



Bird studies on Broughton Island 2017-2020

Alan Stuart

Hunter Bird Observers Club Special Report No. 9

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Cover Photo: Tawny Grassbird *Cincloramphus timoriensis* (Photographer: Alan Stuart)

This male Tawny Grassbird was banded as an adult bird on Broughton Island on 4 November 2018 and photographed in the same area on 27 October 2019.

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Introduction

A study of terrestrial birds on Broughton Island commenced in 2012. The first five years (2012-16) involved twice-yearly surveys of birds on the island, carried out in autumn and spring (Stuart *et al.* 2017). That initial study (the “Phase 1 study”) produced a baseline dataset of information about the common terrestrial birds on the island, and the then-uncommon and vagrant species, against which future changes to the island’s bird population could be measured.

One of the recommendations from the 2012-16 report was to expand the scope of the Broughton Island study by starting a bird-banding project, in order to gain better understandings about which species were resident and to develop insights into the sizes of their populations on the island, and to learn about movements to and from the island (Stuart *et al.* 2017). The expanded study of Broughton Island’s terrestrial birds (the “Phase 2 study”) started in June 2017. In the three years to June 2020, there have been 12 field trips to the island. Each trip has had two main objectives:

- Identify any changes that have occurred to the island’s overall bird diversity, by carrying out systematic surveys. In those surveys, record all species present in previously selected habitats that were deemed to be representative of the overall mix of habitat types on the island.
- Gain insights into the population dynamics of the island’s main species, by means of a rigorous bird banding study.

This report summarises the progress made on both these objectives. The report is divided into two main sections:

- An overview of the species recorded in the quarterly surveys, and comments about any apparent trends.
- An overview of the bird banding project, with a focus on interpreting the results for the three species most commonly captured.

The report also recommends some directions for future studies.

Figure 1. Aerial view of Broughton Island when approaching from the west (photo: Alan Stuart).



Figure 2. The team for the October 2019 field trip to Broughton Island (photo taken by Susanne Callaghan, using a timer). (L to R: Neil Fraser, Tom Clarke, Susanne Callaghan (crouching), Emily Mowat, Alan Stuart, Mel Wells, Rob Kyte, Josie Hewitt, Judy Little, Greg Little).



Methods

The first visit to the island for the current study was in June 2017. Subsequent field trips were at intervals of approximately three months, with their timing and duration governed by weather conditions and personnel availability. The dates for each visit are in **Table 1**. Most field trips involved a stay of two nights on the island. In August 2018, weather conditions limited the field trip to a single night. There was no autumn 2020 visit, because of travel restrictions which were in effect in NSW at that time.

Table 1. Dates of field trips to Broughton Island for period June 2017-June 2020.

Year	Dates
2017	28-30 June
	13-15 October
2018	19-21 January
	20-22 April
	17-18 August
	2-4 November
2019	2-4 February
	11-13 May
	27-29 July
	25-27 October
2020	31 January-2 February
	6-8 June

All field trips had at least four participants; most of them had 6-8 people involved and two of the trips had 8-10 participants including some as day visitors. For each field trip, at least three people focussed their activities on bird capture and banding; and with at least one person (usually 2-3 people) focussed on carrying out systematic surveys.

Bird surveys

In 2012, at the start of the overall study, eleven sites were selected for regular surveys. Six of those sites (with ID codes BT1-BT6) were chosen as representing the main habitat types on the island. Each site has a nominal area of 2 ha and the standard BirdLife Australia 2 ha / 20-minute survey protocol was used for every survey of them. The five larger sites, each of nominal 500 m radius, sub-divide the island into three approximately equally-sized terrestrial areas (sites BT7-BT9) and two coastal/inshore areas (sites BT10, BT11). Every survey of these five sites has used the standard BirdLife Australia 500m radius area survey protocol, involving variable survey duration. **Figure 2** shows the locations of the eleven sites on the island and the general survey route, and **Table 2** provides a basic description of each site.

Figure 2. Broughton Island showing the survey areas BT1–BT11 and indicating the survey routes (Inset: location of the Broughton Group of islands); reproduced from Stuart *et al.* 2017.

