

THE BLACK NODDY BREEDING POPULATION AT HERON ISLAND, GREAT BARRIER REEF: 1985-1989

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The population size of the Black Noddy *Anous minutus* was monitored over five years at Heron Island, a 13.5 ha coral cay located on the southern Great Barrier Reef. The population which reached around 67 000 breeding pairs in 1989 appears to be increasing, although the rate of expansion is difficult to determine. Highest nesting densities are found in large *Pisonia grandis*, probably due to higher nesting site availability. Nesting densities appear to be independent of the degree of habitat modification; differences in breeding success with disturbance remain to be investigated.

INTRODUCTION

The most abundant seabird on Heron Island is the Black Noddy *Anous minutus* (Barnes and Hill 1989). Although some birds remain on Heron Island throughout the year, the annual nesting period in the Great Barrier Reef region occurs between October and April (peak nesting season being November) during which a single egg is laid per clutch (Kikkawa 1976). Nest-site selection lasts approximately one week, incubation around five weeks and the fledging period is six to seven weeks (Hulsman 1983).

Barnes and Hill (1989) show that an exponential increase in the breeding population size seems to have occurred at Heron Island since early this century. Only a small population utilising around 50 trees occurred on the island early this century (MacGillivray 1928) but successive estimates have increased this figure, with the most recent estimate being $63\ 000 \pm 7\ 000$ pairs (Ogden 1993b). While it is clear that numbers have increased, studies have been intermittent and have varied in methodology, complicating a precise interpretation of the long-term trend. Barnes and Hill (1989) suggest that studies in consecutive seasons with consistent methodology are required to address the nature of the population increase.

The Heron Island physical environment has been progressively modified in the western sector since the 1920s. Currently approximately half the island is developed (Fig. 1), although habitat modification to Heron Island does not appear to

have adversely affected the Black Noddy breeding population size. While few birds nest at the western tip of the cay which is essentially urban (Hill and Rosier 1989), Barnes and Hill (1989) found no differences in nesting density between the developed and undeveloped halves of Heron Island. They demonstrated that although there are fewer trees in the developed sector, nesting density per tree was higher in this habitat.

Hulsman (1983) found that *Pisonia* and *Argusia* species on Heron Island supported the highest nesting densities of the Black Noddy. He also showed that Heron Island supported a greater percentage of occupied nests in most tree species and a greater density of occupied nests than nearby Masthead Island, which has not experienced habitat modification. These results suggest that the habitat modification to Heron Island has not affected nesting densities in a detrimental way.

This paper presents results of a study of a Black Noddy breeding population on Heron Island over five consecutive seasons. The paper investigates breeding habitat requirements for the Black Noddy on Heron Island and examines nesting preferences between vegetation species. Trends in the population size are analysed by making comparisons with existing population estimates.

STUDY AREA AND METHODS

Heron Island lies at the southern end of the Great Barrier Reef (23°27'S, 151°58'E). Together with the associated islands of the Capricorn and Bunker groups, this region has the only

