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A SURVEY OF DIURNAL RAPTORS IN THE RICHMOND RIVER DISTRICT, NEW SOUTH WALES, 1996–99

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Between 1996 and 1999 diurnal raptors were counted using roadside surveys in the Richmond River district in north-eastern New South Wales. A total of 3 101 raptors of 17 species was recorded. Relative abundance of raptors (all species), expressed in terms of individuals per 100 kilometres travelled, was 10.75 birds per 100 kilometres, which was markedly higher than had been reported for the area previously. Two species, Nankeen Kestrel *Falco cenchroides* and Black-shouldered Kite *Elanus axillaris*, were most frequently recorded, comprising 56 per cent and 24 per cent respectively of all raptors counted. Both species demonstrated marked seasonality associated with autumn-winter movements into the area. Issues relating to vehicle-based surveying of raptors are discussed.

INTRODUCTION

This paper is the fifth in a series reporting the results of systematic surveys of birds in the Richmond River district, New South Wales (see Gosper and Holmes 2002 for details and reports published to date). Although previous surveys were conducted on foot, each within a specific habitat type, this study used road transects to target a single group, Falconiformes, across habitat types.

Vehicle-based surveys are considered to be suitable tool for the broadscale measurement of the relative abundance of most diurnal raptors, particularly those inhabiting open environments (Baker-Gabb and Steele 1999). Common raptors are relatively conspicuous, have a high degree of mobility and resident pairs in some species may occupy large home ranges (Marchant and Higgins 1993). Roadside survey techniques have been used previously for the collection of baseline data on relative abundance and seasonal change in raptors numbers in northern NSW (Genelly 1978; Debus 1985, 1992; Baker-Gabb and Steele 1999).

The present study sampled raptor communities along roads in primarily agricultural landscapes around Lismore on the north coast of New South Wales, an area of increasing population and intensive land use. Surveys were undertaken during the period 1996-1999.

STUDY AREA

The Richmond River district is located in north-eastern NSW, east of the Great Dividing Range. For the purposes of this and previous studies the survey area (ca. 7 000 sq. km) is defined as the catchment of the Richmond River, also including the minor drainages of the Evans River and Jerusalem Creek (see Gosper 1986; Gosper and Holmes 2002 for maps and detailed descriptions).

The district is predominantly rural and becoming increasing closely settled, especially between Lismore and the coast. An extensive network of main and secondary roads link Lismore (urban population 43 000) and the surrounding centres of Casino, Ballina and Kyogle (each located about 30 km from Lismore), and smaller towns and villages. The intervening landscape is relatively flat and used for pastoral and agricultural purposes, the most widespread being cattle grazing (dairy and beef). Farmlands grade into semi-cleared country away from the floodplain. Little of the road network passes through heavily forested areas and other natural communities, which are largely confined to state forests and national parks in the watershed ranges around the periphery of the district.

METHODS

Roadside surveys of diurnal raptors were made during travel throughout the district between 1996 and 1999. More than 90 per cent of surveys commenced and/or concluded at Goolmangar, 15 kilometres by road north of Lismore. Routes to Lismore were traversed at least weekly (often several times weekly), to Ballina and Casino most months, and other roads less regularly.

Methods were similar to those used for the 1986 – 1990 nation-wide 'Birds of Prey Watch' scheme (Baker-Gabb and Steele 1999), but without the requirement that surveys cover a minimum of 25 kilometres (i.e. in this study raptors were surveyed in the course of all daylight travel). Raptors were counted whilst driving (i.e. unaided vision from a moving vehicle) at normal speeds. Counting ceased during rain, and in the early morning and late afternoon, when light was insufficient to confidently locate and identify birds within the normal range of vision. Individuals unable to be positively identified (usually at limit of vision) were not scored. Brown Goshawks *Accipiter fasciatus* and Collared Sparrowhawks *A.*

TABLE 2

Relative abundance of raptors (birds / 100 km) by year in north-eastern NSW during 1996–99.

Year	Distance (km)	Total Raptors	Raptors / 100 km			
			Nankeen Kestrel	Black-shouldered Kite	Other species	All species
1996	1 303	120	3.45	3.22	2.61	9.21
1997	9 665	935	5.42	1.99	2.23	9.67
1998	8 846	986	5.56	3.56	2.02	11.15
1999	9 024	1 060	7.53	1.93	2.23	11.75
Total	28 838	3 101	6.04	2.51	2.21	10.75

cirrhocephalus could not be reliably separated in some situations (27% of observations involving these species), and such individuals are included in the results as a separate grouping. Details (date, time of day, route, distance and species tallies) were recorded for each trip, including those on which no raptors were sighted.

