AUSTRALIAN BIRD WATCHER 2002, **19**, 184–193

Breeding and Diet of a Pair of Square-tailed Kites *Lophoictinia isura* on the Mid-north Coast of New South Wales

H. GRIFFITHS[1], H. LUTTER[2], A.B. ROSE[3] and S.J.S. DEBUS[4]

[1]10 Anne Street, Wauchope, N.S.W. 2446
[2]203 Pacific Drive, Port Macquarie, N.S.W. 2444
[3]Associate, The Australian Museum, 6 College Street, Sydney, N.S.W. 2010
(Present address: 61 Boundary Street, Forster, N.S.W. 2428)
[4]Division of Zoology, University of New England, Armidale, N.S.W. 2351
(Corresponding author: sdebus@metz.une.edu.au)

Summary

The diet and breeding of a pair of Square-tailed Kites *Lophoictinia isura* were studied at one nest on the mid-north coast of New South Wales, in the spring and early summer of 2001, by direct observation and by analysis of pellets and prey remains. The nest was in a tall Blackbutt *Eucalyptus pilularis* on the edge of forest near a town. The nestling period occupied early October to early December, with fledging of one young by mid December. Brood reduction and cannibalism of the smaller sibling, almost halfway through the nestling phase, were associated with apparent food shortage. The diet consisted mostly of nestling birds, but included two Eastern Rosellas *Platycercus eximius*, a Common Ringtail Possum *Pseudocheirus peregrinus* and a reptile. Nestling growth and development, and some behavioural observations, are described.

Introduction

Knowledge of the ecology of the Square-tailed Kite *Lophoictinia isura* has improved in recent years, although it still remains poorly known in New South Wales. The most comprehensive studies concern a single pair and offspring observed in coastal south-eastern Queensland over two breeding seasons (Barnes *et al.* 1999, 2001). Minor studies of the Kite's breeding biology and diet have been conducted in New South Wales (Debus 1996, Bischoff *et al.* 2000, Brown *et al.* 2000), and a quantitative study has been conducted on breeding-habitat selection by 11 pairs nesting in state forest on the New South Wales mid-north coast over seven years (Kavanagh *et al.* 2001). Knowledge of its foraging behaviour, particularly in the non-breeding season, is limited. More complete knowledge of the Kite's ecological requirements in the state is still needed for the purpose of formulating a recovery plan, as required under the New South Wales *Threatened Species Conservation Act* 1995. Garnett & Crowley (2000) recommended the continued documenting of basic life-history data for this species, including breeding and diet.

In October 2001 an active nest of the Kite was found in the Wauchope region in northern coastal New South Wales. This paper reports on the pair's breeding cycle from the chick stage to fledging of the single juvenile, including the birds' diet, as a contribution towards better understanding of the species' ecology in New South Wales. An observation of the hunting of free-flying parrots, in the Kite's non-breeding season, is included.

Study area and methods

The nest-site was located in state forest in the Wauchope district (31°28'S, 152°44'E). The nest was visited by HG or HL on 24 occasions over 22 days throughout the nestling period, from hatching to fledging. HL visited the site on 15 days between 9 October and 17 December

2001, at various times of day (all times Eastern Standard Time): early morning (once, 0520 h); mid–late morning (seven occasions, 0845–1145 h); early afternoon (four occasions, 1310–1505 h); and mid afternoon (four occasions, 1535–1630 h). Videotape of nesting activity was obtained by Jim Griffiths on nine occasions throughout this period, for a total of 40 minutes of footage, including that of passerine nests brought in as Kite prey. HG also checked the Kites' nest on four occasions between 19 December 2001 and 6 January 2002, after the juvenile had fledged. HL observed the nest on eight days between 28 October and 11 December, for periods of 15–60 minutes totalling 5.5 hours, in late morning and early to mid afternoon. These visits were on different days from those made by HG, except for one day (though at different times of the day). A photographic record of the juvenile was kept by HL and HG, and copies of the videotape are held by HG, HL and SD.

Eighteen regurgitated Kite pellets (12 intact, six fragmented) were collected from the ground beneath the Kites' nest, along with food remains (two birds, eight bird nests). These items were analysed by ABR, microscopically as necessary, with the aid of a handbook (Beruldsen 1980) and a reference collection of bird skulls and feathers. Nests were also identified by SD from the videotape, by comparison with current work on nesting passerines (Debus unpubl.) and a reference collection of disused nests. One of the Kite nestlings, found dead beneath its nest, was examined by SD and its remains (dorsal feathers, post-cranial skeleton) lodged with the Australian Museum (reg. no. O.70591).