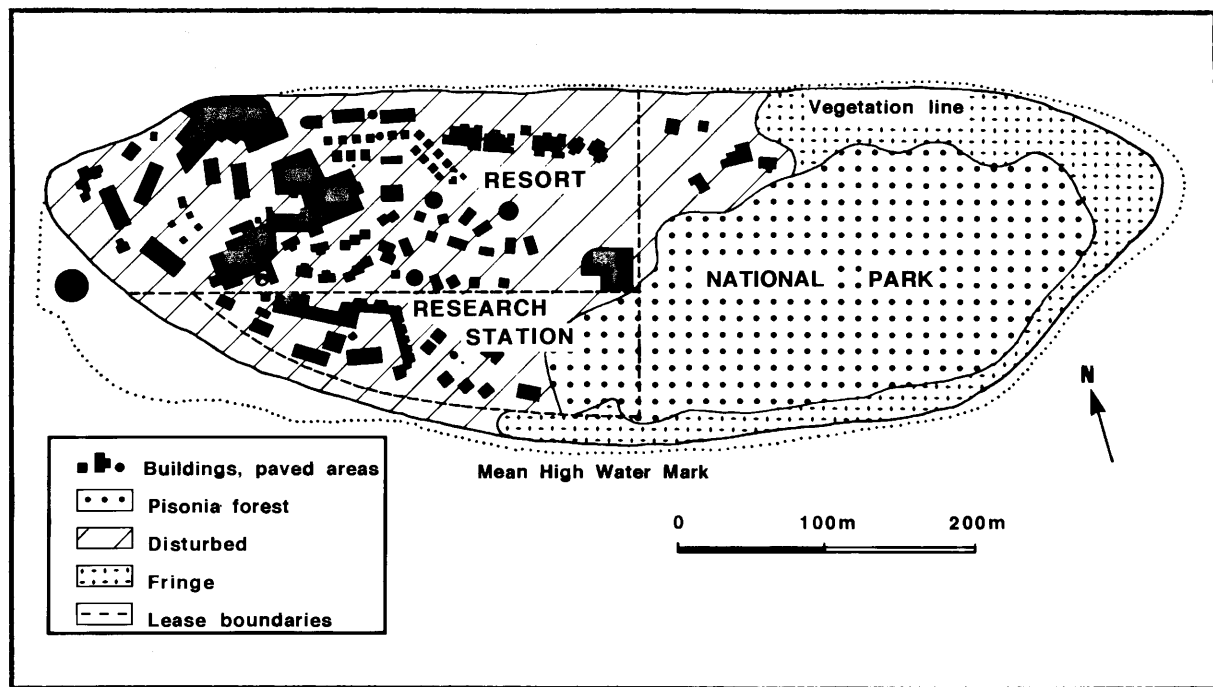


Figure 1. Map of Heron Island showing habitats and developed areas.

major breeding colonies of the Black Noddy on the Great Barrier Reef (Fig. 2). Of these, Heron Island is the third-largest island. The larger North West and Masthead Islands also support higher numbers of Black Noddies.

Heron Island is a coral cay, formed by the deposition of calcareous material by wind and wave action around a zone of convergence (Hopley 1982). Vegetation and beachrock outcrops on the margins of the cay have assisted in stabilization of the island (Mather and Bennett 1984). However, a range of engineered structures such as sea walls and the channel dredged through the reef flat are causing erosion of the cay. Dune ridges on the southern end reach to 3–4.5 metres, sloping to heights of around 1 metre along the northern fringe (Fosberg 1961; Mather and Bennett 1984).

The island experiences a sub-tropical climate, receiving an average annual rainfall of 1 062 mm, mainly in summer storms (Hill and Rosier 1989). Average summer maximum temperature is 30°C and average winter minimum is 16°C (Hill and Rosier 1989). There is an average of one tropical cyclone per two years reaching the Capricorn Group (Flood 1984) causing storm surges and habitat destruction.

The island vegetation comprises a central core of *Pisonia grandis* forest with elements of *Ficus opposita* and *Celtis paniculata*. This habitat is fringed by a woodland of predominantly *Argusia argentea*, *Casuarina equisetifolia* and

Pandanus spp. The western half of the island has been largely cleared to accommodate a tourist resort and university research station.

The methods used in the present study are detailed by Barnes and Hill (1989). In brief, twelve north-south transects were spaced at 45 metre intervals across the island, and each further subdivided into 15 × 15 metre quadrats. Six such transects represented the eastern (national park) sector and the remaining six represented the western (developed) sector. Vegetation type was categorised as either large *Pisonia*; medium *Pisonia*; small *Pisonia*; *Ficus/Celtis*; *Cordia* and 'other'; *Argusia*; *Pandanus* or *Casuarina*. Within each vegetation class the number of each species per quadrat was recorded, and in every second or third individual of each species the total number of active nests per tree or shrub was recorded. By multiplying the number of trees or shrubs by the average number of nests per individual within that category, the average number of nests per vegetation class was calculated. The ratio-to-size estimation method (Cochran 1963) was used to calculate population estimates.

