Notornis, 2015, Vol. 62: 14-20
0029-4470

Banded rail (*Gallirallus philippensis*) occupancy and detection in saltmarsh mangrove systems at Onerahi, Whangarei Harbour

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Abstract Banded rails (*Gallirallus philippensis*) were surveyed in saltmarshes and mangrove fringed habitats at Onerahi, Whangarei, New Zealand. A total of 13 sites were surveyed 3 times per year around sunset during late spring in 2004, 2007 and 2013. On average 4.41 calls were heard per hour. Banded rails were detected at 12 sites with between 0.01 and over 2 ha of saltmarsh and extensive mangroves, but not a saltmarsh site lacking mangroves. Occupancy models favoured those with no change in occupancy state, seasonal detection, and there was with some support for random colonisation of sites. Records from Awaroa Creek indicate that rails can be detected from late afternoon calls throughout the year. Surveys should include the half hour before until at least 10 minutes after sunset.

Beauchamp, A.J. 2015. Banded rail (*Gallirallus philippensis*) occupancy and detection in saltmarsh mangrove systems at Onerahi, Whangarei Harbour. *Notornis 62 (1):* 14-20.

Keywords presence; buff banded rail; mangroves; saltmarsh

INTRODUCTION

Banded rails (*Gallirallus phillipensis*) in New Zealand are generally restricted to saltmarsh and mangrove wetland systems north of latitude 38°S (Ogle 1982; Bellingham & Davis 1983; Marchant & Higgins 1993; Bellingham, *pers. comm*.) and to saltmarshes in Nelson - Golden Bay area of the South Island (Elliott 2003). They are infrequently seen, but are typically spotted in open areas < 10 m from dense cover, or on open tidal flats within mangrove (*Avicennia resinifera*) pneumataphores or seagrass (*Zostera* spp.). Banded rails have been recorded in freshwater habitats in the North Island but the use of and the size of these areas remains poorly investigated (Marchant & Higgins 1993). Banded rails are terrestrial and more visible on Great Barrier Island and other offshore islands that lack mammalian predators except rats (Ogle 1982).

In the upper North Island saline and saltmarsh habitats have become progressively reduced as they have been reclaimed for farmland and coastal property (Walker *et al.* 2008). In most northern harbours, saltmarsh is prevented from expanding landward by seawalls and tide-gates and can only expand outward into tidal flats or mangrove systems. Banded rails can be found within the remaining patches of mixed saltmarsh and mangrove habitats more than 2 ha in size (Elliott 1987). They are also present in areas with tiny (< 0.001 ha) patches of saltmarsh that are surrounded by extensive areas of mangroves.

Mangroves are considered to be taking over habitats like open sand and in some cases seagrass (Morrisey *et al*. 2010), and are being removed legally and illegally in many northern harbours. Under the

Received 16 February 2014; accepted 21 January 2015
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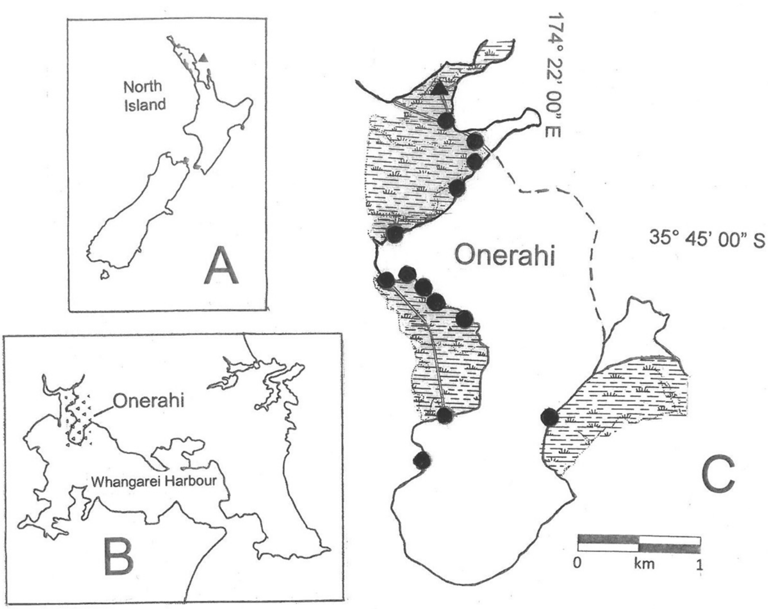

Fig. 1. Counts sites, Onerahi Whangarei. Circles are the sites as specified in Table 1 and the triangle indicates the location of the Awaroa Creek site. Sites 1 – 12 are those from the north to the south west of Onerahi and site 13 is on the east.