During the Kite's nesting period, the mid-north coast of New South Wales experienced drought conditions which might have caused a shortage of prey. Wauchope (mean annual rainfall about 1300 mm) received only 234 mm of rain in the second half of 2001, with August (9 mm) and September (20 mm) being particularly dry, although conditions improved slightly in October (60 mm) and November (94 mm). At least around Forster (80 km south of Wauchope), there were few juvenile passerines present and it appeared that bush birds either made few attempts to breed or their attempts were unsuccessful (ABR pers. obs.).

Results

Breeding habitat and nest-site

An adult Square-tailed Kite was observed soaring over Wauchope in spring 2000, but a nest was not found until 2001. The nest was located 2 km from the township, near an industrial area, on the edge of forest: 40 m from a busy main road, 15 m from a gravel forest road, and directly over a track used by trail bikes, children on bicycles, and people walking their dogs. Houses 100 m away were visible from the nest-site, which was located on the northern side of a rise, just over the brow. The adults and young showed no reaction to one or two observers watching and filming, usually from 40 m away but sometimes closer to and directly below the nest.

The nest was situated about 20 m above ground on a horizontal fork, 2 m from the trunk in a 30 m Blackbutt *Eucalyptus pilularis*, in open forest of this species with a midstorey of Forest She-oak *Allocasuarina torulosa*. The area was burnt in early July 2001, and in the ensuing dry period the understorey remained charred, with dry leaf-litter and dead She-oak saplings. Although surrounded by foliage and well-shaded through the day, the nest had open access on one side and a nearby dead branch (in the nest-tree) on which the adults loafed. The adults had a regular flight-path to and from the nest, via the open side. The nesting area was contiguous with thousands of hectares of state forest, and was one of the 11 Kite territories documented by Kavanagh *et al.* (2001) in state forest between Taree and Kempsey in coastal New South Wales.

The nest survived a severe electrical storm in week 9 of the nestling period. Gale-force winds twisted off a 25 m Blackbutt 5 m above the ground, and other trees and limbs around the site, but the nest-tree lost only a few small branches.

Table 1
Growth and development of nestling Square-tailed Kites, Wauchope district, N.S.W., spring 2001. Week = stage of nestling period, from projected hatching date (approximately 9 October).

Week	*Comments*
4	Heads downy, bodies mostly downy. One chick clambered onto nest edge and defecated over-rim. Dorsal pin-feathers bursting on both chicks; elder had row of pin-feathers on stubby wings. Chick on edge of nest, stretching wings.
5	Surviving chick feathering; doubled in size. Appeared almost fully grown, with some down on breast and belly. Female collected small stick, which she and nestling arranged on nest.
6	Fully feathered, standing in and on edge of nest, preening.
7	Flapping wings.
9	On branch beside nest; primaries and tail shorter than in adults. Fed itself on prey dropped in nest by parent.
10	Fledged; circling low over nest-site, practising landing and taking off. Went to nest for food left there by parent.

Breeding chronology

The female was on the nest (brooding?) on 9 October, and fed young (which were too small to be seen from the ground) on 10 October. One nestling, presumed the younger and which was last seen alive on 4 November, was found dead (decomposed and maggot-eaten) on 10 November. From its bursting dorsal, wing and tail pin-feathers a few centimetres long and its emerging head and breast feathers, it was estimated to be about four weeks old at the time of death (from comparison with Table 2 of Barnes *et al.* 1999). Hatching was therefore early in the second week of October, and laying probably at the end of August (back-dating about 40 days for incubation, from Bischoff *et al.* 2000). The surviving nestling fledged between 11 and 14 December, consistent with an established nestling period of two months for this species (Marchant & Higgins 1993; Barnes *et al.* 1999, 2001).

The juvenile was seen around the nest for three days after it was flying proficiently (until 17 December), almost a week after fledging. Thereafter, during observations on four days over the ensuing three weeks to 6 January, it was not found in the nest area. The adults were near the nest on 19 December, but were not seen thereafter and there was no evidence of overnight use of the nesting area on 6 January. The juvenile's fate is therefore unknown. It may have ranged away from the nesting area, with or without its parents, or perished.

