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Birds on Broughton Island: changes following the removal of Black Rats and European Rabbits

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Abstract. A long-term terrestrial avifauna monitoring project on Broughton Island, New South Wales, has identified changes to the island's bird populations following the eradication of feral mammals (European Rabbits *Oryctolagus cuniculus* and Black Rats *Rattus rattus*) in 2009. Those eradications prompted habitat changes as well as removing predators. The populations of Golden-headed Cisticola *Cisticola exilis* and Australian Pipit *Anthus australis* have decreased and two birds of prey, Whistling Kite *Haliastur sphenurus* and Black-shouldered Kite *Elanus axillaris*, have become far less common. Five species, Silvereye *Zosterops lateralis*, Yellow-faced Honeyeater *Caligavis chrysops*, Brown Goshawk *Accipiter fasciatus*, Little Wattlebird *Anthochaera chrysoptera* and Red-browed Finch *Neochmia temporalis*, have become resident or regular year-round visitors. Two species, Grey Fantail *Rhipidura albiscapa* and Golden Whistler *Pachycephala pectoralis*, have become frequent autumn-winter visitors. Two cryptic species, Lewin's Rail *Lewinia pectoralis* and Buff-banded Rail *Gallirallus philippensis*, had no records from Broughton Island prior to the removal of feral mammals, and possibly are relatively recent arrivals. Records of Buff-banded Rail have increased significantly over the course of the study. Species such as Osprey *Pandion haliaetus* and Sooty Oystercatcher *Haematopus fuliginosus* have an increased number of breeding records.

Key words: Conservation, island ecology, predator control, bird diversity, population trends, long-term monitoring

INTRODUCTION

Invasive non-native mammals, such as Black Rats *Rattus rattus*, are recognised as the main cause of animal extinctions on islands and one of the most important threats to remaining insular biodiversity (Bellard *et al*. 2016; Brooke *et al*. 2018; Medina *et al*. 2011; Tershy *et al*. 2015). The removal of non-native mammalian predators is a known conservation measure for endangered bird species – leading to increases in hatching success and fledging success, and bigger breeding populations (Cote and Sutherland 1997; Smith *et al*. 2010). Predator removal has been particularly effective in spurring the recovery of seabird populations on islands (e.g., Bellard *et al*. 2016; Borrelle *et al*. 2016; Brooke *et al*. 2018; Medina *et al*. 2011;). As stated in Brooke *et al*. (2018): 'Seabirds are among the most threatened groups of birds, and predation by invasive mammals is one of the most acute threats at their island breeding stations. … demonstrated benefits of invasive mammal eradication include increased seabird nesting success and enhanced adult survival.'

There are also many examples where non-seabirds (such as waterbirds and passerines) have benefitted from predator removal, either on islands (e.g., Croll *et al*. 2016; Lord Howe Island Signal 2025; Ralph *et al*. 2022) or at mainland conservation reserves (e.g., Fitzgerald *et al*. 2021).

European Rabbits *Oryctolagus cuniculus* are known to be a significant factor contributing to native vegetation decline and biodiversity loss (Cooke and McPhee 2007). They can prevent the long-term regeneration of trees and shrubs by continually eating young seedlings, which prevents ecosystems from ever reaching their natural, pre-rabbit forms (Taggart and Cooke 2021). This has immense flow-on effects for the availability of food for plant-eating animals, for insect abundance, and for shelter. Rabbits are known to have catastrophic effects on oceanic islands, either by direct destruction of the vegetative cover or from the resulting disturbance of indigenous vertebrates (Courchamp *et al*. 2000). Although the impacts of rabbits are not always easily quantified (Munze *et al*. 2016), their eradication from islands has had clear benefits, for example on Macquarie Island (Bird *et al*. 2024; Olive 2021).

In 2009, the NSW National Parks and Wildlife Service (NPWS) removed European Rabbits and Black Rats from Broughton Island, near Port Stephens in New South Wales. The island was officially declared free of feral mammals in 2011 (Fawcett *et al*. 2016; Priddel *et al*. 2011). A small population of feral Green Tree Frogs *Pelodryas caerulea* is still present, so the island is not entirely free of feral animals. Broughton Island hosts a substantial breeding seabird population (Carlile *et al.* 2012) and NPWS had plans in place for monitoring them post-removal of feral mammals. They enlisted the collaboration of the Hunter Bird Observers Club (HBOC) to monitor the effects on other bird species. Since 2012, there have been regular surveys by HBOC teams, with an emphasis on monitoring diurnal birds – passerines, shorebirds, waterbirds, and birds of prey (raptors). Two earlier reports have presented some related information – the results from a baseline study spanning 2012-2017 (Stuart *et al*. 2017) and an overview of the status of all avian species on the island (Stuart 2025). This present report provides an analysis of the changes identified as having occurred to the bird assemblages on Broughton Island since European Rabbits and Black Rats were removed from the island.

