Bird Conservation International (2003) 13:59–74. © BirdLife International 2003
DOI: 10.1017/S0959270903003058 Printed in the United Kingdom

Population sizes and the conservation status of endemic and restricted-range bird species on Karakelang, Talaud Islands, Indonesia

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Summary

Karakelang, largest of the Talaud Islands, Indonesia, was visited in 1999 with the aim of producing population estimates of globally threatened and Restricted-range bird species. Density estimates were calculated from primary forest and secondary habitats using the variable circular plot method. Eight of the nine restricted-range or threatened species resident on Karakelang were recorded and density estimates calculated for five of these. Two species of rail are endemic to Karakelang, Talaud Bush-hen *Amaurornis magnirostris* and Talaud Rail *Gymnocrex talaudensis*. The bush-hen was encountered in secondary habitat but occurred at higher densities in primary forest and the estimated population was 2,350–9,560 birds. The less vocal, cryptic *G. talaudensis* was noted just twice, in primary forest close to rivers. Both have small populations, are threatened by habitat degradation, hunting, and possibly predation by introduced rats and should be classified as threatened. Population densities of the Endangered, endemic Red-and-blue Lory *Eos histrio* had remained stable since the last survey in 1997. They occurred at higher densities in primary forest, but were also common in human-made habitats. The estimated population was 8,230–21,400 birds, threatened by habitat loss and trapping for the wild bird trade. Although more commonly encountered in forest, the Near Threatened Blue-naped Parrot *Tanygnathus lucionensis* was found at higher densities in secondary habitats, and the population was estimated at 8,130–20,700 birds. The Restricted-range Blue-tailed Imperial Pigeon *D. concinna* was very common on Karakelang (14,500–27,700 birds), whilst the Vulnerable Grey Imperial Pigeon *D. pickeringii* was recorded rarely; both species were more frequently recorded in primary forest. The endemic Talaud Kingfisher *Halcyon enigma* occurred at low densities (5,290–8,690 birds), in primary forest and adjacent disturbed areas. It is heavily dependent on primary forest and threatened by habitat loss, and should be classified as Vulnerable. Approximately 350 km^2 of primary forest on Karakelang is protected, 250 km^2 as a wildlife reserve. However, at present, management is absent and forest is threatened by agricultural encroachment, illegal logging, and fire. Given that all endemic and threatened species were encountered more frequently or occurred at higher densities in primary forests, future conservation efforts should target these protected areas. Management of reserves should involve local stakeholders from government and representatives of island communities. Wildlife trade is a major threat to *Eos histrio* and strict enforcement of the species' protected status should include monitoring of roost sites, patrols of harbours and markets in Talaud, Sulawesi and the Philippines, and the control of Philippine fishing boats involved in the wild bird trade. Further species-specific research and monitoring is also required.

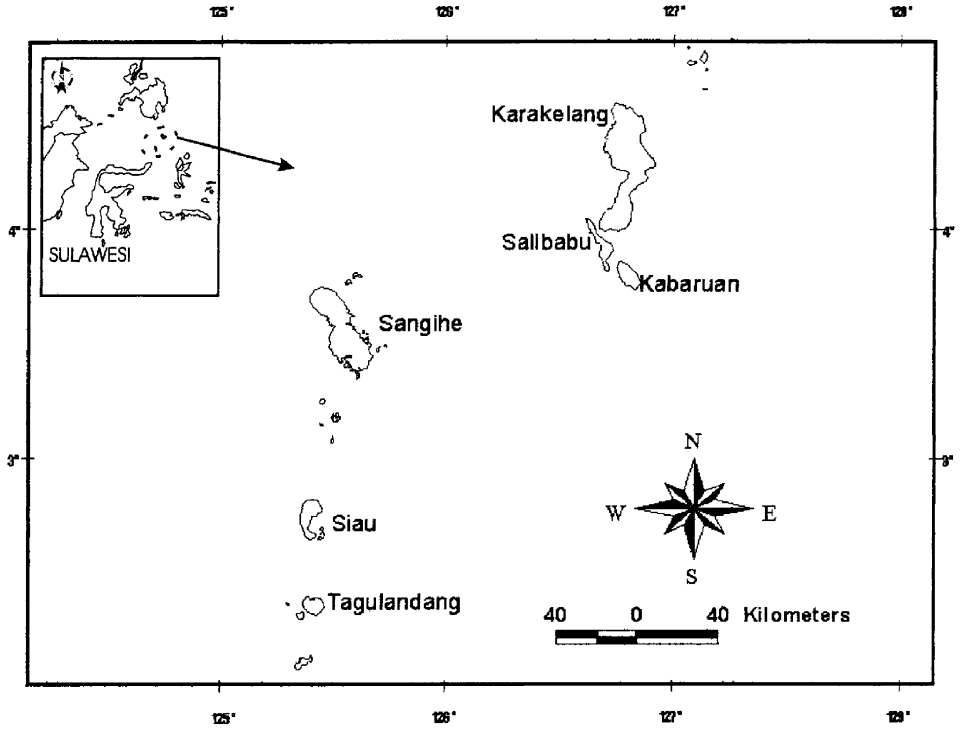

Figure 1. Map of the Sangihe and Talaud Islands.

