

Avifauna of the Lake Kutubu Wildlife Management Area, Papua New Guinea

Authors: Woxvold, Iain A., Diamond, Jared M., Bishop, K. David, and Legra, Leo

Source: Bulletin of the British Ornithologists' Club, 139(3) : 266-292

Published By: British Ornithologists' Club

URL: <https://doi.org/10.25226/bboc.v139i3.2019.a8>

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Avifauna of the Lake Kutubu Wildlife Management Area, Papua New Guinea

by Iain A. Woxvold, Jared M. Diamond, K. David Bishop & Leo Legra

Received 28 April 2019; revised 21 July 2019; published 20 September 2019

<http://zoobank.org/urn:lsid:zoobank.org:pub:6CFCBF65-33D5-451A-8B4D-F2B7F6157298>

SUMMARY.—The Lake Kutubu Wildlife Management Area (WMA) covers approximately 23,500 ha of freshwater lake and surrounding forest environments on the southern slopes of New Guinea's central cordillera in mainland Papua New Guinea (PNG). Ornithological work within the WMA spans more than 50 years, although most of the data are available only in the grey literature and are difficult to obtain. In light of a proposed review of PNG's protected area network, we collate bird records from the WMA and draw upon data from the nearby Agogo Range to consider the potential for additional species to occur within the gazetted area. The WMA inventory stands at 216 species, nearly one-third of all species resident or regularly occurring in the New Guinea region. The high species richness is attributable to the presence of a variety of forest and wetland habitats spanning nearly 600 m elevation, supporting bird species characteristic of lowland, hill and lower montane environments. Resident avifauna include five IUCN threatened or Near Threatened species (New Guinea Harpy Eagle *Harpyopsis novaeguineae*, Gurney's Eagle *Aquila gurneyi*, New Guinea Vulturine Parrot *Psitturichas fulgidus*, Striated Lorikeet *Charmosyna multistriata* and Banded Yellow Robin *Gennaedryas placens*) and the restricted-range Greater Melampitta *Megalampitta gigantea*. Geographic and elevational range extensions are reported for numerous taxa, and recent data are presented to better document the distributional relationships of species pairs in the genera *Talegalla*, *Megapodius*, *Micropsitta* and *Lonchura*, and of races of Brown Cuckoo-Dove *Macropygia amboinensis* and Double-eyed Fig Parrot *Cyclopsitta diophthalma*.

Papua New Guinea's (PNG's) protected area system covers c.4% of its land surface (Adams *et al.* 2017, Leverington *et al.* 2017). Most of the gazetted land is contained within Wildlife Management Areas (WMAs), a legal instrument tailored to function in the context of customary land tenure which accounts for approximately 97% of land in PNG (Allen 2009). Under the WMA system, customary landowners, often in partnership with the government or NGOs, define the boundaries of the area to be protected, establish rules governing the use of its natural resources, and elect local representatives to a Wildlife Management Committee responsible for its regulation and management.

The management of PNG's protected areas has been problematic (Melick *et al.* 2012). Forest loss and degradation continue apace (Bryan *et al.* 2015), WMAs have no legal protection against exploitation (Leverington *et al.* 2017) and, in recent decades, the average rate of loss in most WMAs has been similar to that in unprotected areas (Shearman & Bryan 2011).

In 2014, the PNG government launched its Policy on Protected Areas outlining guidelines for improving the governance and management of protected areas and the biodiversity values they contain (Independent State of Papua New Guinea 2014). The scheme will review the values of existing protected areas and the wishes of customary

landowners, and decide how each area should be defined under the future Protected Area Network. Following review, each area's protected status may be confirmed, reclassified or degazetted.

Within this context, our knowledge of the avifauna present within PNG's protected areas is highly variable. Detailed information is available for sites that are regularly visited by ornithologists (e.g. Varirata National Park: Eastwood 1997) or that have hosted detailed scientific research programmes (e.g. Crater Mountain WMA and YUS Conservation Area: Mack & Wright 1996, Sinclair 2002, Freeman *et al.* 2013, Mack 2014). At the other extreme, some sites remain biologically unexplored, while others have been the subject of one or more surveys but the data are reported only in the grey literature and the summary information is difficult to obtain.

Lake Kutubu WMA is located in Southern Highlands Province, on the southern slopes of New Guinea's central cordillera c.530 km north-west of the national capital Port Moresby (Fig. 1). It was established in 1992 'to conserve the outstanding and internationally significant scenic, geophysical and biodiversity values of the Lake Kutubu WMA, and safeguard the interests and maintain the cultural integrity of its traditional owners' (quoted in D'Cruz 2008: 8–9). Multiple bird surveys have been conducted in the area, with the most recent efforts continuing to further our knowledge of the region's avifauna. Most of the relevant data appear in unpublished NGO reports (*cf.* Schodde & Hitchcock 1968). Here, we review the body of ornithological work conducted within Lake Kutubu WMA, and draw upon the results of surveys conducted on the nearby Agogo Range to consider the potential for additional species to occur in the WMA. This paper is based on a report previously published online (Woxvold & Legra 2018) and incorporates data from additional surveys not available at the time that report was written.

Study area

Lake Kutubu is mainland PNG's largest perched lake. Lying at c.820 m above sea level, and covering more than 4,900 ha, it is flanked by high-relief terrain with forested slopes rising more than 400 m above lake level within 1 km of its shore. Lake Kutubu WMA covers some 23,497 ha of the lake and the environs (Leverington *et al.* 2017) to above 1,380 m at Mount Kemenagi near the southern shore (Fig. 1).

Located in the 'Kikori-Lake Kutubu Karst Area' of the Southern Fold Mountains, the geology is characterised by Tertiary limestones and Pleistocene volcanic deposits forming a north-west-trending series of ridges, plateaux and valleys (Löffler 1977, Bryan & Shearman 2008). Polygonal karst dominates major topographic features south and west of the lake, including the Kutubu anticline and, immediately outside the WMA boundary, the Agogo Range (here considered to include the Iagifu and Hedinia anticlines; Fig. 1). Recent alluvial deposits are located at each end of the nearly 19 km-long lake. Rainfall is 'continuously heavy' (little seasonality) and totals more than 4,000 mm annually (McAlpine *et al.* 1983, Bryan & Shearman 2008). The lake is drained from the north-west via the Soro River which forms part of the Kikori River drainage.

Three major natural vegetation groupings are mapped under the PNG Forest Inventory Mapping System (FIMS) (Hammermaster & Saunders 1995): (1) wooded freshwater swamps—dominated by complexes of Sago *Metroxylon sagu* / *Pandanus* swamp woodland and mixed swamp forest on flood-prone alluvium at each end of the lake, with reedbeds (including *Phragmites*) present at the lake margins; (2) hill forest—medium-crowned forest on slopes below 1,000 m, with *Nothofagus* present on most upper slopes and ridges more than a few hundred metres from the lakeshore; and (3) lower montane forest—on terrain

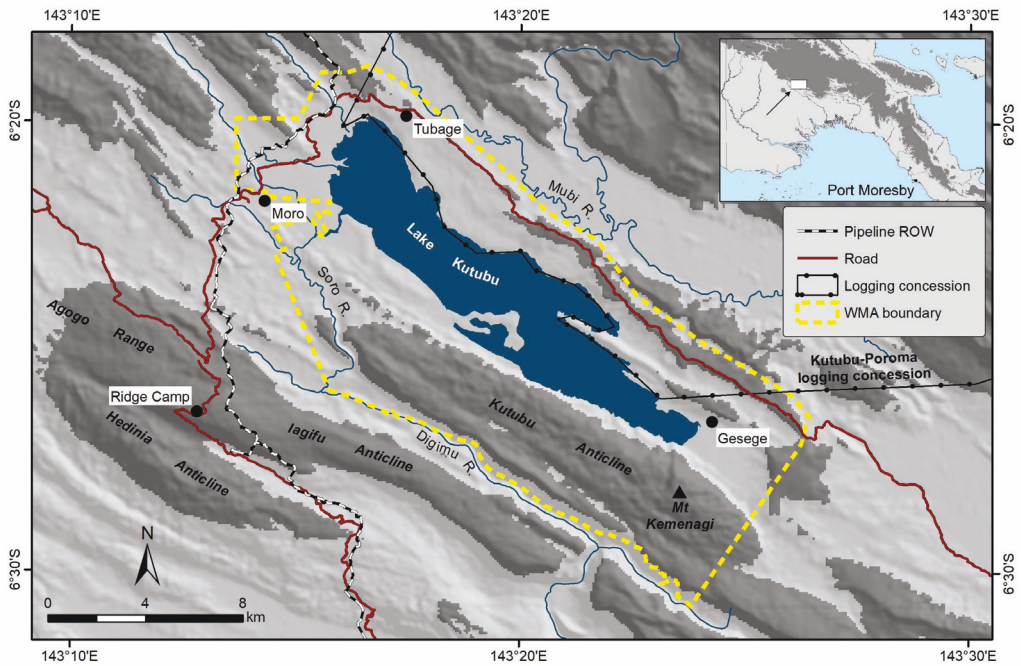


Figure 1. The Lake Kutubu Wildlife Management Area and places mentioned in the text. Land above 1,000 m is shaded darker grey.

above 1,000 m, alone or in complex form as structural variants (small- / very small-crowned) with or without *Nothofagus* prominent in the canopy.

The Lake Kutubu and adjacent Mubi River valleys are the traditional lands of the Foi people (Regis 2000). First contact with Europeans did not occur until the 1930s (Champion 1940). Half a century later, in the late 1980s commercial reserves of oil and gas were discovered in the uplands of the Kikori basin. Petroleum production is ongoing, and the Lake Kutubu area hosts a variety of support facilities and infrastructure.

Vegetation is predominantly intact except in areas cleared for oil and gas infrastructure and around local settlements. Local resident settlements are presently concentrated along the margins of the lake and at a few sites beside roads. Secondary forest in regenerating garden sites and natural forest degraded by local resource extraction is present around settlements and along some roads.

Existing data

The first ornithologist to visit Lake Kutubu was R. Schodde of the Commonwealth Scientific and Industrial Research Organization (CSIRO). In September–October 1961 he spent four weeks surveying birds at the north-west end of the lake between the Soro River outlet and the Mubi River valley (Schodde & Hitchcock 1968). In addition to general field observations, Schodde collected 132 specimens of 79 species (held at the Australian National Wildlife Collection, Canberra; ANWC). The records are well annotated, with most encounters traceable to within the WMA. Exceptions include those species shot by local Papua New Guinean assistants whose movements were not documented but are presumed to have been restricted to the local vicinity.

In partnership with industry leaders, in 1994 the World Wildlife Fund (WWF) initiated the Kikori Integrated Conservation and Development Project (KICDP), currently termed

the Kikori Basin Conservation Program, aimed at preserving biodiversity within the Kikori drainage (Leary *et al.* 1996, McCall & Flemming 2000).

As part of the first KICDP survey programme, in 1994 and 1995 I. Burrows surveyed birds (1) within and immediately adjacent to Lake Kutubu WMA around Moro and the lake area, and (2) more than 4 km south and west of the WMA in the Agogo Range (at c.900–1,100 m; Hartshorn *et al.* 1994, Burrows 1995). No trapping was undertaken, and during a total of ≤10 observation days most of the forest survey effort was expended in the Agogo Range. Only the 1994 reconnaissance report (Hartshorn *et al.* 1994) distinguishes records from the Agogo Range and the Moro–Kutubu areas. Thus, in terms of locating records within the WMA boundary, the provenance of many species observed by Burrows only in 1995 cannot be determined. Nevertheless, all surveys were conducted at elevations within those covered by the WMA, and most species of uncertain provenance have been recorded locally by other workers.

During 1997–99, R. Jaensch (Wetlands International) and various co-workers surveyed birds on four occasions on and around Lake Kutubu (Jaensch undated a,b, Jaensch & Kulmoi undated). No trapping was undertaken. Jaensch made additional brief visits to the Agogo Range outside the WMA and annotated his results sufficiently to distinguish records from each site.

On behalf of WWF, JMD & KDB conducted repeat-visit surveys of the Moro–Lake Kutubu–Agogo Range area in 1998, 1999, 2001, 2003, 2006 and 2007. Their observation-based surveys (no trapping) were conducted at 790–1,440 m while based (1) at Moro near Lake Kutubu, and (2) at the ‘Ridge Camp’, a permanent industrial base located outside the WMA in the Agogo Range. Originally reported as a combined Agogo Range / Moro–Kutubu dataset (Diamond & Bishop 2003, 2007), the list of species recorded within the WMA is here presented separately.

