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RESEARCH PAPER

A Drone Survey of a Feral Population of Emu, *Dromaius novaehollandiae* (Latham, 1790), on Rēkohu / Wharekauri / Chatham Island, Chatham Islands

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ABSTRACT

Species monitoring and surveying is strongly limited by habitat accessibility. A feral population of emu (*Dromaius novaehollandiae*) established from five birds deliberately released on Rēkohu / Wharekauri / Chatham Island more than 30 years ago has not yet been quantitively assessed with respect to its population number and status. To address this issue, we conducted a short manual UAV (drone) survey on a portion of the area where this population is said to be concentrated. In total 303 min of flight/survey time over 5 days (January 2025), we made 70 observations of emu, including 45 adults and 25 juveniles, with a calculated 13.5 emu observations per drone hour. The most observations in a single day were 28 individual birds; 17 adults and 11 juveniles. The largest flocks of emu were six individuals: three adults with three juveniles, and another flock of an adult with five juveniles. There is a need for a more extensive survey to estimate the total population size and a more detailed investigation into the ecology of this population to ascertain the potential impact emu may have on the farmland and associated indigenous terrestrial ecosystems on Rēkohu. Emu have also been released in several locations in Aotearoa / New Zealand, and we advocate for similar studies there.

1 | Introduction

Emu (*Dromaius novaehollandiae* (Latham 1790)), large flightless birds endemic to Australia, have gained prominence in both exotic zoos and animal commodity trade. Emu have been commercially farmed in Aotearoa / New Zealand since the early 1990s, the variety of obtainable emu products, such as low fat meat, fine leather, and oil used in the cosmetic industry (Marshall 1994) and their high productivity (20 chicks per hen per year (O'Malley 1989)) made them a highly valued commercial asset. Captive birds were intensively bred in pairs, eggs artificially incubated, creating a boom in the number of farmed emu, and a small number of eggs were imported into the country in 1995 to increase genetic diversity and flock numbers (Bassett 1996). The number of farmed emu in Aotearoa / New Zealand was the estimated at 2,000–3,000 in 2007, though the number dropped to less than 300 in the 2022 census for both ostriches and emu (Stats NZ, 2022). Wild occurrences of emu have been observed in multiple locations in Aotearoa: Rēkohu / Wharekauri / Chatham Island (henceforth Rēkohu), Chatham Islands, the Waiaapu River Catchment, Tairawhiti / East Cape (G. Atkins, pers. comm. to P. J. de Lange, February 2025; Cannings 2014), and there scattered observations of birds from a range of locations, for example, Waihi Beach (see https://www.birdingnz.net/forum/viewtopic.php?t=6468).

On Rēkohu, the wild population of emu originated from six emu imported to the island c. 30 years ago with the intention to sell emu eggs carved with Māori and Moriori motifs as a tourism venture (D. Goomes, pers. comm. to P. J. de Lange, August 2021, December 2023; T. Gregory-Hunt, pers. comm. to P. J. de Lange, September 2023; Baling et al. 2023). The project failed: after one bird's death by car along Rapanui Road and the remaining five birds failed to lay eggs after some time in captivity. The five birds were released onto farmland bordered by Rapanui and Te Matarae Roads (Figure 1). These remaining birds have since bred, as a feral and unmanaged population now inhabiting the rough pasture and

