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Call survey method for monitoring endangered North Island weka (*Gallirallus australis greyi*)

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Abstract We investigated the use of call count surveys to monitor weka numbers for management purposes. A Generalised Linear Model based on data from 111 nights of listening for weka at Rakauroa (North Island, New Zealand) showed that the number of calls recorded was influenced by listening site and month, but not by wind direction, wind strength, cloud cover, phase of the moon, rainfall or temperature. Mean number of calls heard was highest between December and March, with a peak in January. More birds were heard from certain listening sites. Although there was no correlation between any of the environmental variables and weka calling, wind, and rain may have reduced the audibility of weka in other studies. The estimated probability of detecting weka was 60-80% (mean = 72%). At least 3 nights at each listening station were necessary to improve the census accuracy. Call counts of weka at Rakauroa between 1993 and 1997 showed a decline in the number of weka.

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INTRODUCTION

North Island weka (*Gallirallus australis greyi*) are classified as endangered, whilst the other three sub-species in New Zealand are either potentially endangered or vulnerable (IUCN 1994). North Island weka were formerly common, but are now confined to regions of the East Cape (Beauchamp 1997; Beauchamp *et al.* 1998).

Rails are hard to census, secretive, and generally live in dense vegetation (Johnson & Dinsmore 1986; Robert & Laporte 1997). Three monitoring methods for rails have been published. Roadside counts were used to count Guam rails (*Rallus owstoni*) when they were common (Jenkins 1979), but are not regarded as suitable for detecting Guam rails at low density (K. Brock, pers. comm.). Miller & Mulette (1985) used territory mapping to count Lord Howe Island woodhens (*Tricholimnas sylvestris*). Bart *et al.* (1984) recorded calls by breeding yellow rails (*Coturnicops noveboracensis*) along line and belt transects.

North Island weka are both cryptic and crepuscular (Bramley 1994) which makes survey by territory mapping prohibitively labour-intensive, especially when they are at low density. Weka have a range of calls, the most distinctive of which is a shrill "coo-et", uttered repeatedly at dusk and to a lesser extent at dawn (called a "spacing call" Beauchamp, 1987). Call survey is a potentially feasible method for monitoring weka numbers. Beauchamp (1997) counted weka spacing calls around sunset at East Cape sites in 1985, 1987, 1990, 1991 and 1995 and recorded a decline in weka numbers. The North Island weka recovery plan (Beauchamp *et al.* 1999) suggests that counts based on recording the positions of these calls be used to monitor weka numbers.

Cloud cover and time of day affected the calling behaviour of Virginia rails (*Rallus limicola*) (Gibbs &

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Melvin 1993), but little is known of environmental factors affect the calling behaviour of rails in general, and of weka in particular. For example, it is not known in which seasons or under what weather conditions weka are most likely to call. We addressed this question by surveying weka calls for nearly two years in the valley of the Waikohu River, near Rakauroa, East Cape. We also conducted an annual call count survey from 1993-1997 by listening at fixed sites along the valley in January in order to monitor the resident weka population.

METHODS

Study area

Rakauroa (38°25'S, 177°34'E) is a farming district on the East Coast of North Island. Rakauroa has a damp climate (1988-1992, average rainfall 1429 mm: National Institute of Water and Atmospheric Research data, Rotorua), and in 1992 was considered to be a stronghold of the North Island weka. The study area was a portion of the valley making up the upper catchment of the Waikohu River, at 200-900 m above sea level. Access was provided by Oliver Road, and by Rakauroa/Tahora Road. The valley is steep-sided in places, with many tributaries. The area was mostly farmland with patches of shrubland associated with roads and the river. The shrublands were dominated by manuka (*Leptospermum scoparium*), *Coprosma* spp., fivefinger (*Pseudopanax arborea*), and ferns. Weka were normally found in the shrubland or other dense cover (Bramley & Veltman in press).

One or both of us (usually GNB) visited the study area monthly between March 1992 and January 1994 (except October 1992) for between 4 and 22 days. GNB also visited the area for 2 days in January of 1995 and 1996 to conduct the call count surveys.

