section of the rock formation, where a small stick nest (presumably of Rock Dove) was found on a ledge at a height of 43 m (7 m below the top of the cliff). None of the Fox Kestrel sites faced the nesting site of the Lanners. Fox Kestrel nest sites were on average 830 ± 285 m (range 430–1206 m) away from the Lanners' nest. The pairs avoided the cliff face occupied by the Lanners (Fig. 2). Solitary Fox Kestrels were exclusively recorded on the outskirts of the rock formation where cavities suitable for nesting were lacking, and away from cliffs occupied by congeners or Lanners. On the two days of observation, the Fox Kestrels foraged on farmland and wooded savanna within 1.5 km south and east of the rock formation.

The Pérempé plot held one pair of Fox Kestrels, occupying the only rocky outcrop (in the section surveyed) possessing a sheer cliff *c.* 15 m high. Five smaller rocky outcrops nearby lacked a cliff face, except one which was occupied by a pair of Pied Crows *Corvus albus*. The Fox Kestrels' cliff was sufficiently steep to deter larger predators (and us). It contained several ledges and cavities, with a tell-tale whitewash. At the foot of the outcrop small fields (mostly millet) and sandy dryland extended to the west and south. These fields were used by Fox Kestrels for hunting.

Behaviour

Although not breeding, pairs appeared to be more spaced out than the availability of nesting cliffs would dictate, and showed territorial behaviour when provoked by congeners or humans. Pairs often perched on occupied rocky outcrops and exposed trees, where they were watchful and sometimes preened. Approaching their cliffs elicited

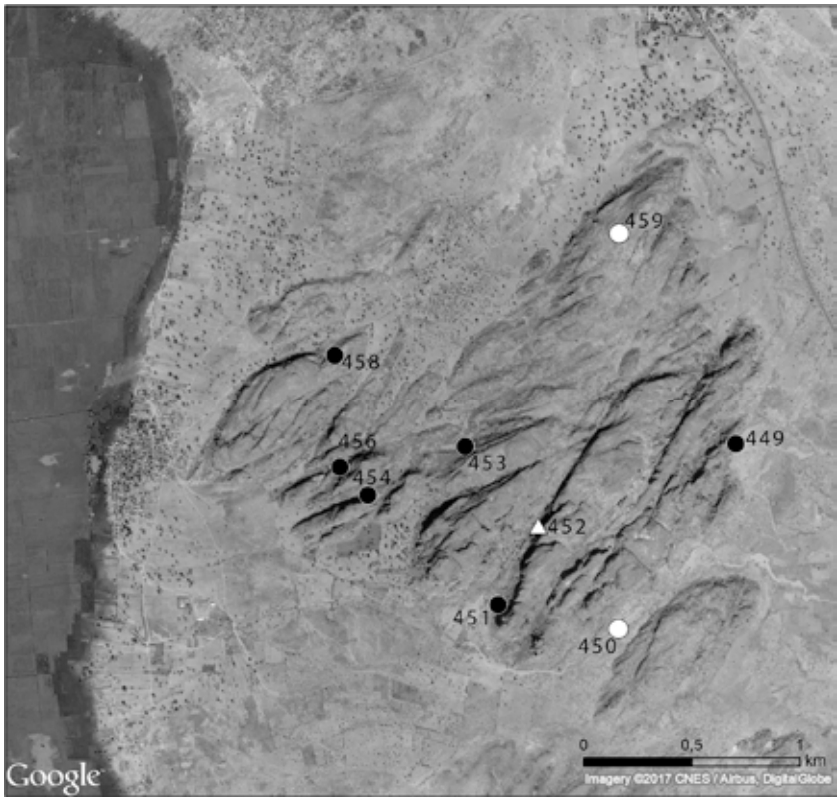

Figure 2. Distribution of Fox Kestrels and Lanner Falcon in the Hamdallaye rock formation near Somadougou, central Mali, on 3 Feb 2005. The flat land in the west is the cultivated floodplain of the Niger River. Circles = Fox Kestrels (black, pairs; white, solitary); triangle = Lanner.

alarm calling in four out of five pairs (not tested for the sixth pair), consisting of a screeching, throaty "krree-krree-krree", harsher than Kestrel *Falco tinnunculus* and less powerful than Lanner. Near nest sites, alarm calling was sometimes accompanied by flights on rapidly beating, stiffly held wings within 20–75 m of the observers. When flushed, birds stayed within sight, watching us from exposed rocks or circling overhead (Fig. 3). None of the nest sites contained eggs or chicks when we searched the plots, but pairs were clearly attached to specific sites and started alarm calling when approached by us or (on 3 Feb 2005) by a Pied Crow.