Introduction

The island of Karakelang (976 km^2, N 04°15′ E 126°48′) is the largest in the remote Indonesian archipelago of Talaud (Figure 1). The Talaud Islands are at the northernmost limit of Wallacea, and have a depauperate avifauna lacking many species found on Sulawesi (White and Bruce 1986). Despite this, three species are endemic to Talaud and a fourth, Red-and-blue Lory *Eos histrio*, is endemic to Talaud and the Sangihe island group to the south. In total five Restricted-range (ICBP 1982) and seven threatened or Near Threatened species (BirdLife International 2001) have been recorded, including the recently described endemics Talaud Bush-hen *Amaurornis magnirostris* and Talaud Rail *Gymnocrex talaudensis* (Lambert 1998a, b) (Table 1). The Talaud Islands, together with the Sangihe Islands, have been classified as one of Indonesia's 24 Endemic Bird Areas and thus as a priority area for the conservation of global bird diversity (Stattersfield *et al*. 1998).

In previous studies endemic species were largely restricted to, or occurred at higher densities in, primary forest on Karakelang (Riley 1997, Lambert 1999). However, commercial logging operations, clear-felling to create land for agriculture, and forest fires have reduced the area of primary forest on the island (Riley 1997, Wardill *et al*. 1997). The objective of this study was to determine if any threatened or Restricted-range species were confined to primary forest or occurred at higher densities in primary forest than disturbed and secondary hab-

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Table 1. Endemic, threatened and restricted-range bird species recorded on the Talaud Islands.

Species	Endemic	Status
Talaud Bush-hen *Amaurornis magnirostris*	E	
Talaud Rail *Gymnocrex talaudensis*	E	EN
Malaysian Plover *Charadrius dubius*		NT
Far Eastern Curlew *Numenius madagascariensis*	M	NT
Nicobar Pigeon *Caloenas nicobarica*		NT
Blue-tailed Imperial Pigeon *Ducula concinna*		RR
Grey Imperial Pigeon *Ducula pickeringii*		VU
Red-and-blue Lory *Eos histrio*	E (ST) SS *talautensis*	EN
Blue-naped Parrot *Tanygnathus lucionensis*	SS *talautensis*	NT
Talaud Kingfisher *Halcyon enigma*	E	NT

E, species endemic to Talaud Islands; E (ST), species endemic to Sangihe and Talaud Islands; SS, subspecies endemic to Talaud Islands; M, migrant visitor; RR, restricted-range species (ICBP 1992); EN, Endangered; VU, Vulnerable; NT, Near Threatened (IUCN 2000, Birdlife International 2001).

itats. The study also aimed to further knowledge of the ecological requirements and distributions of these species, leading to a detailed assessment of their present status, including population sizes, and the threats faced by them. In addition the data produced would act as a baseline when developing conservation strategies and future monitoring work on Karakelang.

Karakelang is the last remaining island in the Talaud group with extensive primary forest, an estimated 35% of the land area (BPS 1999). Forest loss is severe on the other main islands in the archipelago – Salibabu (95 km^2) and Kabaruan (115 km^2) – and only small, patchy areas of forest remain (Riley 1997, BPS 1999).

Study area

Karakelang is *c*. 60 km long and 7–23 km wide (BPS 1999) (Figure 2). The Talaud Islands are non-volcanic and Karakelang is composed primarily of sandstone of the Awit formation, with patches of uplifted coralline limestone along the coast and underlying the central plain. The topography is low-lying but with steeply dissected valleys and narrow ridges, especially in the north. The highest peak is Mt Biala (608 m) in the centre of the island, to the north is Mt Berawang (480 m), to the south Mts Aruwung (448 m) and Piapi (521 m) (Riley, 1997).

Primary lowland tropical moist forest covers most of the north and parts of the south of the island away from the coast. Common trees species include *Campnosperma* sp., *Villebrunea rubescens, Couthovia celebica, Arthrophyllum diversifolium, Canarium* spp., *Cleistanthus myrianthus, Parkia javanica, Eugenia* spp., *Leukosyke capitellata, Terminalia* sp. and *Saurauia* spp. Canopy trees, up to 45 m tall in places, include *Ficus procera, Ficus variegata, Artocarpus* spp., *Bischofia javanica, Dracontomelon dao, Eugenia* spp., *Horsfieldia glabra, Palaquium* sp., and *Pterospermum celebicum* (Holthius and Lam 1942, pers. obs.). The understorey is open, with rattan palms *Calamus* spp. and shrubs *Leea* spp. common, whilst palms *Areca* sp. are locally common (Holthius and Lam 1942, Riley 1997). Riverbanks are characterized by *Pometia pinnata, Albizia saponaria, Macaranga* spp. and *Elaeocarpus dolichostylus*, with shrubs *Pipturus argenteus, Leea* spp., *Piper* sp. and gingers Zingiberaceae (Holthius and Lam 1942, pers. obs.).