Resource Management Act, and in Environment Count hearings, the presence of banded rails in an area is often considered as part of the evidence in deciding the location and degree of mangrove removal. This is due to the threat status of banded rails as "at risk, relict' (Miskelly *et al.* 2008), and the general uncertainty of the robustness of survey methods used to define presence and habitat use of this species.

Foot print methods are one technique used to survey cryptic species such as banded rails, but they are labour intensive and dependent on the relationship between tide state and the activity levels of the birds, as well as the ability of the substrate to hold prints (Elliott 1983). For example, there is often little evidence of rail foot prints on hard sand lacking silt, in areas of dense pneumataphores, within saltmarsh and in very muddy environments even when a rail had been seen walking in an area and the foot prints were searched for minutes later. However, footprints tend to be more obvious in soft sand and this technique can be used in habitats with this type of substrate.

To avoid the problem of substrates unsuitable for recording footprints, Elliott (1983) used the random placement of print stations made from boxes of soft-sand, and found that the activity levels of banded rails in saltmarsh habitats in Nelson peaked in the morning, followed by low activity in the middle of the day, and a secondary peak of activity in the evening. In the warmer months he found that captive rails were active before dawn while in winter they were active from half an hour after dawn (Elliott 1983). Botha (2010) undertook footprint surveys at Ohiwa Harbour, Bay of Plenty using a line transect. She found that banded rail footprints extended out from saltmarsh through the mangroves to the outer scattered trees. Footprints were found frequently under tree on the outer margin of the tidal flats (Botha 2010).

In an assessment of bird use in all wetland habitats in the Hokianga Harbour area, Davis & Bellingham (1984) detected rails using prints (76.8%, n = 284) and calls (23.2%). Most of the calls they heard were in the early morning and late evening. They were able to use prints to identify both adults and young and used birds separated by 100 m as the basis for their estimation of density at 1 pair per 4.78 ha (n = 6 pairs) in freshwater/saltmarsh and mangroves. They considered the main habitat used by banded rails in the Hokianga Harbour was mangroves with areas of jointed rush oioi (*Apodasmia similis*) and sea rush (*Juncus maritimus*), and occasionally *Spartina townsendii*, raupo (*Typha orientalis*), manuka (*Leptospermum scoparium*), marsh ribbonwood (*Plagianthus divaricatus*), and the seashore herb zone (*Samolas repens*, *Selliera radicans* and *Triglochin striatum*).

Call counts are used in New Zealand to assess the presence and size of populations of other species of rails such as weka (*Gallirallus australis*, Beauchamp & Chambers 2000) and spotless crake (*Porzana tabuensis*, Kaufmann 1988). Estimating the size of banded rail populations has been more difficult as pairs do not appear to move around together and duet (Marchant & Higgins 1993; *pers. obs*). As calling by banded rails has also been reported as generally nocturnal (Marchant & Higgins 1993, Gilbert 1936), any surveys using call counts need to occur at periods when birds are active.

In this study I report on the occupancy and presence of banded rails in part of Whangarei Harbour as determined by repeated surveys over a period of 10 years. I also assess the viability of using fixed station and call counts in the late evening as a survey method for this species.

METHODS

Banded rails were surveyed in pockets of freshwater wetlands, and saltmarshes with mangroves in the Onerahi region of Whangarei Harbour. In 2003, I noted the locations that I heard banded rails in these habitats when I was riding a bike home from work, or running in the evenings and other sites with saltmarsh where I did not establish rails were present (Tables 1 & 2).

