EMU Vol. 96, 151-157, 1996

0158-4197/96/03151 + 6
Received 27-4-1995, accepted 6-8-1995

Population Estimate for the Ouvea Parakeet *Eunymphicus cornutus uvaeensis:* its Present Range and Implications for Conservation

Olivier Robinet[1], Nicolas Barre[2] and Michel Salas[3]

[1] Province des Iles Loyauté, BP 50, 98820 Wé Lifou, New Caledonia
[2] CIRAD-EMVT, BP 1232, 97185 Pointe-à-Pitre cedex, Guadeloupe
[3] CIRAD-EMVT, BP 186, 98845 Noumea, New Caledonia

Summary: As a first step in a long-term study of the biology and ecology of the endangered Ouvea Parakeet *Eunymphicus cornutus uvaeensis*, a population count using fixed distance line transects was made in December 1993 during the breeding season, to estimate the minimum size of the population, its distribution in the island of Ouvea and to emphasise threats to its survival in order to plan a conservation program. Transects totalling 134.5 km of walk tracks and roads covered all possible habitats and 73, presumably different, Ouvea Parakeets were observed (65 in north, five in centre and three in south Ouvea). Biases affected an accurate evaluation of densities; we estimated a total population of 617 with an absolute minimum of 274 birds. Implications for conservation are discussed regarding poaching and habitat destruction.

Among the psittacids of the Pacific, the Ouvea Parakeet *Eunymphicus cornutus uvaeensis* is both one of the most threatened and the least known. This sub-species of a New Caledonian endemic genus is restricted to the island of Ouvea in the Loyalty Archipelago, while the nominate sub-species lives on 'Grande Terre', the main island of New Caledonia (Fig. 1). Its original distribution seems always to have been limited to Ouvea (Robinet et al. 1995). In the last few years numbers have declined following forest destruction for plantations and the capture of young for the pet trade (Delacour 1966, King 1981; Hannecart & Létocart 1983; Forshaw 1989; Robinet et al. 1995).

The residual population has been estimated at less than 200 individuals (King 1981; Lambert et al. 1992) and even fewer than 100 (Hahn 1993), and was limited to approximately 2000 ha of forest on the north of the island (Hannecart 1988).

We followed the recommendations of the Species Survival Commission of IUCN that a survey was indispensable to determine the status of the parakeet and to formulate a recovery plan (Lambert et al. 1992). A pilot study to estimate the residual population of these parakeets was carried out within the framework of a long-term study of their biology and ecology to establish a foundation for a conservation management plan. This census was not intended to provide an absolute number of birds, but rather an order of magnitude and a lower limit in relation to habitat suitability and preference in order to clarify the current status of the Ouvea Parakeet (Verner 1985; Bibby et al. 1992).

Methods

Period of study

Our estimate of the population was based on a ground survey from 27 November–10 December 1993, 13 days of census in the middle of the breeding season, when the birds are confined to their territory and locating them is made easier by leaf abscission of many trees (Hannecart & Létocart 1983; Hannecart 1988; Robinet et al. 1995). Because the distribution of the parakeets was believed to be limited to the northern forest (Delacour 1966; Hannecart & Létocart 1983; Hannecart 1988) the census was carried out principally in that area, with control transects in other habitat types and in the centre and south of the island (Fig. 1).

Survey technique

Choice of method

Having identified the objectives of the study, the characteristics of the bird population (low density, conspicuous, territorial in the reproductive season and mobility), the nature of the study area (mainly flat terrain, sparse forest, sparse undergrowth, heterogeneous vegetation) and the availability of human and material re-

Table 1 Classification of the different habitats of Ouvea (from Guillaumin 1945).