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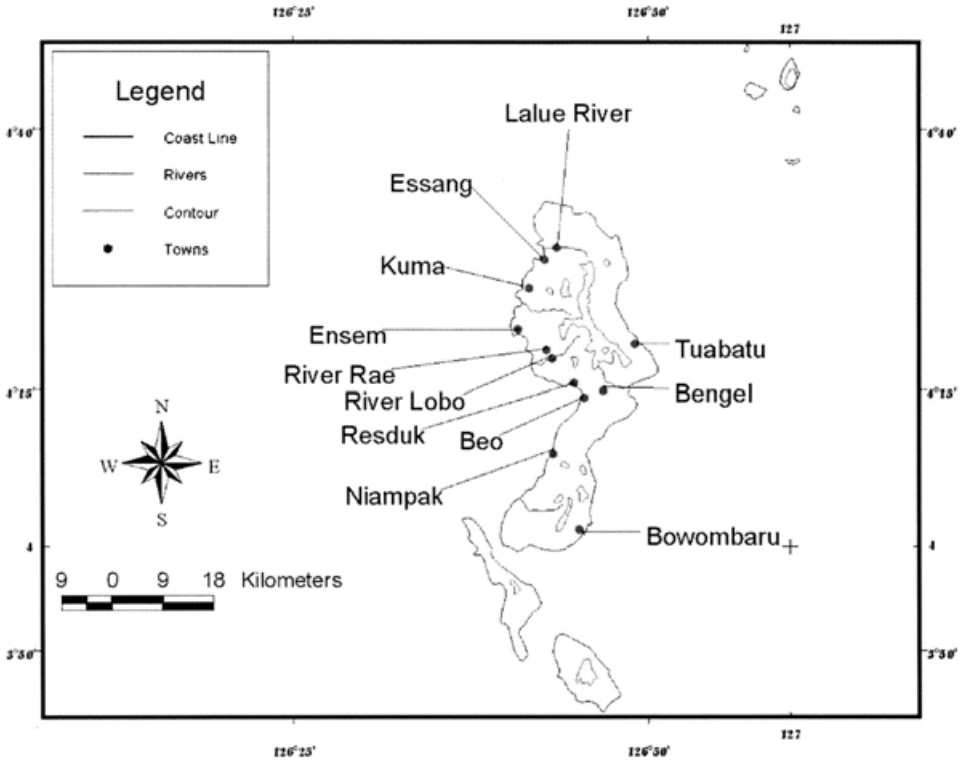

Figure 2. Map of Karakelang.

A distinctive vegetation community can be found on the ultramafic rocks of Mt Piapi. Trees are narrow girthed and low growing (canopy < 10 m), and there is a poorly developed ground layer, except on the less steep and consequently wetter slopes. Typical trees include screw palms *Pandanus* sp. and *Barringtonia* sp., Euphorbiaceae and Guttiferae (Holthius and Lam 1942, Proctor *et al*. 1994).

Agriculture dominates a narrow coastal belt (up to 5 km wide) and the central plain, to *c*. 150 m altitude, between the towns of Beo and Rainis. Much of the agricultural land is at low elevations and this, along with poorly draining dystropept soils, makes many areas prone to seasonal flooding. Crops are characteristically cultivated in small plantations mixed with secondary growth, isolated forest patches and remnant trees. Typical crops include coconut *Cocos nucifera*, nutmeg *Myristica fragrans*, and clove *Eugenia aromatica* interspersed with slash-and-burn gardens of tubers, tomato *Lycopersicum esculentum*, and chilli *Capsicum annum*. Slash-and-burn gardens are found up to *c*. 7 km inland where they form a patchwork amongst primary forest.

Secondary growth that has become established on abandoned agricultural land is found patchily across the island. The structure of this habitat (including tree size, canopy height, understorey density, and the abundance of climbers and lianas) is variable, depending on the age of the secondary growth and soil. Characteristic trees include *Melanolepis multiglandulosa, Mallotus ricinoides, Albizia saponaria, Geunsia pentandra, Macaranga hispida, M. tanarius, Buchanania arborescens*

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and *Homolanthus* sp. This habitat sometimes has a very dense understorey dominated by shrubs and gingers, few tall trees, many lianas and climbers, and includes areas of *Imperata cylindrica* grassland (Holthius and Lam 1942, pers. obs.).

Patches of remnant forest trees are found on steep or rocky ground in areas cleared for agriculture. Most are small, estimated to be < 1 km^2, and some are protected from disturbance by religious taboos (e.g. at Amat village near Tuabatu). Sites of commercial logging operations around Essang and Lalue River (Wardill *et al*. 1997) were not visited in 1999 and the effects on forest have not been observed.