In 2004 and 2007 members of the Northland Branch of the Ornithological Society (OSNZ) were invited to select a site to survey from 13 candidate sites without knowledge of the banded rail status at that site. A survey form was distributed to each survey team, and was designed to record the weather conditions at the start and end of the survey and to record the exact time of calling by any banded rail, the habitat that the bird was within, and any sightings of birds. The survey was conducted without use of call playbacks at 13 sites, beginning from 45 minutes before sunset until 30 minutes after sunset, over 3 nights at each site in the last week of September and first week in October. All data was collected on the landward side of the habitats. In October- November 2013, I resurveyed the 13 sites used in 2004 -2007 OSNZ surveys. My later surveys were carried out slightly later in the year but surveys since 2007 indicated that rails would still be detected readily at that time. In the evenings the majority of the calls were the harsh squeak given as a single note or as a series of notes in quick succession (Marchant & Higgins 1993). All call bouts were counted and the time of each call bout, and the number of birds calling was recorded.

The single species multiple-season occupancy models in the programme PRESENCE (McKenzie *et al.* 2006) were used to assess the importance of occupancy status (ψ), colonisation (γ), extinction-loss (ε) and detection status (p) changes between surveys. The models were designed to assess whether any changes in occupancy between surveys follow Markovian (detection at time *t*-1 is depended on time *t* and is not random) principals and were random, or if the occupancy status did not change. The models were interpreted relative to each other without any understanding if the best model was a robust model using the Akaike Information Criteria (AIC, Burnham & Anderson 2002). Models were interpreted as supported if the ΔAIC was <2, while those within 4-7 ΔAIC were viewed as having substantially less support and those with ΔAIC >10 as having no support. The number of sites was small (*n* = 13) in relation to the number of parameters (δ) in models and δ/n produced values less than 40. Models were adjusted for small sample size using AICc = AIC + 2δ (δ+1)/n-δ-1 (MacKenzie *et al*. 2006).

The assumptions that were made were to meet the requirements of occupancy analysis (McKenzie *et al.* 2006) were: (1) that the number of surveys to determine occupancy status of a site did not change over the duration of survey, (2) the detection histories were independent and (3) banded rails were correctly identified. The duration of surveys at neighbouring sites were generally less than 6 nights, and the points were sufficiently far apart to ensure the same rails were not being detected (to ensure that (2) was met) and the only call scored was the harsh squeak of the rail which is unmistakable and not confused with other species at these sites.

In addition to the count surveys I collected observations of banded rail behaviour from the seaward side of a patch of saltmarsh on Awaroa Creek Road (35.7358 S, 174.3580 E) on the following dates: 10 and 22 October 2012, 13 December 2012, 14 January 2013, 5, 7, and 8 February 2013, 6, 7, and 9 April 2013; 16 June 2013; 7 July 2013; 3 and 23 September 2013, 9 October 2103, 15 November 2013 and 6 December 2013 (Fig. 1). I stood at a 90 degree corner and scanned the skyline and the road 80 m either side of the corner at least every 30 seconds. I noted all birds calling and seen in the area, and the time and presence of Australasian harriers (*Circus approximans*) and other potential predators. I noted the tide state water coverage of mangroves, the location of calling and birds crossing the road, their method of crossing the open space and their entry and exit points of rails from the road. These points were later checked for footprints.

RESULTS

The average number of banded rail calls per hour during the OSNZ surveys was 4.41 (*SE* = 0.58, *n* = 38 range 0 - 12). Banded rails were detected at sites where there was between 0.01 - >2 ha of saltmarsh and extensive mangroves (Table 1). The only site where banded rails were not detected was a freshwater and saltmarsh site of 0.2 ha that abutted open sand flats.

Multi-season occupancy modeling (Mackenzie *et al.* 2006) found 3 models that had support (ΔAICc <2) and together represent a combined weight of 98.5% (Table 3). The other models lacked support. The models with substantial support were those (1) where occupancy of sites was constant (or at

Table 1. Description of sites surveyed for banded rails near Onerahi, Whangarei.

