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Banded rail (*Hypotaenidia philippensis*) detection at Ruakaka estuary before, during, and after mangrove (*Avicennia marina*) removal

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Abstract: Banded rails (*Hypotaenidia philippensis*) were monitored using footprints before, during, and after the partial removal of 1.8 ha of mangroves (*Avicennia marina*) from a 2.4 ha area in the Ruakaka estuary. Mangrove removal occurred in two phases: adult trees in winter 2014 and juvenile plants and pneumatophores in winter 2015. Banded rails were only detected on the margins of mangroves during adult tree removal, and then throughout the cleared areas after seedling and pneumatophore removal. In 2016, 2018, and 2020, rails showed a similar use pattern in the uncleared and cleared areas to that used before mangrove removal. After mangrove seedling and pneumatophore removal, potential predators, including cats (*Felis catus*), were present most of the time, and mustelids (*Mustela* spp.) were present in summer.

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INTRODUCTION

In northern New Zealand, banded rails | moho pererū (*Hypotaenidia philippensis*) predominantly live in wetlands associated with mangroves (*Avicennia marina*, Boffa Miskell 2017), occupying territories of 1.5–4 ha (Bellingham 2013; Beauchamp 2015, 2022).

Some people consider mangroves displace biota from sand flats and saltmarsh, interfere with views, and impair drainage. Consequently, rules covering mangrove removal are included in regional coastal plans in northern New Zealand (Northland Regional Council 2004; Auckland Council 2011). Juvenile mangroves lacking branching can be removed as a permitted activity to maintain access and other estuary values. Older mangroves can be removed to provide access to and along waterways without road access, from near fences and near wharves, within drains and road sight lines (Dencer-Brown *et al.* 2018). Unauthorised removals (i.e. without resource consents) have occurred at Ruakaka and many other locations. During the last decade, permitted mangrove removal has been undertaken by hand and machinery in south Kaipara, Tauranga, Whangamata, Tairua, and Mangawhai Harbours (Lundquist *et al.* 2014; Wildland Consultants 2015; Boffa Miskell 2015, 2017). These removals have provided information on the impact of disturbance on species with affinity with mangroves (Wildland Consultants 2015; Bulmer & Lundquist 2016; Boffa Miskell 2017).

In 2010, the Ruakaka Ratepayers Association (RRA, White 2012) applied to the Northland Regional Council to remove or thin adult mangroves from two small areas (2.56 ha total) of mangrove-saltmarsh habitat, and to remove seedlings from 19.92 ha of open sand flats.

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Figure 1. Ruakaka estuary before (top) and after clearance (bottom) of adult mangroves and seedlings.

The RRA indicated that removal was necessary to provide human access and drainage, maintain existing areas of saltmarsh diversity, and maintain open sandy inter-tidal flats for shore-wading birds. The application acknowledged that banded rails used the mosaic of salt marsh and scattered mangroves (Fig. 1); however, the RRA considered that there would be sufficient cover for the birds that utilise the wetland if some mangroves remained (White 2012).

Most of the existing Ruakaka estuary (87.2 ha) is a gazetted Wildlife Refuge (Fig. 2B). Over the last 50 years, the immediate catchment was highly modified, and the remaining natural values around the estuary were compromised by residential development, stream margin vegetation clearance, and human recreation (Lux *et al.* 2007). In this study, I monitored the saltmarsh-mangrove area in Ruakaka estuary (35.9035S; 174.4520E), as it was cleared of approximately 1.8 ha of dense and scattered mangroves, and an adjacent area where the mangroves were left predominantly unaltered (White 2012). This paper uses footprints to assess changes in banded rail detection before, during, and after mangrove clearance, and the presence of other species, including potential predators of banded rails.

METHODS

Study area

The study was conducted in a *c*. 2.4 ha part of the Ruakaka estuary (Figs 1 & 2) with 3 m high mangroves and a diverse saltmarsh ecosystem (Table 1). After mangroves were removed, the habitat comprised a margin of mangroves, open flooded and crab-holed sandflats lacking pneumatophores, small (less than 200 m^2) patches of oioi (*Apodasmia similis*), hillocks with *Austrostipa stipoides* tussocks and bare ground, and patches of sea rush (*Juncus maritimus*). Small areas of the invasive weed saltwater paspalum (*Paspalum vaginatum*) were present at four sites.