Class (ecotype)	Sub-class	Code	Soil	Dominant vegetation species: Arboreal stratum	Dominant vegetation species: Herbaceous stratum
Semi-humid natural forest	High forest (size > 10 m)	1A		*Syzygium pseudopinnatum* *Intsia bijuga*	*Asplenium nidus* *Microsorium punctatum*
	Medium forest (size: 6-10 m)	1B	Rendzine on coral substrate	*Manikara dissecta* *Dysoxylum rufescens* *Mimusops elengi*	*Rivinia humilis*
	Low forest (size < 6 m)	1C		*Aglaia eleagnoidea* *Garcinia pedicellata* *Ficus* spp.	
Fields and fallows	Cultivated fields	2A		*Psidium guajava* *Carica papaya* *Melochia odorata*	*Solanum capsicum* *Maesa* spp. *Passiflora suberosa*
	Recent fallow		Rendzine on coral substrate	*Hibiscus tiliaceus* *Acacia spirorbis*	
	Old fallow	2B			
Coconut plantations		3	Rendzine on coral substrate	*Coco nucifera*	*Desmodium canum* *Stenotaphrum dimidiatum* *Macroptilum atropurpureum*
Coastal vegetation	On reef bank	4A	Beaches and coral plates	*Pandanus* spp *Cycas* spp. *Coco nucifera* *Casuarina equisetifolia*	*Lotus australis* *Ipomea sp.* *Acrostichum aureum* *Flagellaria indica*
	Mangrove	4B	Alluvial	*Avicennia* spp. *Bruguiera gymnorrhiza* *Rhizophora mucronata*	
Domestic gardens		5	Diverse	*Morinda citrifolia* *Cerbera manghas* *Delonix regia* *Annona muricata*	*Stenotaphrum dimidiatum* *Lantana camara* *Trema* spp.

sources, we chose to do line transects (Burnham et al. 1980, Bibby et al. 1992, Lambert et al. 1992).

Among the line transect methods, the 2-belts technique was inadequate for our case because it presupposes a general relationship between distance and detectability (ease of location) before estimating relative density (Järvinen & Väisanen 1975, 1983; Bibby et al. 1992). The behaviour of the parakeets toward the observer (curiosity/attraction) and the difficulty of evaluating the decrease of detectability with distance made this technique inappropriate. We found the one-belt method was more suitable because the biases inherent in this technique were minimised because only one species was involved, and because we sought an order of magnitude and not an absolute number (Thompson 1989; Bibby et al. 1992). We used two different fixed belts (one of 15 m and the other of 60 m) on each side of the transect line (30 m and 120 m in total), permitting a comparison. These widths corresponded to a band where 100% of the birds are supposed to be found and to the maximum distance of detectability in the study area.

Study areas

For a description of Ouvea see Robinet et al. 1995. We divided the island of Ouvea into three areas, which are sufficiently biogeographically distinct to be treated separately: north, centre and south. The different habitats were: forest, fields, coconut plantations, coastal vegetation and domestic gardens (Table 1). The forest (*sensu lato*), ecotype 1 and 2, comprised a mosaic of true forest with successional stages from the time of Melanesian farming until the return to climax vegetation (recent fallow, ancient fallow and secondary forest).

