

# POPULATION DENSITIES OF THE ROCK FIREFINCH *LAGONOSTICTA SANGUINODORSALIS* AND SOME OTHER ESTRILDINE AND VIDUINE FINCHES ON THE JOS PLATEAU, NIGERIA

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The range-restricted Rock Firefinch *Lagonosticta sanguinodorsalis* is restricted to a small part of West Africa and is of great conservation importance within the Jos Plateau Forest-Grassland Mosaic eco-region, Nigeria. This study estimated the population densities of this and some other estrildine and viduine finches on the Jos Plateau during June–July 2006 and May–June 2007 as a contribution to their conservation management. Randomly chosen line transects ( $n = 55$ ) totalling 47.15 km were carried out using Distance sampling protocols in four habitat types: (i) flat farmland with few or no rocks, (ii) farmland in rocky areas or near inselbergs, (iii) uncultivated flat areas with few or no rocks, and (iv) rocky, uncultivated areas. Rock Firefinches were not recorded in farmland or semi-natural areas without rocks, but only in areas where there are large boulders and inselbergs, either with semi-natural vegetation (0.62 birds/ha calculated using the program Distance) or where this habitat is farmed (0.48 birds/ha). The differences in population density between habitats were not significant, nor did they differ significantly from densities in similar habitats recorded in an earlier study on the Jos Plateau. The Rock Firefinch's host-specific brood parasite, the Jos Plateau Indigobird *Vidua maryae*, was recorded only twice on transect counts and is evidently very scarce. It remains uncertain to what extent increasing habitat degradation may affect these species' ability to persist as small populations in isolated habitat fragments in the face of increasing human pressure on farmland.

## INTRODUCTION

The range-restricted Rock Firefinch *Lagonosticta sanguinodorsalis* occurs on the Jos Plateau in central Nigeria and in the Mandara Mountains on the Nigeria–Cameroon border. This species, together with its host-specific brood parasite, the Jos Plateau Indigobird *Vidua maryae*, are of great conservation importance within the Jos Plateau Forest-Grassland Mosaic eco-region, Nigeria. Typical of the Jos Plateau landscape are rocky outcrops and isolated, sparsely vegetated granitic hills of rounded bare rock (inselbergs, kopjes) rising abruptly from the surrounding dry scrub-savanna. Much of the natural vegetation of the Jos Plateau was devastated by tin-mining operations in the 1920s and today a high human population has resulted in continued, large-scale conversion of grass and scrubland to agriculture. Previous studies of the habitat associations and population density of the Rock Firefinch have centered on the Amurum Forest Reserve, a protected area where the species appears to thrive (Brandt & Cresswell 2008, Wright & Jones 2005) but little is known of its population status elsewhere on the Jos Plateau.

This study aimed to estimate the population densities of Rock Firefinches more widely in unprotected semi-natural

habitats and farmland on the Jos Plateau for comparison with the population density estimated in the protected Amurum Forest Reserve, and to assess whether habitat modification in farmed areas might pose a potential threat to Rock Firefinch populations.

## STUDY AREA AND METHODS

The Jos Plateau is the largest land mass in Nigeria over 1000 m in elevation, covering an area of approximately 8800 km<sup>2</sup>. It stretches from its westernmost point, at the Kagoro Hills, at 8°30'E, south to almost 9°N, east to 9°30'E and north to 10°N. The plateau rises abruptly along an escarpment on the west and the south, whilst on the north-east, the slope towards the lowlands is more gradual. Altitude ranges from 1220 m to 1450 m, with hills rising as high as 1781 m (Payne 1998). The relief is predominantly flat or rolling and is characterised by granitic outcrops and inselbergs. To the south and west of the Jos Plateau Forest-Grassland mosaic, vegetation is characteristic of the Southern Guinea Savanna zone, while the area to the north and east is characteristic of the Northern Guinea Savanna zone (Keay 1959). As a result of its high elevation the temperature of the Jos Plateau ranges from 15.5°C to