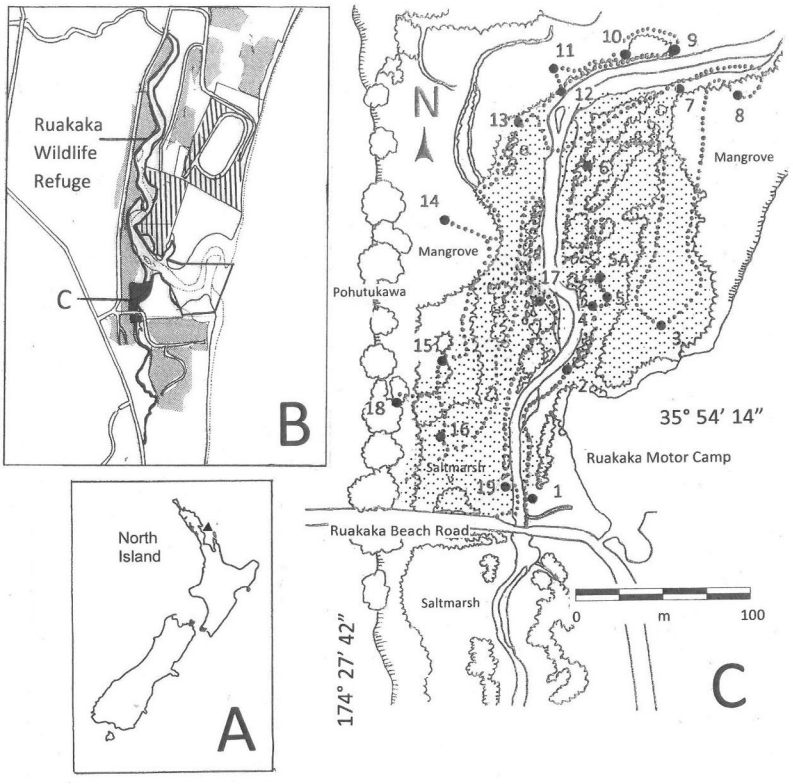

Figure 2. Ruakaka estuary mangrove removal area north of Ruakaka Beach Road causeway, before mangrove removal in 2015. A is the location of the Ruakaka estuary; B is the study area site in the Ruakaka Wildlife Refuge boundary. The shaded areas are the urban zone, and perpendicular lines over the shading are permitted for urban expansion; C, the dotted line is the survey route; and the fine dotted area is where adult mangroves were removed. Numbers and large dots depict the locations of the footprint monitoring points.

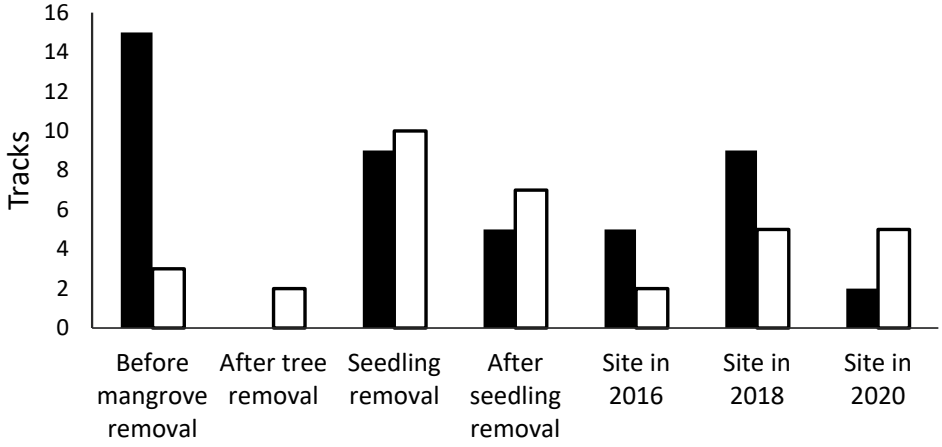

Figure 3. The number of banded rail tracks detected at Ruakaka in relation to site management. Solid bars are the number of detections at sites where mangroves were removed, and the open bars are those at sites where mangroves were not removed.