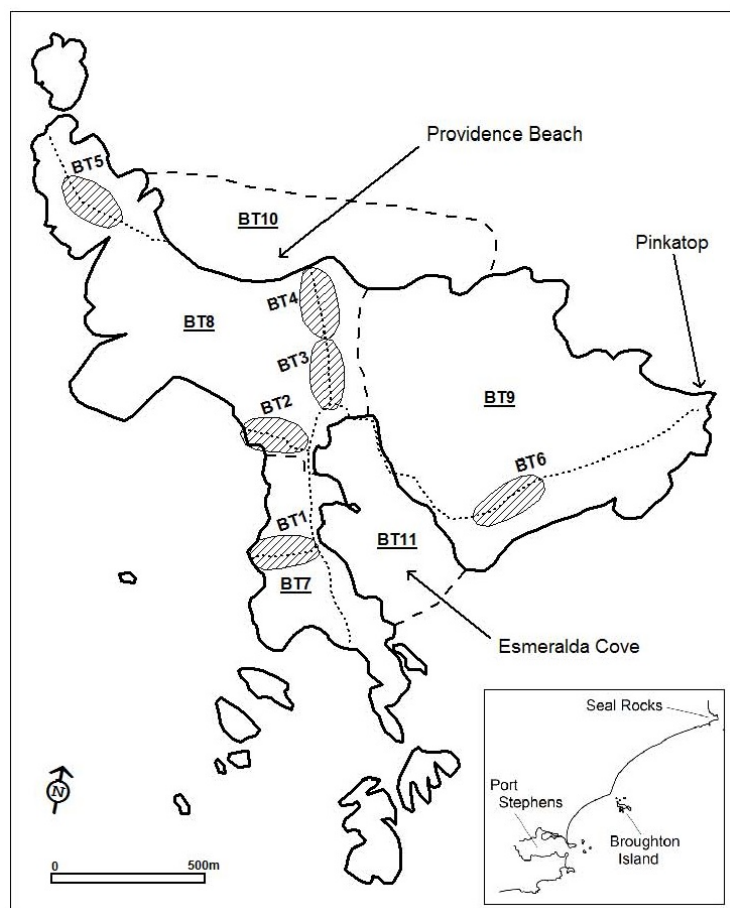


Table 2. The eleven survey areas on Broughton Island (reproduced from Stuart *et al.* 2017).

Site ID	Type	Mid-point	General description
BT1	2 ha	32° 37' 17"S 152° 18' 51"E	Grasses and heath, scattered small shrubs.
BT2	2 ha	32° 37' 05"S 152° 18' 49"E	Shrubs with some areas of grasses and heath, a small wetland.
BT3	2 ha	32° 36' 59"S 152° 18' 56"E	Shrubs including one large banksia.
BT4	2 ha	32° 36' 51"S 152° 18' 55"E	Shrubs and a large area of grasses and heath, and hind-dune swale.
BT5	2 ha	32° 36' 45"S 152° 18' 25"E	Grasses and heath, several small shrubs. An exposed elevated site affected by wind shear.
BT6	2 ha	32° 37' 12"S 152° 19' 06"E	Grasses and heath, a few small shrubs. An exposed elevated site affected by wind shear.
BT7	500 m	32° 37' 18"S 152° 18' 53"E	Grasses and heath with pockets of shrubs and trees; rocky foreshore and some inshore rock platforms.
BT8	500 m	32° 36' 56"S 152° 18' 44"E	Grasses and heath with pockets of shrubs and trees and a wetland; rocky foreshore and some inshore rock platforms.
BT9	500 m	32° 37' 03"S 152° 19' 16"E	Grasses and heath with pockets of shrubs and trees; rocky foreshore and some inshore rock platforms
BT10	500 m	32° 36' 46"S 152° 18' 51"E	Extensive sandy beach (Providence Beach) with some inshore rock platforms and open water.
BT11	500 m	32° 37' 08"S 152° 18' 59"E	Esmeralda Cove: open waters, extensive inshore rock platforms, small sandy beaches.