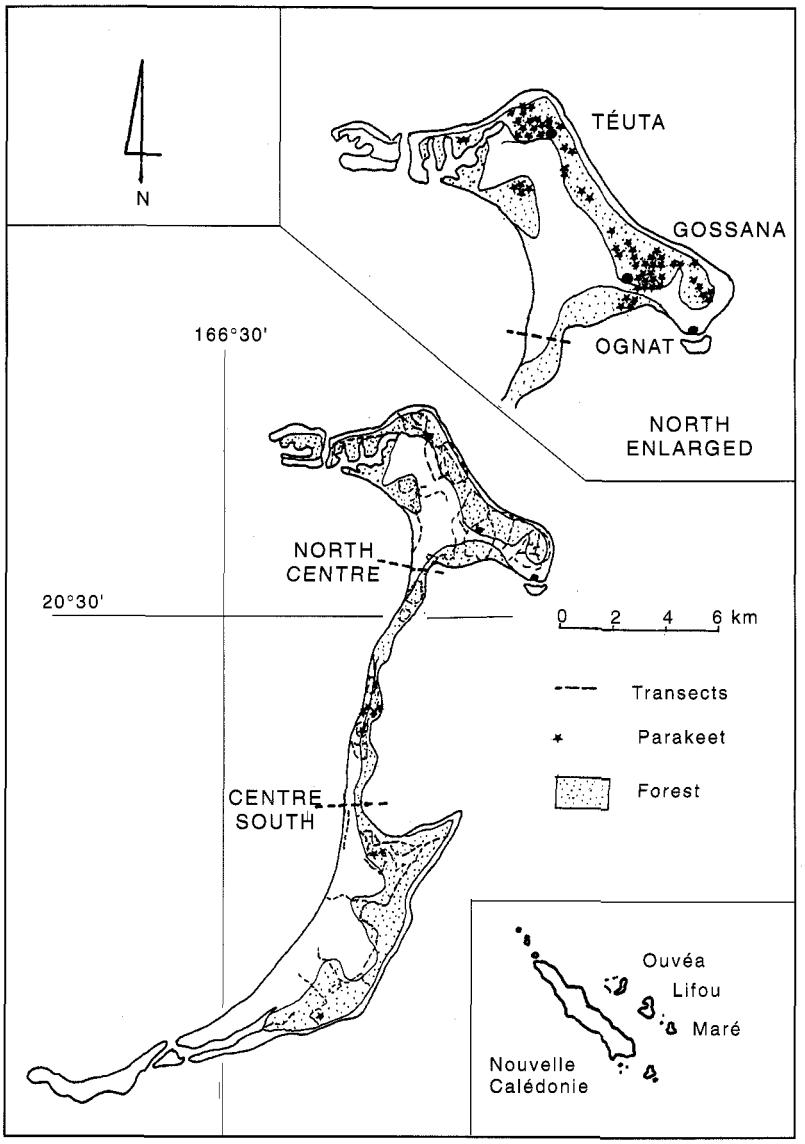

Figure 1 Ouvéa, route of transects, localisations and number of Ouvea Parakeets observed.

The areas covered were chosen to cover the maximum area, leaving sufficient space (> 200 m) between the different transects. The length of the transects was 500 m, which was large enough to obtain valid statistical data but small enough that only one dominant vegetation type was present per transect (Hanowski et al. 1990). Sites for good foraging (presence of papaya trees) and reproduction (hollow trees suitable for nesting) were noted. We covered 134.5 kilometres of transects in 66 hours: 73.5 km in the north, 16.5 km in the centre and 44.5 km in the south (Fig. 1).

Transects were walked at 1-3 km/hr along forest tracks or in a pre-determined direction. The distance travelled was measured with a topographic thread, directions were checked by compass and landmarks (relief, nests and changes of direction) were identified using the Global Positioning System. Two observers accompanied by a local guide walked the transects be-

Table 2 Results of the transects.

Geographic sector	North	Centre and south	Total
Total number of transects	147	122	269
Number of transects in forest (s.l.)	86 (87)	76	162 (163)
Total forest area (in ha)	2061	4613	6674
Number seen (30 m belt)	29 (43)	4	33 (47)
Average seen per transect	0.337	0.053	
Confidence interval (5%)	0.138	0.064	
Number seen (120m belt)	46 (65)	8	54 (73)
Average seen per transect	0.535	0.110	
Confidence interval (5%)	0.185	0.100	

Data in brackets include the flock of 19 parakeets in a papaya field.

tween 0700 and 1100 h and from 1500 to 1700 h, the times of maximum activity by the parakeets (Hannecart & Létocart 1983; Robinet et al. 1995). We recorded: time of observation; length of transect; ecotype (Table 1); distance of bird at first contact calculated perpendicular to the transect; behaviour of the bird: silent, screeching or contact call; foraging behaviour and plants eaten; movement (direction and distance); presence of predators and competitors; and the location of nests.

Evaluation of population size

Density was estimated from the two belt widths. The average density of parakeets was established from transects for each of the four main ecotypes and the three geographic zones. The area of the main ecotypes in the whole of Ouvea was estimated from a map at 1/50 000 scale (Institut Géographique National, 1992) and verified on the ground. The population size was estimated by multiplying densities calculated for each ecotype by their respective areas in the island. We also performed an Analysis of Variance (ANOVA) (SPSS/PC+, version 5, 1992) to estimate the influence of the variables 'occurrence of papaya' and 'occurrence of nest sites' on the calculated densities.