Most recently, birds were surveyed by IAW & LL within the WMA in May 2017 (Woxvold & Legra 2018), and the Agogo Range in 2015 (Woxvold & Legra 2017), 2017 and 2018 (IAW & LL unpubl.). Survey methods included active searches, camera-trapping, mist-netting and screening of automated bioacoustic recorder data. Survey coverage and effort are described in detail in Woxvold & Legra (2018).

Insofar as locality information can be determined with certainty, the results of the above surveys are combined to provide a comprehensive list of birds recorded to date in the Lake Kutubu WMA. While the WMA was delineated to exclude converted habitats of the Moro camp and airstrip, birds recorded at these sites are here included among the WMA records as this area of exclusion is immediately surrounded by the WMA.

Conventions used

Taxonomy follows Beehler & Pratt (2016). Species appearing in square brackets (in text, tables and appendices) were only provisionally identified to species level; although not definitively identified, encounters are considered most likely to have involved the species named and these records are included in the overall species tally. Records denoted by ‘?’ in Appendices 1 and 3 are considered less certain and are not included in site totals.

Species of conservation concern include those listed in the IUCN Red List of Threatened Species (IUCN 2019) as threatened (Vulnerable—VU; no Endangered or Critically Endangered bird species have been recorded in the Lake Kutubu WMA), Near Threatened (NT) or Data Deficient (DD) and those listed as Protected (P) under the PNG Fauna (Protection & Control) Act 1966. The list of nationally protected species was obtained from Kula & George (1996). Restricted-range (RR) species are those having a total global breeding range smaller than 50,000 km² (Stattersfield *et al.* 1998).

Results

At least 216 bird species from 63 families have been recorded in the Lake Kutubu WMA and / or immediately adjacent to the WMA in the Moro facilities area. The taxa recorded by various workers are listed in Appendix 1 along with their conservation status, trapping frequencies and residency / migratory status.

Nine species were recorded within the WMA for the first time during the most recent surveys in 2017–18. Three of these were confirmed present by camera-trapping alone—Wattled Brushturkey *Aepyodius arfakianus*, Cinnamon Ground Dove *Gallicolumba rufigula* and Thick-billed Ground Pigeon *Trugon terrestris*. Mottled Meliphaga *Meliphaga mimikae* was identified from mist-net captures, while other novel records were seen and / or heard during active searches and / or recorded by SM3 recorders—Buff-banded Rail *Hypotaenidia philippensis*, Sooty Owl *Tyto tenebricosa*, Nankeen Kestrel *Falco cenchroides*, Greater Melampitta *Megalampitta gigantea* and Eurasian Tree Sparrow *Passer montanus*.

During a review of prior studies, adjustments were made to the status / identity of seven previously recorded taxa. Reasons for these adjustments are outlined in detail in Appendix 2. The changes are as follows.

Removal from the WMA list of four unconfirmed species whose presence requires a range extension and / or is better assigned to a locally occurring species—Southern Cassowary *Casuarius casuarius*, Yellow-legged Brushturkey *Talegalla fuscirostris*, crowned pigeon *Goura* sp. and Fan-tailed Cuckoo *Cacomantis flabelliformis*.

In the absence of confirmed records, where two closely related species may occur locally and are difficult to distinguish in the field, the expansion of single taxon listings to dual-possibility records—White-throated *Eurostopodus mystacalis* / Papuan Nightjar *E. papuensis*, Uniform *Aerodramus vanikorensis* / Mountain Swiftlet *A. hirundinaceus* and Yellow-billed *Syma torotoro* / Mountain Kingfisher *S. megarhyncha*.

Including data from all surveys, the Lake Kutubu WMA avifauna includes some 192 breeding resident species and 23 species that occur in the Kikori basin only or predominantly as non-breeding migrants (Appendix 1). The residency status of the *Eurostopodus* nightjar recorded by Schodde (Schodde & Hitchcock 1968) is uncertain—it may have been a resident species (*E. papuensis*) or an Australian breeding migrant (*E. mystacalis*) (see Appendix 2). At least five breeding resident species have local regional populations seasonally augmented by non-breeding visitors from Australia—Green Pygmy Goose *Nettapus pulchellus*, Pacific Black Duck *Anas superciliosa*, Australasian Grebe *Tachybaptus novaehollandiae*, Eastern Koel *Eudynamis orientalis* and Oriental Dollarbird *Eurystomus orientalis*. Most migratory birds recorded in the WMA breed outside New Guinea in Australia (17 / 23; 73.9%). Six migratory species breed in the Northern Hemisphere and visit New Guinea during the austral summer—Oriental Cuckoo *Cuculus optatus*, Grey-tailed Tattler *Tringa brevipes*, Common Sandpiper *Actitis hypoleucos*, Red-necked Stint *Calidris ruficollis*, Sharp-tailed Sandpiper *C. acuminata* and Gray's Grasshopper Warbler *Locustella fasciolata*.

Eighteen species of conservation concern have been recorded in the WMA. They include seven birds listed by IUCN as Vulnerable or Near Threatened, 13 that are Protected under PNG law and three restricted-range species. IUCN listed and restricted-range species are discussed individually below (Species accounts).

One non-native bird species was recorded, the commensal *Passer montanus* having recently established itself across much of the Moro facilities area. *P. montanus* was first recorded in mainland PNG at Port Moresby in April 2009 (Gregory 2009). An accomplished colonist, its recent arrival has been followed by a rapid expansion into settled areas with the first record from nearby Gulf Province at Kerema in 2011 (Woxvold *et al.* 2015). This is

the first reported occurrence in Southern Highlands Province, although it is likely already to be more widespread there.

Species accounts

Species accounts follow (in taxonomic order) for conservation listed taxa, restricted-range species, rarely recorded species, and wherever records (post-Schodde & Hitchcock 1968) extend a species' known geographic or elevational range. Unless otherwise stated, summary information on status and distribution is taken from Beehler & Pratt (2016).

RED-LEGGED BRUSHTURKEY *Talegalla jobiensis*

Occupies northern New Guinea from Yapen Island and the Mamberamo basin east to Milne Bay. Until recently, confirmed records from the southern watershed were restricted to a few sites in the Owen Stanley Range (Aroa River area) and the upper Purari River basin (Jones *et al.* 1995, Mack & Wright 1996; J. Ross Sinclair *in litt.* 2015). The shy behaviour of megapodes, and the difficulty in distinguishing closely related species based on vocalisations alone, has meant that some prior southern upland records were reported only at genus level, or followed earlier published authorities in assuming the species to be the southern lowland resident *T. fuscirostris*. However, emerging evidence suggests that *T. jobiensis* replaces *T. fuscirostris* at upland sites across much of southern mainland PNG with confirmed records in most major catchments from the upper Fly River east to the Moroka area (Beehler & Pratt 2016; IAW unpubl.). Camera-trapping in 2017 showed *T. jobiensis* to be fairly common (nine events on seven cameras; Fig. 2a) in hill forest and at the edge of wooded swamps north of the lake. Outside the WMA, it has been camera-trapped at 925–1,400 m in the nearby Agogo Range (Woxvold & Legra 2017). These are the first confirmed records from the Kikori basin.

[NEW GUINEA SCRUBFOWL *Megapodius decollatus*]

Until recently, *M. decollatus* was thought to predominantly occur in northern New Guinea, with Orange-footed Scrubfowl *M. reinwardt* replacing it across most of the southern watershed (Jones *et al.* 1995, Pratt & Beehler 2015). However, there is growing evidence that *M. decollatus* is widespread on the southern slopes of the central cordillera where it replaces *M. reinwardt* in upland environments (Woxvold *et al.* 2015, Beehler & Pratt 2016, Woxvold & Legra 2017). Unfortunately, many prior records of *Megapodius* from southern New Guinea, including from the Moro–Lake Kutubu–Agogo Range area, refer to Common (Dusky) Scrubfowl *M. freycinet*, within which both *M. decollatus* and *M. reinwardt* (*inter alia*) were formerly subsumed (Mayr 1938). Difficulties with observing these species in the field, and with collecting detailed and reliable information from local informants, mean that such records cannot be safely assigned to either taxon. *M. decollatus* has been camera-trapped at 920–1,400 m in forest on limestone in the Agogo Range, c.3–5 km outside the WMA (Woxvold & Legra 2017), and to the south-east at 540 m in the Gobe operations area (IAW unpubl.). These are the first confirmed records from the Kikori basin. Within the WMA, *Megapodius* calls were recorded at three SM3 stations in 2017. *M. reinwardt* certainly occupies lowland habitats further downstream in the Kikori basin (Woxvold 2018a,b). However, based on recent evidence regarding the distribution and habitat requirements of these species in New Guinea's southern watershed, and on confirmed records from comparable habitats nearby, the Lake Kutubu WMA records are here provisionally assigned to *M. decollatus*.

GREEN PYGMY GOOSE *Nettapus pulchellus*

Twenty-nine individuals seen on the lake by Jaensch (undated a) represent a high-elevation record for this species (Coates 1985).



Figure 2(a) Red-legged Brushturkey *Talegalla jobiensis*; (b) Thick-billed Ground Pigeon *Trugon terrestris*; (c) New Guinea Vulturine Parrot *Psittrichas fulgidus*; (d) Greater Melampitta *Megalampitta gigantea*, all camera-trapped in the Agogo Range.

BROWN CUCKOO-DOVE *Macropygia amboinensis*

Beehler & Pratt (2016) subsumed all New Guinean subspecies east of the Bird's Neck within *M. a. cinereiceps*. Simultaneously, Ng *et al.* (2016) rearranged the *M. amboinensis* species complex along bioacoustic lines, proposing that populations with monosyllabic calls in eastern New Guinea be treated as a separate species—Amboyna Cuckoo-Dove *M. amboinensis*—from those with disyllabic call motifs in the west—Sultan's Cuckoo-Dove *M. doreya*. Ng *et al.* (2016) noted that the contact zone of *M. amboinensis* and *M. doreya* is poorly understood, but mapped the distribution of *M. amboinensis* in southern New Guinea west to near the PNG / Indonesian border, aligning with other accounts of the range of *M. a. goldiei* (Baptista *et al.* 1997) which they include within *M. amboinensis*. However, birds in the Kikori River basin, including within the Lake Kutubu WMA, have disyllabic calls characteristic of *M. doreya*.

THICK-BILLED GROUND PIGEON *Trugon terrestris*

A large terrestrial pigeon endemic to lowland and foothill forests of New Guinea and Salawati Island. An individual camera-trapped in hill forest at 865 m on 7 May 2017 (Fig. 2b) is the highest confirmed record for the species (previously up to 640 m).

RUFESCENT IMPERIAL PIGEON *Ducula chalconota*

Two observed by Burrows 'along the swing bridge road Lake Kutubu' on 22 March 1994, and subsequently reported by Jaensch. While the exact location is unknown, the reference

to Lake Kutubu suggests that this is the lowest reported elevation for this species by nearly 200 m (previously as low as 1,000 m).

GREY-TAILED TATTLER *Tringa brevipes* (NT) / **RED-NECKED STINT** *Calidris ruficollis* (NT)

Regionally present at highest density in tidal environments, in 1961 Schodde observed small numbers at the edge of Lake Kutubu—one *C. ruficollis* and ‘occasional groups of two to five birds’ of *T. brevipes* (Schodde & Hitchcock 1968: 23). In 2007 JMD & KDB recorded a single *C. ruficollis* at Moro airstrip.

BAT HAWK *Macheiramphus alcinus*

Rare in New Guinea from the lowlands to above 1,100 m. On 18 October 2007, KDB observed one in flight over a ridge above Kaimari Creek.

NEW GUINEA HARPY EAGLE *Harpyopsis novaeguineae* (VU, P)

Occupies forested habitats from sea level to above 3,000 m. Visually inconspicuous (does not soar), it is most readily detected by its distinctive and far-carrying call. It was observed by JMD & KDB within and / or near the WMA in most survey years (1998, 2001, 2002, 2006, 2007), and the species has been regularly recorded by other observers in the Agogo Range (Hartshorn *et al.* 1994, Burrows 1995; IAW unpubl.).

GURNEY'S EAGLE *Aquila gurneyi* (NT)

Widespread but very sparse in forested habitats throughout New Guinea, mostly below 1,000 m. Occasionally observed high over forest in the WMA—in 2001 a duo near the Soro River (JMD & KDB), and in 2017 singles at the north end of the lake and near Moro (IAW & LL).

WHITE-BELLIED SEA EAGLE *Haliaeetus leucogaster*

Observed over Lake Kutubu in 1998 and 2007 (Diamond & Bishop 2007) and in 2017. This is the highest reported location in New Guinea (previously up to 540 m; reported at 1,700 m on Sulawesi: Thiollay 1994).