One intraspecific aggressive interaction was noted at 9h40 on 3 Feb 2005, when a solitary Fox Kestrel (450 in Fig. 3) came within 100 m of pair 451; one member of the

Figure 3. Fox Kestrel on the alert, near its breeding site in the Hamdallaye mountains, central Mali, 3 Feb 2005.

pair flew directly at it, followed by brief talon-locking (35 m high, for perhaps just 1 s), then pursued it away from the rock formation for some 50 m. This interaction was accompanied by fierce calling; although it was not clear which bird was calling. A male–female interaction (pair 449, Fig. 1) also involved talon-locking for a brief moment, at 9h30 on 3 Feb 2005, with both birds calling loudly. This pair, in which the size difference was clearly noted, had been sitting together on a rock before being disturbed by us; the interaction followed almost immediately after the disturbance, and the birds stayed close together afterwards.

At Hamdallaye, the appearance of the local Lanners elicited flight without calling, as seen twice on 3 Feb 2005. The Fox Kestrel pair at Pérempé, conversely, did not noticeably react to the presence of a single Lanner Falcon (within 100 m distance sometimes).

Two FIDs obtained at Hamdallaye measured 33 and 44 m, but ADs were much larger (61 and 81 m). A FID for one Fox Kestrel taken in Burkina Faso (11°42′N, 1°36′E, 7 km east of Arly National Park) at 9h28 on 10 Feb 2016, was 51 m (AD 67 m) (RGB pers. obs.).

Hunting and food

During hunting, which was always solitary, the birds mostly stayed within 500 m of the outcrops, searching wooded savanna and fields of stubble (millet and rice), where they hunted insects, usually obtaining prey within a short time of starting each foray. On 2 Feb 2005, a single Fox Kestrel was recorded 1.5 km from the Hamdallaye rocks, when flushed from the ground in a harvested, rodent-riddled rice field. We did not

register any grasshoppers or crickets in this field, and the bird may have attempted to capture a rodent. During intermittent observation bouts between 16h00 and 17h00, totalling 11 min., it frequently switched sitting posts in tree tops, and was once observed hovering for 5 s before flying back to a tree. When hovering, the body was held almost vertical, with tail hanging (in little wind). During this whole period no capture attempt was witnessed, which suggested hunting for rodents rather than insects. On 3 Feb 2005, another bird made a 30 m sally from a rocky outcrop, caught with its feet a large locust just above the ground, snipped off the wings and ate the prey on the wing. On 15 Feb 2004, at 10h10, two Fox Kestrels near Pérempé used sitting posts to swoop down on *Schistocerca gregaria* (identified from prey remains) from a height of *c.* 10 m; both birds returned with their prey to the rock where the locusts were quickly dismantled and consumed. Distances between rock and site of capture varied between 30 and 50 m (40 ± 8 m, n = 7). During 12 min. of observation, the birds respectively captured three and four large locusts with sallies from the rock, without once missing.

Pellet size ranged from 12.7 x 8.9 mm to 37.3 x 16.9 mm (mean 25.5 x 15.5 mm, n = 37). They were yellowish grey and consisted of compacted insect remains and grass particles, with loose composition and a tendency to fall apart quickly when deposited in exposed places. All 37 pellets were composed of the remains of locusts and grasshoppers (Orthoptera: Acrididae); fragments were very small, mostly from the abdomen, tibia and femur, consistent with the observations of falcons dismembering locusts before consumption. One of the pellets also contained elytra of an unidentified beetle (Coleoptera).

Moult

Of the nine individual Fox Kestrels observed in Feb 2004 and Feb 2005 sufficiently closely to detect moulted flight feathers unambiguously, four were in immaculate plumage without gaps in wing or tail. The other five showed visible moult, of which three lacked a rectrix (the fifth, counted descendantly), one a single primary in the right wing (presumably the first) and another bird simultaneously the first primary (right wing) and a tail-feather (position not pinpointed). Only two moulting birds were tentatively sexed, both as female (based on a small size difference within apparent pairs, with female sex assigned to the bigger bird: Brown *et al.* 1982).

Discussion

Accounts of Fox Kestrel abundance differ widely, from “rare and local” (Brown 1971 p. 123, presumably referring to its entire range) to “commun et répandu dans toutes les zones de roches et de falaises” (Lamarche 1980, for Mali). Such vagueness of published information on Fox Kestrels is exacerbated by the frequent use of secondary sources which, upon inspection of primary sources, sometimes turn out to be erroneous. For example, the statement that the largest known population of Fox Kestrel is in the Mandara Mountains (Buij & Croes 2014), stems from a misquote of Thiollay (1977 p. 278–9, where he does not mention the Mandara Mts) by Thiollay

(2001 p. 178). It shows that detailed observations are needed, and that checking primary sources is crucial; even self-quotes can be wrong. Our data refer to a small, isolated and peripheral breeding site of Fox Kestrels in Mali, and we do not suggest that the information is typical of Fox Kestrels in general. We need more and better data from various parts of the breeding and wintering range, as summarised for northern Cameroon (Buij & Croes 2014). Data collection using stratified random sampling should be relatively easy, as Fox Kestrel has a patchy breeding distribution "owing to the nature of the ground it inhabits" *i.e.* "rock piles and cliffs" (Bannerman 1953).