Results

If one considers the 30 m wide belt, the area covered by the 269 transects of 500 m each represented 4.8%, 5.1% and 2.0% of north, centre and south of the island, respectively. With the 120 m belt width, the areas covered were four times greater. On these transects, 73 Ouvea Parakeets were observed, an average of one bird for every 1.84 km walked, with most sightings made in the 'Great Northern Forest' (Gossana: one parakeet per 0.54 km; Teuta: one per 1.20 km; and Ognat: one per 1.45 km). We also sighted parakeets twice in the central sector (adults and fledged birds) and twice in the southern sector (adults and young at the nest and one lone adult) (Table 2).

The preferred habitat of Ouvea Parakeets was forest (*sensu lato*) where the birds nest and consume the flowers and fruits of certain trees (*Syzygium* sp., *Ficus* sp., *Mimusops* sp. etc.) and where fallow fields contained plenty of papaya trees *Carica papaya*, *Capsicum* sp., *Passiflora* sp. and *Maesa novo-caledonica*.

We found no parakeets in coconut groves or coastal vegetation (ecotype 3 and 4) but saw two in a garden (ecotype 5) located on the forest edge that we included in the forest ecotype. For the population estimate we only used the 162 transects in ecotype 1 and 2 (forest *sensu lato*). We did not include one transect with an unusual flock of 19 parakeets in a papaya field.

Densities calculated from the 30 m belt, extrapolated to the whole of the study area indicated an estimated population of 463 (± 189) individuals in the north and 154 (± 190) for the centre and south together, giving for the whole island an estimated population of 617 parakeets with a minimum of 274 and a maximum of 996 birds. The same calculation from the 120 m belt gives a population estimate of 184 (± 63) for the north, 85 (± 77) for the centre and south, a total of 269 individuals (minimum: 129, maximum: 409).

The ANOVA showed a significant result for 'papaya' ($P < 0.05$) but a non-significant result for 'nesting sites'.

The nests observed (in use or disused) were in trees of genera *Syzygium*, *Mimusops*, *Dysoxylum* and *Intsia* and to as lesser degree *Ficus*. Their diameter (at breast height) was always greater than 25 cm and often greater than 35 cm.

Predators observed were: four Brown Goshawks *Accipiter fasciatus* in the 30 m belt (six in the 120 m belt), two Barn Owls *Tyto alba* (30 m belt) and one Swamp Harrier *Circus approximans* (120 m belt). We also found three Pacific Boas *Candoia bibroni*. No signs of the Black Rat *Rattus rattus* were found during our stay on Ouvea (no characteristic nests in the forest and no protection of coconut palms with sheet metal as

is necessary in other places). This absence had already been noted by MacMillan (1939) and is confirmed by the island inhabitants who know only the Pacific Rat *Rattus exulans*.

Possible competitors are the Rainbow Lorikeet *Trichoglossus haematodus*, some of which were released in the south of the island in the 1970s. We found a group of eight and another of three close to habitation, but only a single individual in the transects.

Discussion

The method of line transect presents numerous advantages because it is the most efficient technique in terms of data collected per unit of effort (Bibby et al. 1992) and is well adapted to low densities and to conspicuous, mobile birds on relatively flat terrain (Lambert et al. 1992).

This method relies on certain assumptions (Burnham et al. 1980; Seber 1982; Verner 1985; Bibby et al. 1992) namely that:

(1) 'All birds on the transect are detected and identified.' This is not possible for cavity-nesting birds in the reproductive season, where one of a pair may be incubating (Jolly 1981). Moreover, we passed within less than 15 m of parakeets without their vocalising or moving (seven cases out of 28); it is therefore probable others were not detected (Preston 1979). Lambert (1992) believes that line transects lead to a systematic underestimation of populations in humid forest, where parrots often remain silent as observers walk by.

(2) 'Birds do not move before detection.' We noted movements of parakeets in all directions; generally they flew away noisily when observers passed by, but some, supposedly males defending the nest, came to meet us. Whether this would lead to over- or under-estimation is uncertain; movements into and out of the transect would probably compensate each other.

(3) 'Distances are measured accurately.' The authors trained themselves at the outset to visually estimate distances; this was facilitated by the small size of the belt (30 m). Despite that, errors are possible leading to overestimations (Keppler & Scott. 1981; Scott et al. 1985; Verner 1985).