The North Karakelang and South Karakelang Wildlife Reserves (*Suaka Margasatwa*) covering 246.7 km^2 were established in 2000, specifically to protect endemic bird populations (Minister of Forestry Decree 97, 2000). Both protected areas had been created in 1979 as Hunting Reserves (*Taman Buru*) because the forests contained feral pigs and cattle that local people occasionally hunted for food, although the cattle are now probably extinct (Wardill *et al*. 1997). The *c*. 52 km^2 southern reserve is centred on Mt Aruwung, the *c*. 195 km^2 northern reserve on Mt Biala. In addition, four areas of Protection Forest (*Hutan Lindung*) totalling *c*. 98 km^2 have been declared in the east and south of the island, adjoining the wildlife reserve (Riley 1997).

The most recent comparable climatic data come from Sangihe Island. Here there is an average temperature of 25–28 °C with little seasonal variation, and average annual rainfall is 2,928 mm per year, with a distinct wet season in October to January, and average relative humidity is 85% (BPS 1994). Older data from Beo (1931–1941) indicated a similar climate; annual rainfall averaged 3,109 mm, with a dry season from July to September (PPA 1980).

Methods

This paper is based on work conducted between 8 March and 30 June 1999 under the auspices of Action Sampiri, the Sangihe and Talaud Conservation Project, consisting of up to four staff members from the U.K. and a total of 15 students and graduates from Sam Ratulangi University, Manado. The Indonesian Institute of Sciences (LIPI) sponsored all three projects. The location of survey sites visited is shown in Figure 2 and other details are given in Table 2.

Bird censusing

Field methods were based on those used during studies of bird population densities on Sangihe Island in 1998–1999 (Riley 2002). A total of 223 census stations were established in primary forest and 211 census stations in secondary habitats; all census stations were surveyed once. Surveys were carried out on 40 days between 22 March and 20 June 1999 between 05h15 and 10h30, the time of peak bird activity. No surveys were carried out in adverse weather conditions of rain, low cloud, or strong wind.

Stations were surveyed for 10 minutes by two observers. In an effort to reduce bias from different observers four trained fieldworkers were responsible for collecting the bird census data (J.R., I. Hunowu, Y. Hunowu and J. Mole). All obser-

Table 2. Details of survey sites and census data for point count survey on Karakelang, March–June 1999.

Site	Coordinates	Census dates	Primary forest		Secondary habitat	
			Census stations	Altitude range (m)	Census stations	Altitude range (m)
Amat	04°25′N 126°52′E	19–20 June	15	60–365		
Awit	04°20′11N 126°41′51E	25 April			8	30–230
Bantik	04°15′N 126°47′E	28 April			19	15–215
Bengel	04°13′55N 126°50′15E	26 & 29 April, 3 June			21	15–60
Beo	04°14′26N 126°47′42E	27 March–27 April	18	50–230	56	15–200
Bowombaru	04°03′N 126°48′E	30 May–1 June	19	50–275	14	60–290
Ensem	04°22′04N 126°45′17E	15 April, 5–12 May	37	30–275	26	10–60
Essang	04°25′17N 126°46′42E	2–8 April	51	15–200	9	15–100
Kuma	04°24′37N 126°45′08E	10–13 April	39	60–400	9	50–90
Matahit	04°02′N 126°47′E	26 May			7	15–100
Niampak	04°08′N 126°47′E	19–24 March	12	150–275	11	100–275
Rae	04°19′N 126°45′E	8–16 March	Training	30–340		
Rainis	04°14′N 126°51′E	4 May, 5 June			16	50–120
Resduk	04°15′45N 126°47′32E	1–2 April	16	60–320		
Tuabatu	04°19′25N 126°53′06E	9–14 June	16	100–320	15	15–150
Total			223	15–400	211	10–290

vers had conducted VCP surveys for six months on Sangihe Island prior to the current survey and all had worked on previous bird surveys on Karakelang. Random pairs of recorders conducted daily surveys.

Prior to the start of the systematic surveys, eight days were spent training and at the end of this period all species could be correctly identified from sight and aural cues (see Riley 2002 for details). Training was reinforced by regular re-examination of distance estimation accuracy.

Additional observations

Further data included in this paper, including notes on distribution, threats, preferred feeding sites, roosting areas, and nesting behaviour, were gathered using qualitative methods throughout the survey period.

Density and population estimation

Densities, and thus population sizes, of all species for which sufficient information was obtained were estimated using the DISTANCE version 3.5 computer program (Thomas *et al*. 1998). Buckland *et al*. (1993) provides a comprehensive explanation of this method.

The distance data were grouped for analysis to mitigate for the problem of heaping in the distance data (Buckland *et al*. 1993). For the majority of species, between 5% and 25% of the most distant bird records were truncated. The distance bands used and the actual percentage of records that were truncated differed between species. In each case the data were manipulated to minimize Akaike's Information Criterion (AIC) for a particular model (Buckland *et al*. 1993).