Nestlings

Observed growth stages of the young are summarised in Table 1. The dead nestling's body showed signs of having been cannibalised: the carcass was headless and apparently partly eaten; its plucked down and dorsal pin-feathers were among the other food remains, and some of its small rufous feathers (i.e. from head or neck) were in one of the Kite pellets. The carcass was missing the sternum, and the bones of one wing (radius, ulna and carpo-metacarpus) were broken.

Fledgling Square-tailed Kite at 'branching' stage before first flight, Wauchope district, N.S.W., December 2001 (nest just below bird)

Plate 46 Photo: H. Lutter

Fledgling Square-tailed Kite ('brancher') stretching, Wauchope district, N.S.W., December 2001

Plate 47 Photo: H. Lutter

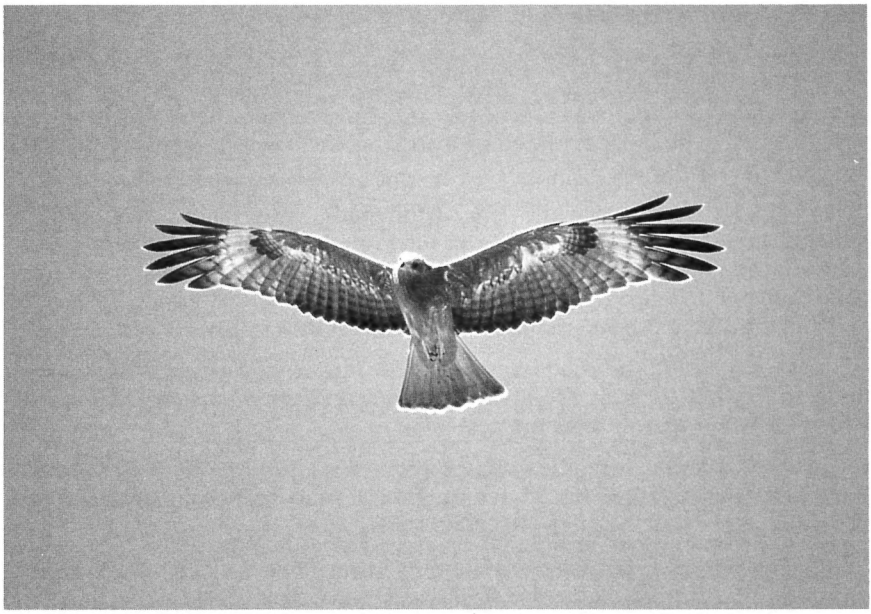
Table 2
Parental behaviour of Square-tailed Kites, Wauchope district, N.S.W., spring 2001. Week = stage of nestling period, from projected hatching date (approximately 9 October). N obs. = no. of observation sessions; M = male, F = female; AM = morning, PM = afternoon.

Week	*n obs.*	*Comments*
1	2	Different days: F on nest ×2; M food drop ×1.
2	1	F on nest; M food drop ×2.
3	1	F on nest; M food drop ×1.
4	3	Two days: (a) F absent from nest, then made food drop; M absent. (b) F on nest, M absent ×2.
5	3	Consecutive days: (a) F on nest, M absent. (b) F initially on nest, then left (hunting?) for 20 min, returned without food. (c) F perching near nest, on bare branch of nest-tree; M made food drop (lizard or snake).
6	4	Three different days: (a) F perching beside nest, M absent. (b) AM: F perching beside nest then left, returning 20 min later without food, left again (hunting?); M absent. PM: F perching beside nest, M absent. (c) F perching beside nest, M absent.
7	3	Three different days: (a) F perching in adjacent tree, M absent. (b) Both parents absent. (c) F perching near nest, M absent.
8	1	F perching beside nest, M absent.
9	2	Different days: (a) F eating large food item in nest, M arrived with small food item but retreated to another tree and ate item. (b) Parent made food drop.
10	2	Different days: parent food drop ×2.

Parental behaviour

In the first three weeks of the nestling period, the female closely attended the nest and the male frequently delivered food items (one item per observation session; Table 2). However, in weeks 4–6 the female was sometimes absent, apparently hunting, and she made one food delivery, whereas the male was usually absent and his only observed food delivery was of an unusual prey item (a reptile, one of two items delivered in 10 observation sessions). From limited data (one delivery in 2.25 hours, 0.4/hr), the feeding rate in weeks 4–6 was low (cf. 0.4–0.5 and 0.6 item/hr in the nestling period; Barnes *et al.* 1999, 2001). This time coincided with the death and apparent cannibalism of the smaller Kite chick, at the end of week 4 or early in week 5.