NEW GUINEA VULTURINE PARROT *Psittrichas fulgidus* (VU, P)

Endemic to New Guinea where it inhabits hill and lower montane forest normally below 1,600 m. A nomadic and specialist frugivore, it feeds almost exclusively on a select variety of figs (*Ficus* spp.; Fig. 2c) (Mack & Wright 1998). *P. fulgidus* is regularly encountered in small numbers in the WMA where it has been recorded by all surveyors (Appendix 1). It is a mobile and easily detected species and multiple records at the same site may involve repeat encounters with the same individuals. Outside the WMA, in 2015 ten were observed at a single fruiting fig in the Agogo Range (Woxvold & Legra 2017).

STRIATED LORIKEET *Charmosyna multistriata* (NT, RR)

A rare blossom nomad, endemic to the southern slopes of the central cordillera from the Snow Mountains in Indonesia east into PNG as far as Crater Mountain (Mack & Wright 1996). On 5 May 1998, JMD & KDB observed a flock of six birds at 825 m near the Soro River.

DOUBLE-EYED FIG PARROT *Cyclopsitta diophthalma*

A widespread and geographically variable species with seven subspecies currently recognised from New Guinea, its satellite islands and north-east Australia (Gill & Donsker

2019). In southern New Guinea there are no published lowland records east of the Fly River (Coates 1985, Beehler & Pratt 2016). However, recent surveys reveal that *C. diophthalma* is widespread in the Kikori-Purari region. Observed in the Lake Kutubu WMA by JMD & KDB (April 2003 and May 2006), elsewhere it has been seen in the nearby Agogo Range (IAW unpubl.), in the Kikori basin lowlands (below 500 m) at Gobe, Kantobo, Pinini Creek and at Kopi (Diamond & Bishop 2003, 2007) and in the Purari basin lowlands (IAW unpubl.). It is often stated that *C. diophthalma* and Orange-breasted Fig Parrot *C. guliemitertii* replace each other locally (Coates 1985, Beehler & Pratt 2016). However, both species have been recorded in Lake Kutubu WMA and at all of the above-listed lowland sites, and in the Purari lowlands they have been observed together in the same fruiting tree. It is uncertain which subspecies is present in the WMA. A lone male observed by IAW in the Agogo Range showed a blue spot in front of the eye and a red forecrown with a yellow posterior margin, recalling the nominate northern mainland form *C. d. diophthalma*. In contrast, a pair observed by IAW in the Purari basin lowlands (below 200 m) was most similar to *C. d. aruensis*, the male showing no obvious blue eye spot or yellow margin to the red forecrown, and the female lacked red facial markings but had grey cheeks and a blue forecrown. As provisionally observed below for two *Micropsitta* species, it is possible that these two *Cyclopsitta* subspecies overlap and separate altitudinally within the Kikori–Purari region.

YELLOW-CAPPED PYGMY PARROT *Micropsitta keiensis* / **BUFF-FACED PYGMY PARROT** *M. pusio*

The distributional limits of *Micropsitta* in southern New Guinea are poorly known. Of two similar-looking lowland species, *M. keiensis* occurs in the west and *M. pusio* in the east, with a potential zone of contact / overlap somewhere in the Gulf of Papua hinterland. Recent field guides and regional checklists report both species in the Kikori basin (Pratt & Beehler 2015, Beehler & Pratt 2016, Gregory 2017), although it is unclear on what records these assessments are based (Beehler & Pratt 2016 cite Schodde & Hitchcock 1968 as the source for a Lake Kutubu record of *M. pusio*, but no such record appears in that report). Both species apparently occur in the Lake Kutubu WMA, where Burrows observed a pair of *M. pusio* ‘along the swamp road, Lake Kutubu’ (1995: 36) and KDB saw *M. keiensis* in 2007 (in addition to sightings of unidentified *Micropsitta* in other years). Burrows’ record is the westernmost sighting of *M. pusio* from the southern watershed, while *M. keiensis* occurs east at least as far as the lower Purari River basin (IAW unpubl.). Other Kutubu area reports refer to *M. pusio* / *keiensis* (Jaensch undated a) or to *M. pusio* without describing the encounter (Jaensch undated b). The Kikori–Purari region may represent a zone of overlap within which these two species separate altitudinally. Elsewhere in the Kikori basin, all confirmed records involve *M. keiensis* at elevations below 200 m – at Iviri and Keboi Kerowa (Leary undated), in the Wau Creek proposed WMA and at Uro Creek (Woxvold 2018a,b). In the Purari basin, *M. pusio* was reported from uplands in Crater Mountain WMA (above 850 m; Mack & Wright 1996), whereas *M. keiensis* is the only species confirmed present at lower elevations (all records below 250 m; IAW unpubl.). Further observations are required to confirm this pattern.

TROPICAL SCRUBWREN *Sericornis beccarii* × **LARGE SCRUBWREN** *S. nouhuysi* (**PERPLEXING SCRUBWREN** *S. virgatus*)

There is much confusion over the taxonomy of some *Sericornis* populations occupying the upper hill–lower montane zone of central and western New Guinea. Morphologically highly variable, they are considered by some to be hybrid populations involving *S. nouhuysi* and *S. beccarii* (e.g. Coates 1990, Beehler & Pratt 2016). Others treat them as a

valid species—Perplexing Scrubwren *S. virgatus* (e.g. Diamond 1985, Gregory 2007, Gill & Donsker 2019)—although there is disagreement as to which populations this taxon should include. Scrubwrens of this troublesome group are present in the Kikori basin. Within the Lake Kutubu WMA, an adult male collected by Schodde at 820 m at the north-west end of the lake is most similar to *S. beccarii*, with a black-and-white pattern on the forehead and an incomplete white eye-ring (Schodde & Hitchcock 1968, Coates 1990). Outside the WMA, duller forms more similar to *S. nouhuysi* have been observed in the lower montane limestone forests of the Agogo Range and at Gobe 50 km south-east of Lake Kutubu (Diamond & Bishop 2003, 2007; IAW unpubl.). These birds show an obscure / thin buffy eye-ring and obscure pale tips to the wing-coverts. Their song—a tinkling *Gerygone*-like song of a couple of repeated short phrases—is the same as that of other populations encountered by JMD on the outlying mountain ranges on New Guinea's north and north-west coast.

BLACK THICKET FANTAIL *Rhipidura maculipectus*

Endemic to the lowland wet-floor forests of south and west New Guinea and satellite islands. Confirmed present in swamp forest north-west of the lake in 2006 and 2007 (Diamond & Bishop 2007), songs provisionally attributed to this species were fairly common there in 2017 and 2018. This is the highest reported elevation for the species.

TWELVE-WIRED BIRD-OF-PARADISE *Seleucidis melanoleuca* (P)

Endemic to lowland forests of New Guinea and Salawati Island, especially swamp forest with *Metroxylon sagu* and *Pandanus* spp. (Coates 1990, Frith & Beehler 1998). Recorded locally by JMD & KDB in 2001 and 2007, the Lake Kutubu swamps are the highest recorded locality for this species (elsewhere up to 180 m).

GREATER MELAMPITTA *Megalampitta gigantea* (RR)

One of New Guinea's most enigmatic birds, *M. gigantea* is a near-specialist inhabitant of forested karst where it is believed to roost and nest underground (Diamond 1983, Gregory 1995). It is a restricted-range species known from a few localities across New Guinea at 500–1,400 m. On 7 May 2017 one was heard from the road in an area of limestone forest north-west of Lake Kutubu near the KP 89–90 section of the pipeline right-of-way (ROW). Elsewhere in the Kikori basin it is fairly common in the Agogo Range and at Gobe (Diamond & Bishop 2003, 2007, Woxvold & Legra 2017; Fig. 2d).

[RUFIOUS MONARCH *Symposiachrus rubiensis*]

An uncommon bird endemic to lowland forests of western and central New Guinea. There are few reports from PNG's southern watershed, including two from the Strickland basin—in the Nomad River area (Bell 1970) and near the Rentoul River (IAW unpubl.). In 1994, Burrows observed a 'male seen at close range...in forest by the Moro camp' (Burrows 1995: 37). Given the large extension in both altitudinal (not previously reported above 175 m) and geographic range, and the lack of records from subsequent surveys, this record is here treated as provisional.

BANDED YELLOW ROBIN *Gennaedryas placens* (NT, RR)

Endemic to New Guinea and Batanta Island (Indonesia), with isolated populations scattered in hill and lower montane forest at 100–1,450 m. First reported from the WMA by Schodde who collected one from forest near Moro (Schodde & Hitchcock 1968), it was later recorded by JMD & KDB (in 2001, 2003, 2006, 2007) and on 9 May 2017 two were heard in forest on limestone at c. 950 m along the KP 89–90 section of the pipeline ROW.

GRAY'S GRASSHOPPER WARBLER *Locustella fasciolata*

There are few records of this Northern Hemisphere migrant from eastern New Guinea. Within the WMA, on 18 October 2007 JMD & KDB observed one in dense secondary scrub (<1 m tall) at the north-east corner of the WMA. Elsewhere locally, this species was observed in the Agogo Range in 2001.

STREAK-HEADED MANNIKIN *Lonchura tristissima* / **WHITE-SPOTTED MANNIKIN**

L. leucosticta

The distributional limits of these uncommon and closely related species are poorly known. *L. leucosticta* occupies southern lowlands from the Lorentz River in Indonesia east at least to the Hegigio–Kikori basin in PNG (Coates 1990). *L. tristissima* occurs in northern New Guinea and the far east and west of the southern watershed; in southern PNG it has been recorded on the south-east peninsula as far west as the Lohiki River between the Purari and Lakekamu basins. Within Lake Kutubu WMA, KDB observed both species along the Swamp Road at the north-west end of the lake—*L. tristissima* in 2003 and *L. leucosticta* in 2006.

Discussion

The Lake Kutubu WMA supports a rich and varied avifaunal community. Surveys conducted to date have recorded nearly one-third of all bird species resident or regularly occurring in the New Guinea region (including satellite islands and excluding seabirds and vagrants: 216 / 696, 31.0%). The high species richness is attributable both to the diverse set of environments present and to the high accumulated survey effort spanning more than 50 years. The diversity, conservation value and potential for additional species within the WMA are discussed below.

Forest environments.—These habitats support the majority of bird species present within the WMA—of 216 bird species recorded, 170 (78.7%) occur in forest environments, most of which are forest-dependent (cannot persist in converted habitats alone). All resident (non-migratory) conservation listed and restricted-range bird species confirmed present in the WMA are dependent on forest habitats.

The WMA supports a wide range of forest environments. Approximately 160 km² of upper hill and lower montane forests span nearly 600 m elevation across a variety of substrates, including limestone karst, non-calcareous sediments and volcanic slopes. In addition, some 19.6 km² of swamp forest / woodland provide an unusually high example of a typically lowland forest ecosystem. Elevation exerts a marked influence on the structure of New Guinean bird communities (Diamond 1972, Beehler 1982), and while some forest birds are capable of utilising all of these environments, several species strongly prefer, or are specialist inhabitants of, just one or a few of these vegetation types. Resident forest birds typical of the upper hill–lower montane transition zone (around 1,000 m) on which the WMA is centred include (but are not limited to) Spotted Honeyeater *Xanthotis polygrammus*, Goldenface *Pachycare flavogriseum*, Papuan Cicadabird *Edolisoma incertum*, Drongo Fantail *Chaetorhynchus papuensis*, Crinkle-collared Manucode *Manucodia chalybatus*, Megalampitta *gigantea*, Black-winged Monarch *Monarcha frater*, White-eyed Robin *Pachycephalopsis poliosoma* and White-rumped Robin *Peneothello bimaculata*. A number of montane birds normally found above 1,000 m are also confirmed present, including *Aepyodius arfakiensis*, Pygmy Lorikeet *Chamosyna wilhelminae*, Goldie's Lorikeet *Psitteuteles goldiei*, Red-breasted Pygmy Parrot *Micropsitta bruijnii*, Mottled Berryhunter *Rhagologus leucostigma* and Black Fantail *Rhipidura atra*. Finally, lowland forest species reported at record or unusually high elevations within the WMA include *Trugon terrestris*, Little Bronze Cuckoo *Chalcites minutillus*, Yellow-streaked Lory *Chalcopsitta scintillata*, Streak-headed Honeyeater *Pycnopygius stictocephalus*, Large-billed

Gerygone *Gerygone magnirostris*, Lowland Peltops *Peltops blainvillii*, *Seleucidis melanoleucus*, King Bird of Paradise *Cicinnurus regius*, [*Symposiachrus rubiensis*] and Black-sided Robin *Poecilodryas hypoleuca*. The well-integrated complex of multiple forest ecosystems present in the WMA thus supports a rich forest bird community that differs in composition among sites within a small geographic area.