Following a trial during September 1996 raptors were routinely counted during all vehicular trips made between October 1996 and November 1999. Due to periods of absence from the district during December 1996 and September 1998, no data were collected for these months. Raptors were surveyed on a total of 527 days (mean 14.6 days/month; range 8–20 days) over 36 months. Total distance travelled was 28 838 kilometres (mean 801 km/month; range 489–1 340 km).

RESULTS

Species richness and relative abundance

A total of 3 101 raptors of 17 species was recorded over a distance of 28 838 kilometres (Table 1). Of species regularly present in the district (see Gosper 1986; Gosper and Holmes 2002) only the Grey Goshawk *Accipter novaehollandiae*, primarily an inhabitant of closed forests, was not recorded during road transects. Nankeen Kestrels *Falco cenchroides* and Black-shouldered Kites *Elanus axillaris* comprised 56 per cent and 24 per cent respectively of all raptors counted. Three species, Nankeen Kestrel, Black-shouldered Kite and Osprey *Pandion haliaetus*, were observed attending nests in roadside locations.

TABLE 1

Count totals and overall relative abundance (in terms of birds / 100 km) of 17 species of diurnal raptor in north-eastern NSW during 1996 – 99.

Species	Count total	Raptors/ 100 km
Osprey *Pandion haliaetus*	131	0.45
Pacific Baza *Aviceda subcristata*	8	<0.05
Black-shouldered Kite *Elanus axillaris*	723	2.51
Square-tailed Kite *Lophoictinia isura*	1	<0.05
Whistling Kite *Haliastur sphenurus*	158	0.55
Brahminy Kite *H. indus*	51	0.18
White-bellied Sea-Eagle *Haliaeetus leucogaster*	36	0.12
Spotted Harrier *Circus assimilis*	8	<0.05
Swamp Harrier *C. approximans*	9	<0.05
Brown Goshawk *Accipiter fasciatus*	14	<0.10
Collared Sparrowhawk *A. cirrhocephalus*	2	<0.05
Accipiter sp. (Goshawk/ Sparrowhawk)	6	
Wedge-tailed Eagle *Aquila audax*	73	0.25
Little Eagle *Hieraaetus morphnoides*	1	<0.05
Brown Falcon *Falco berigora*	110	0.38
Australian Hobby *F. longipennis*	26	<0.10
Peregrine Falcon *F. peregrinus*	3	<0.05
Nankeen Kestrel *F. cenchroides*	1741	6.04

