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Relative abundance of Australasian harriers (*Circus approximans*) in New Zealand

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Abstract I conducted road counts on the North I and South I of New Zealand in Mar 2006 to evaluate relative abundance and distribution of Australasian harriers (*Circus approximans*). Over 1670 km were traveled on the North I with 98 harriers detected, yielding 1 harrier/17.0 km traveled. Over 2430 km were traveled on the South I with 145 harriers detected, yielding 1 harrier/16.8 km traveled, with no difference in number of harriers detected/km traveled between islands ($P > 0.25$). Three survey routes, 1 on southeastern North I and 2 on northeastern and east-central South I, were particularly productive yielding 1 harrier/7.1-11.1 km traveled. My results provide empirical support for the frequently cited description that the Australasian harrier is now New Zealand's most abundant native diurnal raptor, and has largely benefited from the conversion of land from native forest and scrub to pasture at the likely expense of other native and endemic species.

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INTRODUCTION

The South Pacific islands of New Zealand, including the larger North and South Is, the Chatham Is, and Stewart I, were first settled by the Maori around AD 1000 (Williams *et al.* 2000). At that time, 11 species of flightless and herbivorous moa (Dinornithiformes) filled ecological niches elsewhere occupied by animals such as deer and possums (Worthy & Holdaway 2002, Orbell 2003). Prior to human settlement, New Zealand had no terrestrial mammals (except bats), and at the top of the food chain was the now-extinct giant Haast's eagle (*Harpagornis moorei*), the world's largest, which must have preyed upon smaller moa species (i.e., *Pachyornis elephantopus*) and attacked larger ones (i.e., *Dinornis giganteus*) when they became mired in swamps (Bunce *et al.* 2005). Other raptor species thought to have been exterminated prehistorically by humans or human-caused changes in New Zealand's environment include the giant Eyles's harrier (*Circus eylesi*), and the endemic laughing owl (*Sceloglaux albifacies*) last sighted in South Canterbury in 1914 (Fuller 2001, Orbell 2003).

Today, the Australasian harrier (*C. approximans*) and morepork (*Ninox novaeseelandiae*) are described as abundant and common natives on both North and South Is, while the endemic New Zealand falcon (*Falco novaeseelandiae*) is described as uncommon and less widespread. The black kite (*Milvas migrans*), black falcon (*F. sugniger*), nankeen kestrel (*F. cenchroides*), and barn owl (*Tyto alba*) are recorded as rare or uncommon vagrants from Australia, while the introduced little owl (*Athene noctua*) is locally common in farmland on the South I only (Robertson & Heather 2001).

Population estimates for the 3 "types" of New Zealand falcon are 400-800 breeding pairs of "bush falcons" in the main mountain ranges of the North I and the Paparoa Ranges and Nelson Lakes area of the South I. The "eastern falcon" is mostly found in the main mountain ranges of the South I, with an estimated population of 2000-3000 pairs. The "southern falcon" nests in Fiordland, the Auckland Is, and probably Stewart I, with an estimated population of < 250 pairs (M. Brown, *pers. comm.*). These are comparable with Fox (1978), who estimated 450-850 pairs of "bush falcons", 3100-3200 pairs of "eastern falcons", and 140-280 pairs of "southern falcons" almost 30-yrs ago. However, no comparable population estimates or relative abundance indices have been reported for either the diurnal Australasian harrier (Baker-Gabb 1981a, Baker-Gabb 1981b) or nocturnal morepork (Imboden 1975). Here, I estimate the observed relative abundance of Australasian harriers on both

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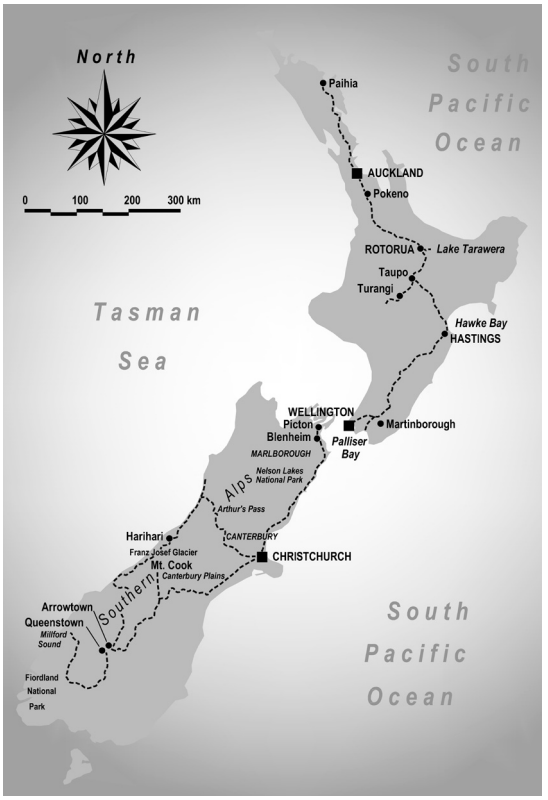

