Research Article

Bird communities of the lower Waria Valley, Morobe Province, Papua New Guinea: a comparison between habitat types

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Abstract
From June, 2007, to February, 2009, the Waria Valley Community Conservation and Sustainable Livelihoods Project (WVCP) completed an inventory survey of the birds of the lower Waria Valley, Morobe Province, Papua New Guinea. Four land use types -- agricultural, secondary forest edge, primary forest edge and primary forest -- were surveyed using Mackinnon list surveys. In total, 125 species representing 43 families were identified, of which 54 (43.2%) are endemic to the islands of New Guinea and the Bismark Archipelago. The avifauna of primary forest edge and primary forest was more species rich and diverse than that of agricultural habitats. Agricultural habitats also differed significantly in both overall community composition and some aspects of guild composition compared to all three forested habitats. Nectarivores and insectivore-frugivores formed a significantly larger proportion of species in agricultural habitats, whereas obligate frugivores formed a significantly greater proportion in forested habitats. We propose further survey and management initiatives that could help contribute to the conservation and sustainable use of the area's important biological resources.

Key Words: New Guinea, Birds, Community composition, Lowland rainforest, Habitat alteration

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Introduction

The tropical rainforests of New Guinea, covering almost 70% of the island [1], are among the last remaining wilderness areas on the planet and are the third largest tropical rainforest in the world after the Amazon and Congo forests [2]. They are rich in biodiversity: Papua New Guinea (PNG) itself contains over 5% of the total estimated world's biodiversity [3], and New Guinea's lowland tropical forests and sub-tropical moist forests rank among the top ten most ecologically diverse regions in the world [2].

Within this richness of biodiversity, the avian diversity of New Guinea and the associated Bismark Archipelago is itself of global importance, with nearly 48% of the estimated 800 species endemic to these islands [4]. This compares favourably with other tropical islands such as Borneo, which has an estimated 620 species but only 6% endemicity, and Madagascar with approximately 297 species and 35% endemicity [5]. Birdlife International has designated 13 areas within Papua New Guinea as Endemic Bird Areas (EBAs), defined as an area encompassing the overlapping breeding ranges of many restricted-range bird species. The Waria Valley itself lies within the South-east Papuan lowlands secondary EBA (EBA s114), a region defined by the restricted range PNG-endemic Brown-headed Paradise-kingfisher *Tanysiptera danae* [6].

The avifauna of New Guinea is distinctly more Australian than Oriental in nature: only four of the 70 families found in New Guinea are absent from northern Australia [7]. New Guinea and Australia also share 13 families not found in South-east Asia [7]. Within New Guinea the distribution of bird species is varied and in some cases enigmatic. Unsurprisingly, the majority of bird species are dependent on forest, with species richness tending to be greatest in the lowland rainforests [7]. Species diversity also varies considerably with altitude, generally decreasing as altitude increases [7]. Many bird species such as fruit-doves *Ptilinopus* spp., several kingfisher genera and monarchs are restricted to the lower altitudes, generally below 1500 m [7]. Compared to other localities, New Guinea's lowland rainforests have an avian community richness comparable to similar tropical forest sites in Borneo, greater than sites in Liberia, but far less than sites in the Amazon [7].

Papua New Guinea has a relatively small human population of around 6.6 million [3]. Because of this low density (approximately 15 people per km^2) most of its natural habitat is still intact, with 71% of the country's total land area covered by forest in 2002 [8]. This means that at present only 36 bird species are listed as vulnerable or worse by the IUCN [9]. However, as the human population continues to grow and industrial activities such as mining and commercial logging increase, more pressure will be put on bird species. Indeed, between 1972 and 2002, 15% of Papua New Guinea's rainforests were cleared and 8.8% degraded to secondary forest, equating to a total loss of 7.9 million hectares [8]. In many areas, hunting for plumes for use in traditional headdresses is considerable, and with the growing use of guns this has meant many species such as Pesquet's Parrot *Psittrichas fulgidus* and Blyth's Hornbill *Aceros plicatus* are absent from many areas [4,7].

No previous field surveys have been carried out on the avifauna of the area, aside from a brief five day environmental investigation undertaken on behalf of PNG Forest Products Pty. Ltd. in 1989, which centred on the Morobe harbour area. This produced a checklist of 257 species of which only 69 were directly observed [10].

There is thus no formal species inventory for the avifauna of the lower Waria Valley, and certainly no information regarding distribution and composition of species within different habitat types. This work was conducted as part of the Waria Valley Community Conservation and Sustainable Livelihoods Project (WVCP) between May 2007 and March 2009. The study set out to complete the first detailed species inventory of the

bird fauna in the lower Waria Valley, to assess species diversity and relative abundance, and to increase knowledge of species distribution in relation to vegetation type.

Methods

Study Area

This study was conducted in the lower Waria Valley based at Nero hamlet near Zare village, approximately 7 km inland from the coast. The Waria Valley is located in the south-east peninsula on the north coast of Papua New Guinea in Morobe Province (Fig. 1). The Waria River, which forms the valley, initially flows south-east out of the Bowutu Mountains through Garaina, before heading north-east where it enters the Solomon Sea near Morobe harbour, approximately 190 km south-east of Lae. The area around the lower valley is generally hilly, characterised by steep-sided, narrow ridges that in some places almost reach the seashore. These ridges tend to have a slope of 20°-30° and reach an altitude of 100-300 m. As the Waria River nears the coast there is an increase in the area of flat alluvial plains.

The Waria Valley lies within the South Eastern Papuan rainforest eco-region, and the lower valley is dominated by Lowland Rainforest, defined as rainforest below 1000 m altitude [8]. The predominant forest sub-type is lowland hill forest on the slopes and ridges with areas of swamp forest occurring in the flatter lower reaches. Lowland plain forest is patchily distributed as the majority has been cleared for cultivation [11]: over 26 km^2 between the Wiwo River and coast, according to satellite imagery.

Fig. 1. Map of the lower Waria Valley and location in Papua New Guinea (insert)

The weather regime around the lower Waria Valley can be described as lowland perhumid with a high relative humidity ranging from 80-90% [12]. Weather data recorded daily at the project base in Nero hamlet (S 7°51.740, E 147°38.072) from August 2007 to February 2009 (except March 2008) gave a mean annual rainfall of over 3000 mm, with a monthly average high temperature of 29-32°C and a low of 24-26°C (see Fig. 2). May to October tended to be the wettest and coolest months, with the hottest and driest from December to April.

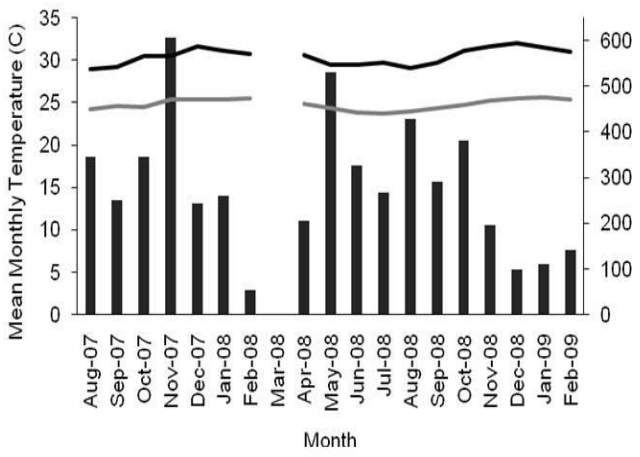

Fig. 2. Mean high and low monthly temperature (°C, line left axis) and total monthly rainfall (mm, bar right axis) recorded at Nero hamlet August 2007 – February 2009

Survey work was conducted in four major habitat types based on preliminary field assessments: Primary forest, Primary forest edge, Secondary forest edge and Agricultural (Table 1 and Fig. 3).

- **Primary forest:** Classified as primary old growth hill or plain forest with a dense canopy reaching 30-35 m. Major canopy genera include *Anisoptera thurifera, Pometia, Syzygium* and *Calophyllum* with *Myristica*, *Cryptocarya* and palms common in the sub-canopy. Survey locations were situated in forests that had a large, continuous expanse and were a minimum of 250 m from the forest edge and fairly undisturbed.

- **Primary forest edge:** Classified as primary old growth hill or plain forest that is subject to a higher level of anthropogenic disturbance through agricultural cultivation practices at the boundary of the primary forest and the selective cutting of trees. These locations were situated in areas of forest which are being reduced in area and within 200 m of the primary forest boundary. As such they are much more prone to edge effects than the primary forest sites.

- **Secondary forest edge:** Classified as secondary forest that has regenerated to a level containing many mature trees of at least 20 years in age. These areas are decreasing in the valley due to the reduction in the swidden cycles from around 15-20 years a generation ago to 5-7 years at present, resulting in areas of forest regrowth being cleared for crops before they have reached a mature secondary stage (Dawson pers. comm. local staff). These areas tend to border primary forest and agricultural land, acting as a buffer between the old growth and man-made habitats. Trees such as *Kleinhovia hospita, Ficus* spp. and *Sloanea* spp. abound, with some typical primary forest species (e.g. *Anisoptera thurifera, Pometia pinnata*) also present.

- **Agricultural:** These are man-made habitats such as food gardens and plantations, including associated early stage regrowth. Major crops include rice *Oryza sativa*, taro *Colocasia esculenta*, sweet potato *Ipomoea batatas,* and banana *Musa* spp. Many plantations for growing coconut *Cocos nucifera* and cocoa *Theobroma cacoa* exist, with *Glaricidea* spp*.,* a common shade tree, used within them. Early stage regrowth in old garden areas is dominated by stands of *Piper aduncum.*

Table 1. Locations and descriptions of the major survey sites

Survey site	AGD 84 co-ordinates		Altitude (m)	Habitat Type	Description
	Latitude	Longitude			
Atai	S 7°52.894	E 147°37.003	95	Primary	Old growth hill forest
Bowe	S 7°53.141	E 147°38.533	20	Primary edge	Old growth hill forest, adjacent to garden areas
Ewaga	S 7°51.929	E 147°35.244	32	Primary	Old growth hill/plain forest bordering Giu river
Mewana	S 7°52.085	E 147°37.090	35	Primary edge	Old growth swamp/hill forest bordering gardens
Mt. Unu	S 7°51.082	E 147°38.693	25-130	Secondary edge	Mature secondary at base, hill forest above bordering gardens
Puene	S 7°51.726	E 147°37.682	50	Secondary edge	Mature secondary, hill forest above, bordering village and gardens
Sowara	S 7°51.161	E 147°37.584	32	Primary edge	Old growth hill/swamp forest bordering cleared garden areas
Unu	S 7°50.987	E 147°39.078	10	Agricultural	Gardens, plantations and regrowth
Wamote	S 7°52.511	E 147°38.679	15	Secondary edge	Mature secondary, hill forest above bordering regrowth and gardens
Wiwo	S 7°56.534	E 147°36.007	200	Primary	Old growth hill forest
Zazamara	S 7°51.842	E 147°37.452	15	Agricultural	Gardens, plantations and regrowth
Zure	S 7°51.447	E 147°38.661	10	Agricultural	Gardens, plantations and regrowth

These habitat types were chosen to reflect the transition from natural lowland rainforest to man-made habitats, so that the effects upon biodiversity composition could be seen and comparisons made. Primary forest and human altered habitats (seen as the paler areas of the satellite image along the rivers in Fig. 3) dominate the area with small areas of mature secondary forest.

Surveys were conducted at 12 major survey sites, of roughly similar area (approximately 4 Ha) representing three replicates of each habitat type. These locations were dictated in a major part by land ownership; being located on land owned by family groups agreeing to work with the project and free of ownership disputes. Land ownership disputes resulted in six other survey sites being lost after one or two surveys.