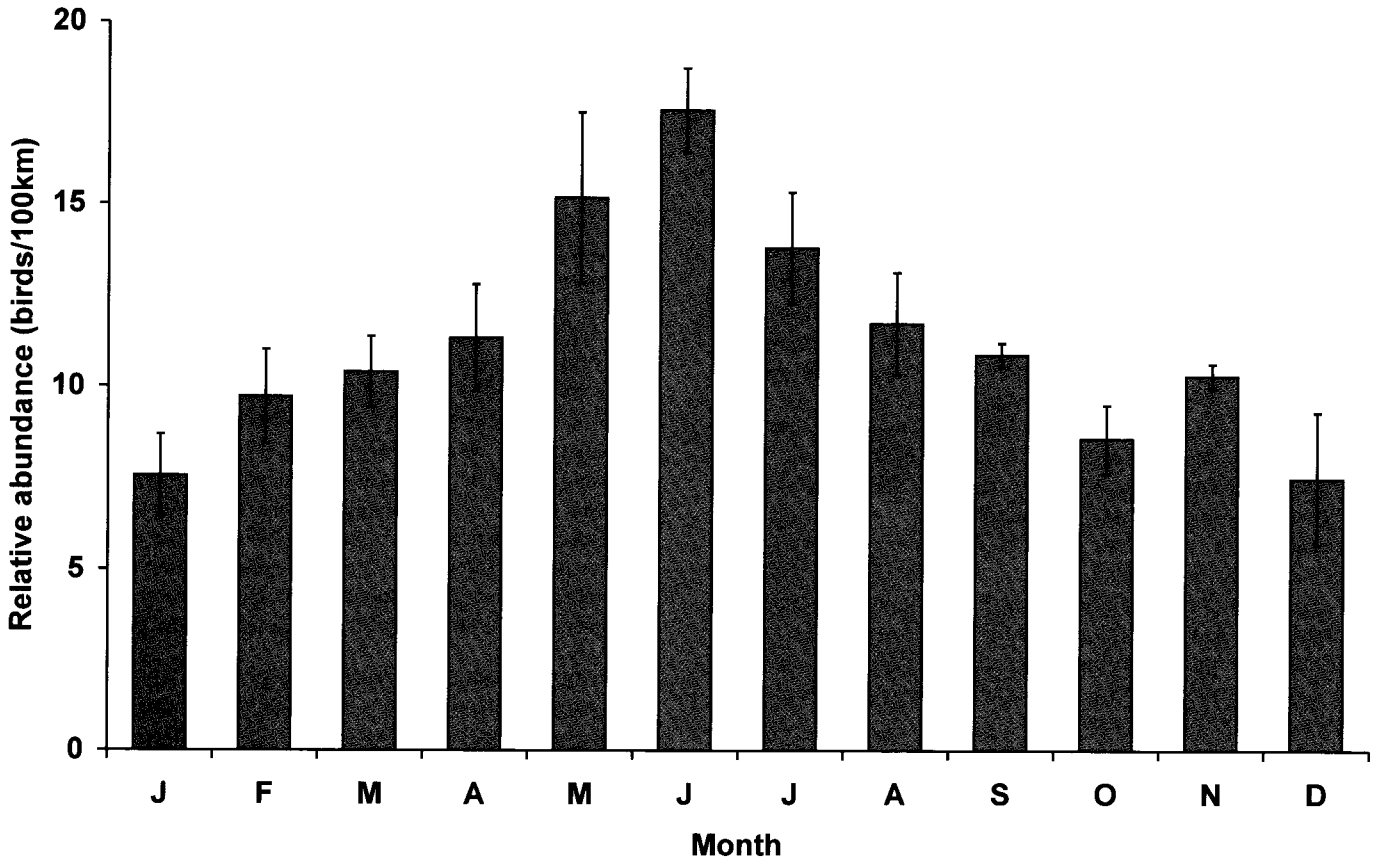

Figure 1. *Monthly variation in the relative abundance of raptors (all species) in north-eastern NSW, 1996-99. Standard error bars show between-year variation.*

The overall recording rate for raptors (all species), expressed in terms of individuals per 100 kilometres travelled over the duration of the study, was 10.75 birds per 100 kilometres. Between-years variation in relative abundance ranged from 9.67 birds per 100 kilometres in 1997 to 11.75 birds per 100 kilometres in 1999 (Table 2).

Nankeen Kestrels (6.04 birds/100 km) and Black-shouldered Kites (2.51 birds/100 km) were the only species recorded at rates in excess of one bird per 100 kilometres. Whistling Kite *Haliastur sphenurus*, Osprey, Brown Falcon *F. berigora*, Wedge-tailed Eagle *Aquila audax*, Brahminy Kite *H. indus*, and White-bellied Sea-Eagle *Haliaeetus leucogaster* were recorded in descending order of relative abundance, at rates of between less than 1.0 and 0.1 birds per 100 kilometres. Recording rates for all other species were less than 0.1 birds per 100 kilometres (Table 1).

Seasonality

Raptor numbers in the district peaked in late autumn–winter (May–July) and were at their lowest in summer (December–January) in all years of the study (Fig. 1). Monthly recording rates ranged from 5.68 birds per 100 kilometres in December 1997 to 19.89 birds per 100 kilometres in June 1999. This effect was largely attributable to fluctuations in the numbers of two species – Nankeen Kestrel and Black-shouldered Kite (Table 3).

Measures of relative abundance for Nankeen Kestrel ranged from less than 3.0 birds per 100 kilometres in October 1996 and January 1998 to greater than 13.0 birds per kilometres in May – June 1999 (Table 3). On the regularly surveyed route between Lismore and Goolmangar the relative density of kestrels ranged from 5.76 birds per 100 kilometres in January 1998 to 20.0 birds per 100 kilometres in June 1999. In all years kestrel recording rates were lowest between October and January, with numbers peaking in autumn – winter. Kestrels bred locally in spring, being observed attending nests in holes in roadside eucalypts between October and December, with fledglings emerging in December.