The WMA forests are well connected with extensive areas of both similar and additional ecosystem types, including montane forest above 2,000 m and lowland forest below 500 m, both of which occur within 10 km of the WMA boundary. The WMA is thus positioned to support a variety of wide-ranging landscape-level nomadic bird species, including various large frugivores and birds of prey that may not permanently reside there.

The WMA's forests face a variety of pressures. Localised conversions to settlements and gardens were formerly largely confined to the lake's margins and islands (Schodde & Hitchcock 1968). Subsequent infrastructure development and local population growth has seen these losses expand to areas along the road networks within the north-west and north-east margins of the WMA (Fig. 1). As well as local losses, small-scale resource harvesting has degraded some areas of forest near settlements and along the road network. Other recent losses are industry based; while the Moro facilities area was excluded from the WMA limits, recent pipeline construction has converted a narrow, c.8 km-long ROW of hill, lower montane and swamp forest environments within the north-west margin of the WMA (Fig. 1).

Logging presents an additional threat (D'Cruz 2008). More than 49 km² of the proposed Kutubu–Poroma logging concession (under the PNG Forest Authority draft National Forest Plan) overlaps the Lake Kutubu WMA at its north-east edge (Fig. 1). As of mid 2019 no commercial logging had taken place within the concession (PNG Forest Observatory, <http://forest.pngsdf.com/>; IAW pers. obs.).

Despite these threats, extensive areas of undisturbed forest remain in the Lake Kutubu WMA. These include much of the wooded swamps and c.80 km² of hill and lower montane forest on the broad limestone ridge of the Kutubu anticline south of the lake. Swamplands and forest on karst are generally unsuitable for gardening and settlement, and are prohibited from logging under PNG law (PNGFA 1996). These areas are expected to remain largely intact into the foreseeable future, and are sufficient to support viable populations of most resident forest bird species.

Lake Kutubu and its environs are the most frequently surveyed area within the Kikori basin. Despite this effort, each new survey reveals the presence of additional birds, with the latest surveys in 2017–18 adding six forest species to the Lake Kutubu WMA list, all of them resident breeders. It follows that additional species probably remain undetected within the WMA. Notably, the Kutubu anticline includes the highest point within the WMA, reaching over 1,380 m at Mount Kemenagi in the south-east, and its limestone forests are unsurveyed.

The Agogo Range lies immediately south of and parallel to the Kutubu anticline, and its forests have been visited by most ornithologists who have worked the Kutubu area (with the exception of Schodde). Given their proximity and the similarity in habitat and elevation, it is reasonable to expect that birds recorded on the Agogo Range also occur on the Kutubu anticline ridge within the southern sector of the Lake Kutubu WMA. Appendix 3 lists 29 bird species not recorded within the WMA, plus four species only provisionally recorded in the WMA, that have been observed in the Agogo Range by the present authors and / or Burrows (1995). Nearly all of these (31 / 33; 93.9%) are forest bird species, including three nationally Protected birds of paradise—Carola's Parotia *Parotia carolae*, Superb Bird of Paradise *Lophorina superba* and Black-billed Sickbill *Drepanornis albertisi*.

Wetland environments.—Twenty-four wetland species have been recorded on the lake, rivers and adjacent low vegetated swamps. They are listed in Table 1, along with their residency / migratory status and numbers reported by Schodde (Schodde & Hitchcock 1968) and Jaensch (undated a). Ten recorded wetland species breed locally in southern New Guinea. Breeding has not been reported within the WMA, though this may be an artefact of under-sampling. For species such as *Nettapus pulchellus*, *Anas superciliosa*, *Tachybaptus novaehollandiae*, White-browed Crake *Amaurornis cinerea*, Dusky Moorhen *Gallinula tenebrosa* and Australian Reed Warbler *Acrocephalus australis*, all of which prefer to breed along the vegetated margins of lakes and slow-moving freshwater systems, Lake Kutubu may represent an important breeding site within the region (for example at the province scale). Others such as Little Ringed Plover *Charadrius dubius*, Azure Kingfisher *Ceyx azureus* and

TABLE 1

Birds of rivers and wetlands, their residency / migratory status (Res / Mig), and notes on abundance by Schodde (Schodde & Hitchcock 1968; 'RS') and Jaensch (undated a; 'RJ'). Res / Mig status indicates: BR—breeding resident species; M—species that occur in New Guinea only as non-breeding migrants; BR/M—breeding residents with populations seasonally augmented by non-breeding visitors, and a widespread local breeding range potentially overlapping the study area; M(BR)—breeding residents augmented by non-breeding visitors but known breeding sites are localised and lie outside the Kikori basin.

Scientific name	English name	Res / Mig	RS	RJ
<i>Nettapus pulchellus</i>	Green Pygmy Goose	BR/M		29
<i>Anas superciliosa</i>	Pacific Black Duck	BR/M	Occasional pairs	10
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	BR/M		[3]
<i>Nycticorax caledonicus</i>	Nankeen Night Heron	M(BR)	Common, singles and groups of up to ten, adults and immatures	
<i>Ardea ibis</i>	Cattle Egret	M		1
<i>Ardea alba</i>	Great Egret	M(BR)	Regular singles and duos	26
<i>Ardea intermedia</i>	Intermediate Egret	M(BR)	Regular singles and duos	22
<i>Egretta picata</i>	Pied Heron	M		3
<i>Egretta novaehollandiae</i>	White-faced Heron	M		
<i>Egretta garzetta</i>	Little Egret	M		7
<i>Microcarbo melanoleucos</i>	Little Pied Cormorant	M(BR)	Several groups of 20–30	65
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	M(BR)	Regular singles and groups of 4–5	
<i>Anhinga novaehollandiae</i>	Australasian Darter	M(BR)	1+	
<i>Amaurornis cinerea</i>	White-browed Crake	BR		[2+]
<i>Gallinula tenebrosa</i>	Dusky Moorhen	BR		3
<i>Charadrius dubius</i>	Little Ringed Plover	BR		
<i>Tringa brevipes</i>	Grey-tailed Tattler	M	Occasional groups of 2–5	
<i>Actitis hypoleucos</i>	Common Sandpiper	M	Regular singles	
<i>Calidris ruficollis</i>	Red-necked Stint	M	1	
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	M	1	
<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle	BR		
<i>Ceyx azureus</i>	Azure Kingfisher	BR	Frequent singles	2
<i>Monachella muelleriana</i>	Torrent Flycatcher	BR		
<i>Acrocephalus australis</i>	Australian Reed Warbler	BR		c

Torrent Flycatcher *Monachella muelleriana* are better adapted to smaller waterways and / or fast-flowing rivers that are well represented across the local region. *Haliaeetus leucogaster* is predominantly a bird of coastal and estuarine environments; Lake Kutubu may support one or more breeding pairs, or they may occur locally as non-breeding visitors. Understanding the importance of the WMA to breeding waterbirds would require additional surveys of vegetated wetlands at the margins of the lake and larger watercourses, and discussions with local residents.

Fourteen migratory wetland species have been recorded in the WMA (Table 1). Ten of these breed in Australia or are known to breed in New Guinea only outside of the Kikori–Purari area. Four are migratory shorebirds that breed in the Northern Hemisphere—*Tringa brevipes*, Common Sandpiper *Actitis hypoleucos*, *Calidris ruficollis* and Sharp-tailed Sandpiper *C. acuminata*. Lake Kutubu does not contain extensive areas of tidal mudflats that are typically required to support large numbers of Palearctic shorebirds, though it may regularly host larger congregations of migrants that breed in Australia or elsewhere in New Guinea. For example, numbers of Little Pied Cormorant *Microcarbo melanoleucos* recorded by Schodde and Jaensch (Table 1) may represent locally significant congregations—while they are much smaller than flock sizes recorded in the middle and lower Fly River wetlands of Western Province (Bishop 2005; up to c.9,000 birds: Gregory *et al.* 1996), they represent the highest concentrations reported to date for the Kikori–Purari systems (Beehler & Pratt 2016; IAW unpubl.).

Numerous additional wetland species have been observed in the expansive system of riverine and estuarine wetlands in the lower Kikori basin (summarised in Woxvold 2018b), many of which may regularly visit Lake Kutubu.

Conclusions

Lake Kutubu WMA is set in one of the world's most biologically diverse and endemically rich terrestrial regions (Olson & Dinerstein 1998, Brooks *et al.* 2006). More than one-third of all New Guinean bird species have been recorded within the WMA and / or the adjacent Agogo Range. The high species richness is attributable to the presence of multiple habitats, including a variety of dryland forest, open-water wetland and swamp vegetation types, spanning an elevational range of nearly 600 m within a small geographic area.

Resident avifauna include five IUCN threatened or Near Threatened species—*Harpypopsis novaeguineae*, *Aquila gurneyi*, *Psittichas fulgidus*, *Charmosyna multistriata* and *Gennaedryas placens*—and a suite of nationally Protected and New Guinean endemic taxa, including three restricted-range bird species—*Charmosyna multistriata*, *Megalampitta gigantea* and *Gennaedryas placens*. Lake Kutubu WMA is the only PNG protected area in which *Megalampitta gigantea* is known to occur.

The area is potentially of great interest to international birdwatchers. 'Adventuring into eco-tourism' is one of four reasons for establishment of the Lake Kutubu WMA listed in its Protected Area Register. In addition to the spectacular scenery afforded by the lake and surrounding landscape, the region's avifauna may play a key role in supporting a sustainable local ecotourism industry.

Acknowledgements

IAW & LL are grateful to ExxonMobil PNG Limited for their funding and logistical support. They are especially indebted to Dr Jane Mogina and Stephen Richards for their vision and efforts in facilitating the multi-disciplinary 2017 biodiversity surveys. Thanks also to Kyle Armstrong and Stephen Richards for deploying SM3 automated sound recorders, and to Pita Amik, Kyle Armstrong and Enock Kale for deploying mist-nets. Anita Mosby, Chris Muller and Pagi Toko provided additional support and company in the field. Bird surveys were conducted in accordance with the permitting procedures of the PNG Conservation and

Environment Protection Authority (CEPA). JMD and KDB thank the World Wildlife Fund, the National Geographic Society, Chevron, and Oil Search (PNG) Ltd. for their support. Thane Pratt and Mary LeCroy provided valuable comments on the submitted draft.

References:

- Adams, V. M., Tulloch, V. J. & Possingham, H. P. 2017. *Land–sea conservation assessment for Papua New Guinea*. Univ. of Queensland, Brisbane.
- Allen, B. 2009. Agricultural development, policy and governance. Pp. 426–488 in Bourke, R. M. & Harwood, T. (eds.) *Food and agriculture in Papua New Guinea*. Australian National Univ. E Press, Canberra.
- Baptista, L. F., Traill, P. W. & Horblit, H. M. 1997. Family Columbidae (pigeons and doves). Pp. 60–245 in del Hoyo, J., Elliott, A. & Sargatal, J. (eds.) *Handbook of the birds of the world*, vol. 4. Lynx Edicions, Barcelona.
- Beehler, B. M. 1982. Ecological structuring of forest bird communities in New Guinea. Pp. 837–860 in Gressitt, J. L. (ed.) *Biogeography and ecology of New Guinea*. Monogr. Biol., vol. 42. Dr W. Junk Publishers, The Hague.
- Beehler, B. M. & Pratt, T. K. 2016. *Birds of New Guinea: distribution, taxonomy, and systematics*. Princeton Univ. Press.
- Bell, H. L. 1970. Field notes on birds of the Nomad River Sub-district, Papua. *Emu* 70: 97–104.
- Bishop, K. D. 2005. A review of the avifauna of the TransFly eco-region: the status, distribution, habitats and conservation of the region's birds. WWF Project: TransFly Ecoregion Action Program. Project no. 9S0739.02.
- Brooks, T. M., Mittermeier, R. A., da Fonseca, G. A. B., Gerlach, J., Hoffmann, M., Lamoreux, J. F., Mittermeier, C. G., Pilgrim, J. D. & Rodrigues, A. S. L. 2006. Global biodiversity conservation priorities. *Science* 313: 58–61.
- Bryan, J. E. & Shearman, P. L. (eds.) 2008. *Papua New Guinea resource information system handbook*. Third edn. Univ. of Papua New Guinea, Port Moresby.
- Bryan, J. E., Shearman, P. L., Aoro, G., Wavine, F. & Zerry, J. 2015. The current state of PNG's forests and changes between 2002 & 2014. Pp. 7–42 in Bryan, J. E. & Shearman, P. L. (eds.) *The state of the forests of Papua New Guinea 2014: measuring change over the period 2002–2014*. Univ. of Papua New Guinea, Port Moresby.
- Burrows, I. 1995. A field survey of the avifauna of the Kikori River Basin. 'Tab D' in Hartshorn, G. S., Lery, T., Seri, L., Burrows, I., Allen, G. R., Polhemus, D. A., Balun, L., Orsak, L., Bigilale, E., Kinbag, F., Kinibel, A., Dal, C., Gebia, O., Wasel, H., Ellis, G. & Forney, M. (eds.) *Field survey of biodiversity in the Kikori River Basin Papua New Guinea*. WWF KICDP area report.
- Champion, I. 1940. The Bamu–Purari patrol, 1936. *Geogr. J.* 96: 190–206.
- Coates, B. J. 1985. *The birds of Papua New Guinea, including the Bismarck archipelago and Bougainville*, vol. 1. Dove Publications, Alderley.
- Coates, B. J. 1990. *The birds of Papua New Guinea, including the Bismarck archipelago and Bougainville*, vol. 2. Dove Publications, Alderley.
- D'Cruz, R. 2008. *Lake Kutubu catchment management plan*. Report prepared by Anonyx Environmental, Malaysia, for the WWF Kikori River Programme.
- Diamond, J. M. 1972. *Avifauna of the eastern highlands of New Guinea*. Nuttall Orn. Cl., Cambridge, MA.
- Diamond, J. M. 1983. *Melampitta gigantea*: possible relation between feather structure and underground roosting habits. *Condor* 85: 89–91.
- Diamond, J. M. 1985. New distributional records and taxa from the outlying mountain ranges of New Guinea. *Emu* 85: 65–91.
- Diamond, J. & Bishop, K. D. 2003. Seasonality in birds in the Kikori River Catchment: year-2003 studies. WWF KICDP area report.
- Diamond, J. & Bishop, K. D. 2007. Status of birds of the Kikori River catchment: year-2007 studies. WWF KICDP area report.
- Eastwood, C. 1997. Site report [Birds seen in Varirata (October 1996 - February 1998)]. *PNG Bird Soc. Newsl.* 291: 8 (also supplement 'Varirata table.xls').
- Freeman, B. G., Class, A., Mandeville, J., Tomassi, S. & Beehler, B. M. 2013. Ornithological survey of the mountains of the Huon Peninsula, Papua New Guinea. *Bull. Brit. Orn. Cl.* 133: 4–18.
- Frith, C. B. & Beehler, B. M. 1998. *The birds of paradise: Paradisaeidae*. Oxford Univ. Press.
- Gill, F. & Donsker, D. (eds.) 2019. IOC World Bird List (v 9.1). <http://www.worldbirdnames.org/>.
- Gregory, P. 1995. *Birds of the Ok Tedi area*. Ok Tedi Mining Ltd., Port Moresby.
- Gregory, P. 2007. Acanthizidae (Australian warblers). Pp. 544–611 in del Hoyo, J., Elliott, A. & Christie, D. A. (eds.) *Handbook of the birds of the world*, vol. 12. Lynx Edicions, Barcelona.
- Gregory, P. 2009. Eurasian Tree Sparrows (*Passer montanus*) in PNG. *Muruk* 9: 96–97.
- Gregory, P. 2017. *Birds of New Guinea. Including Bismarck archipelago and Bougainville*. Lynx Edicions, Barcelona.
- Gregory, P., Halse, S. A., Jaensch, R. P., Kay, W. R., Kulmoi, P., Pearson, G. B. & Storey, A. W. 1996. The middle Fly waterbird survey 1994–95. *Muruk* 8: 1–7.

- Hammermaster, E. T. & Saunders, J. C. 1995. *Forest resources and vegetation mapping of Papua New Guinea*. PNGRIS Publ. 4. Commonwealth Scientific and Industrial Research Organisation & Australian Agency for International Development, Canberra.
- Hartshorn, G. S., Burrows, I., Forney, M., Kosi, T., Mala, T. & Wiakabu, J. 1994. Preliminary biological reconnaissance of the Kikori River Basin, Papua New Guinea. WWF KICDP area report.
- Independent State of Papua New Guinea. 2014. *Papua New Guinea policy on protected areas*. Conservation and Environment Protection Authority, Waigani.
- IUCN. 2019. IUCN Red List of threatened species. V. 2019.2. www.iucnredlist.org.
- Jaensch, R. undated a. Birds recorded at Lake Kutubu, Moro and Agogo Range, Papua New Guinea, 30 July to 2 August 1997. Wetlands International Report.
- Jaensch, R. undated b. Birds of the Lake Kutubu Swamp Forest Papua New Guinea (summary report). Wetlands International Report.
- Jaensch R. & Kulmoi P. undated. Birds recorded at Tubo Lodge, Lake Kutubu, August 1997 and February 1998. Wetlands International Report.
- Jones, D. N., Dekker, R. W. R. J. & Roselaar, C. S. 1995. *The megapodes: Megapodiidae*. Oxford Univ. Press.
- Kula, G. R. & George, I. 1996. *Protected fauna of Papua New Guinea*. Dept. of Environment and Conservation, National Capital District, Papua New Guinea.
- Leary, T. undated. Brief report on Iviri and Keboi Kerowa mammal monitoring - December 2003. WWF KICDP area report.
- Leary, T., Naug, R. & Price, J. 1996. Kikori Integrated Conservation and Development Project. Pp. 805–814 in Buchanan, P. G. (ed.) *Petroleum exploration, development and production in Papua New Guinea*. Proc. Third PNG Petroleum Convention, Port Moresby, 9–11 September 1996.
- Leverington, F., Peterson, A. & Peterson, G. 2017. *Assessment of management effectiveness for Papua New Guinea's protected areas 2017*. Final report. Secretariat of the Pacific Regional Environment Council, Apia, Samoa.
- Löffler, E. 1977. *Geomorphology of Papua New Guinea*. Commonwealth Scientific and Industrial Research Organisation & Australian National Univ. Press, Canberra.
- Mack, A. L. 2014. *Searching for pekpek: cassowaries and conservation in the New Guinea rainforest*. Cassowary Conservation and Publishing, LLC, PA.
- Mack, A. L. & Wright, D. D. 1996. Notes on occurrence and feeding of birds at Crater Mountain Biological Research Station, Papua New Guinea. *Emu* 96: 89–101.
- Mack, A. L. & Wright, D. D. 1998. The Vulturine Parrot, *Psittichas fulgidus*, a threatened New Guinea endemic: notes on its biology and conservation. *Bird Conserv. Intern.* 8: 185–194.
- Mayr, E. 1938. Birds collected during the Whitney South Sea Expedition. 39. Notes on New Guinea birds. 4. *Amer. Mus. Novit.* 1006: 1–16.
- McAlpine, J., Keig, G. & Falls, R. 1983. *Climate of Papua New Guinea*. Australian National Univ., Canberra.
- McCall, D. & Flemming, D. 2000. *Chevron and WWF: lessons learned from six years of collaboration in biodiversity protection*. WWF / Chevron Niugini Report.
- Melick, D. R., Kinch, J. P. & Govan, H. 2012. How global biodiversity targets risk becoming counterproductive: the case of Papua New Guinea. *Conserv. Soc.* 10: 344–353.
- Ng, E. Y. X., Eaton, J. A., Verbelen, P., Hutchinson, R. O. & Rheindt, F. E. 2016. Using bioacoustic data to test species limits in an Indo-Pacific island radiation of *Macropygia* cuckoo doves. *Biol. J. Linn. Soc.* 118: 786–812.
- Olson, D. M. & Dinerstein, E. 1998. The Global 200: a representation approach to conserving the Earth's most biologically valuable ecoregions. *Conserv. Biol.* 12: 502–515.
- PNGFA. 1996. *Papua New Guinea logging code of practice*. Papua New Guinea Forest Authority and Dept. of Environment and Conservation, Port Moresby.
- Pratt, T. K. & Beehler, B. M. 2015. *Birds of New Guinea*. Second edn. Princeton Univ. Press.
- Regis, J. 2000. WWF's partnership with the Foi of Lake Kutubu, Papua New Guinea. Pp. 91–111 in Weber, R., Butler, J. & Patty, L. (eds.) *Indigenous peoples and conservation organizations: experiences in collaboration*. WWF, Washington DC.
- Richards, A. & Rowland, R. 1995. List of birds recorded in Papua New Guinea during the period 16 October, 1992 to 29 November, 1992. *Muruk* 7: 75–95.
- Schodde, R. & Hitchcock, W. B. 1968. *Contributions to Papuan ornithology. I. Report on the Birds of the Lake Kutubu Area, Territory of Papua and New Guinea*. Division of Wildlife Research Tech. Paper no. 13. Commonwealth Scientific and Industrial Research Organisation, Melbourne.
- Shearman, P. L. & Bryan, J. E. 2011. A bioregional analysis of the distribution of rainforest cover, deforestation and degradation in Papua New Guinea. *Austral Ecol.* 36: 9–24.
- Sinclair, J. R. 2002. Selection of incubation mound sites by three sympatric megapodes in Papua New Guinea. *Condor* 104: 395–406.
- Stattersfield, A. J., Crosby, M. J., Long, A. J. & Wege, D. C. 1998. *Endemic Bird Areas of the world: priorities for biodiversity conservation*. BirdLife International, Cambridge, UK.
- Thiollay, J. M. 1994. Family Accipitridae (hawks and eagles). Pp. 52–205 in del Hoyo, J., Elliott, A. & Sargatal, J. (eds.) *Handbook of the birds of the world*, vol. 2. Lynx Edicions, Barcelona.

- Woxvold, I. A. 2018a. Avifauna of the Wau Creek proposed Wildlife Management Area, Gulf Province, Papua New Guinea. Pp. 97–124 in Richards, S. J. (ed.) *Rapid biological assessments of Wau Creek, Uro Creek and Lake Kutubu: documenting biodiversity values to promote forest conservation in the Kikori River basin, Papua New Guinea*. ExxonMobil PNG Ltd., Port Moresby. https://pnglng.com/media/PNG-LNG-Media/Files/Environment/Rapid-biological-assessments-of-Wau-Creek,-Uro-Creek-and-Lake-Kutubu_FINAL.pdf
- Woxvold, I. A. 2018b. Avifauna of the Uro Creek catchment, Gulf Province, Papua New Guinea. Avifauna of the Wau Creek proposed Wildlife Management Area, Gulf Province, Papua New Guinea. Pp. 213–244 in Richards, S. J. (ed.) *Rapid biological assessments of Wau Creek, Uro Creek and Lake Kutubu: documenting biodiversity values to promote forest conservation in the Kikori River basin, Papua New Guinea*. ExxonMobil PNG Ltd., Port Moresby. https://pnglng.com/media/PNG-LNG-Media/Files/Environment/Rapid-biological-assessments-of-Wau-Creek,-Uro-Creek-and-Lake-Kutubu_FINAL.pdf
- Woxvold, I. A. & Legra, L. 2017. Birds. Pp. 91–120 in Richards, S. J. (ed.) *Biodiversity Assessment of the PNG LNG Upstream Project Area, Southern Highlands and Hela Provinces, Papua New Guinea*. ExxonMobil PNG Ltd., Port Moresby. <https://pnglng.com/media/PNG-LNG-Media/Files/Environment/Ecology%20Reports/smaller-PMA3-biodiversity-report-PDF-version-Jan-2018.pdf>
- Woxvold, I. A. & Legra, L. 2018. Avifauna of the Lake Kutubu Wildlife Management Area, Southern Highlands Province, Papua New Guinea. Pp. 317–353 in Richards, S. J. (ed.) *Rapid biological assessments of Wau Creek, Uro Creek and Lake Kutubu: documenting biodiversity values to promote forest conservation in the Kikori River basin, Papua New Guinea*. ExxonMobil PNG Ltd., Port Moresby. https://pnglng.com/media/PNG-LNG-Media/Files/Environment/Rapid-biological-assessments-of-Wau-Creek,-Uro-Creek-and-Lake-Kutubu_FINAL.pdf
- Woxvold, I. A., Ken, B. & Aplin, K. P. 2015. Birds. Pp. 103–130 in Richards, S. & Whitmore, N. (eds.) *A rapid biodiversity assessment of Papua New Guinea's Hindenburg Wall region*. Wildlife Conservation Society Papua New Guinea Program, Goroka.