Each major survey site was surveyed three times between June 2007 and February 2009. To minimise potential effects of weather and seasonality, the three surveys for each major survey site were conducted where possible at different times of the year. Surveys were conducted by trained project staff and volunteers.

Survey Methods

The bird fauna was surveyed by observation using MacKinnon lists [13]; a standardised sampling method which allows accurate quantitative comparison of species richness between sites and habitats which has been successfully used in other tropical forest locations [14-18]. The observer made a list of species detected by recording each new species until a predetermined number of species was reached. Based on preliminary surveys, the list length was set at the advised minimum of 10 species [19]. A species could only be recorded once on each list of 10 species, but could be recorded on subsequent lists if re-detected. A minimum of 19 lists were compiled at each major survey site. If a list was not completed in a single visit it could be continued and finished the following day. Surveying occurred primarily in the mornings from just before dawn till 9.00am and

in late afternoon before dusk totalling approximately five hours per day depending on weather conditions.

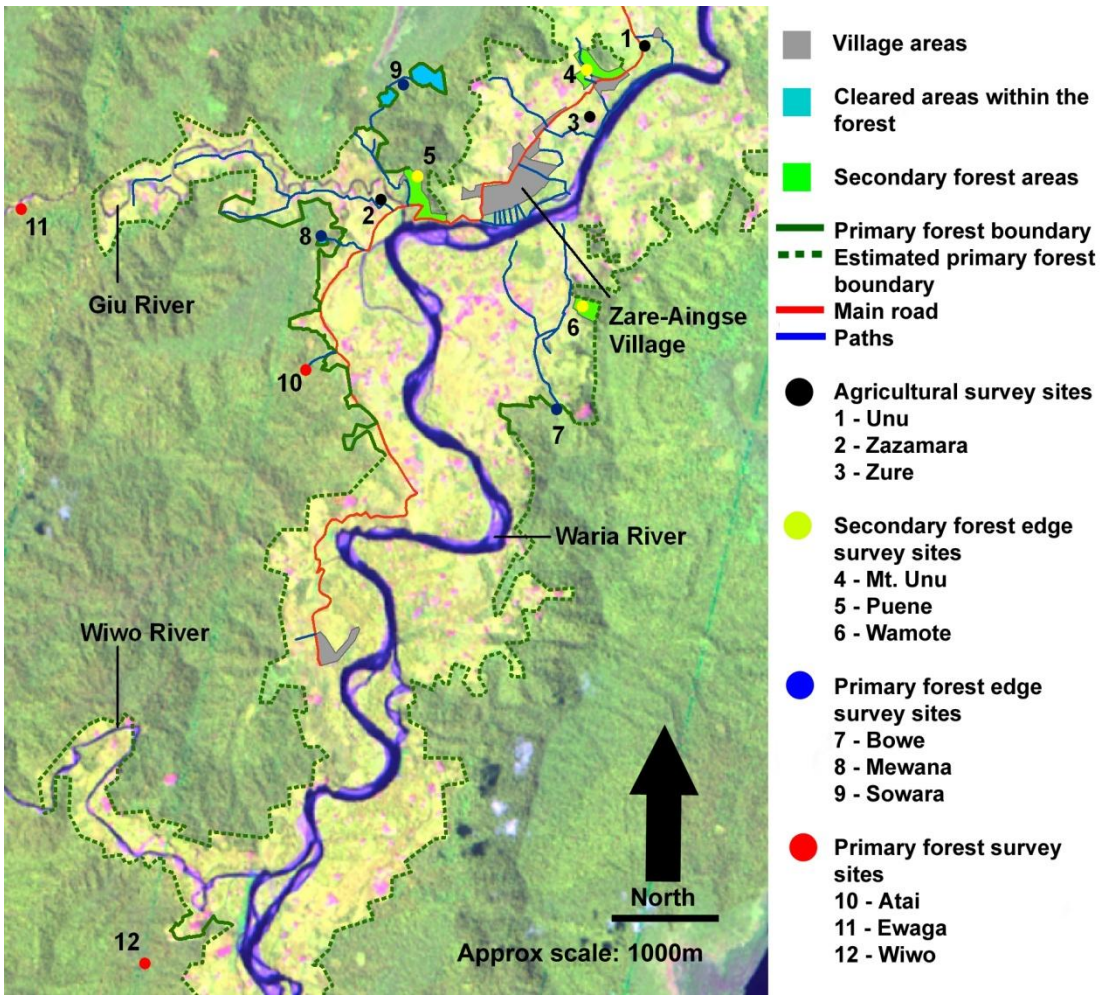

Fig. 3. Map showing habitat boundaries and major survey site locations.

Whilst the Mackinnon list technique is no less susceptible to observer bias than other bird survey techniques [20], it allows for a certain degree of difference in observer ability [21]. Inter- observer bias was minimised by three project staff (JD, OP and AF) acting as primary observers, accounting for over 85% of all lists recorded. All three spent one month in the field familiarising themselves with the avifauna before the first official surveys were conducted. All subsequent observers were given training by these three staff members and accompanied them on a number of surveys before being allowed to conduct surveys independently. In total four other observers, all of whom had previous bird survey experience, conducted surveys independently.

Observers were free to move around the survey site but only recorded birds within the habitat type being studied. Up to three observers were recording independently at any one time but were in separate areas of the site in order to minimise crossing of paths and double recording. Visual observations and calls could be used for species identification, but birds flying over the site were not recorded unless they were foraging or

hawking. For any bird observed that could not be identified immediately, a detailed description was taken for identification later. If the bird was still not able to be positively identified it was discarded from the list. With a few exceptions, birds that could not be identified to species level were not included in the list. Exceptions included *Meliphaga* spp*., Lorius* spp*.* and *Chalcophaps* spp*.,* due to species being so similar that often positive identification was extremely difficult past genus level. Birds were identified using Beehler et al. [7] and Coates and Peckover [4]. Nomenclature follows Coates and Peckover [4]. Birds that were observed outside of formal surveys were recorded as casual observations.

Data Analysis

An Index of Relative Detectability (IRD) rather than abundance was calculated for each species at each major site and for each habitat (incorporating all sites). This calculates the proportion of lists on which a species appears at each location, and thus the index can vary between 0 (species not recorded) and 1 (species recorded on every list). The term 'index of relative detectability' has been used here, rather than the standard 'index of relative abundance', as the frequency of a species occurring on a list is dependent on several factors, of which abundance is only one (see Appendix 1).

Community composition within habitats was examined in terms of feeding guild. All species recorded during the MacKinnon list surveys across the 12 major sites were assigned to one of 12 feeding guilds adapted from Bell [22] (Table 2). Using the IRD values, the relative proportion of each feeding guild was calculated for each site and differences between habitats were tested using a non-parametric Kruskal-Wallis test. The insectivore guild was tested both with and without swifts and swiftlets (Apodidae ssp.) as this latter group was heavily biased towards agricultural habitats. The granivore and lichenivore guilds were not tested as they were represented by a single species each, both of which were recorded at less than three sites each.

Table 2. Assigned feeding guilds and typical representative species

Feeding Guild	Typical species
Nectarivore	Black Sunbird *Nectarinia aspasia*
Insectivore-nectarivore	Meliphaga honeyeaters *Meliphaga* spp*.*
Insectivore	Fantails *Rhipidura* spp., Spangled Drongo *Dicrurus bracteatus*
Insectivore-frugivore	Metallic Starling *Aplonis metallica*, Cuckoo-shrikes *Coracina* spp.
Nectarivore-frugivore	Black-capped Lory *Lorius* spp., Rainbow Lorikeet *Trichoglossus haematodus*
Frugivore-granivore	Sulphur-crested Cockatoo *Cacatua galerita*, Ground-doves *Chalcophaps* spp.
Frugivore	Blyth's Hornbill *Aceros plicatus*, Pinon Imperial-pigeon *Ducula pinon*
Omnivore	Bare-eyed Crow *Corvus tristis*, Red-legged Brush-turkey *Talegella jobiensis*
Carnivore	Hooded Butcherbird *Cracticus cassicus*, Raptors, Kingfishers
Granivore	Streak-headed Mannikin *Lonchura tristissima*
Lichenivore	Buff-faced Pygmy Parrot *Micropsitta pusio*

Further patterns in community composition were assessed using PRIMER [23]. The Bray-Curtis similarity measure was calculated (from the IRD data) between every species permutation of sample pairs [24]. The relationship between survey sites was analysed using a hierarchical agglomerate clustering technique [25]. The CLUSTER analysis successively fuses the samples into groups and the groups into larger clusters, starting with the highest mutual similarities, then gradually lowering the similarity level at which groups are formed. Close groupings of communities reflect similarities in community structure [23].

The similarity in community composition amongst the individual sites was tested against habitat type in a one-way analysis of similarity (ANOSIM) using PRIMER [23]. The species mainly responsible for the dissimilarity between these site groupings was subsequently determined using the SIMPER (similarity percentages) routine [23]. Species diversity metrics were calculated from the original count data sets. Three measures of local diversity were calculated for each survey location and habitat, including: Total number of species (S), Species Richness and Shannon-Weiner diversity $H=\Sigma(Pi*\text{Loge}(Pi))$ where *Pi* is the number of individuals of the *i*th species as a proportion of the total number of all *i*th species [26]. Again, differences amongst habitats were tested using a non-parametric Kruskal-Wallis test.

Results

In total 125 bird species representing 43 families were identified (combining MacKinnon list, mist net and casual observation data) in the lower Waria Valley, of which 48 are endemic to the island of New Guinea (including satellite islands), four are endemic to New Guinea and the islands of the Bismark Archipelago, and two are endemic to Papua New Guinea (see Appendix 2).

Of this total, 113 were recorded from 366 Mackinnon lists completed during the survey period in the 12 major survey sites and in six additional sites (Table 3).

Table 3. MacKinnon lists completed by habitat and location (major sites in bold)

Habitat	Site	Number of lists
Agricultural	Mewana garden	16
	Unu	**19**
	Zazamara	**26**
	Zure	**20**
	Total	81
Secondary forest edge	Main road	3
	Mt. Unu	**20**
	Puene	**21**
	Siu waterfall	10
	Wamote	**22**
	Total	76
Primary forest edge	Aruwo	9
	Bowe	**30**
	Mewana	**20**
	Nero ridge	21
	Sowara	**29**
	Yano	4
	Total	113
Primary forest	**Atai**	**33**
	Ewaga	**44**
	Wiwo	**19**
	Total	96

The species discovery curves show that in all major survey sites, species discovery occurred at roughly the same rate (Fig. 4 and Fig. 5). Plateaus indicate that at some of the survey sites the discovery of new species is unlikely. However, species discoveries were still increasing in all habitat types at Ewaga, Mewana, Puene, Sowara and Zure. Given that sites such as Ewaga and Sowara are still showing increases in species discovery after so many lists and survey efforts, and after plateau periods, it is likely that further species will be identified at the other sites as well.