Figure 1. *Broughton Island and some other islands of the Broughton Group*
Map based on Google Earth sourced 30 June 2025

METHODS

Study site

Broughton Island (32º 37'S, 152º 19'E, Fig. 1) is situated approximately 15 km north-east of the entrance to Port Stephens in New South Wales. It is an important component of the Myall Lakes National Park. With an area of 132 ha, it is the largest coastal island in NSW. It rises from sea level in the north-west, through a centrally located swampy environment, up to the summit of Pinkatop Head (91 m) in the south-east, before dropping abruptly back to the sea. A peninsula, arising from mid-way along the island, terminates toward the south in a series of small islets (Carlile *et al*. 2012).

The vegetated area of the island is 117 ha. At the time of removal of feral mammals, the vegetation was dominated by open grassland and sedgeland habitats (Carlile *et al*. 2012). The major plant species included Spiny-headed Mat-rush *Lomandra longifolia,* Kangaroo Grass *Themeda australis,* Blady Grass *Imperata cylindrica* and Bracken Fern *Pteridium esculentum*, plus alien weeds (Somerville *et al*. 2018). The island once contained expansive areas of trees and shrubs but, by early this century, frequent fire and grazing by feral mammals had reduced those stands to isolated remnants (Carlile *et al*. 2012).

Surveys

Typical visits to Broughton Island for bird monitoring spanned three days, with observers traversing most of the island and surveying sites several times during each visit. Occasionally, the island visits were limited to one or two days, but those shortened time frames still allowed each of the five sites to be surveyed at least once per visit. As the focus was on diurnally-active birds, the systematic surveys were done in daylight hours. The first surveys were in September 2012. During the next five years, there were two visits per year – in autumn and spring (there was no spring visit in 2015). From mid-2017, the visits became quarterly. The island was surveyed at five discrete sites, using BirdLife Australia's 500 m-radius survey protocol (https://birdata.birdlife.org.au/home) in which the survey duration is not fixed. Typically, the duration on Broughton Island was 1-2 hours per site. Three were wholly terrestrial; they occurred within three sectors of the island (north-west, north-east, south-west). The other two sites covered the coastline and inshore waters of Providence Beach, on the northern side of the island, and Esmeralda Cove on the south-eastern side (see Fig. 1; also see Stuart *et al*. 2017 for additional details about the site locations). The latter two sites provided records of shorebirds and raptors (as well as waterbirds, such as cormorants, which are outside the scope of this paper).

During the surveys we also recorded any evidence of breeding activity, such as birds on nest or with dependent young. Although it seems likely that some instances of breeding could have been overlooked, the surveys were done by experienced observers and there were no time constraints, hence suspected breeding activities could be fully investigated.

Where relevant for this report, we have used findings from a terrestrial bird banding project on Broughton Island (see Little and Stuart 2022 for background information about the banding project). From mid-2017, there have been simultaneous bird monitoring and bird banding activities during each visit to the island.

Data management and data analysis

The records from all surveys were entered into BirdLife Australia's Birdata portal (www.birdata.birdlife.org.au) in real time. In September 2025, we downloaded the results for the five sites. For the three wholly terrestrial sites, we calculated the

Table 1

Species with significant or near-significant changes in their number of autumn and spring records, for September 2012 to December 2019 compared with January 2020 to June 2025.

Species	2012-2019	2020-2025		
Wholly terrestrial sites	No. of records (from 82 surveys)	No. of records (from 73 surveys)	χ2 value	Change
Buff-banded Rail	3	13	4.09	Significant increase
Golden-headed Cisticola	75	45	10.82	Highly significant decrease
Red-browed Finch	0	12	8.88	Highly significant increase
Coastal/inshore sites	No. of records (from 55 surveys)	No. of records (from 53 surveys)		
Australasian Pipit	26	16	3.07	Near-significant decrease
Lewin's Rail	10	1	6.76	Highly significant decrease
Ruddy Turnstone	15	3	8.02	Highly significant decrease
All five sites	No. of records (from 137 surveys)	No. of records (from 126 surveys)		
Black-shouldered Kite	32	15	4.2	Significant decrease
Whistling Kite	63	38	3.88	Significant decrease

reporting rates for terrestrial species in each site and collectively (i.e. for the three sites combined). The reporting rate is the number of records divided by the number of surveys, expressed as a percentage. Similarly, we calculated the reporting rates for coastline species for the Providence Beach and Esmeralda Cove sites. We also calculated trip-visit reporting rates, these being a measure of how frequently each species was present on the island.