Addresses: Iain A. Woxvold, 44 Aroona Road, Goldie, VIC 3435, Australia, e-mail: iainwoxvold@gmail.com. Jared M. Diamond, Geography Dept., 1255 Bunche Hall, UCLA, Los Angeles, CA 90095-1524, USA, e-mail: jdiamond@geog.ucla.edu. K. David Bishop, P.O. Box 1234, Armidale, NSW 2350, Australia, e-mail: kdbishop@ozemail.com.au. Leo Legra, Community Relations Department, Newcrest Mining Ltd. – Lihir Island Operations, Lihir, New Ireland, Papua New Guinea, e-mail: llegra09@gmail.com

Appendix 1

Birds recorded in the Lake Kutubu WMA and immediate environs. Conservation status is shown in brackets after the English name for species listed by the IUCN as Vulnerable (VU) and Near Threatened (NT), species Protected (P) under Papua New Guinean law and restricted-range species (RR). Observers—Schodde (RS), Burrows (IB), Jaensch (RJ), JMD & KDB (D-B), IAW & LL (W-L). Square brackets indicate provisional records (uncertain but probable; see Conventions used). Capture rates for the 2017 survey (2017 capt.) are shown as the camera-trapping rate (Relative Abundance Index, proportion <1) and the number of birds mist-netted (integers with the suffix 'n'). Residency / migratory (Res / Mig) status indicates: BR—breeding resident species; M—species that occur in New Guinea only as non-breeding migrants; BR/M—breeding residents with populations seasonally augmented by non-breeding visitors, and widespread local breeding range potentially overlapping the study area; M(BR)—breeding residents augmented by non-breeding visitors, but known breeding sites are localised and outside of the Kikori basin; t—birds of terrestrial environments, including forest, converted lands and aerial foraging species; w—birds of wetlands, including lakes, rivers and streams; wt—species of both wetland and open terrestrial environments; data from Coates (1985, 1990) and Beehler & Pratt (2016).

Scientific name	English name (conservation status)	Observers	2017 capt.	Res / Mig
CASUARIIDAE				
<i>Casuarus bennetti</i>	Dwarf Cassowary	[RS, RJ]		BRt
MEGAPODIIDAE				
<i>Aepyodius arfakianus</i>	Wattled Brushturkey	W-L	0.019	BRt
<i>Talegalla jobiensis</i>	Red-legged Brushturkey	[IB, D-B], W-L	0.173	BRt
<i>Megapodius decollatus</i>	New Guinea Scrubfowl	[D-B, W-L]		BRt
ANATIDAE				
<i>Nettapus pulchellus</i>	Green Pygmy Goose	RJ		BR/Mw
<i>Anas superciliosa</i>	Pacific Black Duck	RS, RJ, D-B		BR/Mw

Scientific name	English name (conservation status)	Observers	2017 capt.	Res / Mig
PODICIPEDIDAE				
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	[RJ]		BR/Mw
COLUMBIDAE				
<i>Reinwardtoena reinwardtii</i>	Great Cuckoo-Dove	RJ, D-B, W-L		BRt
<i>Macropygia amboinensis</i>	Brown Cuckoo-Dove	IB, RJ, D-B, W-L		BRt
<i>Macropygia nigrirostris</i>	Black-billed Cuckoo-Dove	RS, D-B, W-L		BRt
<i>Gallicolumba rufigula</i>	Cinnamon Ground Dove	W-L	0.077	BRt
<i>Alopecoenas jobiensis</i>	White-breasted Ground Dove	RS		BRt
<i>Trugon terrestris</i>	Thick-billed Ground Pigeon	W-L	0.019	BRt
<i>Otidiphaps nobilis</i>	Pheasant Pigeon	D-B, W-L	0.462	BRt
<i>Chalcophaps stephani</i>	Stephan's Emerald Dove	RS, D-B		BRt
<i>Megaloprepia magnifica</i>	Wompoo Fruit Dove	RS, RJ, D-B, W-L		BRt
<i>Ptilinopus nainus</i>	Dwarf Fruit Dove	IB, D-B		BRt
<i>Ptilinopus superbus</i>	Superb Fruit Dove	RS, IB, RJ, D-B, W-L		BRt
<i>Ptilinopus perlatus</i>	Pink-spotted Fruit Dove	RS, IB, D-B, W-L		BRt
<i>Ptilinopus ornatus</i>	Ornate Fruit Dove	RJ, D-B, W-L		BRt
<i>Ptilinopus iozonus</i>	Orange-bellied Fruit Dove	D-B		BRt
<i>Ptilinopus pulchellus</i>	Beautiful Fruit Dove	RS, RJ, D-B, W-L		BRt
<i>Ducula rufigaster</i>	Purple-tailed Imperial Pigeon	RJ, D-B, W-L		BRt
<i>Ducula chalconota</i>	Rufescent Imperial Pigeon	IB, RJ		BRt
<i>Ducula pimon</i>	Pinon's Imperial Pigeon	D-B		BRt
<i>Ducula zoeae</i>	Zoe's Imperial Pigeon	RS, IB, RJ, D-B, W-L		BRt
<i>Gymnophaps albertisii</i>	Papuan Mountain Pigeon	IB, RJ, D-B, W-L		BRt
ARDEIDAE				
<i>Nycticorax caledonicus</i>	Nankeen Night Heron	RS		M(BR)w
<i>Ardea ibis</i>	Cattle Egret	RJ		Mt
<i>Ardea alba</i>	Great Egret (P)	RS, RJ, D-B		M(BR)w
<i>Ardea intermedia</i>	Intermediate Egret (P)	RS, RJ		M(BR)w
<i>Egretta picata</i>	Pied Heron	RJ		Mw
<i>Egretta novaehollandiae</i>	White-faced Heron	D-B		Mw
<i>Egretta garzetta</i>	Little Egret (P)	RJ		Mw
PHALACROCORACIDAE				
<i>Microcarbo melanoleucus</i>	Little Pied Cormorant	RS, RJ		M(BR)w
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	RS		M(BR)w
ANHINGIDAE				
<i>Anhinga novaehollandiae</i>	Australasian Darter	RS, D-B		M(BR)w
RALLIDAE				
<i>Rallina tricolor</i>	Red-necked Crake	D-B, W-L	0.115	BRt
<i>Hypotaenidia philippensis</i>	Buff-banded Rail	W-L		BRwt

Scientific name	English name (conservation status)	Observers	2017 capt.	Res / Mig
<i>Amaurornis cinerea</i>	White-browed Crane	RJ, D-B		BRw
<i>Amaurornis moluccana</i>	Rufous-tailed Bush-hen	RS, D-B		BRt
<i>Gallinula tenebrosa</i>	Dusky Moorhen	RJ		BRw
CENTROPODIDAE				
<i>Centropus menbeki</i>	Greater Black Coucal	IB, [RJ], D-B, W-L		BRt
CUCULIDAE				
<i>Microdynamis parva</i>	Dwarf Koel	D-B, W-L		BRt
<i>Eudynamis orientalis</i>	Eastern Koel	[RJ], D-B, W-L		BR/Mt
<i>Chalcites meyerii</i>	White-eared Bronze Cuckoo	RS, RJ, D-B		BRt
<i>Chalcites minutillus</i>	Little Bronze Cuckoo	D-B, W-L		BRt
<i>Caliechthrus leucolophus</i>	White-crowned Cuckoo	D-B, W-L		BRt
<i>Cacomantis castaneiventris</i>	Chestnut-breasted Cuckoo	IB, [RJ], D-B, W-L		BRt
<i>Cacomantis variolosus</i>	Brush Cuckoo	RJ, D-B, W-L		BRt
<i>Cuculus optatus</i>	Oriental Cuckoo	D-B		Mt
PODARGIDAE				
<i>Podargus ocellatus</i>	Marbled Frogmouth	D-B, W-L		BRt
<i>Podargus papuensis</i>	Papuan Frogmouth	D-B, W-L		BRt
CAPRIMULGIDAE				
<i>Eurostopodus mysticalis / papuensis</i>	White-throated / Papuan Nightjar	RS		BR/Mt
<i>Caprimulgus macrurus</i>	Large-tailed Nightjar	D-B		BRt
AEGOTHELIDAE				
<i>Aegothales sp.</i>	Owlet-nightjar sp.	D-B		BRt
HEMIPROCNIDAE				
<i>Hemiprocnis mystacea</i>	Moustached Treeswift	RS, RJ, D-B, W-L		BRt
APODIDAE				
<i>Collocalia esculenta</i>	Glossy Swiftlet	RS, IB, RJ, D-B, W-L		BRt
<i>Aerodramus vanikorensis / hirundinaceus</i>	Uniform / Mountain Swiftlet	RS, IB, RJ, D-B, W-L		BRt
CHARADRIIDAE				
<i>Charadrius dubius</i>	Little Ringed Plover	D-B, W-L		BRwt
SCOLOPACIDAE				
<i>Tringa brevipes</i>	Grey-tailed Tattler (NT)	RS		Mw
<i>Actitis hypoleucos</i>	Common Sandpiper	RS		Mw
<i>Calidris ruficollis</i>	Red-necked Stint (NT)	RS, D-B		Mw
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	RS, D-B		Mw
GLAREOLIDAE				
<i>Stiltia isabella</i>	Australian Pratincole	RS		Mt
ACCIPTRIDAE				
<i>Aviceda subcristata</i>	Pacific Baza	RS, RJ, D-B, W-L		BRt
<i>Henicopernis longicauda</i>	Long-tailed Buzzard	IB, RJ, D-B, W-L		BRt

Scientific name	English name (conservation status)	Observers	2017 capt.	Res / Mig
<i>Macheiramphus alcinus</i>	Bat Hawk	D-B		BRt
<i>Harpyopsis novaeguineae</i>	New Guinea Harpy Eagle (VU, P)	D-B		BRt
<i>Hieraetus weiskei</i>	Pygmy Eagle	IB, W-L		BRt
<i>Aquila gurneyi</i>	Gurney's Eagle (NT)	D-B, W-L		BRt
<i>Haliastur indus</i>	Brahminy Kite	RS, IB, RJ, D-B, W-L		BRt
<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle	D-B, W-L		BRw
<i>Circus approximans spilothorax</i>	Swamp (Papuan) Harrier	IB		BRt
<i>Circus approximans</i> ?subsp.	Swamp Harrier	D-B		BR/Mwt
<i>Accipiter hiogaster</i>	Variable Goshawk	RJ, D-B		BRt
<i>Accipiter poliocephalus</i>	Grey-headed Goshawk	IB, D-B		BRt
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk	[RJ]		BRt
TYTONIDAE				
<i>Tyto tenebricosa</i>	Sooty Owl	W-L		BRt
STRIGIDAE				
<i>Ninox theomacha</i>	Papuan Boobook	RS, D-B, W-L		BRt
BUCEROTIDAE				
<i>Rhyticeros plicatus</i>	Blyth's Hornbill (P)	RS, IB, RJ, D-B, W-L		BRt
MEROPIDAE				
<i>Merops ornatus</i>	Rainbow Bee-eater	RS, IB, RJ, D-B, W-L		Mt
CORACIIDAE				
<i>Eurystomus orientalis</i>	Oriental Dollarbird	RS, IB, RJ, D-B, W-L		BR/Mt
HALCYONIDAE				
<i>Melidora macrorrhina</i>	Hook-billed Kingfisher	RS, IB, D-B, W-L		BRt
<i>Dacelo gaudichaud</i>	Rufous-bellied Kookaburra	RS, IB, RJ, D-B, W-L		BRt
<i>Todiramphus macleayii</i>	Forest Kingfisher	RS		Mt
<i>Todiramphus sanctus</i>	Sacred Kingfisher	RS, RJ, D-B		Mt
<i>Syma torotoro</i>	Yellow-billed Kingfisher	D-B		BRt
<i>Syma torotoro / megarhyncha</i>	Yellow-billed / Mountain Kingfisher	RJ		BRt
ALCEDINIDAE				
<i>Ceyx solitarius</i>	Papuan Dwarf Kingfisher	D-B, W-L		BRt
<i>Ceyx azureus</i>	Azure Kingfisher	RS, IB, RJ, D-B, W-L	1n	BRw
FALCONIDAE				
<i>Falco cenchroides</i>	Nankeen Kestrel	W-L		Mt
<i>Falco severus</i>	Oriental Hobby	[RS], D-B		BRt
<i>Falco peregrinus</i>	Peregrine Falcon	RJ, D-B		BRt
CACATUIDAE				
<i>Probosciger aterrimus</i>	Palm Cockatoo (P)	RS, IB, RJ, D-B, W-L		BRt
<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	RS, IB, RJ, D-B, W-L		BRt