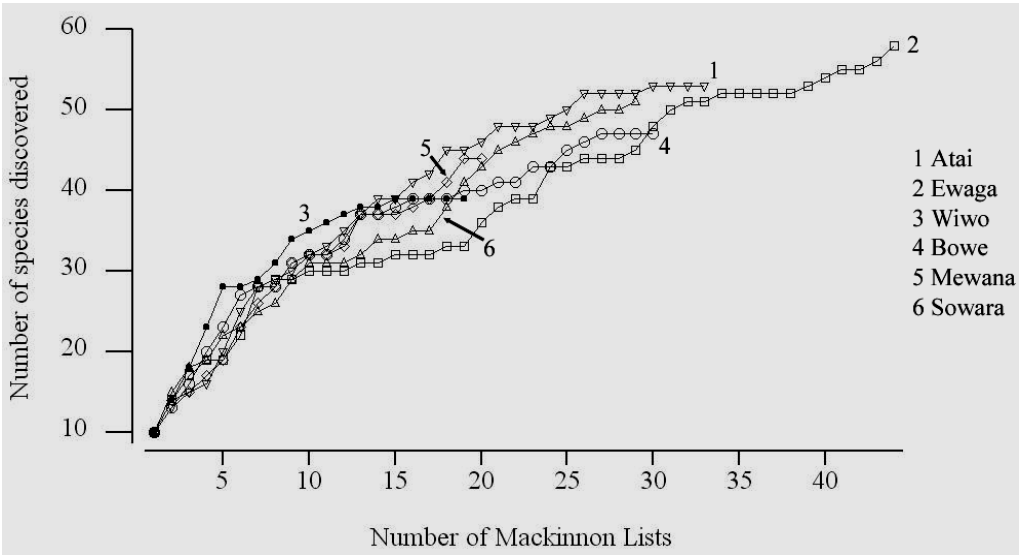

Fig. 4. Bird species discovery curves for each major primary forest and primary forest edge survey site.

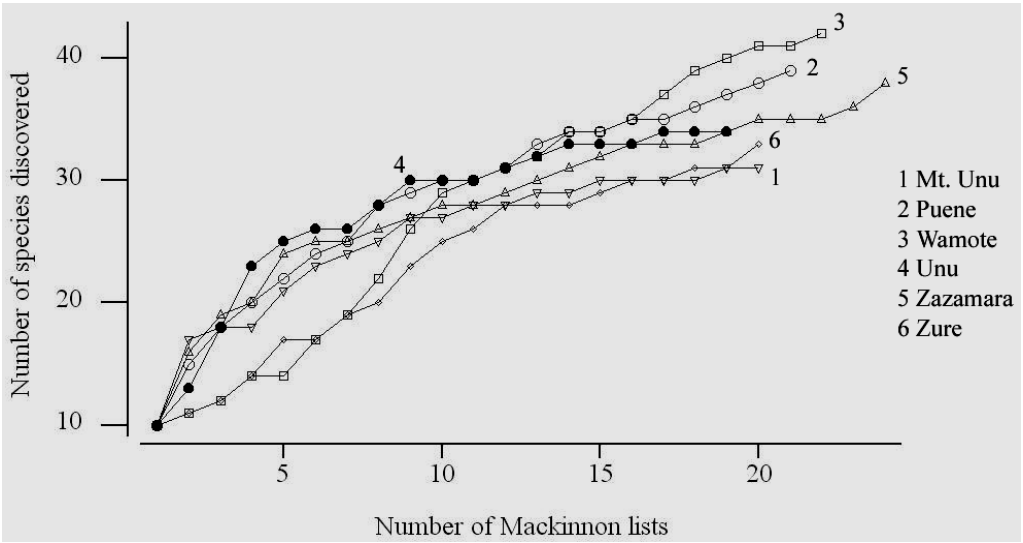

Fig. 5. Bird species discovery curves for each major secondary forest edge and agricultural survey site

Additional species discovery curves were calculated for each habitat type (Fig. 6) utilising data from all 18 survey sites. As with the species discovery curves for the major survey sites, species discovery occurred at roughly the same rate in all habitat types. All the habitat graphs are approaching an asymptote, suggesting that the majority of species have been discovered within each habitat type. It is likely that more species will be discovered, given that the discovery curves for some sites are still increasing, though many more lists will likely need to be completed.

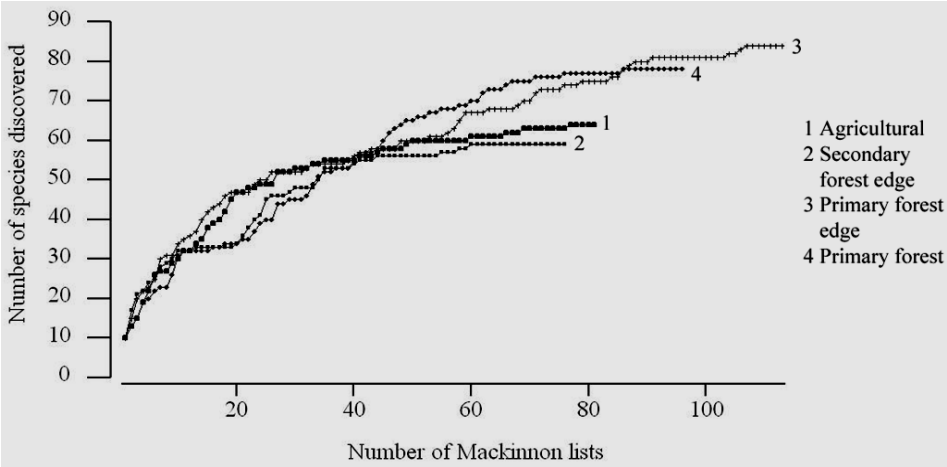

Fig. 6. Bird species discovery curves for each habitat type

Thirteen species were recorded at all the 12 major survey sites with the most commonly recorded species being Blyth's Hornbill, Eclectus Parrot *Eclectus roratus*, Hooded Butcherbird *Cracticus cassicus*, Pinon-imperial Pigeon *Ducula pinon*, Spangled Drongo *Dicrurus bracteatus* and Sulphur-crested Cockatoo *Cacatua galerita*. In total 37 species were recorded within all habitat types and many species were only recorded from a single sighting at one or two sites.

Community Composition

Four feeding guilds showed significant differences amongst habitats (Fig. 7). Nectarivores formed a significantly larger proportion of the birds recorded in agricultural habitat than in all forest habitats ($H = 3.86$, $p = 0.05$). In addition the proportion of birds making up the insectivore-nectarivore guild was significantly greater in agricultural habitat than in both primary forest habitats ($H = 3.86$, $p = 0.05$). The insectivore-frugivore guild also formed a significantly greater proportion of birds recorded in agricultural habitat than in all forested habitats ($H = 3.86$, $p = 0.05$) with a significant difference also between secondary edge and primary forest habitats ($H = 3.86$, $p = 0.05$). Conversely the proportion of obligate frugivores recorded in each forested habitat was significantly greater than that recorded in agricultural habitat ($H = 3.86$, $p = 0.05$).

The cluster comparison for individual sites shows that bird species composition among the three agricultural sites (Unu, Zure and Zazamara) is most distinct (Fig. 8). All the forested sites appear to be fairly similar (> 60%) in terms of bird species composition and are distinct from the agricultural sites.

When analysed for habitat type, the cluster analysis shows a greater distinction between the bird species composition of agricultural habitats and forested habitats. Even though species composition among all three forested habitats is quite similar (approximately 79%), primary forest edge and primary forest habitats form a tighter cluster and are therefore more similar (approximately 84%) than secondary forest edge.

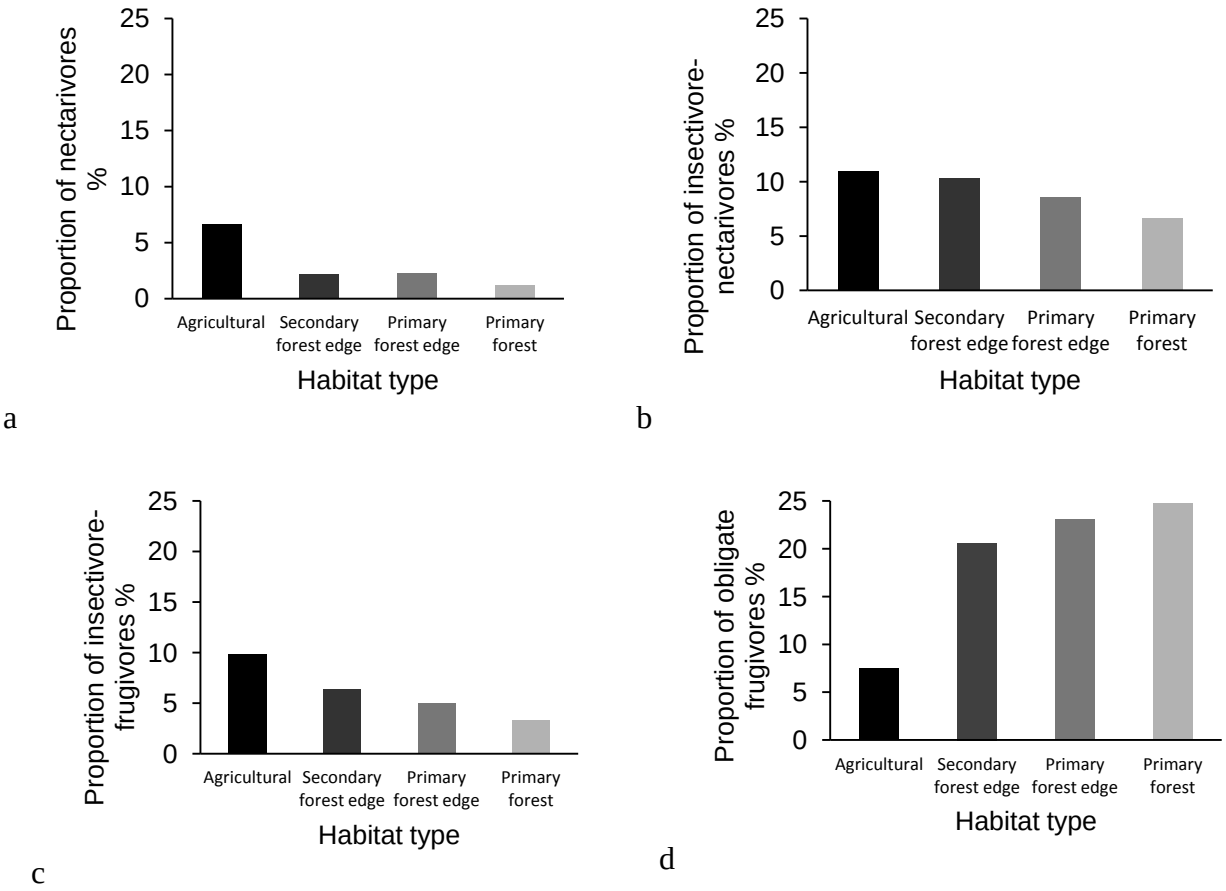

Fig. 7. Proportions of feeding guilds within habitat type (a) nectarivores; (b) insectivore-nectarivores; (c) insectivore-frugivores; (d) obligate frugivores.

In comparing similarity between the community composition between sites and habitat type the ANOSIM returned a global R-value of 0.383 (p = 0.018). Therefore the notion that similarity is due to random occurrence rather than due to habitat type cannot be rejected. When comparing the ANOSIM pair-wise tests however, agricultural sites were found to be much more similar than all other sites (secondary forest edge R = 0.778, p = 0.1; primary forest edge R = 1, p = 0.1; primary forest R = 0.963, p = 0.1. NB 0.1 is the highest p-value the ANOSIM pair-wise tests return). None of the other pair-wise tests were significant.

Although no single species has a particularly high discriminating effect, a number of species individually contribute over 4% of dissimilarity and in each forest habitat five species contribute approximately 25% of the dissimilarity (Table 4). Blyth's Hornbill accounts for the most dissimilarity in all but primary forest, where it is second and is therefore a strong discriminating factor for forest habitats. Equally the abundance of Metallic Starling *Aplonis metallica* appears to be a relatively strong discriminating factor for agricultural habitat. The ratios for species in relation to primary forest tend to be higher than those for other forest habitats, suggesting they will be better discriminators for this forest habitat in relation to agricultural habitat.