We also determined the numbers of records for the above species within two time periods (September 2012 to December 2019 and January 2020 to June 2025, covering the initial and the latter parts of the study) and assessed whether any of the differences were statistically significant. Because the 2012 to mid-2017 visits were only done in autumn or spring, we restricted our comparisons to the results for just those two seasons. For the wholly terrestrial sites, there were 82 surveys in the first time period, and 73 surveys in the second period (and 55 and 53 surveys, respectively, for the two coastal sites). We used the Chi-Square Test (Pearson's Goodness-of-Fit Test) with a Yates correction for one degree of freedom (Fowler and Cohen 1994; Sokal and Rohlf 1995). Calculated Chi-Square (χ^2) values above 3.84 indicate a significant difference in the two data sets, to at least 95% confidence level, while χ^2 values above 6.63 indicate that the difference is highly significant, to at least 99% confidence level. We also treated χ^2 values of 3.0-3.83 as indicating statistically near-significant changes (for one degree of freedom, a χ^2 value of 3.0 is equivalent to p of 0.92). We took into account that the Chi-Square test requires a minimum number of records for the result to be valid.

To further assess for any changes in avian diversity on the island, we searched the Birdata archives (https://birdata.birdlife.org.au/home) Accessed 25 June 2025 for the dates of historical records of various species. Prior to the HBOC surveys starting, there were only 12 surveys for Broughton Island archived in Birdata, spanning 1999-2012. The specific details about the areas covered in those surveys are not available to us. There were no records for Broughton Island in eBird until about five years ago.

RESULTS

From 2012 to mid-2025, there were 39 two- or three-day visits to the island, with 93 species recorded including non-terrestrial birds and vagrants. Twenty-six species were common – they had trip-visit reporting rates above 60% – and a further 27 species had multiple records. However, the latter included three breeding seabird species, which only were recorded incidentally during visits to the island and which we excluded from further analysis. The remaining 50 species comprised 23 terrestrial birds, six shorebirds, 11 waterbirds (including coastal/inshore specialists such as gulls, terns and cormorants) and ten birds of prey. There were breeding records for 20 species (including the three seabird species), as listed in Table 2.

Typical 2-3 day visits to Broughton Island recorded 30-40 species – comprising 30-35 "regulars" (including non-terrestrial birds) and a selection of less common birds plus vagrants. The annual list of recorded species was quite varied, being dependent upon the number of visits for the year and their duration, plus unknown factors. Although trends in annual species counts is a potential measure of richness/diversity changes, we could not find any short-term trends. However, during the first seven years we recorded 30 species, excluding non-terrestrial and vagrants (species with less than three records in the time period), and then 39 species in the second time period – a 30% increase in species richness.

New arrivals

Five species have become regularly recorded on Broughton Island since feral mammals were removed: Silvereye *Zosterops lateralis* (first recorded 2011, a Birdata record), Yellow-faced Honeyeater *Caligavis chrysops* (first recorded April 2009, a Birdata record; regular since 2012), Brown Goshawk *Accipiter fasciatus* (first recorded 2013), Little Wattlebird *Anthochaera chrysoptera* (first recorded 2014) and Red-browed Finch *Neochmia temporalis* (first recorded 2021). Silvereyes and Yellow-faced Honeyeaters have trip-visit reporting rates of 97-100% across 2012-2025, the overall reporting rates for the three

other species were lower than that but Red-browed Finches were recorded on almost every visit after they first arrived.

Unlike the other arriving bush bird species, Little Wattlebirds have never been present in large numbers; the maximum count of them was four birds and during 2024-25 there were only occasional records of a single bird. All the Brown Goshawk sightings have involved single birds, although three individuals have now been banded on the island, including a female and a male on the same day (G. Little, *pers. comm*.).

The 2009 record for Yellow-faced Honeyeater was of two birds in April, which was during the species' known migration period. Given birds were not recorded in visits to the island in December 2009, November 2010 or November 2011, they seems not to have been resident or regularly present on the island prior to 2012.

As well as the above five regular species, the Grey Fantail is now a regular autumn/winter visitor to the island, but it was not recorded until 2013. There were no records of Lewin's Rail *Lewinia pectoralis* before the surveys started, and neither the Buff-banded Rail *Gallirallus philippensis* nor the Golden Whistler *Pachycephala pectoralis* were recorded before 2016. The rail species, although both are cryptic and rarely seen, are now heard regularly all year, and occasionally seen, from locations all over the island. The Golden Whistler has become a regular autumn/winter visitor, in low numbers, since 2016; by now, several individuals have been banded but with no retraps (G. Little, *pers. comm*.).