Student's T-tests were performed to analyse the difference between the lowest and highest population estimates for the entire island, as well as for the developed and undeveloped sectors individually. T-tests were also performed between estimates for the 1987–88 and 1988–89 consecutive years for each sector.

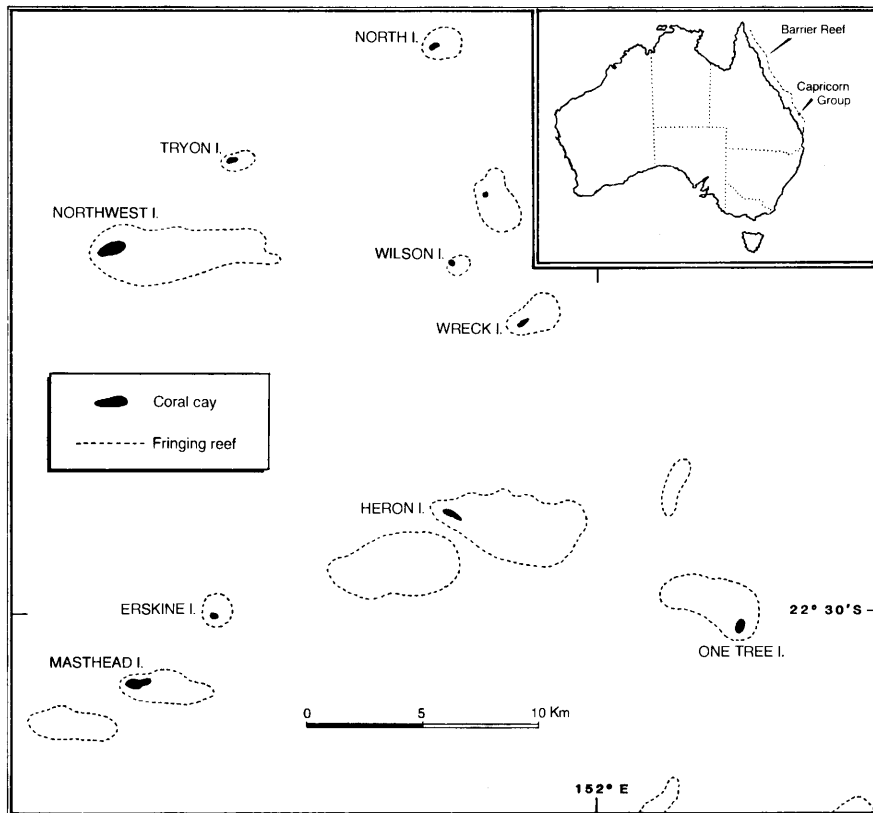


Figure 2. Heron Island locality map.

RESULTS

Nesting abundance

Figure 3 shows the abundance of nests for the whole island as well as abundance of nests in the developed and undeveloped sectors over each year of the study. There was a significant increase between the lowest ($31\,715 \pm 4\,377$) and highest ($67\,691 \pm 5\,933$) population estimate for the whole island ($t_{22} = 4.84$, $p < 0.0005$); for the undeveloped sector ($t_6 = 4.99$, $p < 0.005$) and for the developed sector ($t_{10} = 3.17$, $p < 0.005$).

There were significant increases in population estimates between 1988–89 ($t_{22} = 3.19$, $p < 0.005$) and between 1987–88 ($t_{22} = 1.82$, $p < 0.05$) for the whole island. Likewise, population estimates increased significantly between 1988 and 1989 ($t_{10} = 2.33$, $p < 0.025$), and also between 1987–88 ($t_{10} = 2.40$, $p < 0.025$) in the undeveloped sector.

Population estimates between 1988–89 in the developed sector increased significantly ($t_{10} = 2.24$, $p < 0.05$), but the increase was not significant between 1987–88 ($t_{10} = 0.76$, $p = \text{ns}$).

The total number of nests in the eastern undeveloped sector appeared to closely match the total number of nests in the western developed sector for each year of the study.

Nesting density per tree

In all but three cases (twice for *Cordia*, once for *Argusia*), a greater density of nests was found for species in the developed half of the cay compared with the same species in the undeveloped half of the cay (Table 1).