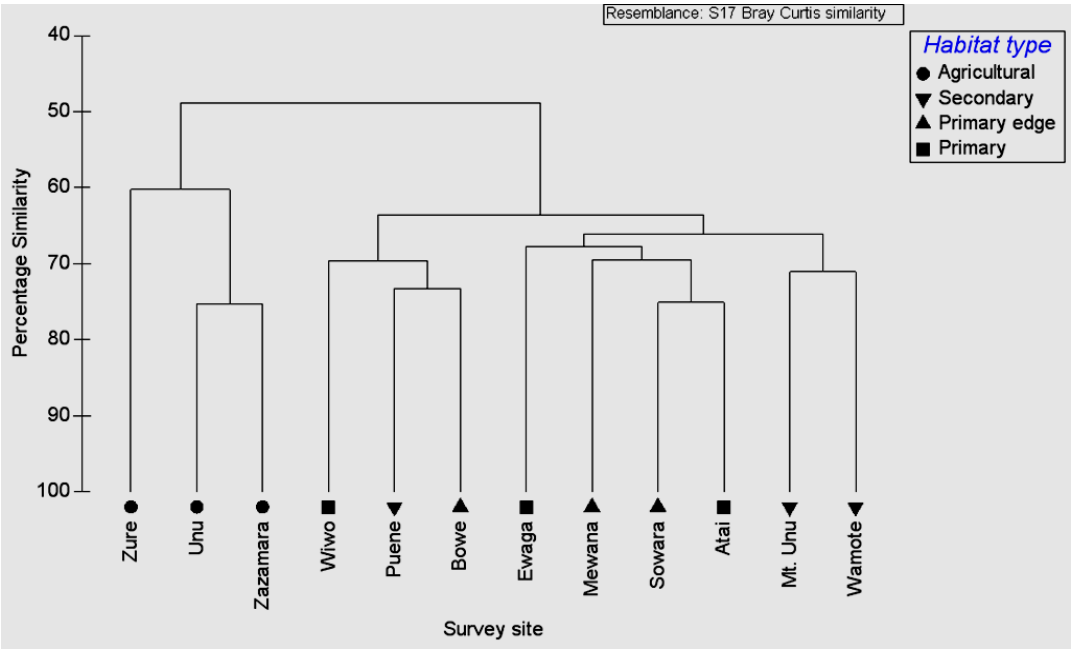

Fig. 8. Dendrogram of bird community composition calculated using group-average linking of Bray-Curtis similarities and labelled according to survey site name.

Diversity and species richness

Atai, Ewaga and Sowara were the most species-rich sites, and overall both primary and primary edge habitats had the greatest species richness (Table 5). Mt. Unu (secondary) and all three agricultural sites (Unu, Zazamara, and Zure) showed the lowest degree of species richness. Primary forest edge sites had significantly higher species richness than both agricultural sites ($H = 3.86$, $p = 0.05$) and secondary forest edge sites ($H = 3.86$, $p = 0.05$). Primary forest sites, however, only showed a significant difference from agricultural sites ($H = 3.86$, $p = 0.05$) and not from secondary forest edge sites ($H = 2.33$, $p > 0.05$).

Diversity (measured by Shannon-Wiener Index) is shown to be high across all of the sites, with primary and primary edge habitats showing the greatest diversity overall (Table 5). Both primary sites and primary edge sites were significantly more diverse than agricultural sites ($H = 3.86$, $p = 0.05$; $H = 3.97$, $p < 0.05$ respectively), but only primary edge sites were significantly more diverse than secondary edge sites ($H = 3.97$, $p < 0.05$).

Discussion

Results from this study indicate that the avifauna of the lower Waria valley is diverse and species rich, as would be expected in a New Guinean lowland rainforest habitat. Species richness and diversity were found to be greater in primary forest and primary edge habitats than in agricultural habitats, which supports findings from another lowland forest site in Madang [27]. In a recent review of studies comparing species richness and diversity in various plant and animal taxa between primary forest and various agro-ecosystems by Scales and Marsden [28], five of the seven bird studies reviewed [e.g. 17,29] also reported richness decreasing with increased agricultural activity. The two other studies, in the Amazon [30] and China [31], reported no consistent differences. Of the 43 studies examined in the review, 34 showed results similar to our findings [28].

Our findings do, however, differ from those at a mid-altitude site at Crater Mountain in Papua New Guinea. There, the highest levels of species richness and bird densities were found in areas of intermediate disturbance, classified as being abandoned gardens eight years or older [32,33]. This also contrasts to lower altitude sites at Crater Mountain (< 651 m), where primary forest held the highest densities of most species

[32]. It is unlikely that this difference is due to lower impact agriculture at higher elevations, as the gardens at higher locations were both older and more densely packed than lower down [32]. One possible explanation given for this is that birds may be more tolerant of small-scale agriculture in New Guinea at higher elevations than at lower elevations, which affects not only richness but also density and abundance [32,33]. Certainly the lack of similar studies in New Guinea means that any firm conclusions relating to differences in bird responses at varying elevations cannot be made at present and the question is an area for further study.

Table 4. SIMPER analysis of dissimilarity between agricultural habitat and combined secondary forest edge, primary forest edge and primary forest habitats.

Comparison	Species	Average abundance		Ratio	Percentage contribution
		Agricultural	Combined Forest		
Secondary forest edge	Blyth's Hornbill	0.18	0.80	3.72	6.56
Average dissimilarity =	Pinon Imperial-pigeon	0.22	0.73	2.10	5.43
47.14	Spangled Drongo	0.24	0.70	4.36	4.90
	Black Sunbird	0.66	0.22	3.13	4.69
	White-bellied Thicket-fantail	0.43	0.03	1.59	4.20
	Metallic Starling	0.94	0.60	3.16	3.53
Primary forest edge	Blyth's Hornbill	0.18	0.89	9.07	6.99
Average dissimilarity =	Metallic Starling	0.94	0.42	4.42	5.09
50.89	Shining Flycatcher	0.51	0.07	2.79	4.26
	Pinon Imperial-pigeon	0.22	0.65	2.70	4.26
	Black Sunbird	0.66	0.23	2.21	4.23
Primary forest	Metallic Starling	0.94	0.21	6.75	6.59
Average dissimilarity =	Blyth's Hornbill	0.18	0.82	5.61	5.83
55.42	Pinon Imperial-pigeon	0.22	0.81	3.01	5.35
	Black Sunbird	0.66	0.12	5.56	4.87
	Glossy Swiftlet	0.51	0.07	5.76	3.97

Within primary forest habitats, no difference was found between edge and interior forest in terms of species richness and diversity. However, whilst primary forest edge habitat had a significantly higher species richness and diversity than secondary forest edge habitat, primary forest (interior) habitat did not. This differs from a number of other tropical studies that find species richness to be reduced close to the edges [e.g. 34-37]. Few studies, though, have examined how far edge effects penetrate into primary forest. Dale et al. [35] found that forest-interior species began increasing in abundance around 400 m in but Canaday [38] reported edge effects reaching 2 km into the forest if the clearings were large enough. It may be that the primary forest sites in our study were not far enough into the interior to register any clear edge effects. Or that due to the vast expanses of undisturbed forests with which the edge sites are associated and the combined effects of habitat heterogeneity [39], no discernable edge effects were seen.

Secondary forest edge sites did not differ significantly from either agricultural or primary forest sites in terms of species richness or diversity, suggesting that they are a transitional habitat able to support a mixed bird community. The similarity shown in the cluster analysis suggests, however, that mature secondary forest would be able to support bird communities more similar to those in primary forest habitats than in agricultural

habitats. This is supported by a study in Madang Province by Bowman et al. [27] which found that secondary forest contained almost as many species as primary forest, with many species in common. Bell [40] also suggests that secondary forest with continuous canopy cover is likely to support a large number of forest bird species, as shown in the New Guinea highlands where lowland forest species have colonised new large areas of secondary forest [41,42]. Bell [40] believes that a substantial proportion of New Guinea birds can adapt to secondary habitat, with most being able to re-occupy disturbed forest within two decades. However, Bowman et al. [27] urge that this similarity be treated with caution as it may be a result of the habitat mosaic present in the landscape, and that the removal of the primary forest may lead to the secondary forests becoming faunally depauperate. Within our study, a total of 28 species were found only in primary forest and primary edge habitats, which would translate to a 27.5% species drop out. These species include Buff-faced Pygmy-parrot *Micropsitta pusio*, Red-cheeked Parrot *Geoffroyus geoffroyi*, New Guinea Bronzewing *Henicophaps albifrons*, New Guinea Tiger-heron *Zonerodius heliosylus* and five species of Monarchidae (see Appendix 2 for full information).

Table 5. Bird Diversity indices for each major survey site and habitat type (all surveys).

Survey site	Total species[1]	Total individuals[2]	Species Richness[3]	Shannon-Wiener Index[4]
Atai	58	330	9.83	3.42
Bowe	50	300	8.59	3.41
Ewaga	60	440	9.69	3.48
Mewana	47	200	8.68	3.41
Mt. Unu	32	200	5.85	3.10
Puene	42	210	7.67	3.22
Sowara	53	290	9.17	3.45
Unu	36	190	6.67	3.16
Wamote	46	220	8.34	3.35
Wiwo	42	190	7.81	3.34
Zazamara	39	260	6.83	3.24
Zure	37	200	6.79	3.14
Habitat type				
Agricultural	71	810	10.45	3.49
Primary	86	960	12.38	3.64
Primary edge	90	1130	12.66	3.59
Secondary edge	65	760	9.65	3.46

[1]Number of Species: the number of species present in a community is a crucial aspect of that community's biodiversity. The number of species varies between locations and can be a useful biodiversity indicator.

[2] Total Number of individuals identified during the survey period.

[3]Species Richness: Species Richness is defined by Margalef's Index ((d=(S-1)/Ln (N)). This incorporates the total number of individuals and is the measure of the number of species present for a given number of individuals. Species richness of the communities sampled in this study are based on same sample sizes and surveying effort.

[4]Shannon-Wiener: represented as H' = -∑i pi Log (pi) where pi is the proportion of the total count arising from the ith species. The higher the figure obtained the higher the diversity of the area.

Although there have been many differences in the patterns of species richness amongst the various studies, one area that is more consistent is the differences in community composition. In general, higher proportions of frugivores are associated with lower levels of forest alteration, and nectarivores are more common in agricultural habitats [27,29,33]. Our results are consistent with these findings, with nectarivores accounting for a significantly higher proportion of the recordings in agricultural habitat than in any of the three forest habitats. Similarly, obligate frugivores accounted for far higher proportions of recordings in each forest habitat than in agricultural habitat. This was also reflected in the SIMPER analysis, with two large frugivores, Blyth's Hornbill and Pinon Imperial-pigeon, both scoring highly as positive discriminating factors for all three forest habitats versus agricultural habitats, and the Black Sunbird *Nectarinia aspasia* the dominant nectarivore scoring as a strong negative discriminating factor.

A high proportion of nectivorous species in agricultural habitats is likely due to the increased availability of food resources [29,43] from planted crops, such as coconut and banana as well as early regrowth species. This may also be a reason for the higher proportion of nectivorous-insectivorous species recorded in agricultural habitats compared to primary forest and primary forest edge habitats.