Breeding occurs during the early part of the rainy season, in March–June, at least in Niger, Nigeria and Cameroon (Elgood 1994, Brouwer & Mullié 2000, Buij & Croes 2014), but may be as late as June–September in Sudan (Brown *et al.* 1982), the latter apparently based on observations of A.D. Forbes-Watson in NW Turkana, Kenya (Brown & Britton 1980). Moult is a reliable secondary cue for timing of breeding, as in small raptors it coincides with gonadal regression (Young *et al.* 2009), hence with incubation or chick stage. Brouwer & Mullié (2000) recorded primary moult, assumed as post-breeding, during July–August at a number of locations in the Dallol Bosso in SW Niger, according with Buij & Croes (2014), who recorded fledglings in the first half of June and noted moult of remiges in June–July. Their photograph of an adult on 10 Jul 2008 shows moult of primaries 5–6, indicating that primary moult must have started during the nestling stage (*cf.* Common Kestrel: Piechocki 1956). Duration of primary replacement scales allometrically with mass, with larger birds requiring disproportionally more time to replace all the primaries (Rohwer *et al.* 2009). Surprisingly, no data on body mass of Fox Kestrels seem to have been published (Brown & Amadon 1968, Brown *et al.* 1982, Dunning 1993), and Cade (1982) assumed a mass of 250–300 g, an estimate subsequently copied by Hoyo *et al*. (1994) and Ferguson-Lees & Christie (2001), but which still needs verification. Assuming that Fox Kestrels weigh 250–300 g (slightly more than Common Kestrels), allows an estimate of moult duration of primaries (as scaled to mass; Rohwer *et al.* 2009) of some 100 days. The few moulting adults at Hamdallaye were in the last stage of primary moult (first primary missing, *i.e.* the last one to be moulted), indicating a start of moult in the last week of October or earlier. This is likely, given that some territorial birds did not show any moult and had probably finished moulting. However, compared to the information on timing of breeding, this would be very late and needs verification.

From the fact that our Fox Kestrels were still present on the presumed breeding cliffs in February (well into the dry season), we surmise that this species is sedentary (as suggested by Elgood *et al.* 1973 for Nigeria). This contrasts with statements that the species, after breeding, descends to lower-lying areas south of the breeding haunts in the dry season (Thiollay 1978, perhaps based on Thiollay 1977: "…une dispersion se produit en saison sèche qui mène régulièrement quelques individues dans le nord de la Côte d'Ivoire et du Ghana entre 8° et 10°"). In northern Cameroon, Buij & Croes (2014) recorded small flocks near irrigated fields, apparently in agreement with Thiollay's (1978) remark, but only sometimes > 1 km away from breeding sites and never in the nearby Waza Logone floodplain (R. Buij pers. comm.). Without results

from ringing or tracking, the extent of distant dispersal remains uncertain. We observed Fox Kestrels during years with high abundance of locusts (Ceccato *et al.* 2007) or rodents (pers. obs. in 2005). Under such conditions, the drive to search for "greener pastures" in the dry season may have been absent. However, subsequent visits to the eastern edge of Hamdallaye, albeit for short periods of time (40 min. on 8 Feb 2012, 15 min. on 11 Nov 2013), did not reveal any Fox Kestrels. If they were truly absent, there was no obvious relationship with rainfall in the previous year, as 2011 was even drier than 2005 (488 mm) and 2013 much wetter than 2004 (742 mm) (L. Zwarts pers. comm.). Although Fox Kestrels may disperse, nomadic movements like those of Grasshopper Buzzards and African Swallow-tailed Kites (Buij *et al.* 2012, 2013) are apparently lacking (Elgood *et al.* 1973). Where Fox Kestrels breed close to farmland, dry season survival may be improved by high food abundance, such as we found at Hamdallaye in 2005, and as suggested by Buij & Croes (2014) for northern Cameroon. Since the extent of farmland is increasing across the Sahel (Zwarts *et al*. 2009 p. 49) and Fox Kestrels are not particularly shy, their use of inaccessible breeding and roosting cliffs close to farmland for foraging may have diminished the movement tendency during past decades.

To end with another quote from Leslie Brown: "…a season's observation in a good area for the particular species would advance our knowledge in to the 'Very well known' class." (Brown 1971 p. 256). We encourage others to make detailed observations of Fox Kestrel, noting abundance, including absence from well-visited areas, age and sex of birds observed, habitat (available versus used), behaviour, nesting including egg and chick measurements, moult, food and foraging.

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