

SHORT NOTE

Swamp harrier (*Circus approximans*) road-kills, 1962–2018, and the effect of rabbit density

JOHN E.C. FLUX

23 Hardy Street, Waterloo, Lower Hutt 5011, New Zealand

Brockie *et al.* (2009) review, in detail, road-kill data for mapping the spread of diseases, the impact on animal populations, and planning road sign placements that prevent deer collisions. Recently Collinson *et al.* (2014) proposed an international standardised protocol for comparing road-kill. However, their proposal requires a start at 90 minutes after dawn, making little allowance for methods required to assess different species of interest. For example, in a study of toads (*Bufo bufo*) in Wales, all 178 corpses were removed by scavengers within an hour of dawn (Slater 2002); following the protocol would therefore not identify much toad road-kill.

In New Zealand, road-kills offer a convenient way of mapping geographic ranges, e.g. wallabies around Rotorua and Waimate, and may sometimes be used to estimate relative abundance over time of animals large enough to be easily seen and identified. In this paper the aim was to look for long-term changes in swamp harrier (*Circus approximans*) abundance, and relate the distribution of carcasses to that of rabbits (*Oryctolagus cuniculus*), one of their main food items (Baker-Gabb 1981; Seaton *et al.* 2013).

To develop a suitable counting technique many variables had to be considered: i) weather

(hedgehogs [*Erinaceus europaeus*] are attracted by rain, and common brushtail possums [*Trichosurus Vulpecula*] repelled), ii) traffic speed and intensity (heavy traffic kills more, but carcasses do not last as long), iii) season (most populations peak in summer, hedgehogs hibernate in winter), iv) time of day (most birds are hit by day, mammals at night), v) size and colour (weasels [*Mustela nivalis*] are smaller than rats [*Rattus* spp.] but easier to see being brightly coloured), vi) scavengers (may eat on site, or remove bodies, by day or night), vii) attraction to dead conspecifics, viii) traffic avoidance behaviour (road-wise common starlings [*Sturnus vulgaris*] are rarely hit), ix) inexperience (most Australian magpies [*Gymnorhina tibicen*] are juveniles); and x) population dispersion (animals living in groups, like rabbits, show more variation in counts than do hares [*Lepus europaeus*], which are evenly spaced).

The best way of avoiding these problems was to accumulate long distance counts. For the mammals I was most interested in counting (i.e. possums, hedgehogs, rabbits, and hares, 4,000 km was chosen because counts over 2,000 km were giving repeatable results; for rarer species like mustelids far longer distances would be required. Comparing ratios (cars do not distinguish rabbits from hares, or stoats [*M. erminea*] from weasels) allows comparisons of relative density without the need to ensure every item of roadkill was identified.

During road-kill counts to measure changes

in mammal abundance throughout New Zealand, 1962–2018 (Flux *et al.* in prep), birds were occasionally identified. This sub-set of counts is analysed here, hence the gaps 1971–1977 and 2003–2016 for the South Island when counts recorded only “birds” without listing species. Only the three-week count in February 2017 aimed to cover all South Island areas with as little overlap as possible, the 6,893 km total included practically all of the 4,500 km of State highway, and the rest 7% of 34,100 km designated “road” (Fig. 1). Birds were also identified on 2,398 km in 2018. For the North Island, harrier numbers were published by Brockie *et al.* (2009), and Sadleir & Linklater (2016).



Figure 1. Map of 6,893 km of State highways covered in February 2017 (shown in red with black edges), and roads (red). In 2018 only the Alexandra area, and east and west routes there from Picton, were covered (2,398 km). Yellow roads show the rabbit problem area; blue circles are dead harrier locations. Map used by permission of A. Smith, Critchlow Associates.

All counts were by the same observer, at random locations, preferably alone, while driving 150 m behind a slow truck, whenever viewing conditions were suitable, avoiding sun glare, rain, busy motorways and towns. Collinson *et al.* (2014) recommend a maximum speed of 20–50 km/h, but this would impede other traffic. Also, in New Zealand there are far fewer mammals to identify, and this can be done at the legal speed limit of 100 km/h. “Random” here means starting and ending at pre-determined points, not when an interesting

kill was seen or unusually high numbers were encountered. Hence, the only road-kill kiwi (*Apteryx australis*) seen, near National Park at a sign saying “Beware, kiwi crossing”, was not included. Where possible the car was stopped to check doubtful identifications – a pile of feathers round a possum might be two harriers, not one (Fig. 2a).



Figure 2. A) Adult harrier flying in to share a possum with a young harrier. They made no attempt to pull it off the road, flying away from approaching cars. B & C) Black-backed gull pulling rabbit off the road.

For the South Island, Table 1 shows no significant change in the overall number of harriers killed per 100 km since the 1960s (two-tailed Chi square test with Yates correction for each time period against the average, $P > 0.0001$). This agrees with their status as “no change” between the 1969–79 and 1999–2004 atlas surveys (Robertson *et al.* 2007). Note that road traffic, judged by the number of licensed vehicles, has increased from 0.6 million in 1963 to 4.2 million in 2017 with no apparent effect (Motor Industry Association 2019). The number of rabbits killed on roads has increased ten-fold since the 1980s when Rabbit Boards were disbanded (Flux 1997), which may have contributed to the slightly higher recent harrier totals in Table 1.