Table 1. Characteristics of each sampling site before mangrove removal and the change in the site's status after mangrove removal.

Site	S	E	Expected cut status	Actual cut status	Substrate	Habitat*
1	-35.9055	174.4520	No	Yes	Soft sand	Sand, open flat below the bridge with no mangrove cover
2	-35.9053	174.4520	Yes	Yes	Soft sand	Saltmarsh sand crest with mangrove overlay
3	-35.9045	174.4526	No	Yes	Hard sand	Short mangrove <1m tall, dense
4	-35.9043	174.4524	Yes	Yes	Soft sand	The margin of the stream with tall mangrove cover over the saltmarsh
5	-35.9042	174.4524	No	No	Hard sand	Oioi saltmarsh
5a	-35.9042	174.4524	No	No	Soft sand	Sand tussock salt marsh
6	-35.9035	174.4522	Yes	Yes	Soft and moderate sand	Tall mangrove
7	-35.9035	174.4522	Yes	No	Moderate sand	Mangrove margin with very small mangroves with barnacles on them
8	-35.9030	174.4534	No	No	Hard sand	In 3-4 m mangroves behind the short outer margin
9	-35.9030	174.4534	No	No	Moderate sand	On the margin of 4 m mangroves and the fringe of seedlings
10	-35.9028	174.4525	No	No	Moderate sand	Margin tongue is very soft drain mud
11	-35.9028	174.4519	No	No	Moderate sand	In 3-4 m mangroves on the margin of a former channel
12	-35.9032	174.4519	Yes	No	Soft sandy silt	At the margin of sand flats and tall mangroves
13	-35.9036	174.4520	Yes	Yes	Hard sand	The margin of short 1m and taller 2 m mangroves in open clearings
14	-35.9039	174.4516	No	No	Hard sand	Within tall mangroves, 2 m tall on the margin
15	-35.9042	174.4515	No	No	Hard sand	Sea rush
16	-35.9051	174.4518	No	Yes	Soft sandy silt	Stream and tussock margin with mangroves cover on the stream banks
17	-35.9054	174.4518	Yes	Yes	Moderate to soft sand	Sea primrose (*Samolus repens*) saltmarsh
18	-35.9051	174.4512	No	No	Hard sand	Margin of <1m and 3 m mangroves and pohutukawa
19	-35.9053	174.4518	Yes	Yes	Soft sand	Stream margin, *Austrostipa* tussocks

* with mangrove removal if the site was cut

Survey method

Banded rail presence was assessed using footprints left in soft sediment (Elliott 1983; Botha 2011; Beauchamp 2015). Prints can show how rails move between habitats and monitoring points; however, there are limitations because prints are not laid down on flooded surfaces, rigid substrates, algal mats, or dense pneumatophores, and they are lost during submersion and by rainfall.

Monitoring sites, 3 metres in radius, were defined on 13 Feb 2013 before mangrove removal, including near where banded rail footprints had been reported (White 2012), and other locations inside and outside the proposed mangrove clearance area (Fig. 2C; Table 1). I used a bent wire of rail mid-toe length and width to confirm that the substrate at each monitoring site would potentially retain footprints. I placed eight monitoring sites where clearance had been permitted (adult or juvenile trees), three sites where there was to be a margin of tall mangroves, and nine sites where mangrove removal was not to occur (Table 1). At the start of the assessment, three sites where removal was permitted included oioi and *Austrostipa* tussock (Lux *et al*. 2007) (Table 1). During removal, three sites that were supposed to

be left unmodified were cut, and one site that was to be cut was left unmodified (Table 1).

I walked the same route between sites and mapped all rail footprints inside and outside these sites on each visit to the study area. I carried out pre-clearance assessments, walking between sites thrice between 13 Feb and 7 Oct 2013. Surveys were then conducted three times between 19 May and 5 Jul 2014 immediately after adult mangrove removal, three times between 21 Mar and 6 Apr 2015 before seedling and pneumataphore removal, and then a further three times between 30 May and 16 Aug 2015 after seedling and pneumatophore removal from part of the area. I then surveyed the study area three times between 27 Oct and 22 Nov 2015 at the start of the expected next breeding season, and 10 Jun–21 Jul 2016, 2 Feb–24 Apr 2018, and 25 May–4 Jul 2020, to assess the impact of the removal longer term. I deemed that rails were present when a footprint was found within a 3 m circle, and detections were aggregated for three surveys during each management period. On three occasions, footprints revealed that the same rail had walked between monitored sites in one survey. Both sites were included in these situations if their modification status differed (modified or unmodified). Otherwise, the first site in the direction of travel was scored.