The far lower proportion of obligate frugivores in agricultural habitats is likely due in part to the lack of canopy vegetation present in these habitats. Most fruit is found in the canopy of tropical forests [22], and in a study at Brown River in Central Province PNG, the vast majority of obligate frugivores were recorded in the canopy [44]. Whilst proportions of obligate frugivores in agricultural habitats were far lower than in forested habitats, the proportion of the insectivore-frugivore guild was significantly higher. This, though, is due to the presence of the Metallic Starling within this guild, which scored as a strong negative discriminating factor for all three forest habitats in the SIMPER analysis. The two other facultative frugivore guilds were very similar in all habitat types.

Taken as a single guild, frugivores per se still accounted for nearly 40% of all recordings in agricultural habitat, indicating that they utilise these areas in some way. A study in New Britain showed that parrots and hornbills frequently visited logged areas and agricultural garden areas to feed, with two species, the Eclectus Parrot and Eastern Black-capped Lory *Lorius hypoinochrous*, reported to be more common in gardens than in primary forest [45]. Though proportions of these two species did not differ significantly amongst habitats they were both commonly seen and recorded in agricultural areas.

It has been suggested that the proximity of agricultural plots to primary forest is an important factor in influencing community composition, with those plots closest to intact primary forest having higher proportions of frugivores [33]. All our agricultural sites were relatively close to primary forest (within 500 m) and this may certainly have influenced the community composition seen. Indeed, many of the larger frugivores, including Blyth's Hornbill, Sulphur-crested Cockatoo and Pinon Imperial-pigeon, were often recorded stopping in agricultural sites whilst en route across large corridors of agricultural and disturbed habitat to another area of primary forest. Primary forest, though, is still critical to these species' continued survival, for whilst agricultural habitats may provide food to a greater or lesser degree, they do not provide enough suitable nesting sites [45].

High proportions of insectivorous species have previously been linked to lower levels of forest disturbance [e.g. 17,29,33]. Our study did not return any significant differences amongst habitats in relation to this guild. However, in terms of insectivore species richness, primary forest and primary forest edge habitats contained far more insectivorous species (combined 36 out of 41) compared with agricultural habitats (20 out of 41).

These included four *Monarcha* species, two *Pitta* species and two relatively common species, the Little Shrike-thrush *Colluricincla megarhyncha* and Grey Whistler *Pachycephela simplex*. Some reasons for this study not finding any differences may be the small data set used for comparison (three sites for each habitat) and the fact that many forest insectivores are small, utilising the dense understorey [44] or have a skulking nature, making positive identification difficult without knowledge of their songs. Forest insectivores may therefore be underrepresented in this study in terms of relative abundance.

New Guinea is geographically complex, with bird populations in both the lowlands and highlands being repeatedly fragmented and rejoined during glacial periods of the Pleistocene [4]. This has given rise to many species having enigmatic or patchy distributions in what appears to be suitable habitat, making bird distributions difficult to delineate [7]. This means that direct comparisons with other lowland rainforest areas in New Guinea are difficult unless they are located in the same geographic area. Comparisons are further complicated by the apparent degree of variation between survey lists within a single locale, with even same-year counts at the same site producing disparities, as found by Beehler et al. [46].

The two main studies of lowland avifauna in New Guinea have also been conducted in the south-east peninsula at Lakekamu (approximately 140 km west of the lower Waria) [46] and the Brown River (approximately 20 km north of Port Moresby) [22,40,44,47-49], though both of these are located on the southern side of the central cordillera. Both of these recorded 184 species, though only 149 (68%) of the total 219 species were shared [45]. Of the 125 species recorded in the Waria Valley, 107 (85.6%) are shared in total at both sites, 96 (76.8%) at Lakekamu and 98 (78.4%) at Brown River. The greater number recorded at these two sites is most likely due to the surveyors' experience and knowledge of bird song.

The only other avifaunal study known of Morobe Province was conducted at Buso, approximately halfway between Lae and the Waria Valley on the coast, by Driscoll [50]. This study recorded a total of 90 species, of which 63 (70%) are shared with the Waria Valley (data taken from [11]). Whilst the Buso study recorded a number of smaller insectivorous species most likely missed in our study, such as Dwarf Honeyeater *Oedistoma iliolophus* and Rusty Mouse-warbler *Crateroscelis murina,* there were a number of notable absences. These included Hooded Butcherbird, Metallic Starling and Sulphur-crested Cockatoo, all of which are very common and abundant in the Waria Valley. Why these widespread, highly visible and noisy species were not recorded at Buso is inexplicable. Assuming that the data presented in the secondary source [11] are accurate, the absences may best be explained by local patchiness of distribution [51].

Overall, our study has highlighted the importance of forested habitats to the avifauna, in that 49 of the total 125 species (39.2%) were recorded only in forested habitats (secondary, primary edge and primary), compared to just 11 species (8.8%) seen solely in agricultural habitats (see Fig. 9 for examples of birds recorded) . It is highly likely that more species exist in the Waria Valley, particularly within the primary forest, as many species expected to be found in lowland rainforest in this part of New Guinea were not recorded, e.g. Blue Jewel-babbler *Ptilorrhoa caerulescens*, and Spotted Honeyeater *Xanthotis polygramma*. Indeed, only about half of the bird species on the checklist produced by Hopkins [10] were recorded. It should be noted, however, that only 69 of the 257 birds on the checklist were directly observed, with 30 others positively identified by local villagers, leaving 158 inferred from the species' known distribution. This is most likely due to the major limitation faced by the survey team: the lack of knowledge of bird calls and unavailability of Papua New Guinea bird call cassettes to the team. Beehler et al. [46] recognise that relatively complete species lists can only be generated through knowledge of calls, which is a very difficult task that must largely be gained through field experience. Certainly towards the end of this project, JD and OP were able to accurately identify the most

commonly encountered species by call. This, however, does not aid the identification of those species that are either nocturnal, small in size, have cryptic colouration and behaviour, or dwell within the dense understory or tree canopy, making visual observation highly difficult.

The majority of species recorded during the project are common and widespread, although three of the species recorded are red-listed by the IUCN [9] as Near Threatened: Gurney's Eagle *Aquila gurneyi*, Dwarf Cassowary *Casuarius bennetti,* and the New Guinea Tiger-heron, of which the latter two are endemic to New Guinea. Both of these appear restricted to primary forest habitats in the area. In addition a number of species are CITES listed [52]. The Palm Cockatoo *Probosciger aterrimus*, which appears to be relatively common in the area, is listed in Appendix I with the Sulphur-crested Cockatoo, Blyth's Hornbill, King Bird of Paradise *Cicinnurus regis*, Crinkle-collared Manucode *Manucodia chalybatus* and all members of the Acciptridae family listed on Appendix II.

Both PNG endemics, the Eastern Black-capped Lory and Brown-headed Paradise-kingfisher, are restricted to the south-eastern peninsula of Papua New Guinea, although the Eastern Black-capped Lory is also found on islands of the Bismark Archipelago. The Waria River represents the western-most part of the Brown-headed Paradise-kingfisher's range [4]. Within the area, it was recorded in all forested habitats but not in agricultural habitats.

One interesting record was the Red-breasted Paradise-kingfisher *Tanysiptera nympha,* which was observed on a number of separate occasions in different locations. Previously this species had only been found along the north coast of New Guinea as far east as Garaina at the headwaters of the Waria River [4]. Recording it within the lower Waria Valley extends its known range slightly eastwards. It is also the first known recording along the Huon Gulf coast. This proves that its range does overlap with the Brown-headed Paradise-kingfisher and suggests the possibility of hybridisation between the two species.

A particularly hard group to identify in the field is the *Meliphaga* group of honeyeaters, due to their similarity in appearance, song and behaviour. Three species were positively identified: the Graceful Honeyeater *Meliphaga gracilis cinereifrons*, Puff-backed Honeyeater *Meliphaga aruensis,* and Scrub White-eared Honeyeater *Meliphaga albonotata*. The presence of the Mimic Honeyeater *Meliphaga analoga* could not be confirmed, and it may be that this is one part of the south-eastern north coast from which it is locally absent [4].

The abundance of species in the area requiring old growth forest to breed, such as Blyth's Hornbill, Sulphur-crested Cockatoo and Palm Cockatoo [4,7], shows that there is still a healthy amount of primary forest in the near vicinity of the community. Their relative abundance is also due in part to the community's ban on using guns for hunting, which has led to a decline and in some instances a disappearance of these species in other parts of New Guinea [4]. With the exception of the Dwarf Cassowary, birds are not actively hunted in the Waria Valley for food, though the eggs of megapodes (e.g. Red-legged Brush-turkey *Talegalla jobiensis*) and wild ducks (e.g. Pacific Black Duck *Anas superciliosa*) are collected when nests are found. A few species such as parrots and paradise-kingfishers are occasionally caught for feathers to use in traditional head dresses. Hunting in the past may have had a part to play in the disappearance of at least one species from the area. Locals described a bird present at least 30 years ago that built its house (but not nest) on the floor out of sticks and was a favourite bird to hunt. This almost certainly refers to the construction of a bower and is likely to be the Fawn-breasted Bowerbird *Chlamydera cerviniventris,* which is found in lowlands of the south-east [4,7].

One bird which is claimed to be present by locals is the Raggiana Bird of Paradise *Paradiseae raggiana*. However it was never sighted or heard during the time of the project. It may be that it used to be present in areas close to villages but now, possibly due to hunting for its feathers, it has retreated into the deeper forest further away from human inhabitation. Two further species which are listed as Vulnerable by the IUCN [9] are also known to the local people, the New Guinea Harpy Eagle *Harpyopsis novaeguineae* and Pesquet's Parrot. Both these species are said to inhabit the deep forest higher up the Waria Valley, although a few locals claim to have seen the New Guinea Harpy Eagle in the forest closer to the villages of Zare and Siu. No sighting was made of the Chestnut-shouldered Goshawk *Erythrotriorchis buergersi* which was recorded by Hopkins in 1989 near Siu village [10].

Fig. 9. Clockwise from top left: Wompoo Fruit-dove (*Ptilinopus magnificus*), Spot-winged Monarch (*Monarcha guttula*), Sulphur-crested Cockatoo (*Cacatua galerita*) eating coconut, Graceful Honeyeater (*Meliphaga gracilis cinerifrons*), Variable Dwarf Kingfisher (*Ceyx lepidus*). Photos by J. Dawson.

Implications for conservation

The main threat to the natural forest habitat is from an increase in subsistence agriculture, a direct result of the growth in the human population. As a whole, Papua New Guinea is experiencing a rapid, sustained population growth of about 2.7% per year [3]. According to the 2000 National Population Census, the population of the lower Waria Valley (including Eware lagoon, Sapa and south coast villages), was 6007, of whom 41% were under 14 years of age. If the area followed the national population growth rate, the population in 2009 would be over 7500. This increase in population, especially of the young, has required more garden areas to grow food, which as well as leading to the loss of more primary forest has led to the loss of most areas of old growth secondary forest (Dawson pers. comm. local villagers). By the time the WVCP left the area in March 2009, nearly all the secondary forest area from Puene along the main road to Nero had been cleared for gardening in addition to new areas of primary forest being cleared. A current mining exploration at the head of the Wiwo and Giu rivers poses a further potential threat to the nearby forest and wildlife should it become a full scale mining operation.

Agricultural habitats are now a major part of the lower Waria Valley landscape and as such will have an important influence on the biodiversity of the area. Scales and Marsden [28] reported that a number of biophysical and socioeconomic factors have been found to influence biodiversity retention in tropical agroecosystems. Agricultural extensification resulting indirectly from human population growth was shown to consistently decrease biodiversity in agroforestry plots and influence their floral/faunal communities (see [28]).