Listening sites and recording calls

We chose 13 sites along the valley, based on the topography and ease of access, from which to listen for weka calls. The sites were 350-1650 m apart (mean = 1007 m). Sites were visited 1-17 times to listen for calls. We listened for as many nights as possible each visit.

We usually started listening about 30 minutes before sunset and continued until 30 minutes after sunset. The time and approximate position of each calling bird were recorded on NZMS260-series topographical maps. We were conservative in our counts of weka — multiple calls from an area were recorded as one bird unless the calls were simultaneous. Wind direction (compass points) and strength (strong, breeze, or calm), percentage cloud cover (0-20%; 20-40%; 40-60%; 60-80%; >80%), temperature (cold, cool, mild, warm, hot), rain (raining, showers, fine), and phase of the moon (1-6: 1= no moon; 2= 1/4; 3= 1/2; 4= 3/4; 5=>3/4 but < full; 6= full) were recorded. We did not listen for weka calls in October of either year of the study.

We explored relationships between the 6 environmental variables, month of the year, listening site, and the number of weka calling at a given site on a particular evening using the GLIM software package (Crawley 1993) to fit generalised linear models to find the factor or combination of factors that best predicted the number of weka heard to call. As these were count data, we specified a Poisson error distribution and a log link function. We estimated the contribution of each factor by evaluating the effect of deleting it from the maximal model (which contains all factors, interaction terms, and covariates). Having identified factors likely to be informative, we developed a minimal adequate model from addition of factors and their interaction terms to the null model. There is acknowledged subjectivity in identifying minimally adequate model(s) (Crawley 1993), and the emphasis was on data exploration rather than confirmation.

In January 1994, GNB spent 5 evenings (1 h each, on 19, 20, and 22-24 January) listening at 1 location, recording the number and location of weka calling each night to provide a measure of the variability of calling between nights.

All 13 sites were used for a population census involving volunteer observers in January 1993. Eleven of the sites were used for a census in January 1994, 1995, and 1996. In January 1997, staff of the New Zealand Department of Conservation (DoC) conducted a census from the same 11 sites, using many of the same volunteers; those results are included here. During call counts, volunteers listened for calling weka from 2000 h to 2200 h NZDT (1900-2100 h NZST) at each site. All listeners recorded the time and approximate positions of calls on NZMS260-series topographical maps and each volunteer's records were cross-referenced against the others to estimate the total number of birds in the valley. During call count surveys, adjacent listeners often reported the same calls and we consider that the whole valley was monitored by this procedure. Surveys

Table 1 Number of counts per site and estimated number of weka (*Gallirallus australis greyi*) present at each site at Rakauroa, North Island.

Site	Counts site[1]	Months	Estimated numbers of weka	Estimated number of pairs	Variability in counts night^{-1} Mean	SEM	Range
1	1	Sep	0	0	0	-	0
2	17	Jan, Feb, Apr, Jun, Jul, Aug, Sep, Dec	5	1	2.3	0.4	0-6
3	9	Jan, Feb, Apr, Jun, Jul, Aug, Nov, Dec	3	0	2.7	0.6	0-6
4	5	Mar, May, Aug, Dec	4	1	4.0	0.5	3-5
5	6	Aug, Sep, Dec	3	1	1.2	0.7	0-4
6	11	Jan, Feb, Apr, May, Jun, Jul, Aug, Nov, Dec	6	3	5.1	1.0	0-10
7	13	Jan, Feb, Mar, May, Jul, Aug, Sep, Dec	6	1	5.1	0.9	0-10
8	14	Jan, Feb, Mar, Apr, Jul, Aug, Sep, Nov, Dec	7	2	6.7	0.8	2-14
9	10	Jan, Feb, Mar, Jul, Aug, Nov, Dec	2	1	2.8	0.4	1-6
10	8	Jan, May, Jul, Aug, Nov, Dec	2	0	1.2	0.5	0-4
11	5	Feb, Jun, Aug, Nov, Dec	2	0	1.2	0.6	0-3
12	11	Jan, Feb, Apr, May, Aug, Nov, Dec	3	1	2.7	0.7	0-7
13	1	Apr	1	0	1	-	1
Total	*n*=111		44	11	36		

Note: The estimated number of weka is derived from call counts and was consistent with a concurrent banding study (Bramley 1994). 36/44 represents an estimated detectability of 82%.