Surveys were conducted every available morning and afternoon and involved randomly-scheduled visits to each of the eleven sites. Results from each survey, including start and finish times, the species present and their estimated numbers, were entered into the national database, Birdata. An overall bird list was also generated for each field trip, and the list was entered into Birdata. This allowed records of uncommon and vagrant species to be captured, since such species sometimes were recorded outside of the formal surveys of the eleven sites.

A bird list for Broughton Island spanning 2017-2020 was generated by extracting the relevant records from Birdata. The list was based upon a combination of the birds recorded during formal surveys, birds recorded on the overall list for each visit, and the sightings from visits by credible observers who visited the island at some other time and who logged their records in Birdata.

Bird banding

Approval was obtained from the Australian Bird and Bat Banding Scheme (ABBBS) for a project led by Greg Little to capture and band terrestrial birds on Broughton Island (ABBBS Authority No: 2899). Most of the bird-banding activities have involved mist-netting (Little *et al.* 2020). Several other methods for capturing birds have been investigated; these largely have been unsuccessful. Where appropriate, bird capture or attempted capture by non-standard methods is discussed in the species accounts.

Mist-netting was done at one set of sites in the afternoon of Day 1 and morning of Day 2, and at a second set of sites in the afternoon of Day 2 and morning of Day 3. The August 2018 visit was shorter and so that trip involved just two half-days of banding activities.

All of the locations for bird trapping (across all field trips) were within an approximate 300 m radius of one another, centred around the south-east part of site BT8. The specific locations for nets (or other trapping methods) were chosen at the start of each field trip, with their selection being based upon observed higher levels of bird activity from an initial reconnaissance. Birds were taken to a centrally-located banding station for processing. After processing, mobile species such as Silvereyes were released near the banding station; all other species were released in the area where they had been caught.

Figure 3. A banding station on Broughton Island; L to R: Josie Hewitt, Rob Kyte, Judy Little (photo: Greg Little).



Figure 4. A 9 m five-shelf mist net in operation on Broughton Island (photo: Rob Kyte).



Results

1. Bird surveys

From June 2017 to June 2020, 180 surveys were carried out, across the eleven survey sites. The least-surveyed site was BT5 (nine surveys from 12 field trips) and the most-surveyed site was BT10 (26 surveys). Site BT10, based on Providence Beach, is tidally influenced and the aim has been to survey it at least once at high tide and at least once at low tide during each field trip.

Overall, 64 species have been recorded since June 2017, including 53 species during the formal surveys, and an additional 11 species recorded either during a field trip but outside of the formal surveys, or by a credible observer at other times. Eleven species have had breeding records.

1.1. Common species

Twenty species have been recorded at least 20 times during the surveys since June 2017. **Table 3** shows number of records for each species. Reporting Rates (RR; number of times recorded, divided by number of surveys) are not presented in the Table. Often RRs are a useful indicator of abundance/distribution; however, for the present purpose they would be misleading, because of the varying survey effort across varying habitat types. RRs are discussed later, for some specific species.

Table 3. The most common species on Broughton Island 2017-2020, presented in descending order of numbers of records (all species with more than 20 records during 180 formal surveys).

Common Name	Scientific Name	No of records
Welcome Swallow	<i>Hirundo neoxena</i>	124
Tawny Grassbird	<i>Cincloramphus timoriensis</i>	115
Silvereye	<i>Zosterops lateralis</i>	94
Golden-headed Cisticola	<i>Cisticola exilis</i>	88
Silver Gull	<i>Chroicocephalus novaehollandiae</i>	82
Brown Quail	<i>Synoicus ypsilophora</i>	76
Australian Raven	<i>Corvus coronoides</i>	69
Sooty Oystercatcher	<i>Haematopus fuliginosus</i>	64
Osprey	<i>Pandion haliaetus</i>	53
Bar-shouldered Dove	<i>Geopelia humeralis</i>	51
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	47
Yellow-faced Honeyeater	<i>Caligavis chrysops</i>	38
Crested Tern	<i>Thalasseus bergii</i>	34
Pied Cormorant	<i>Phalacrocorax varius</i>	33
Whistling Kite	<i>Haliastur sphenurus</i>	30
Australasian Pipit	<i>Anthus novaeseelandiae</i>	30
Eastern Reef Egret	<i>Egretta sacra</i>	29
Swamp Harrier	<i>Circus approximans</i>	28
Great Cormorant	<i>Phalacrocorax carbo</i>	27
Little Wattlebird	<i>Anthochaera chrysoptera</i>	21