A number of studies have shown the shortening of fallow periods to have consistent negative impacts upon biodiversity [e.g. 53], though this is hard to distinguish from the effects of associated impacts such as removal of the understorey and agricultural homogenisation [28]. This is of particular relevance in the lower Waria Valley, where swidden cycles for gardens have decreased from 15-20 years a generation ago to 5-7 years now (Dawson pers. comm. local villagers). This suggests that the species richness of the various agricultural plots has decreased and will continue to do so.

Agricultural homogenisation within the Waria Valley at a landscape scale is not an issue at present, as individual plots tend to be small and comprise a mix of crops interspersed with small cocoa and coconut plantations. However, one of the most important detrimental influences identified by Scales and Marsden [28] is agricultural commercialisation in terms of intensification of management regime, market forces and distance of a holding to the market. The isolation and poor transport infrastructure of the Waria Valley have meant commercial agriculture in the past has been very limited. Now, however, possibilities are opening up for increased commercial opportunities in cocoa and dry grown rice through rural development NGO Bris Kanda Ltd., the reinstatement of a regular ship service to Morobe, and improved road infrastructure in the valley. This represents a great opportunity for improving the livelihoods of many people in this rural community, but also increases threats to the area's biodiversity.

Agricultural landscapes have the potential to be incorporated into biodiversity conservation [54,55] with traditional agroforestry systems serving as wildlife corridors [56] and buffers around conservation forests [57]; some even retain very high levels of biodiversity [e.g. 58]. Even though agricultural habitats in this study showed lower levels of species richness than primary forest, they were still relatively species rich. It is important, therefore, that as agricultural extensification and potential commercialisation increase in the lower Waria Valley, landscape-wide management plans incorporate these areas into a mosaic habitat that includes remnant primary forest and reforested areas to maximise biodiversity.

This study recommends that further surveys, including more intense mist netting and ringing, be carried of the avifauna of the area, especially in more remote primary forest and in the surrounding mangroves of Eware and Bau lagoons. Along with other studies of the mammal, reptile, amphibian and butterfly fauna, this study should provide a baseline for further ecological monitoring in the Waria Valley. Hunting, commercial logging or mining do not as yet pose a serious threat to the forests and avifauna of the Waria Valley; subsistence agriculture and the increasing human population do, however. A series of recommendations to help manage this effectively are:

- Develop workable integrated environmental management plans for the local area from the Morobe Local Level Government down to the village ward councils, focusing on environmental good practice and reforestation.
- Associated education and awareness within the community to promote understanding and support for the plans and methods.
- Establishment of integrated land-use management plans for clan lands to conserve high biodiversity areas, manage natural resources, assign areas for new gardens and the reforestation of old garden areas.
- Environmental monitoring to assess the impact of the mining exploration at the headwaters of the Giu and Wiwo rivers.
- Environmental impact assessments and monitoring to be done in the event of the expansion of mining activities and any future development.

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Appendix 1 (this and next 4 pages). IRD values for each survey site and for each habitat type (including all lists). Species names taken from [4].

	Agricultural				Secondary forest edge				Primary forest edge				Primary forest			
Species	Unu	Zazamara	Zure	All	Mt. Unu	Puene	Wamote	All	Bowe	Mewana	Sowara	All	Atai	Ewaga	Wiwo	All
Egretta intermedia	-	-	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-
Zonerodius heliosylus	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-	0.01
Aviceda subcristata	-	0.04	0.05	0.02	-	-	-	-	-	-	0.03	0.03	-	-	-	-
Henicopernis longicauda	-	-	-	0.01	0.05	0.05	-	0.03	-	-	-	0.01	-	0.07	-	0.03
Haliastur sphenurus	-	0.08	-	0.02	-	-	-	-	-	-	-	0.01	-	-	-	-
Haliastur indus	0.37	0.5	0.45	0.4	0.1	-	0.32	0.2	0.03	0.05	0.17	0.18	0.12	0.36	-	0.21
Haliaeetus leucogaster	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Accipiter novaehollandiae	-	0.15	-	0.05	0.05	-	-	0.01	-	0.2	-	0.06	0.03	0.02	-	0.02
Accipiter poliocephalus	0.05	0.04	-	0.02	-	0.05	-	0.03	-	-	0.14	0.04	-	0.02	-	0.01
Aquila gurneyi	-	-	-	-	-	-	-	-	-	-	-	0.01	-	-	-	-
Dendrocygna guttata	-	0.04	0.05	0.02	-	-	-	-	-	-	-	-	-	-	-	-
Anas superciliosa	-	0.15	-	0.05	-	-	-	-	-	-	-	-	-	0.14	-	0.06
Megapodius reinwardt	-	-	-	-	-	-	0.23	0.07	-	-	0.17	0.04	0.12	-	0.05	0.05
Talegalla jobiensis	-	-	-	-	0.4	0.24	0.05	0.23	0.37	0.1	0.07	0.19	-	0.05	0.58	0.14
Columba vittiensis	-	-	-	-	-	-	-	-	0.03	-	-	0.01	-	-	-	-
Macropygia amboinensis	-	-	-	0.01	-	-	0.09	0.03	-	-	-	0.01	0.06	-	-	0.02
Macropygia nigrirostris	-	-	-	0.01	-	-	-	-	-	-	-	-	0.03	0	-	0.01
Macropygia spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-	0.01
Reinwardtoena reinwardtii	-	-	0.05	0.01	-	-	-	-	-	0.05	-	0.01	-	-	0.16	0.03
Chalcophaps indica	0.05	-	0.05	0.02	-	-	-	-	-	-	-	0.01	-	-	-	0

	Agricultural				Secondary forest edge				Primary forest edge				Primary forest			
Species	Unu	Zazamara	Zure	All	Mt. Unu	Puene	Wamote	All	Bowe	Mewana	Sowara	All	Atai	Ewaga	Wiwo	All
Chalcophaps stephani	-	0.12	0.1	0.06	-	-	0.23	0.08	0.03	-	0.03	0.02	0.06	-	-	0.02
Chalcophaps spp.	-	-	-	-	-	0.05	0.09	0.04	-	-	-	0.01	0.06	-	0.05	0.03
Henicophaps albifrons	-	-	-	-	-	-	-	-	-	0.05	-	0.01	-	-	-	-
Ptilinopus magnificus	-	-	-	-	-	0.1	0.09	0.06	0.1	-	0.1	0.06	0.15	-	0.32	0.11
Ptilinopus perlatus	0.05	-	-	0.01	-	-	-	-	-	-	-	-	0.03	0.02	-	0.02
Ptilinopus superbus	-	-	-	-	-	-	-	-	-	0.1	-	0.02	-	-	0.05	0.01
Ptilinopus coronulatus	-	-	0.05	0.04	0.05	0.05	-	0.03	0.03	0.05	0.03	0.03	0.09	-	0.05	0.04
Ptilinopus pulchellus	-	-	-	-	-	-	0.05	0.01	-	-	0.03	0.01	-	0.02	-	0.01
Ptilinopus iozonus	0.05	-	-	0.01	-	0.05	0.05	0.03	-	0.2	0.1	0.07	0.12	0.02	-	0.05
Ptilinopus spp.	0.05	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Ducula pinon	0.32	0.04	0.3	0.21	0.65	1	0.55	0.79	0.77	0.6	0.59	0.72	0.76	0.68	1	0.77
Ducula zoeae	0.05	0.04	-	0.02	-	-	-	-	-	-	0.03	0.02	0.03	-	0.05	0.02
Trichoglossus haematodus	0.21	0.19	0.1	0.17	0.7	0.24	-	0.3	0.17	0.15	0.41	0.31	0.48	0.43	0.16	0.4
Lorius hypoinochrous	0.79	0.19	0.45	0.4	0.15	0.29	0.18	0.25	0.13	0.1	0.48	0.2	0.45	0.14	0.05	0.23
Lorius lory	0.11	-	0.05	0.05	0.1	0.05	0.05	0.06	0.2	0.2	0.07	0.25	-	0.11	0.11	0.07
Lorius spp.	0.05	-	0.05	0.04	0.4	0.1	0.09	0.17	0.17	0.15	0.1	0.12	0.15	0.18	0.16	0.17
Charmosyna placentis	-	-	-	-	-	-	-	-	-	-	0.03	0.01	-	-	-	-
Probosciger aterrimus	0.05	-	0.2	0.06	0.1	0.19	0.05	0.11	0.27	0.15	0.28	0.22	0.09	0.27	0.32	0.22
Cacatua galerita	0.89	0.46	0.9	0.77	0.8	0.9	0.68	0.89	0.77	0.85	0.93	0.86	0.97	0.66	0.79	0.79
Micropsitta pusio	-	-	-	-	-	-	-	-	-	0.1	0.03	0.03	0.03	-	0.11	0.03
Geoffroyus geoffroyi	-	-	-	-	-	-	-	-	0.03	-	-	0.02	0.12	0.02	-	0.05
Eclectus roratus	0.79	0.35	0.55	0.63	0.5	0.33	0.41	0.51	0.23	0.6	0.55	0.57	0.76	0.57	0.16	0.55
Cacomantis variolosus	-	-	-	-	-	0.67	-	0.2	0.13	0.05	0.03	0.05	0.03	0.09	0.26	0.1
Chrysococcyx minutillus	-	-	-	-	-	-	-	-	-	-	-	0.01	-	-	-	-
Scythrops novaehollandiae	0.05	-	-	0.02	0.05	-	-	0.04	-	-	-	0.02	0.06	-	-	0.02

	Agricultural				Secondary forest edge				Primary forest edge				Primary forest			
Species	Unu	Zazamara	Zure	All	Mt. Unu	Puene	Wamote	All	Bowe	Mewana	Sowara	All	Atai	Ewaga	Wiwo	All
Centropus menbeki	-	-	-	0.02	-	0.05	-	0.01	-	-	-	0.02	-	-	-	-
Centropus phasianinus	0.16	0.65	0.4	0.35	0.05	0.14	0.05	0.08	0.07	-	0.1	0.05	0.03	0.02	-	0.02
Camprimulgus macrurus	-	0.04	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Hemiprocne mystacea	-	-	-	-	-	-	-	-	-	0.05	-	0.01	0.03	-	-	0.01
Collocalia vanikorensis	-	0.15	0.05	0.06	-	-	-	-	0.03	0.05	-	0.02	-	-	-	-
Collocalia esculenta	0.53	0.46	0.55	0.56	0.45	0.05	0.45	0.42	0.07	0.2	0.14	0.11	0.15	0.07	-	0.08
Collocalia spp.	-	-	0.15	0.04	-	0.05	-	0.01	-	-	-	-	-	-	-	-
Mearnsia novaeguineae	0.11	-	-	0.02	-	-	-	-	-	0.05	-	0.01	0.06	-	-	0.02
Tanysiptera galatea	-	-	-	-	0.1	-	0.32	0.13	-	-	-	0.02	-	-	-	-
Tanysiptera nympha	-	-	-	-	-	-	-	0.01	-	0.15	0.03	0.04	-	-	-	-
Tanysiptera danae	-	-	-	-	0.05	-	0.09	0.07	-	-	0.1	0.03	0.06	-	0.16	0.05
Tanysiptera nympha/danae	-	-	-	-	-	0.29	0.05	0.1	0.03	0.15	0.03	0.04	0.06	0.02	0.11	0.05
Melidora macrorrhina	-	-	-	-	0.05	0.1	0.05	0.06	0.03	0.2	0.03	0.05	0.09	0.02	0.11	0.06
Dacelo gaudichaud	0.16	0.81	0.1	0.37	0.35	0.1	0.59	0.34	0.2	0.35	0.34	0.28	0.36	0.09	0.37	0.24
Syma torotoro	-	-	-	-	-	-	0.05	0.01	0.07	0.05	-	0.03	-	-	-	-
Ceyx lepidus	-	-	-	-	-	-	-	0.04	-	-	-	-	-	-	-	-
Alcedo azurea	-	0.04	-	0.01	-	-	0.05	0.01	-	-	0.03	0.02	-	0.14	0.21	0.1
Merops ornatus	0.05	-	-	0.09	-	-	-	-	-	-	-	0.01	0.06	-	-	0.02
Eurystomus orientalis	0.05	0.04	0.05	0.14	-	-	-	0.01	-	0.15	-	0.04	0.12	-	-	0.04
Aceros plicatus	0.21	0.12	0.2	0.23	0.85	0.95	0.59	0.87	0.93	0.8	0.93	0.9	0.7	0.82	0.95	0.8
Pitta erythrogaster	-	-	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-
Pitta sordida	-	-	-	-	-	-	-	-	-	-	0.03	0.01	-	-	-	-
Coracina papuensis	0.05	0.04	-	0.06	-	-	-	-	-	-	0.03	0.01	0.03	-	-	0.01
Coracina boyeri	-	-	-	-	-	-	-	-	-	-	-	0.01	0.03	-	-	0.01
Coracina melaena	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05	-	0.02
Coracina tenuirostris	-	-	-	0.02	-	-	-	-	-	-	-	-	-	-	-	-
Lalage leucomela	-	0.04	-	0.01	-	-	-	-	-	0.05	-	0.01	-	0.09	-	0.04