30.5°C, which is cooler than the surrounding areas. The south-west region of the plateau experiences the highest rainfall, approximately 2000 mm per annum, while rainfall declines towards the north-east to approximately 1500 mm per annum (Lodewijk & Were 2001). The climax ecotone of the region is likely to have been savanna woodland, but human activities have extensively degraded the vegetation. Only a few remnants of woodland remain and these are mainly restricted to steep and less accessible areas of the plateau (Lodewijk & Were 2001), while forests are limited to the steep southern and western escarpments, river edges and the base of rocky outcrops. The vegetation thus now consists mostly of scattered bush and grass, which is both cultivated and grazed by cattle, goats and sheep. It intergrades with the drier lowlands of the Northern Guinea Savanna vegetation to the north and east of the plateau (Payne 1998).

The study was carried out during the wet season between 19 June and 13 September 2006 and from 28 May to 26 June 2007. Birds were surveyed on foot by JIA along straight line transects using Distance sampling protocols. Within the limitations imposed by the availability of transport, transects were selected in as unbiased a manner as possible that would sample the largest feasible area of countryside around the city of Jos (9°56'N, 8°53'E) in the centre of the Jos Plateau. This was carried out by driving along each of the major roads out of the city to open countryside and stopping to survey transects on alternate sides of the road every 10 km within a radius of c. 52 km from the city centre. Each transect was 1 km long, except in areas where parts were inaccessible. In all, 55 transects totalling 47.15 km were walked, usually in the mornings between 06h30 and 11h00, though a few were surveyed in the late afternoon between 16h00 and dusk at c. 18h30. All species of estrildid and viduine finches (firefinches, waxbills, indigobirds) observed were recorded; other birds were ignored. The perpendicular distance of each bird from the observer was recorded using a laser range-finder. The nature of the vegetation (semi-natural, fallow or cultivated farmland) and the presence or absence of rocky ground (inselbergs, large boulders) were noted for each 200 m section of each transect. Most transects ran through the same habitat type throughout their length but others ran through more heterogeneous areas. These were partitioned before analysis into the lengths of their respective habitats. In total, our 55 transects included 68 transect subsections comprising four main habitats:

- Habitat 1: Farmland without rocks (18 transects/subsections totalling 12.8 km);
- Habitat 2: Farmland in rocky areas (18 transects/subsections totalling 13.355 km);
- Habitat 3: Uncultivated areas without rocks (8 transects/subsections totalling 4.4 km);
- Habitat 4: Uncultivated rocky areas (24 transects/subsections totalling 16.6 km).

Population densities (birds/ha) in each habitat type were calculated using the program Distance v.4.1 (Thomas *et al.* 2003). Because some species were uncommon and rarely recorded on the transects, density estimates were made using a global detection function for all species combined, on the reasonable assumption that all the estrildine and viduine finches recorded had similar detectabilities, thereby using more frequently recorded species as surrogates for rarer ones (Buckland *et al.*

2008). Individual species densities were then obtained by post-stratification within the Distance program. Before analysis the dataset was truncated such that the few observations beyond 40–45 m from the transect line were omitted to give a better fit of the detection function. The most appropriate model for the detection function, either half-normal with cosine expansion or hazard-rate with cosine expansion, was chosen initially on the basis of the lowest AIC value (Akaike's Information Criterion; Thomas *et al.* 2003). The best fit of observed to expected detection probabilities was then obtained by visual inspection of the distribution of perpendicular distances of observations from the transect line and adjusting the cut-points accordingly until a P-value of >0.95 could be obtained for a goodness-of-fit chi-squared test. Models were again compared on the basis of their AIC-values and the lowest chosen.