1.2. Terrestrial birds

Table 4 is a list of the 31 terrestrial species recorded since June 2017; note that it includes species recorded during some single-day visits to Broughton Island i.e. on some dates that were not presented in **Table 1**. Sixteen of the species were vagrants, only present on the island for a short time. Eleven species appear to be resident on the island. The other four species are discussed further below.

Table 4. Terrestrial birds recorded since June 2017 (presented in taxonomic order).

Common Name	Scientific Name	Comments
Brown Quail [#]	<i>Synoicus ypsilophora</i>	Common and widespread
Bar-shouldered Dove [#]	<i>Geopelia humeralis</i>	Common and widespread
Pheasant Coucal	<i>Centropus phasianinus</i>	Uncommon, possibly has declined
Channel-billed Cuckoo	<i>Scythrops novaehollandiae</i>	Vagrant: single bird 31 Jan 2020
Horsfield's Bronze-Cuckoo	<i>Chalcites basalus</i>	Vagrant: four birds 13-15 Oct 2017
Shining Bronze-Cuckoo	<i>Chalcites lucidus</i>	Vagrant: single birds 17-18 Aug 2018; 29 July 2019
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>	Vagrant: single bird 28-29 July 2019
Pallid Cuckoo	<i>Heteroscenes pallidus</i>	Vagrant: single bird 13 Sep 2017
White-throated Needletail	<i>Hirundapus caudacutus</i>	Vagrant: two birds 31 Jan 2020
Fork-tailed Swift	<i>Apus pacificus</i>	Vagrant: six birds 19 Dec 2019
Sacred Kingfisher	<i>Todiramphus sanctus</i>	Single bird 25-26 Oct 2019; 31 Jan 2020
Scarlet Honeyeater	<i>Myzomela sanguinolenta</i>	Vagrant: two birds 13 & 15 Oct 2017
Little Wattlebird	<i>Anthochaera chrysoptera</i>	Common but only around site BT3
Yellow-faced Honeyeater	<i>Caligavis chrysops</i>	Common within site BT8
Spotted Pardalote	<i>Pardalotus punctatus</i>	Vagrant: two birds 31 Jan & 2 Feb 2020
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	Vagrant: single bird 25-26 Oct 2019
White-winged Triller	<i>Lalage tricolor</i>	Vagrant: single birds 15 Oct 2017; 9 Oct 2019
Golden Whistler	<i>Pachycephala pectoralis</i>	Single birds 24 June 2017; 13 Oct 2017; 20-22 Apr 2018; 12 May 2019; 25-26 Oct 2019
Olive-backed Oriole	<i>Oriolus sagittatus</i>	Vagrant: single birds 13 Oct 2017; 25 Oct 2019
Spangled Drongo	<i>Dicrurus bracteatus</i>	Vagrant: single bird 20 Apr 2018
Willie Wagtail	<i>Rhipidura leucophrys</i>	Often present, peak count three birds
Grey Fantail	<i>Rhipidura fuliginosa</i>	Single birds 22 Apr 2018; 17 Aug 2018; 12 May 2019; 27-29 July 2019; 8 June 2020
Australian Raven	<i>Corvus coronoides</i>	Common and widespread
Eastern Yellow Robin	<i>Eopsaltria australis</i>	Vagrant: single bird 27-29 July 2019
Australasian Pipit [*]	<i>Anthus novaeseelandiae</i>	Uncommon, mostly on beaches and dunes
Golden-headed Cisticola [#]	<i>Cisticola exilis</i>	Common, although has declined
Brown Songlark	<i>Cincloramphus cruralis</i>	Vagrant: single bird 26 Oct 2019
Tawny Grassbird	<i>Cincloramphus timoriensis</i>	Common and widespread
Tree Martin	<i>Petrochelidon nigricans</i>	Vagrant: single bird 19 Jan 2018
Welcome Swallow [#]	<i>Hirundo neoxena</i>	Common and widespread
Silvereye [#]	<i>Zosterops lateralis</i>	Common and widespread