Fig. 1 Raptor survey routes on North Island and South Island, New Zealand, March 2006.

the North and South Is. I used km traveled/harrier detected during roadside counts, to estimate the relative abundance and distribution of this native raptor.

METHODS AND MATERIALS

New Zealand stretches 1600 km from north to south. I surveyed harriers in both the North I and South I, from Paihia in the north down to Fiordland in the south (Fig. 1). Because of their different geological features, the North and South Is have distinct rainfall patterns. In the South I, the Southern Alps create a wet climate west of the mountains (annual average of 7500 mm rainfall) and a dry climate on the east side (annual average of 330 mm rainfall). In the North I, the western sides of high volcanoes receive more rain than the eastern sides, but the rain shadow is not as pronounced with rainfall more evenly distributed (annual average 1300 mm) (Williams *et al.* 2000). When the first Europeans arrived in the 1800's, about 70% of New Zealand was covered in native forest. Much of it was cleared for timber or for farming. Today, only 10-15% of New Zealand's land area is covered in native vegetation (Williams *et al.* 2000).

Table 1 Routes surveyed, distances traveled, and number of harriers observed on North I, New Zealand, 2006.

Date	Route	Distance (km)	Number
2 Mar	Auckland-Paihia	241	8
5 Mar	Paihia-Pokeno	302	5
6 Mar	Pokeno-Rotorua	203	6
7 Mar	Lake Tarawera	1	1
8 Mar	Rotorua	30	3
9 Mar	Rotorua-Taupo	97	4
11 Mar	Taupo-Turangi	130	5
12 Mar	Turangi-Hastings	230	15
13 Mar	Hastings	40	5
14 Mar	Hastings-Wharekauhau	297	42
15 Mar	Wharekauhau	1	3
16 Mar	Wharekauhau-Wellington	99	1
Total		1671	98

Roadside counts of harriers were conducted on both the North and South Is using a vehicle from 2-31 March 2006 (Fig.1). Five observers traveling together located and identified harriers on both sides of the road during these counts, and recorded data on number observed, habitat type, and activity (Bibby *et al.* 1998, Bibby *et al.* 2000). Driving speeds were variable, but roadway conditions limited speeds to < 60 km/hr. Harriers were readily detected and identified from the moving vehicle, but periodic stops were also made to scan for distant harriers in open landscapes. The location of each observation was plotted on a 1:1300000 scale map of the islands, and the date and time of each sighting noted. Survey times ranged from 0600-1800 h local time. Weather conditions were variable during the survey period, but mostly without precipitation.

Many studies have indicated that roadside surveys can give biased estimates of raptor densities and habitat associations. However, roadside surveys can be useful and appropriate when large areas need to be sampled and monitored (Fuller & Mosher 1987) and have been widely employed around the world in a variety of cover types (e.g., Eakle 1994, Eakle 1997, Eakle 2001, Eakle 2003, Eakle *et al.* 1996). The use of roadways was the only feasible means of surveying harriers over such a large area and provide a useful estimate of relative population size given an understanding of factors that influence and limit the utility of such counts (Millsap & LeFranc 1988). A two-tailed *t*-test was used to compare harrier counts (mean number

Table 2 Routes surveyed, distances traveled, and number of harriers observed on South I, New Zealand, 2006.

Date	Route	Distance (km)	Number
16 Mar	Picton-Blenheim	29	5
17 Mar	Blenheim-Christchurch	321	29
19 Mar	Christchurch-Arthurs Pass	178	4
20 Mar	Arthurs Pass	20	3
21 Mar	Arthurs Pass-Harihari	321	11
22 Mar	Harihari-Franz Josef	165	1
23 Mar	Harihari-Arrowtown	417	14
24 Mar	Arrowtown-Queenstown	36	4
25 Mar	Queenstown-Milford	300	7
26 Mar	Queenstown	18	2
27 Mar	Arrowtown-Queenstown	36	3
28 Mar	Arrowtown-Mount Cook	242	16
30 Mar	Mount Cook-Christchurch	339	45
31 Mar	Christchurch	10	1
Total		2432	145

detected/km traveled) between islands. Statistical significance was assumed at $P = 0.05$.