Site name	Site number	S	E	Habitat	Area of saltmarsh (ha)	Area of mangrove (ha)
Awaroa Creek Road	1	35.7381	174.3591	Saltmarsh and mangroves	0.32	4.0
Riverside Drive	2	35.7401	174.3621	Saltmarsh with extensive mangroves	2.02	9.7
Waimahanga Road	3	35.7418	174.3623	Small margin of saltmarsh against old mangrove forest	0.03	2.4
Waimahanga Road end	4	35.7449	174.3596	Saltmarsh and mangroves 20 m from main stream. 20% lost by 2013	0.43	4.1
Siding saltmarsh track	5	35.7486	174.3527	Bush against saltmarsh and extensive dense mangroves with no freshwater input	0.18	4.1
First railway bridge	6	35.7516	174.3541	Small perched saltmarsh against old mangroves and streambed	0.01	2.5
Swing bridge	7	35.7506	174.3558	Saltmarsh between bush and old mangroves 5 m from a stream	0.02	5.0
Two totara trees	8	35.7512	174.3569	Bush against saltmarsh and small dense mangroves	0.03	5.0
Kahikatea tree	9	35.7516	174.3573	Bush against saltmarsh and small dense mangroves	0.02	5.0
Swamp saltmarsh	10	35.7540	174.3618	Raupo and saltmarsh with fresh water inputs		
Saltmarsh end of Waimahanga track	11	35.7617	174.3599	Very low mangroves mosaic with saltmarsh without freshwater input	0.06	16.0
Pa hill	12	35.7656	174.3582	Margin of saltmarsh and perched raupo swampland with no mangroves	0.20	0
Beach Road intersection	13	35.7622	174.3700	Small area of saltmarsh at back of extensive mangrove forest and freshwater drain input	0.34	9.0

equilibrium) during all 3 sampling seasons, (2) colonisation/extinction was probably constant, and (3) detection differed between years relative to 2004. The inclusion of the model ($\psi(.),\gamma(.),\varepsilon$=1-$\gamma$,p(year)) among the 3 supported models, indicated that there was some evidence for random changes in occupancy relative to 2004 between survey periods. The weighted average values for occupancy for the 3 supported models with ΔAICc <2 (Table 3) was 0.7957 (*SE* = 0.1642) and 0.4236, (*SE* = 0.1522) for the colonisation/extinction model. The detection probabilities for 2004, 2007 and 2013 were 0.6664 (*SE* = 0.1454), 0.6631, (*SE* = 0.1459) and 0.5626 (*SE* = 0.1459), respectively.

Overall, the supported models can be interpreted as indicating that a banded rail population occupied the areas with larger areas of saltmarsh and surrounding mangroves throughout a number of years, but also included some random occupancy/loss of lesser favoured sites with smaller regions of saltmarsh (< 0.04 ha saltmarsh; Table 1) but with surrounding mangroves.

Awaroa stream site survey

The average number of banded rail calls per hour throughout the year was 4.17 (se = 1.20, n = 16, range 01 - 16). The maximum number of calls heard was 14 per hour on 23 September 2013, and 16 per hour on 9 October 2013. The data from OSNZ counts and those at Awaroa Creek indicate peaks in calling in the half hour before sunset (Fig. 2). There were significantly less calls per 5 minutes surveyed after sunset (χ^2 = 13.36, df = 1, P < 0.001, n = 48, 2004 & 2007 counts).

The number of rails seen was not well correlated with the number of calls (Spearman's Rank: P =

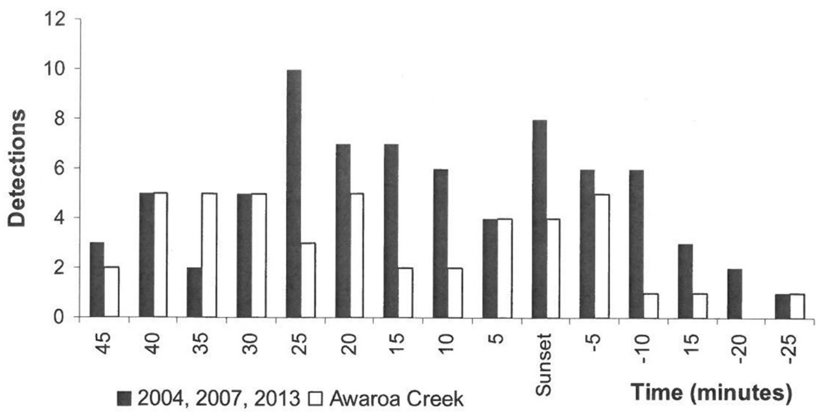

Fig. 2. Distribution of banded rail calls in the 2 survey types (positive values are minutes before sunset and negative values are minutes after sunset).