[#]2017-2020 breeding record/s ^{*}Pre-2017 breeding record/s only

The most common terrestrial birds have been Brown Quail, Bar-shouldered Dove, Australian Raven, Australasian Pipit, Golden-headed Cisticola, Tawny Grassbird, Welcome Swallow and Silvereye. All bar Australasian Pipit are widespread around the island; most records of the Pipit are from along

Providence Beach and occasionally at Esmeralda Cove. The Golden-headed Cisticola is now uncommon in the central parts of the island but remains common elsewhere; its decline seems to be from areas where the vegetation has become denser (see the later Discussion).

Little Wattlebird and Yellow-faced Honeyeater also are common species on Broughton Island. Both species have self-introduced to the island since 2012 (Stuart *et al.* 2017). However, there are only a small number of Little Wattlebirds (most estimates have been of 2-4 birds) and they are only found in or near a small section of *Banksia integrifolia* near the centre of the island (in survey area BT3, see **Figure 2**). Although the Yellow-faced Honeyeaters also prefer that part of the island, they have spread out more widely and there have been at least 19 birds recorded (see the Banding section of this report for more information).

It was estimated from the 2012-2016 surveys that there were two pairs of Pheasant Coucal on the island (Stuart *et al.* 2017). However, there have been no records since then of any birds at one territory (which was in the BT9 area) and only occasional records of birds from the other territory (which is in the BT8 area).

There have been many records of the Willie Wagtail, mainly from Esmeralda Cove and Providence Beach and usually as single birds. Three birds were flying together in the BT4 site (see **Figure 2**) on 7 June 2020, and later that morning two birds were recorded together along Providence Beach with a third bird heard nearby (presumed therefore to be the same group of three birds). However, Willie Wagtails seem not to be resident on the island, since on several field trips no birds have been detected.

A Shining Bronze-Cuckoo was present on Broughton Island over 17-18 Aug 2018 and a bird was also recorded on 29 July 2019. The latter bird was captured and banded, and was identified as subspecies *plagosus*.

Figure 5. Shining Bronze-Cuckoo ssp *plagosus*, Broughton Island 29 July 2019 (photo: Greg Little).



There have been regular records of Grey Fantail (although mainly in autumn/winter); all records have been of single birds. However, although a Grey Fantail was captured and banded on the island in July 2019, a bird seen in June 2020 had no band. Thus, there have been at least two birds on the island.

The first Sacred Kingfisher record for the island was on 25 October 2019; the bird was captured and banded the following day. What probably was the same bird was recorded again on 31 January 2020 (no band was visible, but the views were distant). Sacred Kingfishers are summer migrants, arriving

in the Hunter Region in spring and staying for about six months (Williams 2019). The likely scenario was that the same bird spent the entire migratory season on Broughton Island.

The Golden Whistler records all were of single birds. A bird was captured and banded 24 June 2017; the subspecies was not noted. Since then, there have been records on four of the subsequent field trips. In those records, no band was noticed, but the views were brief. The likely scenario is that it has been the same bird on Broughton Island since September 2016.

1.3. Waterbirds and shoreline/coastal birds

Table 5 lists the 19 waterbird and shoreline/coastal bird species recorded since June 2017; note that the Table includes species recorded during some single-day visits to Broughton Island i.e. on some dates that were not presented in **Table 1**.

Table 5. Waterbirds and shoreline/coastal birds recorded since June 2017 (presented in taxonomic order).