## RESULTS

Eleven species of firefinch, waxbill and indigobird were encountered on transects (Table 1). Ten of these occurred around inselbergs and in uncultivated rocky areas, while nine species occurred in similar areas that were farmed. Away from rocky areas the species richness was lower, with five species encountered in farmed areas without rocks and only two species in similar uncultivated areas of semi-natural vegetation. Two species, the Red-cheeked Cordon Bleu and Village Indigobird were found in all four habitat types, while three species, Black-faced Firefinch, Lavender Waxbill and Jos Plateau Indigobird, were each found in one habitat only. In most cases the number of individuals of each species that were encountered on surveys were insufficient to give robust density estimates (coefficient of variation almost always >35%), despite the number of transects and large distances traversed. Rock Firefinches were encountered only in rocky areas, both farmed (Habitat 2) and semi-natural (Habitat 4). Population density appeared to be rather lower in rocky areas that were farmed ( $0.48 \pm 0.28$  birds/ha; Table 1) than in similar areas that had semi-natural vegetation ( $0.62 \pm 0.21$  birds/ha) but the difference between these habitats was not significant ( $F_{1,50} = 0.156$ ,  $P = 0.694$ ).

The only other species for which some relatively robust estimates of population density could be made was the Red-cheeked Cordon Bleu, which occurred at mean densities of 0.51–1.61 birds/ha (Table 1; density estimates with coefficients of variation of 29.7% and 22.6% in Habitats 1 and 4 respectively), but no significant differences were evident between habitats.

The Rock Firefinch's brood parasite, the Jos Plateau Indigobird, was encountered too seldom to give a reliable density estimate in the one habitat in which it was seen, and was not recorded at all in the semi-natural rocky habitat where its host occurred most often.

## DISCUSSION

It is disappointing that despite the sampling design adopted and the effort involved, so few robust population estimates could be made. Buckland *et al.* (2001) recommended at least 10–20 randomly replicated transects for reliable estimates, and we were able to achieve this in three of the four habitats surveyed ( $n = 18, 18, 8, 24$  transects in Habitats 1–4, respectively). Two reasons for the high variance in many of our

**Table 1.** Density estimates during the wet season (May–September) of estrildine and viduine finches on the Jos Plateau, obtained by Distance analyses conducted separately for transect counts in four habitats, post-stratified by species<sup>1</sup>. n = total no. individuals recorded in each habitat. Robust estimates in bold: \* = % coefficient of variation < 35%; \*\* %CV < 25%.

Species	Habitat 1 Farmland, no rocks (n = 46)		Habitat 2 Farmland in rocky area (n = 76)		Habitat 3 Uncultivated area, no rocks (n = 13)		Habitat 4 Uncultivated rocky area (n = 132)	
	Mean (birds/ha)	95% C.I.	Mean (birds/ha)	95% C.I.	Mean (birds/ha)	95% C.I.	Mean (birds/ha)	95% C.I.
Bar-breasted Firefinch <i>Lagonosticta rufopicta</i>	–		0.15	0.03–0.73	–		0.09	0.03–0.25
Black-bellied Firefinch <i>Lagonosticta rara</i>	–		0.13	0.03–0.46	–		0.06	0.02–0.19
Black-faced Firefinch <i>Lagonosticta larvata</i>	–		–		–		0.13	0.04–0.41
Black-rumped Waxbill <i>Estrilda troglodytes</i>	0.28	0.10–0.79	0.38	0.14–1.00	–		0.09	0.02–0.38
Red-billed Firefinch <i>Lagonosticta senegala</i>	0.13	0.04–0.46	0.13	0.05–0.30	–		0.24	0.09–0.64
Rock Firefinch <i>Lagonosticta sanguinodorsalis</i>	–		0.48	0.16–1.47	–		<b>0.62*</b>	0.32–1.21
Lavender Waxbill <i>Estrilda caerulescens</i>	–		–		–		0.07	0.03–0.18
Red-cheeked Cordonbleu <i>Uraeginthus bengalus</i>	<b>0.64*</b>	0.35–1.15	0.51	0.18–1.41	1.61	0.34–7.65	<b>1.08**</b>	0.69–1.71
Orange-cheeked Waxbill <i>Amandava subflava</i>	0.03	0.005–0.12	0.05	0.004–0.72	–		0.06	0.02–0.19
Jos Plateau Indigobird <i>Vidua maryae</i>	–		0.05	0.01–0.17	–		–	
Village Indigobird <i>Vidua chalybeata</i>	0.10	0.03–0.41	0.05	0.009–0.28	0.48	0.01–2.34	0.02	0.004–0.08