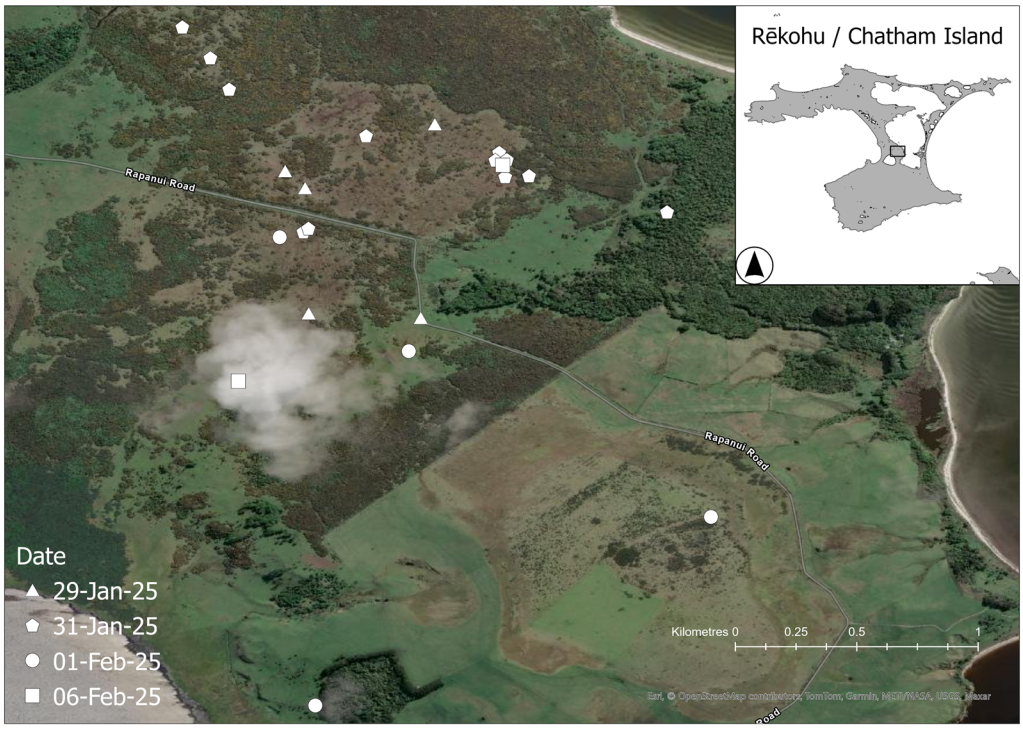

FIGURE 1 | Rēkohu / Wharekauri / Chatham Island, Chatham Island Group, with emu observations made for each date.

gorse (*Ulex europaeus* L.) shrubland in this area (with sporadic reports as far north as the Airport Road).

Multiple emu have been frequently seen by locals in farmland bounded by Lake Huro (in the west), Te Whanga (in the east), and the Rapanui and Ouenga | Owenga Road in the north and south, respectively. The birds are now a tourist attraction for local businesses, yet in an effort to reduce numbers, they have also been added to the game list for travelling hunters (R. Chappell, pers. comm., February 2025). Despite multiple observations of adults, juveniles, and chicks (including in iNaturalist), Baling et al. (2023) was the first official publication providing the circumstances around and documenting the naturalised occurrence of feral emu on Rēkohu, a record lacking from previous checklists of the avifauna of the islands (Aikman and Miskelly 2004; Miskelly et al. 2006). Therefore, much of the current information is based on unrecorded local knowledge and online observations, where Rēkohu locals estimate a population between 60 and 200 feral birds, with reported flocks of greater than 20 individuals, and a record of a group of up to 50 individuals (P. J. de Lange, pers. obs., see https://inaturalist.nz/observations/75587059). There has been no quantitative survey conducted on this wild population.

Unmanned aerial vehicles, (UAV or drones) are a revolutionary technology, with increasing use in wildlife studies, advantageous for habitats that are inaccessible to humans (Bollard et al. 2022). In Aotearoa / New Zealand, the use of drones has already proved their efficacy for bird population surveys, where they were used for multiple penguin species in the subantarctic islands (Mattern et al. 2021; Muller et al. 2019; Muller 2022) and shag populations in the Foveaux and Otago (Parker and Huber 2021). Drones have also been used as a tool to monitor endangered and invasive species (Dubos et al. 2023) and are considered the most cost-effective method for inaccessible areas. In this brief study, we use a UAV / drone to conduct a short dedicated aerial survey of the feral emu population.

2 | Materials and Methods

Surveys were conducted along Te Matarae / Rapanui Roads (Figure 1) between 29th January and 6th February 2025, with permission granted by the private landowners for access to the road and flights over their land. Land surveyed was cattle farmland overlying karst, with remnant forest / swamp forest dominated by mataira (*Myrsine chathamica* F.Muell.), karamu hikoa (*Coprosma chathamica* Cockayne), hakapiri (*Olearia traversiorum* (F.Muell.) Hook.f. and *O. telmatica* Heenan & de Lange), inihina (*Melicytus chathamicus* (F.Muell.) Garn._Jones, and intermittent stands of kopi / karaka (*Corynocarpus laevigatus* J.R.Forst. et G.Forst.). Also, rough pasture (dominated by *Agrostis capillaris* L., *Lolium perenne* L., and in places *Juncus pallidus* R.Br.), grading into tall (>2 m) gorse shrubland.

Drone surveys were conducted with a DJI Mavic 2 Pro (Shenzen, China), with take-offs and landing points were located on the road (open area), and all flights were within a safe distance from the Chatham Island Airport no-fly zone. Flight sessions were conducted between 07:00–09:00 h local time, with sessions lasting c. 20 mins each. Surveys were conducted as a systematic search, with an iPad 10.9 (10th generation, Apple, Cupertino, USA) connected to the drone remote, displaying camera feedback through software app, DJI GO 4 (V .4.3.64). This allowed an individual to manually fly the drone and to see the flight path in real time, and a second individual as an observer to watch the live footage. Flight paths were at a height of 40 m, perpendicular to the road, and areas covered were not reobserved during the same session to avoid double counts. The drone was lowered where possible for closer photos of emu.