Throughout the island, nesting densities were consistently higher in large *Pisonia*. Next in order of importance in the undeveloped sector was

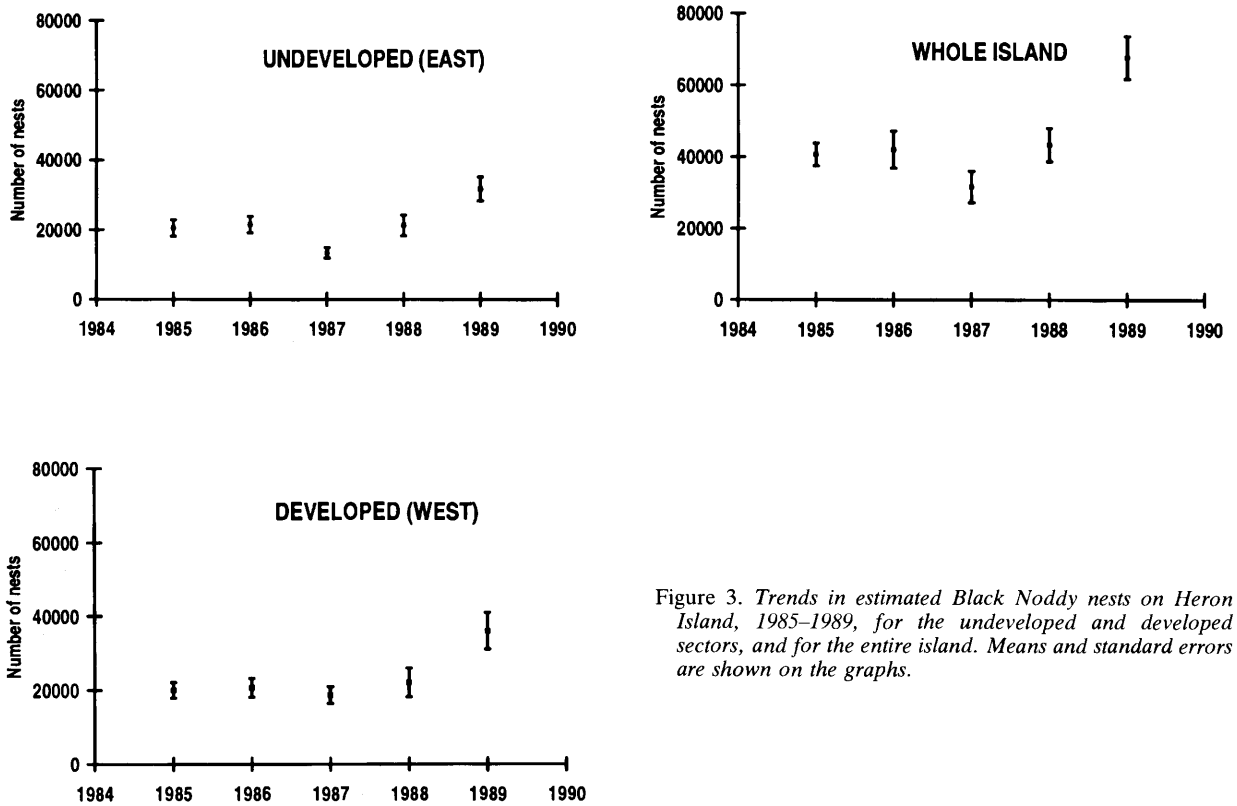


Figure 3. Trends in estimated Black Noddy nests on Heron Island, 1985–1989, for the undeveloped and developed sectors, and for the entire island. Means and standard errors are shown on the graphs.

TABLE 1

Mean nesting density per tree for Black Noddies on Heron Island for each season 1985–1989. Standard errors are given in brackets. Tree species used as nest sites for undeveloped (eastern) sector and developed (western) sector.