	Agricultural				Secondary forest edge				Primary forest edge				Primary forest			
Species	Unu	Zazamara	Zure	All	Mt. Unu	Puene	Wamote	All	Bowe	Mewana	Sowara	All	Atai	Ewaga	Wiwo	All
Gerygone chrysogaster	-	-	-	0.01	-	0.1	-	0.03	0.03	-	0.07	0.03	0.03	-	0.05	0.02
Gerygone magnirostris	-	-	-	0.02	-	-	-	-	-	-	-	-	-	-	-	-
Gerygone palpebrosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05	0.01
Rhipidura threnothorax	-	-	-	-	-	-	-	-	0.1	-	-	0.03	-	-	-	-
Rhipidura leucothorax	0.16	0.73	0.4	0.38	-	0.05	0.05	0.06	-	0.15	0.14	0.07	0.06	0.39	-	0.2
Rhipidura rufidorsa	-	-	-	-	-	-	0.05	0.01	0.03	-	-	0.01	-	-	-	-
Rhipidura rufiventris	-	-	0.05	0.01	-	0.05	-	0.01	0.07	0.05	0.17	0.07	-	0.05	-	0.02
Rhipidura leucophrys	-	0.04	-	0.02	-	-	0.05	0.01	-	-	-	-	-	-	-	-
Monarcha melanopsis	-	-	-	-	-	-	-	-	-	-	0.07	0.02	-	-	-	-
Monarcha guttula	-	-	-	-	-	-	-	-	0.37	0.05	0.07	0.12	-	-	-	-
Monarcha manadensis	-	-	-	-	-	-	-	-	0.03	-	-	0.01	-	0.05	-	0.02
Monarcha chrysomela	-	-	-	-	-	-	-	-	0.03	-	0.03	0.02	-	0.05	-	0.02
Arses telescophthalmus	-	-	-	-	-	-	-	-	0.23	-	0.03	0.07	-	0.11	0.11	0.07
Myiagra alecto	0.47	0.35	0.7	0.41	0.25	0.1	0.18	0.17	0.07	0.05	0.1	0.06	0.03	0.11	0.21	0.1
Myiagra cyanoleuca	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Myiagra cyanoleuca/rubecula	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-	0.01
Microeca flavigaster	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Microeca flavovirescens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.16	0.03
Poecilodryas hypoleuca	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-	0.01
Pachycephela simplex	-	-	-	-	-	0.05	-	0.01	0.37	-	0.03	0.11	0.06	0.02	0.21	0.07
Colluricincla megarhyncha	-	-	-	-	-	0.14	0.09	0.1	0.27	0.1	0.07	0.11	0.06	0.07	0.21	0.09

	Agricultural				Secondary forest edge				Primary forest edge				Primary forest			
Species	Unu	Zazamara	Zure	All	Mt. Unu	Puene	Wamote	All	Bowe	Mewana	Sowara	All	Atai	Ewaga	Wiwo	All
Pitohui dichrous	-	-	-	0.01	0.1	-	0.05	0.07	-	-	-	0.03	0.03	0.05	0.05	0.04
Dicaeum pectorale	-	-	-	0.01	-	0.05	-	0.01	-	0.05	-	0.03	0.06	0.02	0.05	0.04
Nectarinia aspasia	0.74	0.54	0.7	0.65	0.15	0.14	0.36	0.24	0.17	0.45	0.07	0.23	0.09	0.16	0.11	0.13
Nectarinia jugularis	-	-	-	0.02	-	-	-	-	-	-	-	-	-	-	-	-
Melilestes megarhynchus	-	-	-	-	-	-	0.09	0.03	-	0.05	0.03	0.02	0.03	0.02	-	0.02
Oedistoma iliolophus	-	-	-	-	-	-	-	-	0.03	-	-	0.01	-	-	-	-
Glycichaera fallax	-	-	-	-	-	-	-	-	0.03	-	-	0.01	-	-	-	-
Meliphaga albonotata	-	0.46	0.2	0.2	-	0.14	0.05	0.06	0.03	0.05	-	0.02	-	0.02	-	0.01
Meliphaga aruensis	-	-	-	-	-	0.05	0.05	0.04	0.07	-	-	0.02	-	-	-	-
Meliphaga gracilis cinereifrons	-	-	0.05	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Meliphaga spp.	0.74	0.19	0.8	0.51	0.6	0.33	0.91	0.63	0.33	0.45	0.45	0.39	0.27	0.3	0.37	0.3
Xanthotis flaviventer	-	-	-	-	-	-	-	-	-	-	-	-	0.03	-	-	0.01
Pycnopygius ixoides	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Philemon meyeri	0.26	0.04	0.05	0.09	0.25	0.1	0.23	0.17	0.2	0.15	0.21	0.13	0.15	0.11	0.11	0.13
Philemon buceroides	0.21	0.08	0.05	0.12	0.15	-	0.09	0.1	0.07	0.05	0.24	0.1	0.18	0.2	-	0.16
Philemon spp.	-	0.19	-	0.06	-	-	-	-	0.1	-	-	0.05	0.03	-	0.05	0.02
Lonchura tristissima	-	0.12	0.05	0.06	-	-	-	-	-	-	-	-	-	0.02	-	0.01
Aplonis metallica	0.89	0.92	1	0.75	0.65	0.48	0.68	0.55	0.4	0.55	0.31	0.31	0.33	0.18	0.11	0.22
Mino dumontii dumontii	0.21	0.5	-	0.21	0.35	0.57	0.18	0.38	0.63	0.6	0.31	0.64	0.33	0.59	0.58	0.5
Oriolus szalayi	-	-	-	0.01	-	-	-	-	-	-	-	-	-	0.05	-	0.02
Dicrurus bracteatus carbonarius	0.16	0.35	0.2	0.37	0.75	0.62	0.73	0.73	0.7	0.5	0.52	0.58	0.76	0.59	0.26	0.58
Cracticus cassicus	0.53	0.54	0.2	0.48	0.7	0.81	0.45	0.62	0.5	0.6	0.28	0.48	0.7	0.57	0.42	0.58
Peltops blainvillii	-	-	-	-	-	-	-	-	-	-	-	-	0.03	0.02	-	0.02
Manucodia chalybatus	-	-	-	-	-	0.05	-	0.01	-	-	-	-	0.03	-	-	0.01
Manucodia spp.	-	-	-	-	-	-	0.05	0.01	-	-	-	-	0.03	-	-	0.01
Cicinnurus regis	-	-	-	-	-	-	-	-	0.03	-	-	0.01	-	0.07	-	0.03
Corvus orru	0.21	-	0.65	0.23	-	-	0.05	0.01	-	-	-	0.05	-	0.02	-	0.01
Corvus tristis	0.16	0.19	-	0.1	0.05	0.14	0.18	0.23	0.2	0.1	0.52	0.27	0.06	0.48	0.58	0.35

Appendix 2 (this and next three pages). Bird species list for the lower Waria Valley. 1) Species and common name are all taken from [4] 2) Name of species in the local Zia language 3) Habitat where the species was recorded 1 = agricultural, 2 = secondary forest edge, 3 = primary forest edge, 4 = primary forest, 5 = river i.e. large river 4) IUCN status from the IUCN 2010 Red List 5) Endemicity taken from [4].

Species[1]	Local Zia name[2]	Habitat[3]	IUCN status[4]	Endemicity[5]
Dwarf Cassowary *Casuarius bennetti*	Moke	4	Near Threatened	New Guinea and Bismark Archipelago
Little Black Cormorant *Phalacrocorax sulcirostris*		5	Least Concern	Resident, visitor
Little Pied Cormorant *Phalacrocorax melanoleucos*		5	Least Concern	Resident, visitor
Intermediate Egret *Egretta intermedia*	Oro	1,2,5	Least Concern	Visitor
Rufous Night-heron *Nycticorax caledonicus*		3	Least Concern	Resident, visitor
New Guinea Tiger-heron *Zonerodius heliosylus*	Waugira	4,5	Near Threatened	New Guinea (inc satellites)
Bat Hawk *Macheiramphus alcinus*		2	Least Concern	Resident
Pacific Baza *Aviceda subcristata*	Borezizi	1,3	Least Concern	Resident
Long-tailed Buzzard *Henicopernis longicauda*	Borezizi	1,2,3,4	Least Concern	New Guinea (inc satellites)
Whistling Kite *Haliastur sphenurus*	Duna	1,3	Least Concern	Resident
Brahminy Kite *Haliastur Indus*	Duna	1,2,3,4	Least Concern	Resident
White-bellied Sea-eagle *Haliaeetus leucogaster*	Kiki	1	Least Concern	Resident
Variable Goshawk *Accipiter novaehollandiae*	Kiniso	1,2,3,4	Least Concern	Resident
Grey-headed Goshawk *Accipiter poliocephalus*	Kiniso	1,2,3,4	Least Concern	New Guinea (inc satellites)
Gurney's Eagle *Aquila gurneyi*	Duna	3	Near Threatened	Resident
Spotted Whistling Duck *Dendrocygna guttata*	Borowa	1	Least Concern	Resident
White-headed Shelduck *Tadorna radjah*	Borowa	5	Least Concern	Resident
Pacific Black Duck *Anas superciliosa*	Borowa	1,4,5	Least Concern	Resident
Orange-footed Scrubfowl *Megapodius reinwardt*	Kotio	2,3,4	Least Concern	Resident
Red-legged Brush-turkey *Talegalla jobiensis*	Gowaong	2,3,4	Least Concern	New Guinea (inc satellites)
Purple Swamphen *Porphyrio porphyrio*		5	Least Concern	Resident, visitor
Common Sandpiper *Actitis hypoleucos*	Kinikini	5	Least Concern	Visitor
White-throated Pigeon *Columba vittiensis*		3	Least Concern	Resident
Brown Cuckoo-dove *Macropygia amboinensis*	Peai	1,2,3,4	Least Concern	Resident
Bar-tailed Cuckoo-dove *Macropygia nigrirostris*	Peai	1,4	Least Concern	New Guinea and Bismark Archipelago
Great Cuckoo-dove *Reinwardtoena reinwardtii*	Nibo	1,3,4	Least Concern	Resident
Emerald Ground-dove *Chalcophaps indica*	Niboai/Pongapongao	1,3,4	Least Concern	Resident