Changes in reporting rates

In Table 1, we list the species for which the changes in reporting rates were either statistically near-significant, significant or highly significant (i.e., all those species with calculated χ^2 values above 3.0). Two species had notable increases in their number of records, Buff-banded Rail and Red-browed Finch; in both cases the changes were statistically highly significant. Four species had statistically significant decreases in number of records, and there was a near-significant decrease in the number of records of Australian Pipit *Anthus australis*. For two raptors, Black-shouldered Kite and Whistling Kite, the changes were observed across all five sites.

DISCUSSION

Vegetative changes

Our qualitative assessment is that there has been considerable change since the most recent formal reassessment of the state of vegetation on Broughton Island (Somerville *et al*. 2018). A substantial amount of the central section of the island is now covered in large shrubs or trees, principally Corkwood *Duboisia myoporoides*, Tree Broom Heath *Monotoca elliptica*, Coast Wattle *Acacia sophorae* and some stands of Coast Banksia *Banksia integrifolia*. The more wind-swept southern and eastern parts of the island remain dominated by open grassland and sedgeland habitats, but these areas are now interspersed with sprawling stands of Coast Wattle and, less frequently, Tree Broom Heath. The rate of growth in the grassland habitats is such that most walking tracks have all-but disappeared, except for the main ones, which are mowed occasionally by NPWS staff. Alien weed species have become dominant in some grassland areas, particularly Prickly Pear *Opuntia* spp. and Common Morning Glory *Ipomoea purpurea*.

Table 2

Species with breeding records on Broughton Island since 2012.

Species
Brown Quail *Synoicus ypsilophorus*
Bar-shouldered Dove *Geopelia humeralis*
Buff-banded Rail *Gallirallus philippensis*
Little Penguin *Eudyptula minor*
Gould's Petrel *Pterodroma leucoptera*
Wedge-tailed Shearwater *Ardenna pacifica*
Australian Pied Oystercatcher *Haematopus longirostris*
Sooty Oystercatcher *Haematopus fuliginosus*
Red-capped Plover *Charadrius ruficapillus*
Silver Gull *Chroicocephalus novaehollandiae*
Greater Crested *Tern Thalasseus bergii*
Osprey *Pandion haliaetus*
Peregrine Falcon *Falco peregrinus*
Yellow-faced Honeyeater *Caligavis chrysops*
Australian Raven *Corvus coronoides*
Golden-headed Cisticola *Cisticola exilis*
Tawny Grassbird *Cincloramphus timoriensis*
Welcome Swallow *Hirundo neoxena*
Silvereye *Zosterops lateralis*
Red-browed Finch *Neochmia temporalis*

The now-extensive areas of Tree Broom Heath have become important for passerine species such as Yellow-faced Honeyeaters and Silvereyes. Banding studies have shown that there is a resident population of Silvereyes (G. Little, *pers. comm*.), but in the years when there has been prolific flowering and fruiting by Tree Broom Heath, there have been substantial influxes of additional Silvereyes, and of Yellow-faced Honeyeaters to a lesser extent.

Changes in species richness/diversity

Nine species have become regular on Broughton Island, presumably in response to the habitat changes that already have occurred. Two of those species, Grey Fantail and Golden Whistler, are regular autumn/winter visitors. Prior to 2012, visits by birdwatchers outside of late spring and summer were infrequent. It is possible that these two species already were travelling to the island but were overlooked. However, the balance of probabilities suggests not, especially for the Golden Whistler where the first record was not until in 2016.

There were no records of Lewin's Rail before the surveys started, and none of Buff-banded Rail until 2016. These cryptic species possibly were overlooked in earlier visits. Buff-banded Rails are known co-exist with rodents and also to be susceptible to rodenticides (O'Dwyer *et al*. 2024), and the same probably applies for Lewin's Rails. It cannot be excluded that they were present prior to the removal of feral mammals and that mortalities occurred during the removal phase. Equally, they may have benefitted from the availability now of substantial areas of rank grasses and other dense ground cover. The number

of records for Buff-banded Rails have increased significantly over time.

We found the Lewin's Rail to have declined in our surveys of the coastal sites, but that was due to special circumstances. Between 2012 and 2021, we recorded it regularly around the huts at Esmeralda Cove. The rank vegetation around the huts is now regularly slashed, and the Lewin's Rail territory boundary has retreated to outside of the survey area for the Esmeralda Cove coastal site. Based upon the results from the wholly terrestrial surveys, the Lewin's Rail population is stable.