RESULTS AND DISCUSSION

Over 4100 km were traveled and a total of 243 Australasian harriers were detected on both islands combined (Tables 1 & 2), yielding 0.06 harrier/km traveled or 16.9 km traveled/harrier sighted. There was no significant difference between islands in the mean number of harriers detected/km traveled ($P > 0.25$), and no other diurnal or nocturnal raptors were detected during the surveys. Three survey routes were particularly productive, yielding 1 harrier sighted/7.1-11.1 km traveled. On North I, the 297 km route from Hastings to Wharekauhau produced 42 harriers, or 0.14 individuals sighted/km traveled (Table 1). This area is characterized by rolling hills and sheep pastures with vineyards in the Martinborough area (Fig. 1). On South I, the 321 km route from Blenheim to Christchurch produced 29 harriers, or 0.09 individuals sighted/km traveled (Table 2). The habitat along this route ranged from vineyards in Marlborough to dry and flat in the south (Fig. 1). Thirdly, the 339 km route from Mount Cook to Christchurch produced 45 harriers, or 0.13 individuals sighted/km traveled (Table 2). This route crossed the foothills of the Mackenzie Basin and much of the southern Canterbury Plains (Fig.1).

Using comparable methods, Eakle (1997) detected 67 swamp (Australasian) harriers over 594 km traveled in Vanuatu, a chain of about 100 ash and coral uplifted islands located about 2000 km northwest of New Zealand (13-23°S, 166-173°E). That survey yielded relative abundance indices of 0.11 individuals sighted/km traveled or 8.9 km traveled/bird sighted, comparable to those observed between Hastings-Wharekauhau (0.14 harriers/km), Blenheim-Christchurch (0.09 harriers/km), and Mount Cook-Christchurch (0.13 harriers/km) in this study.

The Australasian harrier is found from southern New Guinea, throughout Melanesia, Australia, New Zealand, and Polynesia east to Tonga, and forms a superspecies with the African marsh harrier (*C. ranivorus*), Eastern marsh harrier (*C. splinonotus*), Madagascar marsh harrier (*C. macrosceles*), Reunion marsh harrier (*C. maillardi*), and western or European marsh harrier (*C. aeruginosus*) (Simmons 1991, del Hoyo *et al.* 1994, Simmons 2000). Baker-Gabb (1981a, 1981b) reported the Australasian harrier as common and wide-spread in New Zealand, occupying open habitats such as wetlands, sand dunes, fields, tussocks, and agricultural areas with densities up to one bird/50 ha (or 120 ha/breeding pair). In Australia, Baker-Gabb (1982) reported densities of 15 nests or breeding pairs/10 km^2. Orbell (2003) also described the harrier as occupying open habitats in New Zealand, with the conversion of native forests to livestock pastures resulting in a great increase in their numbers, especially with the introduction of non-native rats, mice, rabbits and birds, and carrion now widely available on farmlands and along roads (Robertson 1980).

There presently is no evidence to suggest that the Australasian harrier was part of the pre-human fauna in New Zealand, and is thought to have colonized the islands with the demise of the specialized Eyles's harrier (Worthy & Holdaway 2002). The success of the Australasian harrier may also have occurred at the expense of the endemic New Zealand falcon, once thought more widespread and now mostly restricted to forests and tussocks in mountainous regions (Orbell 2003). The falcon is the only 1 of 4 diurnal raptors in the late Holocene avifauna of New Zealand to survive today (Worthy & Holdaway 2002). Fox (1978) suggested that changes in land use and forest conversions made the "bush falcon" most at risk, whereas most of the "southern falcons" were found in protected areas in Fiordland National Park on South I, and the "eastern falcon" had adapted to introduced prey

and land use changes. However, Stewart & Hyde (2004) found that "bush falcons" seemed adapted to exotic pine forests, with high densities of falcons now found in these intensively managed landscapes on North I with abundant introduced prey and foraging opportunities in forest clear-cuts. "Eastern falcons" have also been reported frequenting exotic pine forests on South I (N. Hyde, *pers. comm*.). Most of the harriers observed in this survey occurred in highly modified habitats, such as pastures, vineyards and croplands, suggesting current land use patterns have benefited this species. Whether future changes in land use patterns, such as increased dairy farming and conversion of pasture to vineyards will affect the abundance of harriers is not known but the data presented here will provide a baseline to compare with future population estimates.

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