Groups were entered as clusters for all species. The group size of bird clusters that were heard only and could not be counted accurately was assumed to be the same as the mean group size of that species observed during point counts in that habitat (after Lambert 1993, Marsden *et al*. 1997).

For the commonly recorded species, bird records were entered into DISTANCE in two habitat categories: primary forest and secondary habitats. To calculate precise density estimates using DISTANCE, over 100 observations were needed to model a species' detection function accurately (Buckland *et al*. 1993). Where sample sizes obtained during the current survey were not large enough to do this, species detection functions were obtained and then used to calculate density estimates in each habitat.

To calculate total population estimates the total area of habitat available to that species was multiplied by individual species density estimates. In the absence of satellite images or recent maps, the area of primary forest on Karakelang in 1999 was taken to be the area of protected forest on the island, or 350 km^2. The total area of Karakelang was taken to be 950 km^2 (BPS 1999) excluding small islands and islets close to the mainland, thus secondary habitats cover 600 km^2. No detailed assessments of altitudinal associations and the specific habitat requirements of species have been made, although where data are available it is mentioned in the species accounts. This may lead to inaccuracies and overestimates where species have more restricted ranges. The absence of land cover data and the approximation of primary forest area on the island means that total population estimates should be seen only as indications of the likely magnitude of populations on Karakelang. However, the figures are of use when assessing the conservation status of these species.

Taxonomy and English names follow Coates and Bishop (1987). Two recently described endemics, Talaud Bush-hen *Amaurornis magnirostris* and Talaud Rail *Gymnocrex talaudensis* are recognized following Lambert (1998a, b). Two Near Threatened species, Malaysian Plover *Charadrius dubius* and Far Eastern Curlew *Numenius madagascariensis* are found only in coastal habitats on Karakelang or are migrants and are not considered in this paper.

Habitat recording

Habitat surrounding census stations was classified subjectively using vegetation structure, levels of human disturbance and species composition characteristics (after Holthius and Lam 1942) into two categories: primary forest and secondary habitat. Primary forest was classified as forest with a closed canopy and low levels of habitat disturbance (e.g. no trees recently felled for timber or rattan collection, no clear-felling for agriculture). Census stations classified as primary forest were always more than 100 m from disturbed habitat such as slash-and-

Table 3. Encounter rates in primary forest and secondary habitat on Karakelang, March–June 1999.

Species	Forest $K = 223$			Secondary $K = 211$		
	n	*i*	*r*	*n*	*i*	*r*
Amaurornis magnirostris	24	28	0.11	13	17	0.06
Gymnocrex talaudensis	2	3	0.01			
Ducula concinna	400	421	1.79	91	99	0.41
Ducula pickeringii	4		0.02	1		0.005
Eos histrio	61	97	0.27	19	51	0.09
Tanygnathus lucionensis	71	79	0.32	43	49	0.19
Halcyon enigma	191	196	0.86	25		0.11

[n] Number of contacts; [i] number of individuals, if $n = I$ this column is left blank; K number of point counts in habitat; [r] encounter rate n/K.

burn gardens or secondary growth. No attempt was made to distinguish between different levels of habitat disturbance in the forest (rattan collecting, timber extraction), despite the influence of anthropogenic disturbance on bird distributions (e.g., Johns 1986, Lambert 1992).

Secondary habitat was used to classify stations not located in primary forest. This heterogeneous habitat classification included plantations, secondary growth, and remnant patches of forest trees; all these habitats are the result of anthropogenic activities.

Results

Seven of the eight target species were recorded during timed point counts, with six species encountered in secondary habitat and all seven in primary forest. One species, Nicobar Pigeon *Caloenas nicobarica* was not recorded during fieldwork. Sample sizes for *G. talaudensis* and *D. pickeringii* were too small for population density estimates to be calculated satisfactorily and simple encounter rates were calculated. These are expressed as the average number of encounters with the species at a census station in primary forest or secondary habitat (Table 3).

Sample sizes were large enough for population density estimates to be calculated for the remaining five species. The smallest sample size, 37 records, was for *A. magnirostris* and the largest, 491 records for *D. concinna* (Tables 3 and 4). The standard error as a percentage of mean density varied between 6.7% and 35.3% in primary forest and between 24% and 36% in secondary habitat. In primary forest variance was less than 25% for all species except *A. magnirostris*, the figure used by Buckland *et al*. (1993) and Marsden *et al*. (1997) to assess the robustness of density estimates. Estimates were less robust in secondary habitats, reflecting the smaller sample sizes from this habitat.

Talaud Bush-hen *Amaurornis magnirostris*

This recently described endemic is, to date, only known from Karakelang (Lambert 1998b). It was recorded in primary forest, secondary growth, plantations and remnant forest patches up to 290 m altitude, including scrubby grasslands at least 3 km from the forest edge. Population density estimates were

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Table 4. Density estimates and population sizes in primary forest and secondary habitats on Karakelang.