	Undeveloped					Developed				
	1985	1986	1987	1988	1989	1985	1986	1987	1988	1989
Large <i>Pisonia</i> (height > 15 m)	24.3 (2.6)	21.0 (1.9)	13.1 (0.5)	23.0 (2.9)	29.3 (2.0)	28.3 (2.6)	22.7 (1.5)	20.5 (1.1)	32.0 (2.0)	37.7 (1.2)
Med <i>Pisonia</i> (10 m > height > 15 m)	6.7 (1.2)	5.1 (0.5)	5.4 (0.6)	10.1 (0.7)	8.8 (1.2)	10.1 (1.6)	8.5 (1.1)	7.7 (0.4)	13.5 (1.4)	11.8 (1.2)
Small <i>Pisonia</i> (height < 10 m)	3.0 (0.8)	1.8 (0.4)	1.2 (0.1)	1.5 (0.2)	1.7 (0.3)	6.4 (2.4)	2.1 (0.2)	1.7 (0.1)	2.1 (0.4)	2.6 (0.6)
<i>Ficus</i>	5.5 (1.7)	5.0 (1.4)	4.5 (0.9)	7.6 (1.2)	9.6 (3.2)	10.2 (1.8)	13.4 (5.3)	7.7 (1.8)	10.3 (2.4)	19.3 (5.7)
<i>Cordia</i>	9.0 (1.7)	6.3 (1.8)	1.1 (0.3)	6.4 (3.2)	7.2 (1.8)	2.0 (1.1)	2.1 (0.7)	4.7 (0.9)	10.8 (1.1)	14.7 (5.9)
<i>Argusia</i>	5.0 (2.2)	8.3 (1.4)	5.9 (2.4)	12.3 (4.9)	14.8 (6.4)	6.1 (3.5)	9.9 (3.1)	14.6 (4.1)	20.6 (5.5)	12.2 (6.6)
<i>Pandanus</i>	2.5 (0.8)	2.9 (0.3)	2.2 (0.5)	1.8 (0.4)	2.3 (0.6)	2.6 (1.1)	6.7 (3.4)	2.5 (0.9)	3.1 (3.1)	3.5 (3.5)
<i>Casuarina</i>	1.3 (0.6)	2.3 (0.7)	— (—)	1.2 (0.6)	2.8 (2.4)	1.7 (0.6)	4.6 (3.4)	2.8 (1.7)	4.4 (3.2)	8.2 (5.1)

Argusia, whereas in the developed sector, noddies selected both *Argusia* and *Ficus/Celtis*, depending on the year. Although medium *Pisonia* made a large contribution to the number of noddy nests in these habitats, they ranked behind *Argusia* and *Ficus/Celtis* in terms of nesting density. *Casuarina* and small *Pisonia* classes consistently returned relatively low nesting densities per tree.

DISCUSSION

Nesting abundance

It is likely that the population of Black Noddies on Heron Island is increasing. This proposal is supported by the significant increase between the lowest (1987–88) and highest (1989–90) population estimates found. However, seabird populations have large inter-annual fluctuations in population size (Hulsman 1984) and a single comparison cannot be interpreted as conclusive. The significant increases in population also found between 1988–89 and 1987–88 for the island and the undeveloped sector help to establish an increasing trend.

Ogden (1993a) estimated $63\,000 \pm 7\,000$ nests during the 1992–93 breeding season and calculated a 7% average rate of increase per annum since the early 1900s. Although this is lower than the highest population size found in the current study (in 1989–90), it is well within the range of population estimates and again, probably a reflection of large population variability between years.

While it is clear that an increase has occurred in this population over past decades, the magnitude of the increase since Shipway's (1969) study in 1965 is still indeterminate because of methodological differences between different survey teams. Ogden (1993a) suggests that an exponential increase cannot continue. However, the current authors believe that Heron Island could certainly support many more breeding pairs given the relatively large proportion of the cay which is currently little used by breeding birds (see Barnes and Hill 1989).

Barnes and Hill (1989) suggested recent colonization of the developed sector because Shipway (1969) found an absence of nests in the west and Hulsman (1983) found lower nesting densities in the west. However, in the current study, it was only the undeveloped sector which

had significant increases in consecutive years. This does not necessarily mean that the developed sector of the cay has been saturated with nests. Observations suggest that, with the possible exception of some individual *Argusia* shrubs, no trees on the cay are completely saturated with nests. What remains to be seen is whether the increases in population size are detrimentally affecting breeding success.