The decline of the Golden-headed Cisticola population due to the vegetative changes was statistically highly significant. It has now become uncommon to find them in the central parts of the island, where the vegetative changes are greatest, although they continue to be present in the windswept grassland areas in the southern and eastern parts of it (sampled by the north-east and south-west terrestrial surveys). For example, we found no significant change in the reporting rate for them in the north-eastern sector of the island (χ^2 value 0.83).

Fraser (2021a) reported the Whistling Kite to be the second-most common raptor on Broughton Island. That situation has changed, such that birds no longer are always present and the overall reporting rate has dipped below 80%. The decline was evident for the wholly terrestrial sites and for the coastal sites, and similarly for the Black-shouldered Kite. Because of their timing, it seems clear that these declines are not specifically linked to the absence of mammalian prey, and thus we speculate that the foraging opportunities for these two raptors have become more limited now that vegetative cover on the island has increased. However, the Whistling Kite population in nearby Port Stephens is also in decline (Stuart 2024) and so there might be a more widespread explanation for the change.

Two other species have become uncommon on the island: Ruddy Turnstone *Arenaria interpres* and Australian Pipit. Ruddy Turnstones were often found on Providence Beach during 2012-2020, but there have not been any records since October 2020. This change probably reflects the decline of this species in the East Asian-Australasian Flyway; it has recently been classified as Vulnerable in New South Wales (NSW Threatened Species Scientific Committee 2025). Australian Pipits were regularly recorded in small numbers at several locations around the island, but since 2022 they have become uncommon. We suggest that there is less foraging habitat available now that vegetative cover on the island has increased.

Breeding records

Prior to 2012, only seven species had breeding records on Broughton Island: Wedge-tailed Shearwater *Ardenna pacifica* , Short-tailed Shearwater *A. tenuirostris* and Little Penguin *Eudyptula minor* were known to be breeding regularly and successfully (Carlile *et al*. 2012), Silver Gull *Chroicocephalus novaehollandiae* and Greater Crested Tern *Thalasseus bergii* had variable breeding populations (Carlile *et al*. 2012), and there were one-off records of breeding by Sooty Oystercatcher *Haematopus fuliginosus* (SC, *pers. obs*.) and Gould's Petrel *Pterodroma leucoptera* (Carlile *et al*. 2012). There were no breeding records for terrestrial species in Birdata nor are we aware of any anecdotal reports of them breeding. However, such records probably would have been under-recorded and/or under-reported.

Although there were no breeding records on Broughton Island for Brown Quail *Synoicus ypsilophorus* Golden-headed Cisticola *Cisticola exilis*, Tawny Grassbird *Cincloramphus timoriensis* or Welcome Swallow *Hirundo neoxena* prior to 2012, these four species were common, and probably were resident. It seems likely that they would have been breeding. There now are regular breeding records for them.

While there are no confirmed breeding records for Lewin's Rail, there have been several for Buff-banded Rail since 2016.

Ospreys *Pandion haliaetus* were present on Broughton Island prior to feral mammal removal. However, the first confirmed breeding record was not until 2016, at a nest constructed in the south-eastern part of the island (Fraser 2021a). Since then, a pair has bred there regularly, fledging 1-2 chicks most years.

There was only one known breeding record for Sooty Oystercatchers prior to 2012. Now, successful breeding has occurred at six locations around the island. It is possible that some earlier breeding attempts would have been overlooked, as most of the recent breeding locations are not easy to access; however, Fraser (2021b) speculated that Sooty Oystercatcher breeding success has improved because of the absence of rats.

Ongoing change

Although some changes to bird populations on Broughton Island occurred relatively quickly, other changes are more recent, for example, the arrival of Red-browed Finches in 2021, the decline in Australian Pipits since 2022 and the decline in Whistling Kites since 2023. It is now 16 years since feral mammals were removed, which probably is still early days in the restoration process. For example, a multi-decade study on New Zealand's Moturoa Island (at 150 ha, similar in size to Broughton Island) following removal of rats *Rattus* spp. and Stoats *Mustela ermina* in the 1980s found that gradual, longer-term shifts only started to become clear during 'maturation', a period beginning about 13 years after predator control started (Ralph *et al*. 2022). Shifts in species composition were still ongoing on Moturoa Island 20 years after predator control, with both gradual, long-term increases and declines.

Individual Black Rats were detected on Broughton Island on two occasions in 2025. Although both individuals were subsequently removed, there will need to be constant vigilance if the island is to remain free of mammalian predators.

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