Species[1]	Local Zia name[2]	Habitat[3]	IUCN status[4]	Endemicity[5]
Stephans Ground-dove *Chalcophaps stephani*	Niboai/Pongapongao	1,2,3,4	Least Concern	Resident
New Guinea Bronzewing *Henicophaps albifrons*		3	Least Concern	New Guinea (inc satellites)
Wompoo Fruit-dove *Ptilinopus magnificus*	Uko	2,3,4	Least Concern	Resident
Pink-spotted Fruit-dove *Ptilinopus perlatus*	Uko	1,4	Least Concern	New Guinea (inc satellites)
Superb Fruit-dove *Ptilinopus superbus*	Uko	3,4	Least Concern	Resident
Coroneted Fruit-dove *Ptilinopus coronulatus*	Uko	1,2,3,4	Least Concern	New Guinea (inc satellites)
Beautiful Fruit-dove *Ptilinopus pulchellus*	Uko	2,3,4	Least Concern	New Guinea (inc satellites)
Orange-bellied Fruit-dove *Ptilinopus iozonus*	Uko	1,2,3,4	Least Concern	New Guinea (inc satellites)
Pinon Imperial-pigeon *Ducula pinon*	Audubo	1,2,3,4	Least Concern	New Guinea (inc satellites)
Zoe Imperial-pigeon *Ducula zoeae*	Audubo	1,3,4	Least Concern	New Guinea (inc satellites)
Rainbow Lorikeet *Trichoglossus haematodus*	Zazani	1,2,3,4	Least Concern	Resident
Eastern Black-capped Lory *Lorius hypoinochrous*	Woiwa	1,2,3,4	Least Concern	PNG and Bismark Archipelago
Western Black-capped Lory *Lorius lory*	Woiwa	1,2,3,4	Least Concern	New Guinea (inc satellites)
Red-flanked Lorikeet *Charmosyna placentis*		1,3	Least Concern	Resident
Palm Cockatoo *Probosciger aterrimus*	Kiwaing	1,2,3,4	Least Concern	Resident
Sulphur-crested Cockatoo *Cacatua galerita*	Kaingyo	1,2,3,4	Least Concern	Resident
Buff-faced Pygmy-parrot *Micropsitta pusio*		3,4	Least Concern	New Guinea and Bismark Archipelago
Red-cheeked Parrot *Geoffroyus geoffroyi*	Alla	3,4	Least Concern	Resident
Eclectus Parrot *Eclectus roratus*	Gaiwa Doba (male), Gaiwa Sau (female)	1,2,3,4	Least Concern	Resident
Brush Cuckoo *Cacomantis variolosus*	Kokopio	2,3,4	Least Concern	Resident, visitor
Malay Bronze-cuckoo *Chrysococcyx minutillus*		3	Least Concern	Resident, visitor
Channel-billed Cuckoo *Scythrops novaehollandiae*	Ama	1,2,3,4	Least Concern	Resident, visitor
Greater Black Coucal *Centropus menbeki*	Ogou	1,2,3	Least Concern	New Guinea (inc satellites)
Pheasant Coucal *Centropus phasianinus*	Ogou	1,2,3,4	Least Concern	Resident
Papuan Frogmouth *Podagus papuensis*	Omea	3	Least Concern	Resident
Large-tailed Nightjar *Caprimulgus macrurus*		1	Least Concern	Resident
Moustached Tree-swift *Hemiprocne mystacea*		3,4	Least Concern	Resident
Uniform Swiftlet *Collocalia vanikorensis*	Merimeri	1,3,5	Least Concern	Resident
Glossy Swiftlet *Collocalia esculenta*	Merimeri	1,2,3,4	Least Concern	Resident
Papuan Spine-tailed Swift *Mearnsia novaeguineae*	Merimeri	1,3,4	Least Concern	New Guinea (inc satellites)
Common Paradise-kingfisher *Tanysiptera galatea*	Sokana	2,3	Least Concern	Resident
Red-breasted Paradise-kingfisher *Tanysiptera nympha*	Sokana	2,3	Least Concern	New Guinea (inc satellites)
Brown-headed Paradise-kingfisher *Tanysiptera danae*	Sokana	2,3,4	Least Concern	PNG mainland

Species[1]	Local Zia name[2]	Habitat[3]	IUCN status[4]	Endemicity[5]
Hook-billed Kingfisher *Melidora macrorrhina*	Otio-Otio	2,3,4	Least Concern	New Guinea (inc satellites)
Rufous-bellied Kookaburra *Dacelo gaudichaud*	Tororo	1,2,3,4	Least Concern	New Guinea (inc satellites)
Sacred Kingfisher *Halcyon sancta*	Topaung	1	Least Concern	Visitor
Lesser Yellow-billed Kingfisher *Syma torotoro*	Sobiro	2,3,4	Least Concern	Resident
Variable Dwarf Kingfisher *Ceyx lepidus*	Ningi	2	Least Concern	Resident
Azure Kingfisher *Alcedo azurea*	Ningi	1,3,4,5	Least Concern	Resident
Common Kingfisher *Alcedo atthis*	Ningi	5	Least Concern	Resident
Rainbow Bee-eater *Merops ornatus*	Buakaro	1,3,4	Least Concern	Visitor, resident
Common Dollarbird *Eurystomus orientalis*	Gereai	1,2,3,4	Least Concern	Resident, visitor
Blyth's Hornbill *Aceros plicatus*	Biyama	1,2,3,4	Least Concern	Resident
Blue-breasted Pitta *Pitta erythrogaster*	Powapowa	2,4	Least Concern	Resident
Hooded Pitta *Pitta sordid*		2,3	Least Concern	Resident
Pacific Swallow *Hirundo tahitica*	Owe Owe	1,5	Least Concern	Resident
White-bellied Cuckoo-shrike *Coracina papuensis*		1,3,4	Least Concern	Resident
Boyer's Cuckoo-shrike *Coracina boyeri*		3,4	Least Concern	New Guinea (inc satellites)
Black Cuckoo-shrike *Coracina melaena*		4	Least Concern	New Guinea (inc satellites)
Common Cicadabird *Coracina tenuirostris*		1	Least Concern	Resident, visitor
Varied Triller *Lalage leucomela*		1,3,4	Least Concern	Resident
White-shouldered Fairy-wren *Malurus alboscapulatus*	Tingtaing	1	Least Concern	New Guinea (inc satellites)
Pale-billed Scrub Wren *Sericornis spilodera*		2	Least Concern	New Guinea (inc satellites)
Yellow-bellied Gerygone *Gerygone chrysogaster*		1,2,3,4	Least Concern	New Guinea (inc satellites)
Large-billed Gerygone *Gerygone magnirostris*		1	Least Concern	Resident
Fairy Gerygone *Gerygone palpebrosa*		4	Least Concern	Resident
Sooty Thicket-Fantail *Rhipidura threnothorax*		3	Least Concern	New Guinea (inc satellites)
White-bellied Thicket-fantail *Rhipidura leucothorax*		1,2,3,4	Least Concern	New Guinea (inc satellites)
Rufous-backed Fantail *Rhipidura rufidorsa*		2,3	Least Concern	New Guinea (inc satellites)
Northern Fantail *Rhipidura rufiventris*		1,2,3,4	Least Concern	Resident
Willie Wagtail *Rhipidura leucophrys*		1,2	Least Concern	Resident
Black-faced Monarch *Monarcha melanopsis*		3	Least Concern	Visitor
Spot-winged Monarch *Monarcha guttula*		3	Least Concern	New Guinea (inc satellites)
Hooded Monarch *Monarcha manadensis*		3,4	Least Concern	New Guinea (inc satellites)
Golden Monarch *Monarcha chrysomela*		3,4	Least Concern	New Guinea and Bismark Archipelago
Frilled Monarch *Arses telescophthalmus*		3,4	Least Concern	New Guinea (inc satellites)

Species[1]	Local Zia name[2]	Habitat[3]	IUCN status[4]	Endemicity[5]
Shining Flycatcher *Myiagra alecto*		1,2,3,4	Least Concern	Resident
Satin Flycatcher *Myiagra cyanoleuca*		1, 4	Least Concern	Visitor
Lemon-bellied Flycatcher *Microeca flavigaster*		1	Least Concern	Resident
Olive Flycatcher *Microeca flavovirescens*		4	Least Concern	New Guinea (inc satellites)
Black-sided Robin *Poecilodryas hypoleuca*		4	Least Concern	New Guinea (inc satellites)
Grey Whistler *Pachycephela simplex*		2,3,4	Least Concern	Resident
Little Shrike-thrush *Colluricincla megarhyncha*	Ziki	2,3,4	Least Concern	Resident
Hooded Pitohui *Pitohui dichrous*	Korekore	1,2,3,4	Least Concern	New Guinea (inc satellites)
Papuan Flowerpecker *Dicaeum pectorale*		1,2,3,4	Least Concern	New Guinea (inc satellites)
Black Sunbird *Nectarinia aspasia*	Sisiki	1,2,3,4	Least Concern	Resident
Yellow-bellied Sunbird *Nectarinia jugularis*		1	Least Concern	Resident
Long-billed Honeyeater *Melilestes megarhynchus*		2,3,4	Least Concern	New Guinea (inc satellites)
Grey-bellied Longbill *Oedistoma iliolophus*		3	Least Concern	New Guinea (inc satellites)
Green-backed Honeyeater *Glycichaera fallax*		3	Least Concern	New Guinea (inc satellites)
Scrub White-eared Honeyeater *Meliphaga albonotata*	Topu	1,2,3,4	Least Concern	New Guinea (inc satellites)
Puff-backed Honeyeater *Meliphaga aruensis*	Topu	2,3,4	Least Concern	New Guinea (inc satellites)
Graceful Honeyeater *Meliphaga gracilis cinereifrons*	Topu	1	Least Concern	New Guinea mainland
Tawny-breasted Honeyeater *Xanthotis flaviventer*	Topu	4	Least Concern	Resident
Plain Honeyeater *Pycnopygius ixoides*	Topu	1	Least Concern	New Guinea (inc satellites)
Meyers Friarbird *Philemon meyeri*	Kuworo	1,2,3,4	Least Concern	New Guinea (inc satellites)
Helmeted Friarbird *Philemon buceroides*	Kuworo	1,2,3,4	Least Concern	Resident
Streak-headed Mannikin *Lonchura tristissima*		1,4	Least Concern	New Guinea (inc satellites)
Metallic Starling *Aplonis metallica*	Nisokiyang	1,2,3,4	Least Concern	Resident
Yellow-faced Myna *Mino dumontii dumontii*	Gagaro	1,2,3,4	Least Concern	New Guinea (inc satellites)
Brown Oriole *Oriolus szalayi*	Kuworo	1,4	Least Concern	New Guinea (inc satellites)
Spangled Drongo *Dicrurus bracteatus carbonarius*	Tatakio	1,2,3,4	Least Concern	Resident
Hooded Butcherbird *Cracticus cassicus*	Gomu Kuworo	1,2,3,4	Least Concern	New Guinea (inc satellites)
Lowland Peltops *Peltops blainvillii*		4	Least Concern	New Guinea (inc satellites)
Crinkle-collared Manucode *Manucodia chalybatus*		2,4	Least Concern	New Guinea (inc satellites)
King Bird of Paradise *Cicinnurus regis*	Newa	3,4	Least Concern	New Guinea (inc satellites)
Torresian Crow *Corvus orru*	Ama	1,2,3,4	Least Concern	New Guinea (inc satellites)
Bare-eyed Crow *Corvus tristis*	Ovu	1,2,3,4	Least Concern	Resident