Scientific name	English name (conservation status)	Observers	2017 capt.	Res / Mig
PSITTRICHASIDAE				
<i>Psittrichas fulgidus</i>	New Guinea Vulturine Parrot (VU, P)	RS, IB, RJ, D-B, W-L		BRt
PSITTACULIDAE				
<i>Charmosyna placentis</i>	Red-flanked Lorikeet	D-B, [W-L]		BRt
<i>Charmosyna wilhelminae</i>	Pygmy Lorikeet	D-B, [W-L]		BRt
<i>Charmosyna multistriata</i>	Striated Lorikeet (NT, RR)	D-B		BRt
<i>Charmosyna pulchella</i>	Fairy Lorikeet	D-B		BRt
<i>Lorius lory</i>	Black-capped Lory	RS, IB, RJ, D-B, W-L		BRt
<i>Psitteuteles goldiei</i>	Goldie's Lorikeet	D-B		BRt
<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	RS, RJ, D-B, W-L		BRt
<i>Pseudeos fuscata</i>	Dusky Lory	RS, RJ, D-B, W-L		BRt
<i>Chalcopsitta scintillata</i>	Yellow-streaked Lory	RJ, D-B, W-L		BRt
<i>Psittaculirostris desmarestii</i>	Large Fig Parrot	RJ, D-B		BRt
<i>Cyclopsitta gulelmitertii</i>	Orange-breasted Fig Parrot	IB, RJ, D-B, W-L		BRt
<i>Cyclopsitta diophthalma</i>	Double-eyed Fig Parrot	D-B		BRt
<i>Loriculus aurantiifrons</i>	Orange-fronted Hanging Parrot	RS, RJ, D-B		BRt
<i>Alisterus chloropterus</i>	Papuan King Parrot	D-B, W-L		BRt
<i>Eclectus roratus</i>	Eclectus Parrot	RS, IB, RJ, D-B, W-L		BRt
<i>Geoffroyus geoffroyi</i>	Red-cheeked Parrot	RS, RJ, D-B, W-L		BRt
<i>Geoffroyus simplex</i>	Blue-collared Parrot	IB, D-B, W-L		BRt
<i>Micropsitta keiensis</i>	Yellow-capped Pygmy Parrot	D-B		BRt
<i>Micropsitta pusio</i>	Buff-faced Pygmy Parrot	IB, [RJ], ?D-B		BRt
<i>Micropsitta bruijnii</i>	Red-breasted Pygmy Parrot	RJ		BRt
PITTIDAE				
<i>Erythropitta erythrogaster</i>	Red-bellied Pitta	D-B, W-L	0.192	BRt
<i>Pitta sordida</i>	Hooded Pitta	D-B		BRt
PTILONORHYNCHIDAE				
<i>Ailuroedus buccoides</i>	White-eared Catbird	RS, D-B, W-L	1n	BRt
MALURIDAE				
<i>Sipodotus wallacii</i>	Wallace's Fairywren	RJ		BRt
<i>Malurus cyanocephalus</i>	Emperor Fairywren	RS, IB, RJ, D-B, W-L		BRt
<i>Malurus alboscapulatus</i>	White-shouldered Fairywren	RS, IB, RJ, D-B, W-L		BRt
MELIPHAGIDAE				
<i>Myzomela eques</i>	Ruby-throated Myzomela	D-B		BRt
<i>Xanthotis flaviventer</i>	Tawny-breasted Honeyeater	RS, IB, RJ, D-B, W-L		BRt
<i>Xanthotis polygrammus</i>	Spotted Honeyeater	RS, D-B		BRt
<i>Philemon meyeri</i>	Meyer's Friarbird	[RJ], D-B		BRt
<i>Philemon buceroides</i>	Helmeted Friarbird	RS, IB, RJ, D-B, W-L		BRt
<i>Glycichaera fallax</i>	Green-backed Honeyeater	D-B		BRt

Scientific name	English name (conservation status)	Observers	2017 capt.	Res / Mig
<i>Pycnopygius ixoides</i>	Plain Honeyeater	D-B		BRt
<i>Pycnopygius stictocephalus</i>	Streak-headed Honeyeater	D-B, W-L		BRt
<i>Melilestes megarhynchus</i>	Long-billed Honeyeater	RS, IB, RJ, D-B, W-L	2n	BRt
<i>Meliphaga aruensis</i>	Puff-backed Meliphaga	D-B, W-L	2n	BRt
<i>Meliphaga albonotata</i>	Scrub Meliphaga	RS, IB, RJ, D-B, W-L		BRt
<i>Meliphaga analoga</i>	Mimic Meliphaga	RS, D-B		BRt
<i>Meliphaga mimikae</i>	Mottled Meliphaga	W-L	1n	BRt
<i>Meliphaga</i> sp.		RJ		BRt
<i>Caligavis obscura</i>	Obscure Honeyeater	RS, D-B, W-L		BRt
ACANTHIZIDAE				
<i>Pachycare flavogriseum</i>	Goldenface	D-B, W-L		BRt
<i>Crateroscelis murina</i>	Rusty Mouse Warbler	RS, IB, RJ, D-B, W-L		BRt
<i>Sericornis beccarii</i>	Tropical Scrubwren	RS		BRt
<i>Gerygone chrysogaster</i>	Yellow-bellied Gerygone	RJ, D-B, W-L		BRt
<i>Gerygone chloronota</i>	Green-backed Gerygone	IB, RJ, D-B, W-L		BRt
<i>Gerygone palpebrosa</i>	Fairy Gerygone	RJ, D-B, W-L		BRt
<i>Gerygone magnirostris</i>	Large-billed Gerygone	D-B		BRt
MELANOCHARITIDAE				
<i>Melanocharis nigra</i>	Black Berrypecker	RS, D-B, W-L	1n	BRt
<i>Oedistoma iliolophus</i>	Spectacled Longbill	RS, D-B, W-L		BRt
<i>Oedistoma pygmaeum</i>	Pygmy Longbill	RS, D-B, W-L		BRt
<i>Toxorhamphus poliopterus</i>	Slaty-headed Longbill	RJ		BRt
CINCLOSOMATIDAE				
<i>Ptilorrhoa castanonota</i>	Chestnut-backed Jewel-babbler	RJ, D-B, W-L	0.019	BRt
MACHAERIRHYNCHIDAE				
<i>Machaerirhynchus flaviventer</i>	Yellow-breasted Boatbill	RS, D-B		BRt
CRACTICIDAE				
<i>Peltops blainvillii</i>	Lowland Peltops	RS, IB, D-B		BRt
<i>Peltops montanus</i>	Mountain Peltops	RJ, D-B, W-L		BRt
<i>Cracticus quoyi</i>	Black Butcherbird	RS, D-B, W-L		BRt
<i>Cracticus cassicus</i>	Hooded Butcherbird	RS, IB, RJ, D-B, W-L		BRt
ARTAMIDAE				
<i>Artamus maximus</i>	Great Woodswallow	RS, IB, RJ, D-B, W-L		BRt
RHAGOLOGIDAE				
<i>Rhagologus leucostigma</i>	Mottled Berryhunter	RS		BRt
CAMPEPHAGIDAE				
<i>Coracina caeruleogrisea</i>	Stout-billed Cuckooshrike	IB, RJ		BRt
<i>Coracina boyeri</i>	Boyer's Cuckooshrike	RS, IB, RJ, D-B, W-L		BRt
<i>Coracina papuensis</i>	White-bellied Cuckooshrike	RS		BRt

Scientific name	English name (conservation status)	Observers	2017 capt.	Res / Mig
<i>Campochaera sloetii</i>	Golden Cuckooshrike	RJ, D-B, W-L		BRt
<i>Lalage leucomela</i>	Varied Triller	IB, RJ, D-B, W-L		BRt
<i>Edolisoma incertum</i>	Papuan Cicadabird	IB, D-B, W-L		BRt
<i>Edolisoma tenuirostre</i>	Common Cicadabird	IB		Mt
<i>Edolisoma schisticeps</i>	Grey-headed Cicadabird	IB, RJ, D-B, W-L		BRt
<i>Edolisoma melas</i>	Black Cicadabird	RS, RJ, D-B, W-L		BRt
OREOICIDAE				
<i>Ornorectes cristatus</i>	Piping Bellbird	RS, IB, D-B, W-L	0.058	BRt
PACHYCEPHALIDAE				
<i>Colluricincla megarhyncha</i>	Little Shrikethrush	RS, IB, RJ, D-B, W-L		BRt
<i>Pseudorectes ferrugineus</i>	Rusty Shrikethrush	RS, IB, D-B, W-L	4n	BRt
<i>Pachycephala hyperythra</i>	Rusty Whistler	RS		BRt
<i>Pachycephala simplex</i>	Grey Whistler	RS, D-B, W-L		BRt
ORIOOLIDAE				
<i>Pitohui uropygialis</i>	Southern Variable Pitohui	RS, IB, RJ, D-B, W-L	1n	BRt
<i>Pitohui dichrous</i>	Hooded Pitohui	RS, IB, RJ		BRt
<i>Oriolus szalayi</i>	Brown Oriole	RS, IB, [RJ], D-B, W-L		BRt
RHIPIDURIDAE				
<i>Chaetorhynchus papuensis</i>	Drongo Fantail	RS, W-L		BRt
<i>Rhipidura leucophrys</i>	Willie Wagtail	RS, IB, RJ, D-B, W-L		BRt
<i>Rhipidura maculipectus</i>	Black Thicket Fantail	D-B, [W-L]		BRt
<i>Rhipidura leucothorax</i>	White-bellied Thicket Fantail	RS, RJ, D-B, W-L		BRt
<i>Rhipidura threnothorax</i>	Sooty Thicket Fantail	D-B, W-L		BRt
<i>Rhipidura rufidorsa</i>	Rufous-backed Fantail	[RJ], D-B		BRt
<i>Rhipidura atra</i>	Black Fantail	RS		BRt
<i>Rhipidura hyperythra</i>	Chestnut-bellied Fantail	RS, D-B		BRt
<i>Rhipidura rufiventris</i>	Northern Fantail	RS, IB, RJ, D-B, W-L		BRt
DICRURIDAE				
<i>Dicrurus bracteatus carbonarius</i>	(Papuan) Spangled Drongo	RS, IB, RJ, D-B, W-L		BRt
PARADISAEIDAE				
<i>Manucodia chalybatus</i>	Crinkle-collared Manucode (P)	RS, RJ, D-B		BRt
<i>Seleucidis melanoleucus</i>	Twelve-wired Bird of Paradise (P)	D-B		BRt
<i>Ptiloris magnificus</i>	Magnificent Riflebird (P)	RS, IB, RJ, D-B, W-L		BRt
<i>Cicinnurus regius</i>	King Bird of Paradise (P)	RS, IB, RJ, D-B, W-L		BRt
<i>Cicinnurus magnificus</i>	Magnificent Bird of Paradise (P)	RS, IB, RJ, D-B, W-L		BRt
<i>Paradisaea raggiana</i>	Raggiana Bird of Paradise (P)	RS, IB, RJ, D-B, W-L		BRt
MELAMPITTIDAE				
<i>Megalampitta gigantea</i>	Greater Melampitta (RR)	W-L		BRt