(4) 'Individuals are counted only once.' By spacing 500 m transects more than 200 m apart and surveying during the reproductive season when the birds are on their territories, the effects of double-counting were limited.

In total, considering these biases of fixed belt line transects it is very difficult to obtain an accurate value of the population size (Bibby et al. 1992). The 120 m fixed belt method certainly greatly underestimated the population size; the 30 m fixed belt technique was more precise, even if it also led to an underestimate. This was shown in a similar study on Lovebirds *Agapornis sp.* by Thompson (1989), who attempted to prove the reliability of one-belt line transects by a capture, tagging and recapture process.

The most reliable estimate of the total population is thus 617 with a minimum of 274 and a maximum of 996 individuals. The large confidence interval is explained mainly by the low density of parakeets and many transects without any birds. The lower limit of 274 parakeets constitutes an absolute minimum and is a basis on which to found a conservation plan. These results show a larger population than estimates advanced by other authors (Delacour 1966; King 1981; Hannecart & Létocart 1983; Hannecart 1988; Lambert et al. 1992; Hahn 1993). For the continuing program we propose that the reliability of this technique should be verified by setting up quadrats and mapping territories during the breeding season and to repeat the transects each year under the same conditions.

During this study, Ouvea Parakeets were seen over the entire island of Ouvea, although some authors had restricted its habitat to the 'Great Forest' (*c.* 2000 ha) in the north of the island (Delacour 1966; King 1981; Hannecart & Létocart 1983; Hannecart 1988; Hahn 1993).

The area theoretically available for the parakeets is approximately 6600 ha, sufficient to hold 2000 individuals if the densities observed in the north are extrapolated to all the suitable habitat in Ouvea. The origin of the birds encountered in the centre and the south must be elucidated (by tagging and radio tracking). If they are colonising birds, a reinforcement of the population could be envisaged using birds taken from the north.

The parakeets' habitat is the forest. This forest must have trees tall enough to afford nest sites and varied species for a regular food supply. The areas available in forests are, however, much less than those from human-modified environments (traditional fields and fallow systems) colonised by introduced species; this explains the higher densities of parakeets observed at the interface of these two habitats. That the factor 'presence of papaya' had a significant effect on the variation of density observed in the transects confirms the importance of foraging sites to observe the birds. Also the traditional Melanesian agricultural practice, which consists of opening small clearings in the forest for manual cultiva-

tion of yams and other tubers over one or two years and then leaving these fallow for several decades, introduces a phenotypic succession that provides available and suitable nutrition for the parakeets. This does not apply to bulldozer incursions into the forest that diminish nest sites by direct destruction and facilitate access into remote areas for loggers and traffickers. The importance of loss of habitat on Ouvea, mainly due to coconut plantations and logging, has been emphasised recently (Robinet et al. 1995). The primary forest has been reduced between a third and a half in the past 30 years. The pressure on remnants of native forest is still growing with the lack of timber and the rapid increase of the human population.

Among other threats, predation both natural and human is controversial: the Goshawk and the Barn Owl are known predators of parakeets confirmed by observations of feathers by islanders (Rinke 1988; Seitre & Seitre 1992; Robinet et al. 1995). The Swamp Harrier and the Peregrine Falcon *Falco peregrinus* have a habitat and population density that make them unlikely to exert predation pressure on parakeets. The Pacific Boa is an occasional predator of nestlings (Hannecart 1988; Rinke 1988; Robinet et al. 1995) but because of its population density and its size, it does not appear to have catastrophic consequences on the avifauna, contrary to other ophidians introduced into the Pacific (Hay 1986; Savidge 1987). The absence of the Black Rat on Ouvea, if confirmed by a large-scale survey over the entire island (Robinet in prep), is very important for conservation. Its introduction would certainly be catastrophic on the avifauna as has been the case on numerous other islands (Atkinson 1985; Hay 1986; Seitre & Seitre 1992).

The rapid decline of the Norfolk Island Parakeet *Cyanoramphus novaezelandiae cookii* (a taxon closely related to the genus *Eunymphicus*) following the accidental introduction of the Black Rat (Taylor 1985; Hay 1986; Forshaw & Cooper 1989), suggests that precautions must be taken immediately to prevent its introduction to Ouvea.