From week 5, the female started perching beside or near the nest rather than on it with the nestling (Table 2). From week 7 she sometimes perched in an adjacent tree, and from week 9 the parents usually visited the nest only to deliver food. In weeks 10 and 11, after the juvenile had fledged, the parents continued to drop food in the nest, and the juvenile followed the parent to the nest or arrived promptly to eat the item at the nest.



Juvenile Square-tailed Kite soaring, Bundaberg, Qld, late spring 1999
Plate 48 Photo: C.P. Barnes

Adult Square-tailed Kite carrying nesting material, Bundaberg, Qld, spring 1999
Plate 49 Photo: C.P. Barnes

Miscellaneous observations

On one occasion in week 9, when the female was eating in the nest (Table 2), the male visited the nest without food, flew down to the ground below and back up to the nest, then perched in a nearby tree for 5 minutes before revisiting the nest, then left to hunt. He returned with prey, but ate it before again revisiting the nest, and then departed.

In week 10, after the juvenile fledged, the food-bearing parent gave a call as it arrived: three soft screeches falling in pitch, probably the hoarse *eep... eep...* yelp, or the *ee-ee...* squeal or more rasping version, previously described (Marchant & Higgins 1993, Barnes *et al.* 1999, Bischoff *et al.* 2000). The fledgling's begging call was a loud version of the latter call.

In week 5, one of the adults chased a Pied Currawong *Strepera graculina* near the nest. In week 10, after a food delivery, the adult chased a group of Torresian Crows *Corvus orru* away from the nest area.

Two days after the juvenile was last seen, in mid afternoon (1530 h) the adults were perching together for 15 minutes on a dead branch in the nest-tree, allopreening, before they flew off individually.

In addition to the observation of hunting behaviour described opposite, ABR has other recent observations of the Square-tailed Kite in the Forster district (32°11′S, 152°31′E). In May 2001 a Kite was seen over Booti Booti National Park adjoining south Forster, and in October 2001 one was seen over forest on the new Pacific Highway south of Taree. These records add Forster to the growing number of localities on the mid-north coast of New South Wales where the Kite is being reported, and a further example of its use of 'green' urban areas, as detailed by Bischoff *et al.* (2000).

Diet

The only food items observed were: (a) a 20 cm reptile (lizard or snake) dropped into the nest by the male Kite, and eaten by the female and chick, and (b) pink flesh of vertebrate prey too large to swallow whole and eaten piecemeal by the female in the nest, while the fledgling was perching on a branch beside the nest. A further 10 small items delivered to the nest by the parents could not be identified.

Twelve intact pellets measured 20–46 × 15–26 mm (mean 31.6 × 19.3 mm). Seventeen of the 18 pellets contained the remains of small nestling birds: mostly small feathers (including many in pin), with a few small avian bones in two of these pellets. One pellet contained the teeth and part of the upper jaw of a Common Ringtail Possum *Pseudocheirus peregrinus*: remains from a well-grown animal that probably weighed at least 500 g (adults being 660+ g: Menkhorst & Knight 2001). The remains of small insects and seeds, most likely from the stomach contents of prey, were found in 10 and six pellets respectively, indicating that the Kites took mostly insectivorous but some granivorous birds. Other prey remains were the skulls of two adult Eastern Rosellas *Platycercus eximius*. Whole nests or nest-lining brought to the Kites' nest, presumably with prey, were from small passerines that build open, cup-shaped nests in the tree or shrub canopy (Table 3).

Table 3
Breeding diet of a family of Square-tailed Kites in the Wauchope district, N.S.W., 2001: nestling period. Minimum number of prey individuals (n) in pellets (total no. 18) and prey remains (total no. 2). Nests of prey species, brought to Kites' nest, also listed.