Scientific name	English name (conservation status)	Observers	2017 capt.	Res / Mig
MONARCHIDAE				
<i>Arses telescopthalmus</i>	Frilled Monarch	IB, RJ, D-B, W-L		BRt
<i>Myiagra alecto</i>	Shining Flycatcher	RS, D-B, W-L		BRt
<i>Symposiachrus rubiensi</i>	Rufous Monarch	[IB]		BRt
<i>Symposiachrus guttula</i>	Spot-winged Monarch	RS, RJ, D-B		BRt
<i>Carterornis chrysomela</i>	Golden Monarch	RS, RJ, D-B, W-L		BRt
<i>Monarcha frater</i>	Black-winged Monarch	RS, D-B		BRt
CORVIDAE				
<i>Corvus tristis</i>	Grey Crow	RS, IB, RJ, D-B, W-L		BRt
PETROICIDAE				
<i>Pachycephalopsis poliosoma</i>	White-eyed Robin	D-B		BRt
<i>Kempiella flavovirescens</i>	Olive Flyrobin	IB, [RJ], W-L		BRt
<i>Monachella muelleriana</i>	Torrent Flycatcher	D-B		BRw
<i>Drymodes beccarii</i>	Papuan Scrub Robin	D-B, W-L	0.038	BRt
<i>Poecilodryas hypoleuca</i>	Black-sided Robin	RS, IB, D-B, W-L		BRt
<i>Peneothello bimaculata</i>	White-rumped Robin	RS, D-B, W-L		BRt
<i>Gennaeodryas placens</i>	Banded Yellow Robin (NT, RR)	RS, D-B, W-L		BRt
HIRUNDINIDAE				
<i>Hirundo tahitica</i>	Pacific Swallow	RS, IB, RJ, D-B, W-L		BRt
ZOSTEROPIDAE				
<i>Zosterops atrifrons</i>	Black-fronted White-eye	RJ, D-B, W-L		BRt
ACROCEPHALIDAE				
<i>Acrocephalus australis</i>	Australian Reed Warbler	RJ, D-B		BRw
LOCUSTELLIDAE				
<i>Locustella fasciolata</i>	Gray's Grasshopper Warbler	D-B		Mt
<i>Megalurus macrurus</i>	Papuan Grassbird	RS		BRt
STURNIDAE				
<i>Aplonis metallica</i>	Metallic Starling	D-B		BRt
<i>Mino dumontii</i>	Yellow-faced Myna	RS, IB, RJ, D-B, W-L		BRt
MUSCICAPIDAE				
<i>Saxicola caprata</i>	Pied Bushchat	IB, RJ, D-B, W-L		BRt
DICAEIDAE				
<i>Dicaeum geelvinkianum</i>	Red-capped Flowerpecker	RJ, D-B, W-L		BRt
NECTARINIIDAE				
<i>Leptocoma aspasia</i>	Black Sunbird	RS, IB, RJ, D-B, W-L		BRt
PASSERIDAE				
<i>Passer montanus</i>	Eurasian Tree Sparrow	W-L		BRt
ESTRILDIDAE				
<i>Erythrura trichroa</i>	Blue-faced Parrotfinch	D-B		BRt

Scientific name	English name (conservation status)	Observers	2017 capt.	Res / Mig
<i>Lonchura tristissima</i>	Streak-headed Mannikin	D-B		BRt
<i>Lonchura leucosticta</i>	White-spotted Mannikin	D-B		BRt

Appendix 2

The following accounts outline reasoning for adjustment to the status / identity of prior recorded species. They exclude recent taxonomic adjustments where there is no confusion over the identity of the recorded species.

SOUTHERN CASSOWARY *Casuarius casuarius*

A lowland species (most records below 300 m) replaced in upland environments, and on steep terrain in some lowland areas, by *C. bennetti*. The identity of cassowaries within Lake Kutubu WMA is yet to be confirmed. Schodde & Hitchcock (1968) presumed both species present based on reports from local residents and European officers. This is higher than all confirmed localities for *C. casuarius* in New Guinea and, given the unreliability of many second-hand accounts, requires confirmation from direct field sightings (Beehler & Pratt 2016). Until there is evidence to prove otherwise, all WMA records are provisionally referred to *C. bennetti*, which is known to occur locally outside the WMA in the Agogo Range (Woxvold & Legra 2017) and downstream in the Gobe area.

YELLOW-LEGGED BRUSHTURKEY *Talegalla fuscirostris*

A lowland species with one confirmed record above 400 m, on the Sogeri Plateau in Varirata National Park near Port Moresby where the species is known to breed (Richards & Rowland 1995). Emerging evidence suggests that *T. jobiensis* replaces *T. fuscirostris* in upland sites across much of southern mainland Papua New Guinea (see Species accounts), with the latter potentially occupying isolated hill-zone sites of relatively gentle terrain (such as at Varirata). Schodde & Hitchcock (1968) reported flushing a bird with 'pale yellowish feet' (R. Schodde *in litt.* 2015), implying *T. fuscirostris*, in the Mubi River valley. The Mubi River valley includes the largest area of flat alluvial terrain locally present, though this lies mostly outside of the WMA boundary. On similar terrain within the WMA (see Species accounts), camera-trapping revealed *T. jobiensis* to be fairly common with no images taken of *T. fuscirostris*. Given the fleeting nature and uncertain location (with respect to the WMA boundary) of Schodde's sighting, his record of *T. fuscirostris* is here excluded from the WMA tally. Burrows (Hartshorn *et al.* 1994) and Diamond & Bishop (2003, 2007) also reported *T. fuscirostris* from the Moro / Kutubu and Agogo Range areas. However, *T. jobiensis* is the only *Talegalla* confirmed present in the Agogo Range (Woxvold & Legra 2017) and Lake Kutubu WMA, and it is likely that, as many have done before them, these surveyors were interpreting fleeting glimpses and / or aural encounters based on incomplete distribution data available at the time. Until there is evidence to prove otherwise, these records are provisionally ascribed to *T. jobiensis*.

SOUTHERN CROWNED PIGEON *Goura scheepmakeri*

Crowned pigeons are terrestrial-foraging species endemic to the New Guinea lowlands where they prefer forest on gentle terrain. Schodde & Hitchcock (1968: 29) stated that '*Goura* pigeons ... were reported by the CSIRO Resources Survey forest botanist ... from the primary rainforest between Kutubu station and the Mubi River'. There are no other reports of crowned pigeons from above 500 m, and this record is excluded from subsequent regional handbooks or checklists (Coates 1985, Beehler & Pratt 2016). Without good views, inexperienced observers may confuse other large terrestrial birds such as *Otidiphaps nobilis*, *Trugon terrestris* or even megapodes for crowned pigeons. The Kutubu *Goura* record is here excluded from the WMA list.

FAN-TAILED CUCKOO *Cacomantis flabelliformis*

A 'tentative identification' by Jaensch (undated a) for the Moro / Lake Kutubu area, potentially within range of the rarely recorded migratory Australian subspecies *C. f. flabelliformis* (distribution poorly known) but below that of resident montane *C. f. excitus* (Beehler & Pratt 2016). The locality is within the elevational range of the similar looking, and almost identical sounding, common resident Chestnut-breasted Cuckoo *C. castaneiventris*, a bird confirmed present by other observers. Jaensch's record is here provisionally reassigned to the latter species.

WHITE-THROATED NIGHTJAR *Eurostopodus mystacalis* / PAPUAN NIGHTJAR *E. papuensis*

Schodde reported *Eurostopodus* nightjars from forest clearings near Moro, 'tentatively' identifying them as *E. papuensis*, a poorly known species endemic to the lowlands of New Guinea and Salawati Island, 'on account of the absence of large white marks in the wings and tail and the general locality and habitat, which should exclude [Archbold's Nightjar] *E. archboldi*' (Schodde & Hitchcock 1968: 34). Another possible species is *E. mystacalis*, a non-breeding migrant from Australia that may remain in the area as late as September–October (Beehler & Pratt 2016). The highest reported elevation for *E. papuensis* is 400 m; that for *E. mystacalis* is

above 1,500 m (Coates 1985, Beehler & Pratt 2016). Until their identity is confirmed, rather than invoking an elevational record for *E. papuensis*, the Moro nightjars are here recorded as *Eurostopodus mystacalis* / *E. papuensis*.

UNIFORM SWIFTLET *Aerodramus vanikorensis* / MOUNTAIN SWIFTLET *A. hirundinaceus*

Lake Kutubu WMA is located in an elevational zone of overlap for *A. vanikorensis* and *A. hirundinaceus*, two common and widespread species that are indistinguishable in flight. *Aerodramus* are common in the WMA and have been reported variously as *A. vanikorensis*? (Schodde & Hitchcock 1968), *A. hirundinaceus* (Hartshorn *et al.* 1994, Burrows 1995, Jaensch & Kulmoi undated), *A. hirundinaceus*? (Jaensch undated a), *Aerodramus* sp. (Jaensch undated b) and *A. hirundinaceus* and / or *A. vanikorensis* (Diamond & Bishop 2003, 2007). Until identifications are confirmed (requiring birds in the hand), all *Aerodramus* records are here presented as *A. vanikorensis* / *hirundinaceus* (Appendix 1). It is acknowledged that the rare Bare-legged Swiftlet *A. nuditarisus* and / or Three-toed Swiftlet *A. papuensis* may also occur locally; we consider that these larger species are (at least by some observers) distinguishable in the field and, if present, would occur at lower density than the common smaller species, so that *A. vanikorensis* / *hirundinaceus* would account for some, if not all, *Aerodramus* swiftlets observed by various workers.

Appendix 3

Possible additional species recorded in comparable habitats in the nearby Agogo Range by (observers) Burrows (IB), JMD & KDB (D-B), and IAW & LL (W-L) (some birds recorded by Burrows may have been recorded within the WMA but this cannot be ascertained from his report; see text). The symbol '[WMA]' appears after the English name for species confirmed present in the Agogo Range and provisionally recorded within the WMA. Conservation status is shown in brackets after the English name for species Protected (P) under Papua New Guinean law. Residency / migratory (Res / Mig) status indicates: BR—breeding resident species; M—species that occur in New Guinea only as non-breeding migrants; BR/M—breeding residents with populations seasonally augmented by non-breeding visitors, and widespread local breeding range potentially overlapping the study area; M(BR)—breeding residents augmented by non-breeding visitors, but known breeding sites are localised and outside of the Kikori basin; t—birds of terrestrial environments, including forest, open areas and aerial foraging species; w—birds of wetlands, including lakes, rivers and streams; data from Coates (1985, 1990) and Beehler & Pratt (2016).

Scientific name	English name (status)	Observers	Res / Mig
<i>Casuarus bennetti</i>	Dwarf Cassowary [WMA]	D-B, W-L	BRt
<i>Megapodius decollatus</i>	New Guinea Scrubfowl [WMA]	W-L	BRt
<i>Henicophaps albifrons</i>	New Guinea Bronzewing	IB, D-B, W-L	BRt
<i>Alopecoenas beccarii</i>	Bronze Ground Dove	W-L	BRt
<i>Ptilinopus bellus</i>	Mountain Fruit Dove	D-B, W-L	BRt
<i>Gymnocrex plumbeiventris</i>	Bare-eyed Rail	W-L	BRt
<i>Aegotheles insignis</i>	Feline Owlet-nightjar	D-B	BRt
<i>Aegotheles albertisi</i>	Mountain Owlet-nightjar	W-L	BRt
<i>Megatriorchis doriae</i>	Doria's Hawk	D-B	BRt
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk [WMA]	IB, D-B	BRt
<i>Accipiter meyerianus</i>	Meyer's Goshawk	IB	BRt
<i>Tanysiptera sylvia</i>	Buff-breasted Paradise Kingfisher	D-B	Mt
<i>Syma megarhyncha</i>	Mountain Kingfisher [WMA]	W-L	BRt
<i>Falco berigora</i>	Brown Falcon	IB, D-B	BRt
<i>Charmosyna josefinae</i>	Josephine's Lorikeet	D-B	BRt
<i>Ailuroedus melanotis</i>	Black-eared Catbird	IB, D-B, W-L	BRt
<i>Myzomela cruentata</i>	Red Myzomela	IB, D-B	BRt
<i>Myzomela nigrita</i>	Papuan Black Myzomela	IB, D-B, W-L	BRt
<i>Myzomela adolphinae</i>	Elfin Myzomela	IB, D-B	BRt

Scientific name	English name (status)	Observers	Res / Mig
<i>Meliphaga orientalis</i>	Mountain Meliphaga	D-B	BRt
<i>Sericornis spilodera</i>	Pale-billed Scrubwren	D-B, [W-L]	BRt
<i>Sericornis arfakianus</i>	Grey-green Scrubwren	W-L	BRt
<i>Melanocharis arfakiana</i>	Obscure Berrypecker	D-B	BRt
<i>Melanocharis longicauda</i>	Mid-mountain Berrypecker	?IB	BRt
<i>Edolisoma montanum</i>	Black-bellied Cicadabird	IB, D-B, W-L	BRt
<i>Parotia carolae</i>	Carola's Parotia (P)	D-B, W-L	BRt
<i>Lophorina superba</i>	Superb Bird of Paradise (P)	D-B	BRt
<i>Drepanornis albertisi</i>	Black-billed Sicklebill (P)	D-B	BRt
<i>Symposiachrus axillaris</i>	Fan-tailed Monarch	D-B, W-L	BRt
<i>Kempiella griseiceps</i>	Yellow-legged Flyrobin	D-B, [W-L]	BRt
<i>Tregellasia leucops</i>	White-faced Robin	D-B, W-L	BRt
<i>Petrochelidon nigricans</i>	Tree Martin	D-B	Mt
<i>Seicercus poliocephalus</i>	Island Leaf Warbler	D-B, W-L	BRt
<i>Zosterornis heinei</i>	Russet-tailed Thrush	W-L	BRt