Observations of emu were captured using the drone's standard camera, 1-inch 20 M with a 28 mm (35 mm format equivalent) lens. During the flights, any reactions or responses from other birds were also recorded. All GPS coordinates of emu observations were extracted after flights from the images of emu captured by the drone.

We compiled all observations and calculated the catch per unit effort as the average number of emu observed per hour and the average flock observed per hour.

3 | Results

We conducted a total of 303 min of flight/survey time over 5 days (29th Jan, 30th Jan, 31st Jan, 1st Feb and 6th Feb 2025). Average duration of a drone flight (the life of the drone battery) was 22 mins, with the longest timed flight was 26 mins. Drone surveys in total covered c. 350 ha surrounding the Rapanui and Te Matarae Roads, with the majority of observations at Rapanui Road, ranging to c. 800 m either side of the main road (Figure 1). We made a total of 70 observations comprising of 24 flocks of 45 adults and 25 juveniles. There were five sessions with no observations of emu, including all three sessions on 30th January 2025.

We observed an average of 13.5 emu observations per drone hour, with the most observations in a single session being 28 individual birds, 17 adults and 11 juveniles on 31st January 2024 (Table 1). The average emu flocks observed was 4.2 flocks per drone hour, with an average of 2.7 birds per flock. There were nine unique combinations of flocks out of the 24 flocks observed, with potential unique individuals of 18 adults and 16 juveniles (Table 2). Birds in a flock were observed ranging between one and six birds (Table 1), comprising of all adults (1–5 individuals) or mixed of adults and juveniles (1–3 adults and 1–4 juveniles) (Table 2, Figure 2). The largest flock were six individuals, comprising of three adults with three juveniles on the 29th of January 2025 and one adult with five juveniles on 6th February 2025 (Figure 2).

During the flight sessions, we observed responses from buff weka (*Gallirallus australis hectori* (Hutton, 1873)) ($n = 2$), Eurasian skylarks (*Alauda arvensis* Linnaeus, 1758) ($n = 5$) and kāhu / swamp harriers (*Circus approximans* Peale, 1848) ($n = 1$). Weka were observed running away from the drones, skylarks flying around

TABLE 2 | Flock combination of adult and juvenile emu observed at Rēkohu / Wharekauri / Chatham Island, Chatham Islands Group. No. Adults and Juveniles represent number of individuals within a flock combination, with total of individuals in the flock. No. Flocks denotes the number of flocks observed within each combination during survey on 29th January–6th February 2025.

	No. Adult	No. Juvenile	Total	No. Flocks
Flocks	1	0	1	5
	1	1	2	1
	1	3	4	4
	1	4	5	1
	1	5	6	1
	2	0	2	7
	3	0	3	2
	3	3	6	1
	5	0	5	2
Total	**18**	**16**	**34**	**24**

TABLE 1 | Observations of emu from drone flight sessions on 29th January–6th February 2025 at Rēkohu / Wharekauri / Chatham Island, Chatham Islands Group. Time represents the local time in 24 h, No. flocks is the total number of bird flocks during each session, Mean is the average number of birds during each flight session, with range of number of birds in parentheses, and n is the total number of adult or juvenile emu in each flight session.

			Adults		Juveniles	
Date	Time h	No. flocks	Mean	n	Mean	n
29 Jan 2025	06:59	3	2.3 (1–3)	7	2.0 (0–3)	6
	07:27	2	3.5 (2–5)	7	0.0	0
	07:57	0	0.0	0	0.0	0
30 Jan 2025	07:13	0	0.0	0	0.0	0
	07:49	0	0.0	0	0.0	0
	08:24	0	0.0	0	0.0	0
31 Jan 2025	06:47	3	1.0	3	0.0 (0–4)	4
	07:17	5	1.4 (1–2)	7	0.8 (1–3)	4
	07:52	5	1.4 (1–2)	7	0.6 (0–3)	3
01 Feb 2025	06:34	1	5.0	5	0.0	0
	07:03	2	2.5 (2–3)	5	0.0	0
	07:31	1	1.0	1	3.0	3
06 Feb 2025	06:59	0	0.0	0	0.0	0
	07:33	2	1.0 (1–2)	1	0.0 (0–5)	5

FIGURE 2 | Drone images of emu during flight sessions at Rēkohu / Wharekauri / Chatham Island. Top: five juveniles and one adult, bottom: a flock of three juveniles and one adult stationary but observing the drone above.

the drone, and the harrier was flying under the drone. Emu were observed to range from not reacting to the drone, freezing, to running away. A moving drone elicited more responses from the emu than when the drone was stationary.