<sup>1</sup> Model fitting: Habitat 1: Hazard-rate (cosine expansion), goodness-of-fit  $\chi^2_1 = 0.0001$ ,  $P = 1.00$ ; Habitat 2: Hazard-rate (cos),  $\chi^2_2 = 0.042$ ,  $P = 0.98$ ; Habitat 3: Half-normal (cos),  $\chi^2_1 = 0.007$ ,  $P = 0.99$ ; Habitat 4: Half-normal (cos),  $\chi^2_3 = 0.222$ ,  $P = 0.97$ .

density estimates were that each habitat type was itself rather heterogeneous and the number of individual birds seen was quite small for many species. Nevertheless, our study did yield sufficiently robust estimates for the Rock Firefinch, for which the survey was specifically intended.

As its name suggests, the Rock Firefinch is closely associated with inselbergs and rocky habitats on the Jos Plateau, confirming the findings of earlier studies in a more restricted geographical area around the Amurum Forest Reserve on the Jos Plateau (Brandt & Cresswell 2008, Wright & Jones 2005). Both the present study and that of Wright & Jones (2005) were carried out during the wet season but during the dry season this habitat association may not be as strong. Using radio-telemetry, Brandt & Cresswell (2008) found that during the dry season Rock Firefinches were more likely to utilise scrub savanna on flatter ground which they had to cross to reach water in gallery forests along gullies. We could not make a seasonal comparison in our present study because we were unable to carry out sufficient transect counts during the dry season.

The population density of Rock Firefinches in relatively undisturbed semi-natural habitat around inselbergs and large boulders found in this study, 0.62 birds/ha, was rather lower than the 0.79 birds/ha obtained by Wright & Jones (2005) from point counts in the protected semi-natural vegetation around the Amurum inselbergs but the difference was not significant ( $F_{1,80} = 0.407$ ,  $P = 0.525$ ). Similarly, the population density in farmed areas around inselberg habitat in the present study, 0.48 birds/ha, was not significantly different from the density

of 0.55 birds/ha found by Wright & Jones (2005) in the farmland immediately around the Amurum Reserve ( $F_{1,85} = 0.071$ ,  $P = 0.791$ ). As these two studies are in broad agreement about the relative abundances of Rock Firefinches in semi-natural compared to farmed rocky landscapes, it is tempting to suggest that farmland around inselberg habitat may not be as suitable as similar, relatively undisturbed areas, with protected habitat being best of all. Nevertheless, the Rock Firefinch appears to survive (almost) as well in farmed areas, provided there are inselbergs or large rocks nearby, as in less disturbed inselberg habitat.

It seems clear that the Rock Firefinch's brood parasite, the Jos Plateau Indigobird, is rare or very local in distribution. Only two individuals were seen, and although these were in rocky habitat they were on farmland and none was seen in the semi-natural habitat where its host, the Rock Firefinch, was most abundant and where they should have been most likely to occur. Their density estimated in this study, only 0.05 birds/ha, is an order of magnitude smaller than that of its host in the same habitat, 0.55 birds/ha. Although unreliable because so few birds were seen, this estimate nevertheless accords with the finding of an earlier study in which the Red-billed Firefinch was shown to be 10 times more abundant than its brood parasite the Village Indigobird (Payne & Payne 1994). Unfortunately, density estimates for Red-billed Firefinch and Village Indigobird from the present study are unreliable because of very small sample sizes and do not show any consistent relationship (Table 1).

The present evidence suggests that the Rock Firefinch

may not have been greatly affected by the increasing extent of agriculture on the Jos Plateau because areas closest to inselbergs and rock outcrops are less suitable for farming. It remains uncertain, however, to what extent the Rock Firefinch and its much rarer brood parasite can persist as small populations as rocky habitats become increasingly fragmented in the face of human pressure on farmland.

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