Predators and potential human disturbance

Mangrove clearance facilitated public access between Ruakaka Beach Road and Princess Road. Following the first seedling clearance, I assessed the site 22 times between October 2015 and October 2017 to see how people, dogs, and potential predators used the modified site and how their use compared with that of banded rails. Footprint data for all species were assessed as within mangroves (sites 3, 8, 11 & 18), on the margin of mangroves (sites 9, 10, 12 & 13), in saltmarsh (sites 4. 5, 5A, 15 & 19), and as open ground (sites 1, 2, 6, 7, 16 & 17) using only the records of the times that the substrate could have held banded rail footprints (i.e. the species with the most inconspicuous footprints).

RESULTS

Banded rail detection

I detected banded rails over the entire site before tree removal. There were no footprints detected in the modified area during large tree removal, and no increase in the number of footprints detected in the unmodified areas of mangroves (Fig. 3). Rail prints were detected more consistently in both the removal area and the unmodified mangrove area before seedling and pneumatophore removal (*Fisher exact test P= 0.0153*) and after they were removed (*Fisher exact test P= 0.0346*). On 23 & 30 Mar 2015, these habitats included sandy stream margin mounds (Fig. 2C, sites 2, 4, 5A, 6, 13, 19) previously partly covered by tall mangrove canopy, which remained dry during spring tides. Banded rails foraged along the open sand margins of the stream (Fig. 2C, site 6) after May 2015. However, when the habitat was maintained in its modified state, rail use fluctuated between no difference with the unmodified state (*Fisher exact test*, winter 2016 *P= 1.00*; summer, 2018 *P= 0.675*) and significantly more detections in the unmodified areas (winter 2020 *P= 0.0168*).

Number of banded rails detected by prints and other means

The size and distribution of tracks seen during each assessment indicated that 0–3 birds were present during each visit, and calls and sightings indicated that at least three birds were present on 25 Oct 2017.

Banded rails did not use the retained salt marsh for roosting, as their footprints were not found in saltmarsh habitats that remained dry during all tides. The only evidence of breeding was seen on 25 Apr 2017 at site 19 (Fig. 2C). There, footprints showed that an adult with one dependent young entered the clearance zone from under the bridge to the south, and from an area of unmodified mangrove-saltmarsh habitat.

Other species use of the wetland

Cats (*Felis catus*) and stoats (*Mustela erminea*) were detected in the saltmarsh and open habitats, but not near or within the remaining mangroves (Fig. 4). Cat tracks led from the roads and the banks below one property, but never into the mangrove region north of sites 13 or 6. Cat and kitten tracks were detected on 14 Jul 2014, 8 Nov 2015, and 8 Apr 2017. Stoats were detected four times between November 2015 and March 2016, and again in September and October 2017 near the bridge and along the stream margin as far as site nine at the margin of the estuary sand flat (Fig. 2C). Dog (*Canis familiaris*) prints were generally associated with people walking the track along the western margin of the creek. Dogs also played with people near sites 1 and 2 (Fig. 2C). Only once did footprints show that a dog accessed the site without a person. Rats (*Rattus* spp.) were frequently detected away from the assessed sites; however, their tracks were often hard to find, especially as most surveys followed a diurnal high tide.