Species	Primary forest						Secondary habitats					
	Density estimate			Population estimate			Density estimate			Population estimate		
	Mean	Lower 95% CI	Upper 95% CI	Mean	Minimum	Maximum	Mean	Lower 95% CI	Upper 95% CI	Mean	Minimum	Maximum
Amaurornis magnirostris	7.05	3.56	13.94	2,470	1,250	4,880	3.76	1.89	7.47	2,260	1,100	4,480
Ducula concinna	36.71	32.2	41.84	12,800	11,300	14,600	10.83	5.39	21.76	6,500	3,230	13,100
Eos histrio	20.68	15.23	28.09	7,240	5,330	9,830	9.66	4.84	19.29	5,800	2,900	11,600
Tanygnathus lucionensis	11.29	7.09	17.97	3,950	2,480	6,290	15.01	9.41	23.93	9,000	5,650	14,400
Halcyon enigma	15.56	12.99	18.64	5,450	4,550	6,520	2.11	1.23	3.61	1,270	740	2,170

Karakelang island size 950 km^2; primary forest area 350 km^2; secondary habitats area 600 km^2; densities are number of individuals/km^2; populations < 10,000 birds rounded to nearest 10; populations > 10,000 birds rounded to nearest 100.

higher in primary forest, but the overall population estimate on Karakelang was small (2,350–9,360 birds). This may be an underestimate of the species' true population given its cryptic behaviour and that bush-hens were less vocal during the early part of the survey.

Lambert (1998b) considered *A. magnirostris* to be Near Threatened, noting that the species' exact ecological requirements were unknown and considering that rails on islands have been vulnerable to extinction elsewhere. The current surveys suggest that *A. magnirostris* should be classified as a threatened species. Whilst it was widespread across Karakelang, recorded at plots in 66% of both secondary and forest survey localities, it occurred at low densities, had a small population and densities were highest in primary forest. It is therefore threatened by continuing loss of primary forest on Karakelang. Further pressures included the widespread trapping of rails by local people for food and possible predation by introduced rats.

Rail trappers in Ensem, Beo, and Niampak villages stated that *A. magnirostris* is trapped using lines of rope snares that are usually set in swampy areas of secondary habitat, and only rarely in forest. Rails are eaten by trappers and also sold in markets. Indeed, the type specimen was purchased in Beo market (Lambert 1998b). Introduced rats, probably ricefield rat *Rattus argentiventer*, are common and widespread in all habitats. Although no direct evidence of rat predation of rails (or their nests) has been collected on Karakelang, introduced rats are known to have caused declines in a number of rail species (e.g. Collar *et al*. 1994) and might affect *A. magnirostris*.

Talaud Rail *Gymnocrex talaudensis*

The second species of rail endemic to Karakelang was also described recently (Lambert 1998a) and there are few field sightings (BirdLife International 2001). Talaud Rail was not seen during the current survey, but the deep, swallowed *ump-ump-ump* calls attributed to it by local people were heard twice during timed surveys in primary riverine forest. Three further records of calling birds were made, all in early May in primary riverine forest at Ensem. Away from primary forest *G. talaudensis* has been recorded in swampy grassland surrounded by agricultural smallholdings and secondary forest (Lambert 1998a) and was reported by trappers to occur in similar habitat at Essang and Ensem.

It seems likely that Talaud Rail is widespread but under-recorded on Karakelang favouring primary riverine forest or swampy grassland close to secondary forest. The species remains little-known and is a priority for further research. It should retain its Endangered status (BirdLife International 2001).

Nicobar Pigeon *Caloenas nicobarica*

Whilst there were no direct sightings of this species during the survey, it was known to villagers interviewed in Beo and Tuabatu. They reported seeing pigeons very occasionally in primary forest, with three informants in Beo independently suggesting that the species was scarcer now than in the past. It seems likely that only a small population of this nomadic species persists on Karakelang.

Blue-tailed Imperial Pigeon *Ducula concinna*

A common species on Karakelang and one of the most frequently encountered during point counts. Most often recorded singly or in small groups of up to 14 birds; in early May there were observations of two large flocks of 40–50 birds in remnant forest trees at Apan and Ganalo on the east coast. The population was estimated at between 14,500–27,700 birds, with densities much higher in primary forest than in secondary habitat.

Grey Imperial Pigeon *Ducula pickeringii*

Ducula pickeringii was uncommon and only recorded five times during point counts, with a further four records outside of the timed surveys; six of the nine records were made in primary forest. The species was widely distributed on the island and was noted at Essang, Beo, Kuma and Tuabatu. The data suggest that *D. pickeringii* was not dependent on primary forest and it was noted feeding on fruits of *Ficus procera* and *Cananga odorata*, both common trees in primary forest and secondary habitats.