Species	*n*
Eastern Rosella *Platycercus eximius* (adult)	2
Unidentified nestling birds	17
Common Ringtail Possum *Pseudocheirus peregrinus*	1
Total	20
Nests:	
Honeyeater sp. (Meliphagidae)	1
Eastern Yellow Robin *Eopsaltria australis*	1
Varied Sittella *Daphoenositta chrysoptera*	1
Willie Wagtail *Rhipidura leucophrys*	1
Flycatcher (Dicruridae; *Myiagra*/*Rhipidura* spp.?)	4
Total	8

Hunting behaviour

In April 2001, ABR observed a Square-tailed Kite foraging over a suburban garden in Forster. At 1100 h the Kite circled low over a house, mobbed by Galahs *Cacatua roseicapilla* and by Rainbow and Scaly-breasted Lorikeets *Trichoglossus haematodus* and *T. chlorolepidotus*. It circled away out of sight, around a nearby reserve at treetop height. Half an hour later it returned low, minus the mobbing birds, and skimmed the top of a *Grevillea* 'Honey Gem' on which the lorikeets normally fed and from which they had taken off when the Kite first appeared. The Kite's apparent intention was to seize a lorikeet as they flushed, by returning stealthily to their feeding site in anticipation of surprising them, but they had departed.

Discussion

The Kites' nesting situation agrees with other recent information that this species is remarkably tolerant of passive human disturbance near the nest (e.g. Bischoff *et al.* 2000, Brown *et al.* 2000). The nest of the subject pair, and those reported by Bischoff *et al.* (2000), are among the 11 territories studied by Kavanagh *et al.* (2001). That study found that, in mid-coastal New South Wales, this species selects nest-trees in areas containing a high proportion of older-aged regrowth Blackbutt forest (28–59 m tall, 70–100 years old), on commercially productive (i.e. fertile) sites.

Open access to the nest, as provided by tall, mature trees, seems important in this long-winged species. An opening in the surrounding canopy may facilitate the carrying of sticks to the nest, and also enable advanced nestlings to exercise their wings without entanglement in, and injury or death from, foliage or branches (G. Czechura pers. comm.).

Growth and development of the Kite nestlings accord with previous information, as does the nestling period of approximately 60 days (Barnes *et al.* 1999, 2001). The female Kite usually attends the nest closely until fledging (Marchant & Higgins 1993), but in this case her absence (to hunt?) and food delivery early in the nestling phase suggest that the male was unable to provide enough food.

The dead nestling might have died from starvation, or it may have been the victim of harassment or even siblicide by the other. Brood reduction (Marchant & Higgins 1993) and aggression by the elder sibling towards the younger (Barnes *et al.* 1999) have been recorded in this species, although siblicide remains to be confirmed. Opportunistic cannibalism could occur if an inert, dead nestling is not distinguished from prey in the nest, and is therefore fed to, or eaten by, the other nestling. Food shortage appears to be a factor in observed cases of brood reduction, sibling aggression, and a weak younger sibling, and may contribute to the frequently observed low productivity in coastal eastern Australia resulting in one or sometimes no fledgling per breeding attempt (Barnes *et al.* 1999, Bischoff *et al.* 2000, Brown *et al.* 2000, Kavanagh *et al.* 2001, this study).

The male's behaviour in week 9, of visiting the nest, checking the ground beneath, then eating rather than depositing a food item (Table 2), seemed unusual. We speculate that he may have been searching for accidentally dropped food, or edible fragments, and monitoring the family's food needs.

The Kites' breeding diet was generally similar to that documented by Barnes *et al.* (1999, 2001) and Brown *et al.* (2000), although no eggshells, or insects definitely caught by the Kites, were found in the small sample of pellets in this study. The Common Ringtail Possum, or indeed any similarly sized mammal, has not previously been recorded in the Kite's diet (Marchant & Higgins 1993), although a 'small' (kitten, 300 g?) Rabbit *Oryctolagus cuniculus* has been reported as prey (Borella & Borella 1997). It is not surprising that Ringtail Possums are occasionally captured, as they build dreys in trees or shrubs for daytime denning (Menkhorst & Knight 2001) and could be susceptible to the Kite's foraging method of aerial searching and raiding nests in foliage (e.g. Debus 1996).

An adult or subadult Ringtail is a large prey item for the light-bodied, weak-footed, small-billed Kite; observations of the capture method would be valuable. It seems that the Kite might sometimes take larger prey than hitherto believed, particularly if a shortage of usual prey forces it to switch prey types. Alternatively, the possum may have been a freshly dead animal, perhaps road-killed or pirated from another predator, although there are no confirmed records of the Kite scavenging or stealing food.

This study provides further examples of adult parrots as occasional prey of the Kite, but sheds no further light on how such potentially difficult (i.e. defensive) prey are captured and subdued. The foraging observation suggests how the Kite might hunt lorikeets. The examples of bird nests show that, in some situations, the Kite preys on a range of other small forest or woodland passerines (as nestlings) besides honeyeaters. Many of these nests are well camouflaged, raising the question of whether the Kite locates them mainly by sight or also by the squeaks of nestlings (e.g. Debus 1996) or the behaviour of parent birds.