Nesting density per tree

The results from this study support the suggestion by Barnes and Hill (1989) that a greater nesting density per tree, in all species, generally occurs in the developed habitat. The higher nesting densities found in these trees may be due to the fact that there are a smaller number of trees within this area, (therefore greater nesting densities) or to improved access to nesting sites within individual trees at reduced tree densities (Hulsman *et al.* 1984).

However, the important follow-up to this interpretation is to investigate breeding success. Higher mortality rates in the developed sector of the island may result from increased predation by Silver Gulls *Larus novaehollandiae* and Eastern Reef Egrets *Egretta sacra* in the more open habitat, and also from chicks falling during strong winds or heavy rain. Higher mortality would offset any increase in nesting density in this habitat. Until a study investigating differences in breeding success between the developed and undeveloped sectors of the island is conducted, the high nesting densities found in the west cannot be accepted as evidence of high breeding success there.

Large *Pisonia*, up to 20 m in height, supported the highest numbers of nests in both the developed and undeveloped halves of the island, in comparison with other nesting trees. The preference for large *Pisonia* is probably a reflection of the tree size and volume and a greater availability of sites for nesting, rather than a preference for the species itself.

Argusia trees, up to 3 m in height, were the next most popular nest tree. The open growth habit or branching structure in the species may provide good accessibility for nesting sites. *Argusia*, which occurs in the woodland within the undeveloped area, is a more recently selected nesting site, since Shipway (1969) found no nests in this species.

Ficus/Celtis were important for nest sites in the developed area, but of low importance in the undeveloped sector. This may be due to their larger growth habit in the developed area, providing more nesting sites or lower availability of trees with a structure which facilitates nest building.

Ogden (1979) found medium *Pisonia* trees (stem cluster 100–250 cm diameter at ground level) had a higher number of nests than small or large *Pisonia*, and suggested relatively large *Pisonia* (stem cluster > 250 cm at ground level) were avoided because of the risk of wind-throw following cyclone. However, as he points out, most of the large *Pisonia* sampled in that study occurred in dense forest, where interlocking crowns may inhibit access to good nesting sites. In the current study, with much larger sample sizes, a different result was obtained demonstrating that large *Pisonia* are important, at least where nesting sites are readily accessible within the crown (for example, in the developed sector of the cay where large trees are widely spaced).

The current study suggests small *Pisonia* are not important to Black Noddies at Heron Island. This may be due to tree architecture (few horizontal branches) or susceptibility to breaking or swaying with nest weight. In addition, they tend to be found in regenerating areas where noddy chicks may be more vulnerable to predation.

Hulsman (1981) suggested that in saturated colonies, Black Noddies will also nest in *Casuarina* and *Pandanus* species. Nesting densities of noddies throughout the island have continued to increase in *Casuarina* species during the course of this study, however, such increases are also shown in large *Pisonia*, *Ficus*, *Cordia* and *Argusia*. Nesting density in *Pandanus* throughout the island has not greatly increased over the course of the study. It is difficult to ascertain the validity of Hulsman's (1981) suggestion, although the developed sector certainly showed a greater increase in nesting density in both *Casuarina* and *Pandanus* when compared with the undeveloped sector. Higher nesting densities in the developed sector may have forced greater utilization of *Casuarina* and *Pandanus*.

It appears that nest-site selection may be related to the growth habit of the tree which varies with differing physical conditions and its ability to provide suitable nesting sites rather than the tree species itself. The disturbed habitat,

although possibly advantageous to the Black Noddy at this locality (subject to breeding success results) may have affected other avian species no longer present on the island. Management strategies need to consider how activities impact on the growth habits of nesting vegetation of the species.

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LITERATURE REVIEW

Compiled by B. Baker

This section is compiled from journals which are often not available to non-professional ornithologists in Australia. The following criteria are used to select papers for review:

- They relate to species which occur in Australia and its Territories;
- They provide details of techniques and equipment that may be of use in Australia;
- They provide details of studies that may be of general interest to Australian ornithologists.