Table 1. Stability in numbers of harriers killed per 100 km on South Island roads over four time zones, 1962–2018.

Years	Number of harriers	Distance covered (km)	Harriers per 100 km	Significance	Chi square P value
1962–1970	5	1,025	0.49	NS	0.96
1978–1989	24	6,270	0.38	NS	0.28
1990–2002	17	3,192	0.53	NS	0.92
2017–2018	53	9,291	0.58	NS	0.32

However, significantly (two-tail Chi square test with Yates' correction, $P < 0.0001$) higher numbers of harriers were killed in the rabbit problem area (Central Otago, and Pukaki to Fairlie) than in the rest of the South Island (Table 2). Curiously, this difference holds for possums ($P < 0.0001$) despite

the lack of trees. Even hares are more abundant ($P = 0.006$). Since hares are dominated by rabbits and compete with them for food (Flux 2008), I had expected fewer hares in the rabbit problem area, not more.

Table 2. Road-kills of harriers, rabbits, hares, and common brushtail possums per 100 km in the rabbit problem area (Central Otago, and Pukaki to Fairlie) are significantly higher than in the rest of the South Island, 2017–18, but not in proportion to the 20-fold higher rabbit numbers.

	Distance (km)	Harrier (n)	Rabbit (n)	Possum (n)	Hare (n)
Rabbit area	806	1.86 (15)	95.78 (727)	31.51 (254)	2.23 (18)
Rest of South Island	8,485	0.45 (38)	4.74 (412)	6.65 (565)	1.19 (101)

From the 2007 Atlas (Robertson *et al.* 2007), Central Otago is not a favoured breeding area for harriers, despite the abundant road-kill food available. They appear to be transient or opportunist feeders. As juvenile harriers disperse widely, and would find road-kills easy pickings, there may be proportionately more killed in Central Otago, but unfortunately age ratios were not recorded.

Table 3 compares harrier counts in the North Island with those of Brockie *et al.* (2009), and Sadleir & Linklater (2016). They show reasonably similar results within the range 0.18 to 0.27 harriers/100 km, apart from one high of 0.78 in 1994. In this year Brockie *et al.* (2009) record more than three times as many possums killed, and they may have attracted harriers.

Table 3. Comparison of harrier road-kill counts in the North Island with those published by Brockie *et al.* (2009) and Sadleir & Linklater (2016).

	Distance (km)	Number of harriers	Harriers/100 km
Flux (1970–1990)	2,649	7	0.26
Flux (1991–1994)	3,005	8	0.27
Flux (1995–2016)	1,353	3	0.22
Brockie (1984)	1,660	3	0.18
Brockie (1994)	1,660	13	0.78
Brockie (2005)	1,660	3	0.18
Sadleir (2016)	5,814	16	0.25

Harrier deaths on roads raise interesting questions: does the benefit of easily scavenged food outweigh the risk and thus increase the harrier (and native owl) populations; and are scavengers being selected to avoid cars, or to remove road-kills before eating them? Harriers lift animals off the road and eat them in nearby fields, but I have not seen harriers pulling carcasses to the verge the way black-

backed gulls (*Larus dominicanus*) do (Fig. 2b,c). This behaviour may be innate, as gulls often pull dead fish ashore, and might explain their low position in the list of birds killed (Table 4) as they are common scavengers far inland (Miskelly 2013). It may seem counter-intuitive but, like cats at present (Flux 2017), road-kill may well promote biodiversity in New Zealand by killing more introduced pests than native species.

Table 4. Complete list of birds recorded as road-kill for the South Island in 2017–18 (9,291 km).

Species	Number counted
Swamp harrier (<i>Circus approximans</i>)	53
Eurasian blackbird (<i>Turdus merula</i>)	31
Australian magpie (<i>Gymnorhina tibicen</i>)	29
Mallard (<i>Anas platyrhynchos</i>)	26
Pukeko (<i>Porphyrio melanotus</i>)	19
House sparrow (<i>Passer domesticus</i>)	10
Red-bill gull (<i>Larus novaehollandiae</i>)	5
Weka (<i>Gallirallus australis</i>)	5
Song thrush (<i>Turdus philomelos</i>)	5
Common starling (<i>Sturnus vulgaris</i>)	3
Silvereye (<i>Zosterops lateralis</i>)	3
Spur-winged plover (<i>Vanellus miles</i>)	2
Dunnock (<i>Prunella modularis</i>)	2
European goldfinch (<i>Carduelis carduelis</i>)	2
Morepork (<i>Ninox novaeseelandiae</i>)	2
Little owl (<i>Athene noctua</i>)	1
Paradise shelduck (<i>Tadorna variegata</i>)	1
Grey teal (<i>Anas gracilis</i>)	1
Pied stilt (<i>Himantopus himantopus</i>)	1
Welcome swallow (<i>Hirundo neoxina</i>)	1
Chaffinch (<i>Fringilla coelebs</i>)	1
European greenfinch (<i>Carduelis chloris</i>)	1
Yellowhammer (<i>Emberiza citrinella</i>)	1
Black-backed gull (<i>Larus dominicanus</i>)	1
unidentified "sparrow-size"	89
unidentified "blackbird-size"	14
TOTAL	309

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