Table 2. Results of surveys for banded rails near Onerahi, Whangarei. See table 1 for description of each site. Sites where banded rails were detected are indicated by "1", not detected by "0", and no survey by "-".

Site number	Rail status in 2003	Survey 2004			Survey 2007			Survey 2013		
		1	2	3	1	2	3	1	2	3
1	Present	1	1	1	1	1	1	1	1	1
2	Present	1	1	1	1	1	1	1	1	1
3	Present	1	1	0	-	-	-	0	1	1
4	Present	0	0	1	0	1	1	0	0	0
5	Present	1	0	1	1	1	0	0	0	0
6	Unknown	0	0	0	0	0	1	0	0	0
7	Present	1	1	1	0	1	0	0	0	0
8	Unknown	1	0	0	1	1	1	1	1	1
9	Present	0	1	1	1	1	1	1	1	0
10	Unknown	1	0	0	0	1	0	0	0	1
11	Unknown	0	0	0	0	0	0	0	0	1
12	Unknown	0	0	0	0	0	0	0	0	0
13	Present	1	1	1	-	-	-	0	1	1

0.269, n = 16 counts, Fig. 3). Banded rails crossed the 7 m wide road 30 times during 10 counts (59% of counts) between 42 minutes before sunset and 18 minutes after sunset. No rail foot-prints were seen in the mud at these crossing points. Crossings occurred during outgoing (n = 10), low (n = 10), incoming (n = 8) and high tides (n = 2) and mostly occurred (93.3%) at 2 sites with little road verge vegetation. Two crossings only took place from very dense grass and weed covered verge. All crossings commenced when vehicles were absent on the 160 m of road that was under observation.

Australasia harriers were seen during 10 counts within 50 m of the count station. Banded rails were detected during all but 1 count when harriers were present. The exception was on the 8 February 2013, when a harrier was disturbed within the mangroves as I entered the site, and then swept the site 3 more times.

DISCUSSION

This study indicates that banded rails can be surveyed in the northern harbours using unsolicited calls around sunset throughout the year. These counts should include the saltmarsh/mangrove margin to give consistent results.

Calls have been used at all times of the day and night to survey other species of rails including weka (Beauchamp & Chambers 2000), spotless crake (Kaufmann 1988), corncrake (*Crex crex*, Cadbury

Table 3. Results of modelling of occupancy of banded rails at 13 sites in at Onerahi, Whangarei.

Model	AICc	ΔAICc	δ	AICc weight	-2 log likelihood
ψ(.),γ(.), p(year)	156.1	0.0	5	0.558	137.56
ψ(.),γ(.),ε=1-γ,p(year)	158.0	1.8	5	0.224	139.39
ψ(.),p(year)	158.2	2.0	4	0.203	145.15
Ψ(.),γ(.),ε(.),p(year)	163.4	7.2	6	0.015	137.38
ψ(year),γ(.),p(year)	176.7	20.6	7	0.000	140.34
Ψ (.),γ(year),ε(year),p(year)	184.4	28.2	8	0.000	132.37
ψ(year),γ(year),p(year)	192.5	36.4	8	0.000	140.54

(.) differences between surveys are not used in the model, and (year) differences between surveys are used in the model. δ = the number of parameters