This Literature Review is a selection taken from the following journals: *American Zoologist*, *Animal Behaviour*, *Auk*, *Australian Bird Watcher*, *Bird Conservation International*, *Bird Study*, *Canadian Journal of Zoology*, *Canberra Bird Notes*, *Conservation Biology*, *Emu*, *Israel Journal of Zoology*, *Journal of Field Ornithology*, *Journal of Raptor Research*, *Journal of Wildlife Management*, *Journal of Zoology London*, *North American Bird Bander*, *RAOU Conservation Statement*, *RAOU Vic. Group Newsletter*, *South Australian Ornithologist*, *Stilt*, *Wildlife Research*.

PLUMAGES, MOULT AND MORPHOMETRICS

Red-capped parrot *Purpureicephalus spurius*: moult, age and sex determination. Mawson, P. R. and Massam, M. C. (1996). *Emu* 96: 240–244. (Describes an underwing stripe and other plumage characteristics that enable age and sex to be determined in the hand.)

Terminology in molt and wing feathers: use of descendant, ascendant, and lesser coverts. Winkler, R. and Jenni, L. (1996). *Auk* 113: 968–969. (The incorrect or imprecise use of the terms 'descendant' and 'ascendant' to describe wing moult creates confusion and the authors suggest that others report the order of numbering and the moult of remiges in a more descriptive manner.)

Weights and pre-migratory mass gain of the Red-necked Stint *Calidris ruficollis* in Victoria, Australia. Rogers, K. G., Rogers, D. I. and Minton, C. D. T. (1996). *Stilt* 29: 2–23. (Stints weigh about 28 gm on arrival in Victoria in spring, and recover to about 29–31 gms quickly. This is maintained through the austral summer, but in March–April adults undergo rapid pre-migratory mass gain. Departure mass is about 40 gms.)

TECHNIQUES AND ANALYSES

Investigation of bird movements using the Australian Bird Count: a pilot study based on the silveryeye, *Zosterops lateralis*. Griffioen, P. (1996). *Graduate Diploma of Zoology Thesis*, La Trobe University: Victoria, Australia. (The ability of the ABC data to reveal currently unknown silveryeye movement patterns was examined, and methods for mapping the data were developed. In addition to the known migration of Tasmanian silveryeyes to the mainland, Victorian birds appear to appear to migrate to both South Australia and the New South Wales/Queensland regions.)

Short-range high-precision surveillance of nocturnal migration and tracking of single targets. Bruderer, B., Steuri, T. and Baumgartner, M. (1995). *Israel Journal of Zoology* 5: 207–220. (Summarises the possibilities and limitations in the application of different radar types for bird research.)

Long-range surveillance radars as indicators of bird numbers aloft. Buurma, L. S. (1995). *Israel Journal of Zoology* 41: 221–236. (Selection of altitude and track direction in relation to landscape, wind and flight phase appears to be the key issue.)

The use of satellite systems for the study of bird migration. Fuller, M. R., Seegar, W. S. and Howey, P. W. (1995). *Israel Journal of Zoology* 41: 243–252. (Reviews satellite tracking technology used in avian studies.)

New trends and capabilities of satellites for bird tracking and monitoring. Ginati, A., Lehmann, G. and Schulz, U. (1995). *Israel Journal of Zoology* 41: 253–259. (Two advanced satellite tracking systems are described.)

Satellite tracking of white-naped crane migration and the importance of the Korean Demilitarized Zone. Higuchi, H., Ozaki, K., Fujita, G., Minton, J., Ueta, M., Soma, M. and Mita, N. (1996). *Conservation Biology* 10: 806–812. (Satellite tracking of 15 cranes identified the migration route of these birds and important stopover sites.)

Biases in diet study methods in the Bonelli's Eagle. Real, J. (1996). *Journal of Wildlife Management* 60: 632–638. (Compared three methods of studying diets with the delivered prey by eagles at two nests. Methods compared were: 1. recent prey present in the nest; 2. remains collected in the nest after breeding; and 3. pellet contents. Pellet analysis was the most efficient method of monitoring the diet of Bonelli's eagle.)