Table 2 The effect of weather conditions, month and location on calling by weka (*Gallirallus australis greyi*) at Rakauroa. % variation, percentage variation in the model explained by each variable.

	Maximal model				Minimal adequate model			
Variable	% variation	χ^2	df	*P*	% variation	χ^2	df	*P*
Month	10.60	19.43	10	0.0112				
Location	36.70	66.96	12	0.00001	84.6	154.7	68	0.00001
Moon	4.20	7.68	5	0.0608				
Cloud	2.90	5.40	5	0.1121				
Temperature	1.00	2.00	4	0.1839				
Wind direction	0.80	1.59	5	0.1204				
Wind strength	0.00	0.008	2	0.4980				
Rain	2.10	3.96	2	0.0690				

continued for more than 1 evening because it was unlikely that all individuals called on any particular evening. We cross-referenced the calls between nights and only increased our estimate of the total number of individuals when calls were heard from new areas or when more birds called at a site than on the previous evening(s). This procedure may have overestimated the number of weka if they were very mobile, but radio-tracking (Bramley 1994) indicated that they were relatively sedentary.

In 1993, 3 of the listeners broadcast taped weka calls using hand-held cassette players and one listener whistled, mimicking a weka call at 2100 h and 2130 h each evening to encourage birds to call. No calls were heard in immediate response to these broadcast calls or whistles, so the practice was abandoned.

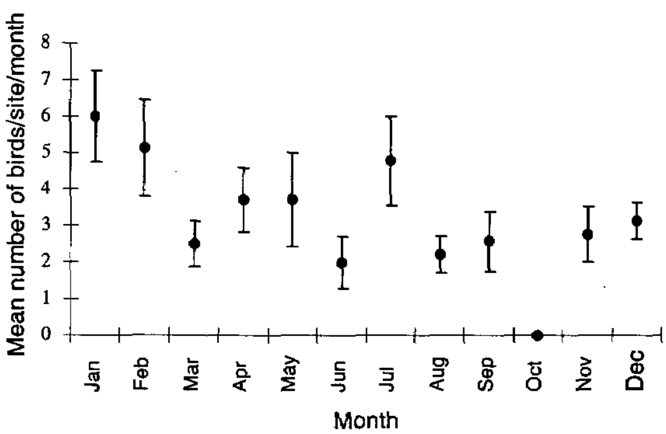

Fig. 1 Monthly calling rate (birds h^{-1} night^{-1}) of North Island weka (*Gallirallus australis* greyi) at Rakauroa between March 1992 and January 1994. Data are means ± 1 $SE_{\bar{x}}$

Table 3 North Island weka (*Gallirallus australis greyi*) population size from counts of evening calls at Rakauroa, North Island, New Zealand. Number of new birds heard during the 2nd and 3rd nights in parentheses.

Year	Number of sites (Night 1, 2, 3)	Night 1	Population Night 2	estimate Night 3	Total
1993	13, 13, 8	38	36 (10)	33 (9)	57
1994	11, 11	31	25 (5)	-	36
1995	11, 11	23	36 (16)	-	39
1996	11, 11	11	19 (11)	-	22
1997	11, 11	5	9 (4)	-	9

Note: Number of listening sites varied between 1993 and 1994. Data from 1997 collected by staff of New Zealand Department of Conservation using our method and listening sites.

RESULTS

We listened to and recorded weka calls at Rakauroa on each of 111 nights between March 1992 and January 1994. More weka were recorded as calling between December and March (Fig. 1) which coincides with the period of peak breeding between November and January, although weka breed throughout the year (Bramley 1994, unpubl. data).

Because weka were located patchily through the valley, we consistently heard more weka at some sites than at others (Table 1). Deletion of month and listening site from the maximal model significantly increased the deviance (Table 2), indicating these factors were associated with numbers of weka heard to call. The interaction between month and listening site provided the minimum adequate model. The other variables recorded (wind strength and direction, rain, phase of the moon, percentage cloud cover and temperature) were not associated with variations in the numbers of weka calling.