Human predation involves the capture of juveniles from the nest for pets. This activity has always existed but has increased in recent decades due to greater external demand. The impact of capture on the viability of populations is not obvious with long-living species capable of re-nesting, provided that the captures remain below a certain level (Lambert et al. 1992; Beissinger et al. 1992). With at least 30-50 young captured each year (Robinet et al. 1995), it seems that we are close to that threshold, if it has not already been exceeded. That these captures generally are accompanied by destruction of the nest leads to further limitation of nest sites.

Conclusion

Although it did not give us an absolute number of Ouvea Parakeets, this census clarified the distribution of this sub-species and defined an order of magnitude: 617 parakeets and an absolute minimum of 274 individuals. A long-term study on the ecology and biology of the Ouvea Parakeet is continuing this census. This project aims to clarify the population dynamics of the species and to make a population and habitat viability analysis to assess the relative importance of different threats and the impact of modifications to the environment on the survival of the parakeets (Gilpin & Soule 1986; Lambert et al. 1992). At the same time, conservation actions, including management *in situ* (habitat protection and restoration), recovery efforts (providing nest boxes and food) and education and public awareness on the protection of both the parakeet and its habitat have already started and need to be emphasised. However, knowing the size of the remaining habitat and the demand for wood by the growing population, a program of captive breeding and/or translocation to a more suitable island needs to be discussed and undertaken as soon as its suitability is confirmed by ecological study.

Acknowledgements

This study was requested by the 'Association pour la Sauvegarde de la Perruche d'Ouvéa' and supported by the Loyalty Island Province, in the person of its President Richard Kaloi, the French Ministry of DOM-TOM, the Zoologische Gesellschaft fur Arten-und Populationsschutz (ZGAP) and Siftung Avifauna Protecta (SAP) from Germany. It was undertaken as a part of a Ph.D. thesis by O. Robinet with the University of Auckland. We are pleased to thank our supervisors Mick Clout, Rod Hay and John Craig, and Mr Dulieu, of the CIRAD EMVT in New Caledonia, who initiated the study and provided botanical expertise and logistic support. For assistance in the field, we thank Maurice Saoumoe, Dewi Epimako, André Tangopi and E. Dao, who guided us and have shared with us their knowledge of the forest. Many helpful comments on earlier drafts of this paper were provided by referees Stephen Ambrose and Stephen Garnett.

References

Atkinson, I.A.E. 1985. The spread of commensal species of *Rattus* to oceanic islands and their effects on island avi-

fauna. Pp. 35-81 in Conservation of Island Birds. Ed. P.J. Moors. Technical Publication No. 3. International Council for Bird Conservation, Cambridge, UK.

Beissinger, S.R. & Bucher, E.H. 1992. Sustainable harvesting of Parrots for Conservation. Pp. 73-115 in New World Parrots in Crisis. Eds S.R. Beissinger & F.R. Snyder. Smithsonian Institution Press, Washington.

Bibby, C.J., Burgess, N.D. & Hill, D.A. 1992. Bird Census Techniques. Academic Press. London.

Burnham, K.P., Anderson, D.R. & Laake, J.L. 1980. Estimation of density from line transect sampling of biological populations. Wildlife Monograph 72, 1-201.

Delacour, J. 1966. Guide des Oiseaux de Nouvelle Calédonie. Delachaux et Niestlé, Neuchâtel.

Forshaw, J.M. 1989. Parrots of the World. Lansdowne Edition, Willoughby, Australia.

Gilpin, M.E. & Soulé, M.E. 1986. Minimum viable population: process of species extinction. Pp. 19-34 in Conservation Biology: the Science of Scarcity and Diversity. Ed. M.E. Soulé. Sinauer Associates, Massachussets.

Guillaumin, A. 1948. Flore Analytique et Synoptique de la Nouvelle Calédonie: Phanérogames. Office de la Recherche Scientifique Coloniale, Paris.

Hahn, P. 1993. Anmerkungen zur Situation des Hornsittichs *Eunymphicus cornutus* auf Neukaledonien und Ouvéa. Papageien 6, 181-89.