Measures of relative abundance for Black-shouldered Kite ranged from less than 1.0 bird per 100 kilometres in January – February 1997 and 1999 to greater than 6.0 birds per 100 kilometres in June – July 1998 (Table 3). Between Lismore and Goolmangar the relative density of kites was 2.0 birds per 100 kilometres in February 1997 compared with 8.89 birds per 100 kilometres in July 1998. Black-shouldered Kite numbers were lowest in summer in all years, with a variable peak between May and August. Relative abundance varied considerably between years (Table 2). A roadside nest near Goolmangar had large young in October 1998 and was being brooded again in April 1999.

DISCUSSION

Diurnal raptors in the study area were previously surveyed using similar vehicle-based methods by multiple observers participating in the 'Birds of Prey Watch' between 1986 and 1990 (Baker-Gabb and Steele 1999). For the analysis of results from that study the continent was divided into 61 biogeographical regions. Two of these zones, Gympie and Kempsey, overlap the Richmond River district, enabling some comparison of results between the studies. Baker-Gabb and Steele reported that 666 and 725 surveys were made in the Gympie and Kempsey zones respectively over five years. In the present study surveys were made on 527 days over three years.

Basic species richness scores (number of species recorded) obtained in both studies were similar – 18 species in both Gympie and Kempsey zones compared with 17 species in the Richmond River district. However, the overall relative abundance rate for raptors of 10.75 birds per 100 kilometres obtained in the present study was much higher than the rates of 3.0 and 2.8 birds per 100 kilometres for Gympie and Kempsey respectively. Analyses at species level shows that the much higher relative abundance values obtained for Nankeen Kestrel and Black-shouldered Kite in the present study (Table 2) are responsible for the difference.

There appear to be a number of factors that may have contributed to this result:

- it is likely that in the present study a greater proportion of surveys was carried out on rural roads traversing intensively farmed agricultural landscapes. Such habitats appear to support high numbers of Nankeen Kestrels and Black-shouldered Kites. It is probable that 'Birds of Prey Watch' surveys would have involved more highway routes, which pass through the forested terrains that lie between the floodplains of the major rivers of coastal north-eastern NSW, and also between the coastal plain and the Northern Tablelands.

- a feature of the present study was the high level of replication of surveys. Some routes were censused at least weekly, others monthly, with most of the remainder also replicated at irregular intervals. This contributed to observer familiarity with routes being surveyed. The observer, when regularly using particular routes, identified perches (both natural and man-made) that appeared to be preferred by individual raptors, particularly among Nankeen Kestrels, Black-shouldered Kites and Ospreys. Repeated surveying of routes, enabling systematic checking of known perches, probably increased the chances of detecting any raptors present.

- in the Richmond River district power poles and lines (above-ground utilities) where perched birds were easily seen, were frequently located along rural roadsides. Their presence is likely to result in a higher proportion of some species being recorded, as these structures appear to be favoured perches

TABLE 3

Relative abundance of raptors (birds / 100 km) by month in north-eastern NSW during 1996–99.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Nankeen Kestrel												
1996										2.37	4.60	
1997	3.80	4.70	4.95	5.82	7.40	9.00	8.39	6.88	6.15	4.83	3.75	3.20
1998	2.98	4.04	3.63	6.28	7.00	8.50	8.16	5.51		5.27	5.10	5.14
1999	6.59	8.91	7.71	7.46	13.46	14.43	8.88	4.94	5.48	4.39	5.89	
Mean	4.43	6.21	5.57	6.58	9.67	10.44	8.44	5.75	5.85	4.32	4.85	4.01
Black-shouldered Kite												
1996										2.67	3.80	
1997	0.45	0.78	1.23	1.25	1.32	1.84	2.38	4.41	2.76	2.21	3.38	1.76
1998	1.79	2.22	3.33	3.08	4.41	6.28	6.36	3.48		3.82	3.24	2.46
1999	0.98	0.50	2.98	2.87	4.44	3.16	1.21	1.01	1.78	1.34	1.53	
Mean	1.12	1.28	2.51	2.44	3.51	4.18	3.58	2.85	2.31	1.86	2.10	2.05
Other species												
1996										3.12	1.90	
1997	2.26	1.76	3.03	1.37	2.85	5.73	3.38	2.73	2.26	1.31	2.42	0.72
1998	1.57	1.57	2.73	2.87	2.76	1.48	1.68	2.90		1.98	1.70	1.68
1999	2.23	2.18	1.62	2.87	1.72	2.29	0.87	3.26	3.26	0.90	3.77	
Mean	2.00	1.82	2.42	2.30	2.43	3.00	2.13	2.98	2.58	1.67	2.54	1.12

for a number of raptor species, notably Nankeen Kestrels (cf. Genelly 1978), Black-shouldered Kites, Brown Falcons, and to a lesser extent Brown Goshawks. In areas of improved pasture and cropping, where even scattered trees have been removed, these structures may provide the only perches available to raptors. Observations suggest that in areas of similar open habitat, where powerlines are absent or located away from roads, the chances of detecting these species while driving decreases.