Red-and-blue Lory *Eos histrio talautensis*

The previous population estimate, based on data collected in 1996, was of 9,400–24,150 birds, with population densities of 26.7–65.9 birds per km^2 in undisturbed forest and 9.1–24.9 birds per km^2 in agricultural smallholdings (Lambert 1997). These estimates were made on the assumption that the total area of Karakelang was 803 km^2, undisturbed forest covered 220 km^2 and lories occupied 70% (or 388 km^2) of the 580 km^2 of non-forested habitats (Lambert 1997). Applying the island area of 950 km^2, with 350 km^2 of primary forest and 600 km^2 of secondary habitat, to the population density estimates of Lambert (1997), the total population of *E. histrio* was estimated to be 14,800–38,000 birds in 1996.

The current data suggest that lory population densities have remained stable or declined slightly since 1996, with 15.2–28.1 birds per km^2 in primary forest and 4.8–19.3 birds per km^2 in secondary habitats, equivalent to a total population of 8,230–21,400 birds. Small numbers of *E. histrio* were seen on Salibabu in June 1999, but the population was small and apparently restricted to primary habitat in the island's central hills.

The majority of the remaining world population of this species is now restricted to Karakelang and previous studies have concluded that *E. histrio* is threatened primarily by forest loss and trapping (Riley 1995, Lambert 1997, Riley 1997, Wardill and Riley 1997). Whilst it can forage in secondary habitats, and was frequently recorded in coconut plantations (Wardill and Riley 1997), it needs large forest trees with cavities for nesting and was much more commonly encountered feeding in forest. Trapping for the wild bird trade is also a major pressure, with up to 1,000 birds exported from Karakelang in 1997 (Riley 1997). Given the continued loss of the species' preferred primary habitat and ongoing trapping and trade, *E. histrio* should retain its Endangered status (BirdLife International 2001).

Blue-naped Parrot *Tanygnathus lucionensis talautensis*

The endemic subspecies of this Near Threatened parrot (IUCN 2000) was recorded in small groups of up to eight birds in primary forest and secondary habitats, with population density estimates suggesting a slight preference for disturbed areas even though encounter rates were higher in primary forest. The total population on Karakelang was estimated to be 8,130–20,700 birds. Trapping does not, at the present time, represent a serious threat although some birds were noted in captivity and were occasionally seen for sale in Manado, the provincial capital.

Talaud Kingfisher *Halcyon enigma*

This endemic species has been recorded from Karakelang and Salibabu in recent times, with no contemporary records from Kabaruan (White and Bruce 1986, Riley *et al*. 1998). During this survey, *H. enigma* was heavily dependent on primary forest or forest edge habitats and in more degraded areas distant from forest was replaced by Collared Kingfisher *H. chloris*. Population density estimates were 13.0–18.6 birds per km^2 in undisturbed forest and 1.2–3.6 birds per km^2 in secondary habitats (birds mainly recorded at points along the forest edge).

The Karakelang population was estimated to be 5,290–8,690 birds and, given the small area of primary forest remaining on Salibabu and Kabaruan, it seems unlikely that the total Talaud Island population exceeded a maximum of 9,000 birds. The heavy dependence on primary forest indicates that the kingfisher is at risk from any future habitat loss or degradation. The small population size, restricted distribution, and dependence on primary forest suggest that *H. enigma* should be classified as Vulnerable and its population and forest habitat carefully monitored.

Discussion

That seven of the eight restricted-range or threatened species known from Karakelang were recorded in 1999 (the only exception being the nomadic *C. nicobarica*) highlights the importance of the island to conservation efforts in Talaud. Karakelang is the only island where all four endemic species have been recorded and primary forest, largely undisturbed, still covers at least 35% of the island. On Salibabu and Kabaruan, the total area of forest probably does not exceed 20 km^2, the majority heavily degraded, and recent surveys on Salibabu have only recorded very small numbers of *H. enigma* and *E. histrio*.

The main pressure on these species is undoubtedly loss and degradation of primary forest and all four endemics qualify as globally threatened because of ongoing habitat change (Table 5). Indeed all the target species, bar *T. lucionensis*, were recorded at higher densities in primary forest and at least four (*A. magnirostris, D. concinna, E. histrio, H. enigma*) have more than half their population distributed in primary forest. No species was found solely in primary forest, although 75–85% of the Karakelang population of *H. enigma* is dependent on this habitat.

Whilst approximately 350 km^2 of primary forest on Karakelang is protected,

https://doi.org/10.1017/S0959270903003058 Published online by Cambridge University Press

Table 5. The current status of threatened and restricted-range bird species on Karakelang.