When GNB listened at a site for five nights in January 1994, during which weather conditions were similar, except for drizzle during the final night, 5 different weka were heard calling. On 2 nights, 3 weka called (60%), and on 3 nights 4 weka called (80%), which represents a mean detectability of 72%. Taken over the whole study detectability of weka was 82% (Table 1).

Population size estimated from call counts

Based on call counts the number of weka more than 12 weeks old at Rakauroa was at least 22-57 birds during the period of our study (Table 3). It appears from call counts that the weka population at Rakauroa was declining, because more birds were heard in 1993 than in 1997.

DISCUSSION

For weka at Rakauroa, and probably other North Island sites, the best time to conduct a call count survey is January, because weka are more likely to call then, and conditions are congenial for listeners. A population survey in January also has the potential to detect young birds from the previous breeding season, which appear to remain near their parental home range for some time before dispersing (Marchant & Higgins 1993; Bramley 1994). Young weka begin to call at about 12 weeks of age (GNB pers. obs.), and it is likely that some of the birds calling in January are young from breeding attempts before November of the previous year. Estimates based on call count surveys in January will help to indicate the breeding success of the previous season, and the maximum population estimate for the year. Furthermore, experienced listeners can sex weka by their calls so recording the sex of calling individuals will allow the number of females in a population to be estimated.

The Royal Forest and Bird Protection Society of New Zealand and DoC conducted a call count survey in the valley using a method similar to ours in January 1991 and heard 55 birds on 1 night of listening (DoC, Rotorua, unpublished files). Annual call count surveys should be maintained in the study area, and for other North Island weka populations to give data on long-term fluctuations in weka abundance and distribution. These data will allow managers to determine the normal variability in call counts between years and determine what constitutes a decline in call rate (and presumably bird numbers) that is not recoverable. Without a long-term record, appropriate management decisions based on call counts cannot be made.

Because we listened for a total of 111 different nights and measured 6 environmental variables, call data from every possible combination of variables were not recorded. Some of the factors may therefore be significant, but undetected. Nonetheless, we can be confident that location and month were associated with variation in weka vocalisation. Although other variables recorded were not truly independent (e.g., the proportion of cloud cover and the recorded rainfall were probably correlated), it appeared from our model that they did not significantly affect weka calling. However, Beauchamp (1987) used a similar analytical technique to predict the number of weka seen or heard during walking counts on Kapiti Island and concluded that both increasing rainfall and wind speed negatively affected the number of weka recorded. Darkness and cloud cover increased calling in North Island brown kiwi (*Apteryx australis australis*) (Colbourne & Kleinpaste 1984) and Virginia rails (*Rallus limicola*) (Gibbs & Melvin 1993). Johnson & Dinsmore (1986) believed call responsiveness to vary with the onset of breeding for Virginia rails and soras (*Porzana carolina*).

Rails may use vocalisations to indicate the presence of territory boundaries to conspecifics (Beauchamp 1987; Ridpath 1972) or potentially competing individuals of another species (Kaufmann 1989). Calling is therefore often more frequent in dense populations, particularly during breeding (Kaufmann 1989), and reinforced by chasing and agonistic encounters between residents and invaders. Virginia rail and sora call frequencies appeared to increase as a pair bond was formed (Kaufmann 1989). In weka, calling may contribute to maintaining the pair bond (Beauchamp 1987). Thus in dense populations of weka call counts may over-estimate the number of resident weka, particularly during the breeding season.

We recorded a decline in the number of weka heard calling between 1993 and 1997 and could account for more deaths than births during the 1992-1994 period (Bramley & Veltman in press). It is almost certain that the population was declining during this period, with very low recruitment and high mortality resulting from predation and motor vehicles (Bramley 1996; Bramley and Veltman in press).

We estimate that three visits would be required to detect 98% of resident weka (assuming detectability of 72% on each night) at Rakauroa. This is comparable to the number of visits needed to detect yellow rails (Bart *et al.* 1984) and Virginia rails (Gibbs & Melvin 1993). We conclude that listening at each location for at least three nights, ideally with similar weather conditions, during population surveys will be adequate for monitoring North Island weka.

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