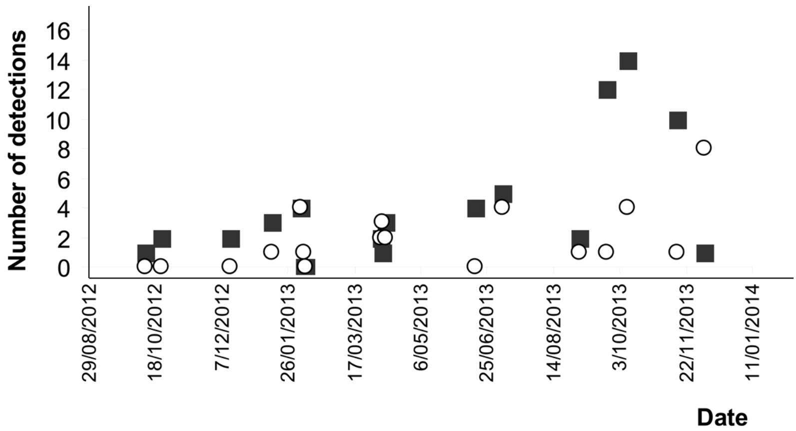

Fig. 3. Banded rail detections at Awaroa Creek October 2012 to December 2013. Open circles are birds seen and closed squares are birds heard.

1980), clapper rail (*Rallus longrostris*, Tomlinson & Todd 1973) and black rail (*Latterallus jamaicensis*, Repking & Ohmart 1977). Response by all species of rails appears to be variable, and playbacks of rail calls can make some species less detectable, especially if the calls given are territory-defense related. For example, Davis & Bellingham (1984) found tape playback for banded rails often caused the birds to become silent.

Most studies have used call counts without detailed understanding of confounding influences like moult, nesting and chick rearing, at the time (Cadbury 1980; Repking & Ohmart 1977; Tomlinson & Todd 1973). In studies that have had such data there is indication that call rates are higher immediately before incubation, and then rails become less conspicuous, but not undetectable during chick rearing and moult (Beauchamp & Chambers 2000, Kaufman 1988, Johnson & Dinsmore 1986). At Awaroa Stream, there were no periods when banded rails were undetectable, including the late summer post breeding moult. Thus, counts done at any season are likely to be useful in at least detecting the presence of banded rails, although differences in call rates with stage of breeding mean caution is needed in assessing population density without first correcting for seasonal effects.

The current study did not investigate all survey methods. For example, all the surveys were conducted during the day (or shortly after sunset), and banded rail response to tapes may be different at night. The banded rails at Awaroa Creek are active and call to some extent throughout the day (*unpubl. data*). It may be that there are better times for diurnal surveying, and extensive presence/absence surveys using microphones and data loggers could be carried out to resolve survey timing issues. Nevertheless, the period in the 0.5 to 1 hour before sunset appears to be an adequate time for survey.

The data collected 3 times over 10 years indicates that there was substantial stability in occupancy, or absence of occupancy, at the saltmarsh/mangrove sites at Onerahi. However, there was evidence that there may be some change between sampling periods. Sites that had banded rails detected during all 3 counts were those with larger areas of saltmarsh and access to over 2 ha of mangroves. The small area of saltmarsh with and without mangroves appear to be less suitable habitat for banded rail and should be used with caution when assessing long-term trends in populations. Recent applications have resulted in consents allowing removal of mangroves (at Mangawhai Harbour), or reduction of mangroves to marginal strips (at Tairua and Whangamata Harbours). The sites that hold banded rails before modification need to be monitored to determine if rails remain in such areas during following years.

Currently calls cannot be used to assess density. Banded rails do not appear to duet, so calls cannot be translated to pair status as can be done for other rails (Beauchamp & Chambers 2000; Kaufman 1988). Consequently the only way of converting calls to numbers of birds relies on mapping the timing of calls and birds. During most times of the year the harsh squeak call is only given 1-2 times an hour, so such actions are only possible in spring, when rails call at approximately minute intervals during periods exceeding 10 minutes.

Further work is needed to understand how banded rails are using habitat and to assess if call counts can tell you anything about density. It should now be possible to use transmitters to assess the relationship between presence and calling, habitat use and home range size, and to estimate longevity.

ACKNOWLEDGEMENTS

The following members of the Northland Branch of the Ornithological Society took place in counts in 2004 and/or 2007. Janet Snell, Lloyd Snell, Katrina Hansen, Gerard Pilon, Audrey Williams, Prue Cozens, Paulene Smith, Claire Burtt, Marie Smith, Jean Hawkins and other unrecorded members. They are all thanked for their contribution to this study. Jeanie Preddey provided comments on drafts of this paper and an anonymous reviewer is thanked for comments that have improved the paper.

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