Species	Population estimate[a]	Status of threatened, endemic species	Criteria codes for endemic species
Talaud Bush-hen *Amaurornis magnirostris*	2,350–9,360	VU	B1+2cde, C1+2b
Talaud Rail *Gymnocrex talaudensis*	< 5,000[b]	EN	B1+2abcde
Nicobar Pigeon *Caloenas nicobarica*	< 500[b]	NT	
Blue-tailed Imperial Pigeon *Ducula concinna*	14,500–27,700	LC	
Grey Imperial Pigeon *Ducula pickeringii*	< 5,000[b]	VU	
Red-and-blue Lory *Eos histrio*	8,230–21,400	EN	A2bcd, B1+2abcde
Blue-naped Parrot *Tanygnathus lucionensis*	8,130–20,700	NT	
Talaud Kingfisher *Halcyon enigma*	5,290–8,690	VU	B1+2abcde

EN, Endangered; VU, Vulnerable; NT, Near-threatened; LC, Least Concern. Status of threatened species and the interpretation of criteria codes for endemic species follows IUCN (2000).
[a] Minimum population = min. population primary forest + min. population secondary habitat; maximum population = max. population primary forest + max. population secondary habitats.
[b] Population figure based on qualitative estimate only.

250 km^2 as a wildlife reserve, management of these protected areas is, at present, absent and they are threatened by agricultural encroachment, illegal logging and fire (see Lambert 1997, Riley 1997, Wardill *et al*. 1997). During the current survey commercial logging was taking place in Essang district, north-west Karakelang. There are also plans to develop a commercial banana plantation bordering the wildlife reserve between Beo and Rainis (Yayasan Sampiri verbally 2002). Smallholder agricultural encroachment into primary forest was noted at all survey sites, especially along rivers; between surveys in March 1997 and April 1999 farmers had cleared a *c*. 200 m wide corridor of forest *c*. 1 km long on both sides of the River Essang inside the wildlife reserve.

Given that all endemic and threatened species were recorded at higher densities in primary forests, future conservation efforts should target these protected areas. Detailed recommendations were made in Lambert (1997) and Riley (1997) and the results of this study serve to highlight their importance.

The protected status of the reserve areas on Karakelang has recently been strengthened to Wildlife Reserve *Suaka Margasatwa* (Minister of Forestry Decree 97, 2000) and awareness of the reserves' value amongst provincial and district government officials and in local communities is higher now than at any time in the past. Support for the reserves' continued existence in local communities and amongst government officials, development of an inclusive management plan involving all local stakeholders, and implementation of adequate protection measures (such as starting regular forest patrols and placing border markers) will be encouraged by a Global Environment Facility (GEF) funded project implemented by the Indonesian Department of Forestry and BirdLife International with local partners. This four-year project will address environmental and conservation problems on Mt Sahendaruman, Sangihe (e.g. Riley 2002) and in the Karakelang Wildlife Reserves. In addition to establishing management systems for the reserves and strengthening local capacity for planning and management,

this vital initiative will create a wider constituency of support for forest conservation among the population of the islands, and more widely, via an extensive public awareness campaign.

Community-awareness will also be central to efforts to control the trapping and trade that are major threats to *E. histrio* (for details see Lambert 1997, Riley 1997). Although the lory is listed on Appendix 1 of CITES and is protected by national law (Presidential Ruling 7, 1999), which bans all capture and trade, this is not enforced. There needs to be enforcement of the species' protected status that should include monitoring of lory roost sites for trapping activity, patrols of harbours and markets in Talaud, Sulawesi and the Philippines, and the control of Philippine fishing boats involved in the wild bird trade. The GEF programme will specifically target the Sulawesi-Talaud-Philippine bird trade route (Y. Cahyadin verbally 2001).

Further detailed research, in particular monitoring of endemic bird populations, is also required. Future monitoring work could be combined with educational or awareness activities and an important project that could be easily adapted to monitor *E. histrio* populations is outlined by Aguilera *et al*. (1999). Other more specific questions remain. For example, there is still not enough information to produce a population estimate for *G. talaudensis* or to assess accurately the species' conservation requirements and this is clearly a priority for research. In particular, the precise impact of feral rats on *G. talaudensis* and *A. magnirostris* needs to be quantified. Finally, the discovery on Karakelang of two new species to science as recently as 1996 suggests that further detailed research is still required to document fully the biodiversity of the island.

Acknowledgements

Fieldwork was undertaken with permission from the Indonesian Institute of Sciences (LIPI) and sponsored by the Research and Development Centre for Biology (PPPB). Research in the Karakelang protected areas was assisted by Mr Tunas Yansen, head of SS-KSDA Beo and Spener Monas, park ranger, SS-KSDA Beo. Field surveys would not have been possible without the support and enthusiasm of Iwan Hunowu, Yusman Hunowu and Jorys Mole. The 1999 surveys were conducted under the auspices of Action Sampiri – Sangihe and Talaud Conservation Project, and I am indebted to my colleagues Damien Hicks and James C. Wardill. The 1998–1999 Action Sampiri project was sponsored by the BP Conservation Programme, Zoologische Gesellschaft für Arten- und Populationsschutz (Germany), Vereinigung für Artenschutz und Zucht (Germany), Stiftung Avifauna Protecta (Germany), Papageien (Germany), British Ornithologists' Union, Royal Geographical Society and the June Chamberlain Charity.

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Received 29 January 2002; revision accepted 10 October 2002