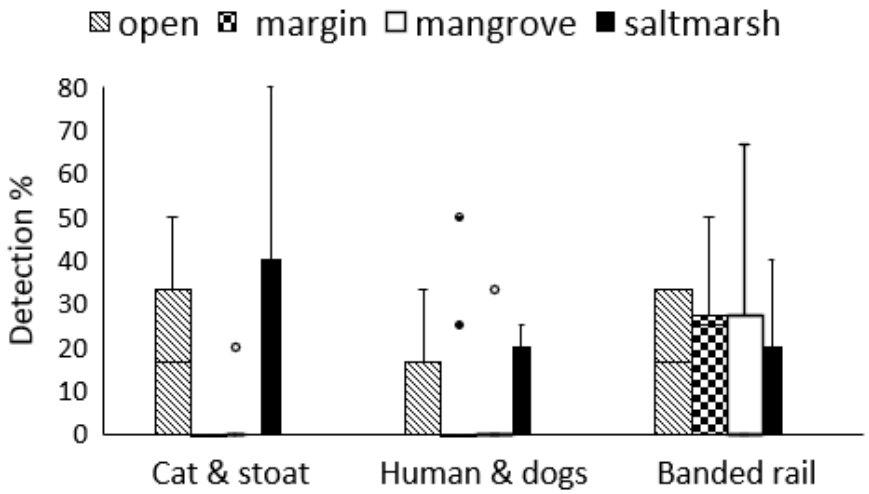

Figure 4. Box and whisker plots of the proportion of surveys (%) where footprints occurred at the points in each habitat class at Ruakaka estuary, Northland, June 2014 to October 2017.

DISCUSSION

Detection issues

The removal of adult mangroves, seedlings, and pneumatophores at Ruakaka estuary opened areas that were 30 m from mangroves or salt marsh cover; however, most of the site remained within 6 m of overhead vegetation. Banded rails were present during most visits and had accessed the site after diurnal high tides. The area of mangrove tree removal was initially avoided by rails; however, they returned to it before seedlings and pneumatophores were removed. Rails continued to use the modified and unmodified sites 6 years after mangrove removal.

Importance of saltmarsh to rails

Saltmarsh is the predominant habitat used by rails in the northern South Island, where mangroves are absent (Elliott 1983), and it has been assumed that rails could live on the North Island within mangrove-free saltmarsh alone (Boffa Miskell Ltd. 2017). Oioi and sea rush dominate the saltmarsh types generally associated with banded rails (Elliott 1987, 1989; Botha 2011). At Ruakaka, banded rail footprints were absent in oioi and seldom found in sea rush. The lack of detection of rails in mangrove-free saltmarsh vegetation indicated that rails were not using this vegetation type at Ruakaka.

Observations at other sites also support this assessment. Mangrove removal has occurred at Whangamata (Wildland Consultants 2014), Tauranga Harbour (Win *et al.* 2015), Tairua Harbour, and Mangawhai. One of the mangrove removal areas at Whangamata adjoined a 2.5 ha area where most mangroves were illegally cleared back to the saltmarsh (Wildland Consultants 2014). Here, rail footprints were absent along the margin of that saltmarsh or in the small, isolated patches of mangroves that remained and that were detached from the saltmarsh (Wildland Consultants 2014). At another site at Whangamata, mangroves were reduced to a *c.* 50 m-wide fringe abutting the saltmarsh, and rail footprints were detected before and after removal in the mangrove fringe.

At Lincoln Road, Mangawhai, banded rails are infrequently detected in a saltmarsh (0.4 ha) that was formerly a 0.6 ha saltmarsh-mangrove mosaic. When present, rails foraged in open tidal puddles up to 10 m from the oioi patches and other vegetation that was part of the former outer margin mosaic (author, *unpubl*.).

Predator control

During the monitoring at Ruakaka, 0–3 rails were detected. These numbers equate to a *c.* 0.22–0.75 banded rails ha^{-1}, which is lower than the *c.* 2.5–4.9 banded rails ha^{-1} seen within a 2.8 ha predator-controlled part of Sandspit estuary (36.3924S, 174.7272E; author, *unpubl*.). One potential reason for the low presence of banded rails is predation by cats, mustelids, and rats (O'Donnell *et al*. 2015; Dencer-Brown *et al.* 2018). Predator control has been suggested as a mitigation measure for mangrove removal (Boffa Miskell Ltd., 2017). This study found that domestic and wild cats, small mustelids, hedgehogs, and rats regularly used the mangrove-cleared area after tree clearance at Ruakaka estuary; however, rails persisted. Thus, some predator control and cat owner awareness programs may help reduce potential predator impacts on rails at Ruakaka and other sites with similar mangrove wetland management.

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