Hannecart, F. 1988. Les oiseaux menacés de la Nouvelle Calédonie et des Iles proches. Pp. 143-165 in Livre Rouge des Oiseaux Menacés des Régions Françaises d'Outre-mer Eds J.C. Thibault & I. Guyot. CIPO Monographies No. 5. Cambridge, U.K.

Hannecart, F. & Létocart, Y. 1983. Oiseaux de Nouvelle Calédonie et des Iles Loyauté. Tome II Les Editions Cardinalis, Nouméa, Nouvelle-Calédonie.

Hanowski, J.M., Niemi, G.J. & Blake, J.G. 1990. Statistical perspectives and experimental design when counting birds on line transects. Condor 92, 326-335.

Hay, R. 1986. Bird Conservation in the Pacific Islands. Study Report No. 7. International Council for Bird Preservation, Cambridge, U.K.

Järvinen, O. & Väisanen, R.A. 1975. Estimating relative densities of breeding birds by the line transect method. Oikos 26, 316-322.

Järvinen, O. & Väisanen, R.A. 1983. Confidence limits for estimates of population density in line transects. Ornis Scandinavia 14, 129-134.

Jolly, G.M. 1981. Summarizing remarks: comparison of methods. Pp. 215-216 in Estimating Number of Terrestrial Birds. Eds C.J. Ralph & J.M. Scott. Studies in Avian Biology 6.

Kepler, C.B. & Scott, J.M. 1981. Reducing count variability by training observers. Pp. 336-371 in Estimating Number of Terrestrial Birds. Eds C.J. Ralph & J.M. Scott. Studies in Avian Biology 6.

King, W. 1981. Endangered Birds of the World. The ICBP Red Data Book. Smithsonian Institution Press, Washington D.C.

Lambert, F.R. 1992. The status and trade of *Cacatua alba*, *Lorius garrulus* and *Eos squamata* in the North Moluccan Province, Indonesia. Unpublished report to the CITES secretariat. Trade Specialist Group of the Species Survival Commission of IUCN, Cambridge.

Lambert, F., Wirth, R., Ulysses, S.S., Thomsen, J.B. & Ellis-Joseph, S. 1992. Parrots: an Action Plan for their Conservation 1993-1998. Birdlife International-IUCN.

Macmillan, L. 1939. Note sur les oiseaux des Iles Loyauté. Etudes Mélanésiennes 2, 30-41.

Preston, F.W. 1979. The invisible birds. Ecology 60, 451-454.

Rinke, D. 1988. On the ecology of the Red Shining Parrot (*Prosopeia tabuensis)* on the Tongan island of 'Eua, southwest Pacific. Ökologie. Vögel 10, 203-217.

Robinet, O., Beugnet, F., Dulieu, D. & Chardonnet, Ph. 1995. The Ouvea parakeet – state of knowledge and conservation status. Oryx 29, 143-150.

Savidge, J.A. 1987. Extinction of an island forest avifauna by an introduced snake. Ecology 68, 660-668.

Scott, J.M., Ramsey, F.L. & Kepler, C.B. 1981. Distance estimation as a variable in estimating birds number. Pp. 334-340 in Estimating Numbers of Terrestrial Birds. Eds C.J. Ralph & J.M. Scott. Studies in Avian Biology 6.

Seber, G.A.F. 1992. Estimation of Animal Abundance and Related Parameters, 2nd edn. Griffin, London.

Seitre, R. & Seitre, J. 1992. Causes of land bird extinction in the French Polynesia. Oryx 26, 215-222.

Taylor, R.H. 1985. Status, habit and conservation of *Cyanoramphus* parakeets in the New Zealand region. Pp. 195-211 in Conservation of Island Birds. Ed. P.J. Moors. Technical Publication No. 3. International Council for Bird Preservation. Cambridge, U.K.

Thompson, J.J. 1989. A comparison of some avian census techniques in a population of Lovebirds at Lake Naivasha, Kenya. African Journal of Ecology, 157-166.

Verner, J. 1985. Assessement of counting techniques. Pp. 247-302 in Current Ornithology, Vol. 2. Ed. R.F. Johnston. Plenum Press, New York.