The results of this study, along with those from other parts of coastal New South Wales and Queensland (Debus & Czechura 1989; Barnes *et al.* 1999, 2001; Bischoff *et al.* 2000; Brown *et al.* 2000), show that in coastal eastern Australia the Square-tailed Kite can be characterised in the following way. When breeding, it is a predator of the forest and woodland canopy, taking mainly small birds and especially fledglings and the contents of nests, but also opportunistically taking other prey such as insects (including larvae from nests of communal wasps), tree-frogs, reptiles and mammals, occasionally up to almost its own body weight. Post-breeding and through the cooler months it apparently becomes more

insectivorous, but has the capacity to take vertebrates including free-flying birds under the right conditions.

Aspects of the breeding cycle of individual pairs of Kites are now well documented, with this study contributing a little more to the comprehensive composite picture of parental behaviour, and nestling/fledgling behaviour and development. The study by Kavanagh *et al.* (2001) has provided quantitative information on breeding-habitat selection and nest-site characteristics in coastal New South Wales. It remains to better document diet, by larger samples of pellets and particularly for the non-breeding season; foraging behaviour, particularly for large prey such as parrots and mammals; home-range size and habitat use; and nesting density and long-term fledgling productivity. More complete ecological information will place the anticipated recovery plan on a sounder basis. It appears that populations of the Kite on the New South Wales north coast are sufficiently dense for worthwhile research.

Acknowledgements

Special thanks to Jim Griffiths for his sterling efforts in obtaining video footage of the Kites' breeding cycle, for photography, and for supporting HG's role in the study. We also thank Walter Boles of the Australian Museum for helping to identify some food remains and for assessing the Kite chick's skeleton, and Andrew Ley for conveying the dead Kite chick to SD. We thank Andrew Ley and Julia Hurley for editing, and Greg Clancy, Greg Czechura and Rod Kavanagh for their helpful comments as referees.

References

Barnes, C.P., Zillmann, E.E. & Rose, A.B. (1999), 'Breeding behaviour and diet of the Square-tailed Kite *Lophoictinia isura* in south-eastern Queensland', *Australian Bird Watcher* **18**, 133–152.

Barnes, C.P., Zillmann, E.E., Rose, A.B. & Debus, S.J.S. (2001), 'Diet and biology of Square-tailed Kites *Lophoictinia isura* breeding in south-eastern Queensland: nest-building to post-fledging', *Australian Bird Watcher* **19**, 28–43.

Beruldsen, G.R. (1980), *Field Guide to Nests and Eggs of Australian Birds*, Rigby, Adelaide.

Bischoff, T., Lutter, H. & Debus, S. (2000), 'Square-tailed Kites breeding on the mid-north coast of New South Wales', *Australian Bird Watcher* **18**, 233–240.

Borella, M.C. & Borella, M. (1997), 'Square-tailed Kite breeding near Ararat, Victoria', *Australian Bird Watcher* **17**, 157–158.

Brown, B., Brown, F. & Debus, S.J.S. (2000), 'Further observations on a pair of Square-tailed Kites nesting near Grafton, New South Wales', *Australian Bird Watcher* **18**, 270–273.

Debus, S.J.S. (1996), 'Further observations on the Square-tailed Kite', *Australian Birds* **29**, 44–53; 62.

Debus, S.J.S. & Czechura, G.V. (1989), 'The Square-tailed Kite *Lophoictinia isura*: a review', *Australian Bird Watcher* **13**, 81–97.

Garnett, S.T. & Crowley, G.M. (2000), *The Action Plan for Australian Birds 2000*, Environment Australia, Canberra.

Kavanagh, R.P., Cann, B., Ellis, B. & Williams, J. (2001), 'Habitat selection by the Square-tailed Kite *Lophoictinia isura* on the mid-north coast of New South Wales', abstracts, Australian Ornithological Conference, Charles Sturt University, Bathurst (Dec. 2001), p. 27.

Marchant, S. & Higgins, P.J. (Eds) (1993), *Handbook of Australian, New Zealand and Antarctic Birds*, vol. 2, Oxford University Press, Melbourne.

Menkhorst, P. & Knight, F. (2001), *A Field Guide to the Mammals of Australia*, Oxford University Press, Melbourne.

Received 15 February 2002 ■