Overall relative abundance scores obtained for most other raptor species fell within the range reported in the Gympie and Kempsey zones by Baker-Gabb and Steele (1999). A higher than expected score for Osprey, even taking into account its increasing numbers in the study area (Gosper and Holmes 2002), probably resulted from the presence of an artificial nest pole and platform beside a route traversed most survey months. Ospreys used this structure each year for breeding, and at other times as a loafing perch. Lower recording rates for Swamp Harrier *Circus approximans* and Whistling Kite may reflect lack of wetlands along regularly surveyed routes. Debus (1992), whose routes commenced/finished at Armidale on the adjacent NSW Northern Tablelands, and primarily traversed less closely settled landscapes, reported relatively fewer Nankeen Kestrels, but higher numbers of Whistling Kite (all recorded on the coastal plain) and Wedge-tailed Eagle (most records from the tablelands, escarpment and foothills) (S. Debus *in litt.*).

The predictability with which Nankeen Kestrels were recorded at given locations and perches (see above) along regularly surveyed routes (e.g. Goolmangar–Lismore) strongly suggested that pairs occupied fixed territories throughout the duration of the study. This result supports the notion that part of the population is sedentary. Kestrels are considered to be partial migrants, with a large proportion of the population migrating from southern Australia and areas of greater climatic extreme, northwards and/or to coastal lowlands during autumn (Debus 1985; Marchant and Higgins 1993). The 'Bird of Prey Watch' identified the Darling Downs in south-eastern Queensland as an important wintering ground for kestrels (Baker-Gabb and Steele 1999). Findings reported here indicate that agricultural and grazing lands in north-eastern NSW also support significant numbers of visiting kestrels in autumn – winter, in addition to a resident breeding population.

Marchant and Higgins (1993) described the Black-shouldered Kite as being a breeding resident (fluctuating numbers) in higher rainfall coastal lowlands in eastern Australia, but as irruptive in more arid parts of its range. Kites were recorded in every month of the present study, but there was little indication of sedentariness. Rates dropped to below 1 bird per 100 kilometres in two of three summers, while peaks occurred briefly in autumn – winter in each year but in different months, and overall relative abundance varied between years. This result indicates an annual seasonal movement into the area, but one that is more irregular in its timing and magnitude. On regularly surveyed routes kites were not found at fixed locations for extended periods. Rather it appeared that birds remained in an area for a time, perhaps in response to food availability, but then moved on. It also appeared that breeding pairs occupied temporary territories while nesting, but these territories subsequently lapsed when the young fledged.

Amongst less frequently recorded species there was a weak overall trend towards autumn – winter peaks and summer lows in relative abundance (Table 3). Whistling Kite, Brown Falcon, Wedge-tailed Eagle, Australian Hobby *F. longipennis* and Brown Goshawk each recorded their highest relative abundance scores in the autumn-winter period, and lowest in summer. Although findings for some (e.g. Brown Falcon and Australian Hobby) appear to be supported by earlier local studies, results for others (e.g. Whistling Kite) are equivocal (cf. Gosper 1981, 1983). All Pacific Baza *Aviceda subcristata* records were between October and January, which is inconsistent with other local data (Gosper and Holmes 2002). Results should therefore be treated with caution as they may well be an artefact of small sample size, bias in the types of habitats sampled, between-month variations in routes surveyed and local movement away from the vicinity of roads and / or more closely settled areas by some species to nest.

In terms of methodology this study demonstrates that intensive long-term vehicle-based surveys of regular routes are an effective means of assessing the relative abundance and seasonality of open-country raptors in pastoral and agricultural landscapes. Complementary systematic on foot and/or stationary vantage point counts, as proposed by Debus (1992), may be required to effectively survey species which utilise forest, wetland and coastline (littoral) habitats in the district.

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