4 | Discussion

This survey investigated the occurrence of feral emu at Te Matarae / Rapanui Roads, Rēkohu, Chatham Islands. In January 2025, we conducted an aerial systematic search of emu over a large portion of their known range that was bounded by landowner's approval for the drone survey. The drone was flown at a height above ground where birds could be easily detected amongst the tall gorse (shrubs that would otherwise obscure direct human sight). We made a total of 70 observations of birds, comprising of 20 flocks that range between one and six individuals per flock. The flocks varied from all adults to a mix of adults and juveniles, with the two largest flocks comprising three adults with three juveniles, and another being one adult with five juveniles. These values were similar to observations recorded on iNaturalist (2011–2025; https://www.inaturalist.org/observations?nelat=-43.36281049999999&nelng=-175.548506&subview=table&swlat=-44.6338309&swlng=-177.2094382&taxon_id=20503) where flock numbers range from one to seven, with a maximum of 14 individuals seen in one flock.

This opportunistic study was highly limited for population estimation as individuals were not marked, the short duration of the survey (five days between 07:00-09:00 hrs), starting points of the survey were from the main road, and areas surveyed were subject to landowners' approval. Nevertheless, our aerial survey results showed a high occurrence of emu observations (13.5 emu per drone hour, 4.2 flocks per drone hour) at the study site, which reflects the potential high population size at Te Matarae / Rapanui Roads. Due to the lack of mark-recapture, it is impossible to distinguish observations of unique individuals between days in this study. Therefore, for this survey, we estimate emu counts based on the maximum number of observations of a single day and the number of individuals in unique flocks. Here, we suggest that the population surveyed had 28–34 individuals (17–18 adults and 11–16 juveniles).

In their native range, emu tend to be solitary animals or live in pairs. They form flocks only in areas of abundant food or when travelling long distances (Bolland 2003; Patodkar et al. 2009), with social foraging groups rarely exceeding 10 individuals. Our results corroborate these observations; average flock size observed was 2.7 emu per flock, ranging from 1 to 6 birds per flock, with the largest adult flock we observed comprising of five adults. However, our study did not record very large flocks (14–50 individuals) previously reported in iNaturalist (https://www.inaturalist.org/observations?nelat=-43.36281049999999&nelng=-175.548506&subview=table&swlat=-44.6338309&swlng=-177.2094382&taxon_id=20503). Therefore, we suggest that future field surveys should include a mark-recapture or distance sampling approach (Witczuk and Pagacz 2021) and extend the area surveyed (beyond the roads) to provide more accurate information on flock size and estimated population size. Investigations into the time of day for the most effective field survey should also be conducted to increase the frequency of observations of emu and account for daily activity pattern variations.

In comparison, under farming conditions, the birds are known to form small coherent flocks with social hierarchy (Bucław and Szczerbińska, 2017). A common observation in this study was that juveniles were always in a flock with adults, the largest flock containing one adult with five juveniles. Though there is no data to conclude clutch size of this population, in general, clutch size for emu is variable, 3–32 eggs, with mean ≈11 eggs (Ryeland et al. 2021). Male emu have a high degree of parental care, including egg incubation, and guarding the growing chicks for up to seven months, often longer until the next breeding season (Davies 2002).

This study showed the usefulness of drones for surveying emu, confirming other similar wildlife studies involving systematic searches in large terrains. The drone survey height of 40 m allows surveying of much larger areas, and the distinctiveness of the emu also aids in the effectiveness of this technique, with birds being large and never confused with other species, decreasing the risk of interobserver bias. Emu responses to the drone were relatively unaffected but were variable: mostly, the birds were completely undisturbed when flying at the height of 40 m, although during one drone take-off, an approaching flock of five adult emu ran off after the drone was raised to 30 m. Notably, adults with groups of juveniles were more cautious of the drone, often remaining alert, this was very apparent when the drone was lowered to a 4-m height. We suspect that this behaviour may also reflect a sensitivity to the drone caused by an island-wide aerial campaign (September–October 2024) to reduce feral cattle numbers on Rēkohu. Although not specifically targeted, during that culling of at least 20 emu were also shot from a helicopter by

Environment Canterbury staff (R. Seymour pers. comm., October 2024).

This study is the first to survey emu on Rēkohu, with future potential in using drones to monitor this feral population and establish their official status. There remains a need to better document the numbers of birds and the extent of their range on Rēkohu, as well as to identify further the habitats that they may occupy. Emu diet primarily consists of vegetation, occasionally insects (Quin 1996) and they act as seed dispersers (Nield et al. 2015). However, the main source of nutrition for the Rēkohu population is not known. Knowledge of the diet of these feral birds is vital to understanding the potential ecological implications (e.g. seed dispersers of exotic or invasive weeds, destruction of native vegetation or invertebrates) of their presence as an exotic organism on the island. Irrespective, this study illustrates that this species may be naturalising after release, a matter that has relevance not only to Rēkohu but to greater Aotearoa / New Zealand, where feral emu are being increasingly reported.

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Conflicts of Interest

The authors report there are no competing interests to declare.

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