Common Name	Scientific Name	Comments
Lewin's Rail	<i>Lewinia pectoralis</i>	Uncommon but widespread
Buff-banded Rail*	<i>Hypotaenidia philippensis</i>	Uncommon but widespread
Australian Pied Oystercatcher*	<i>Haematopus longirostris</i>	Pairs 25 June 2017; 6 June 2020
Sooty Oystercatcher#	<i>Haematopus fuliginosus</i>	Common and widespread
Red-capped Plover*	<i>Charadrius ruficapillus</i>	Common on Providence Beach
Double-banded Plover	<i>Charadrius bicinctus</i>	Single bird 17-18 Aug 2018, three birds 11 May 2019
Bar-tailed Godwit	<i>Limosa lapponica</i>	Vagrant: single bird 14 Oct 2017
Ruddy Turnstone	<i>Arenaria interpres</i>	Single birds 13-15 Oct 2017; 28-29 July 2019; 25-26 Oct 2019
Arctic Jaeger	<i>Stercorarius parasiticus</i>	Single bird 1 Feb 2020
Silver Gull*	<i>Chroicocephalus novaehollandiae</i>	Common and widespread
Crested Tern*	<i>Thalasseus bergii</i>	Widespread
Australian Pelican	<i>Pelecanus conspicillatus</i>	Vagrant: single bird 24 June 2017
White-faced Heron	<i>Egretta novaehollandiae</i>	Uncommon but widespread
Eastern Reef Egret	<i>Egretta sacra</i>	Uncommon but widespread
Australasian Gannet	<i>Morus serrator</i>	Common inshore in winter
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>	Uncommon
Great Cormorant	<i>Phalacrocorax carbo</i>	Common and widespread
Pied Cormorant	<i>Phalacrocorax varius</i>	Common and widespread
Australasian Darter	<i>Anhinga novaehollandiae</i>	Vagrant: single birds 25 & 27 Oct 2019; 6-8 June 2020

#2017-2020 breeding record/s *Pre-2017 breeding record/s only

The most common shorebird has been the Sooty Oystercatcher, which is listed as Vulnerable under the NSW Biodiversity Conservation Act. 15-20 birds often were recorded at Providence Beach, especially at high tide, and there are an estimated 30-35 birds on the island overall. Broughton Island has recently been recognised as one of the most important sites for Sooty Oystercatchers within the Hunter Region (Wooding 2019). In October 2019, two pairs had nests with eggs, and subsequent visits in December and January established that both pairs were with chicks. These were the first confirmed breeding records for Sooty Oystercatcher on Broughton Island since the late 1990s (Wooding 2019).

Other commonly recorded species have been Red-capped Plover, Silver Gull, Crested Tern, White-faced Heron (as single birds), Eastern Reef Egret, Great Cormorant and Pied Cormorant. In winter, Australasian Gannets often were fishing in inshore waters. Silver Gulls and Crested Terns breed on the island every year, with the main breeding colonies being around the southern part of the island.

Figure 6. The two nests of Sooty Oystercatchers found in the October 2019 field trip (Photos: Neil Fraser).



Figure 7. Crested Tern chick and eggs at the breeding colony, photographed during the October 2019 field trip (Photos: Neil Fraser).



There have been no breeding records for the other common species of **Table 4**; however, in February 2020 an inactive nest thought to belong to a pair of Eastern Reef Egrets was found in a grotto near Esmeralda Cove. A Reef Egret's feather was alongside the nest. In the June 2020 field trip, motion-sensitive cameras were installed with the aim to try to monitor activity at and around the nest.

Figure 8. Nest thought to belong to Eastern Reef Egrets, located in a grotto on Broughton Island near Esmeralda Cove (photo: Rob Kyte).



From the 2012-2016 surveys, Broughton Island became known to be a reliable site for Lewin's Rails and Buff-banded Rails (Stuart *et al.* 2017), both of which are infrequently recorded elsewhere in the Hunter Region. That situation continued over 2017-2020, with many and widespread records of both species. However, there were no Lewin's Rail records in the April and August 2018 visits, nor in the February 2019 visit. Conditions were dryer then and possibly the birds were calling less often (or, had departed the island). Buff-banded Rails also were not recorded on every visit; however, there seems no obvious pattern of presence/absence. Both of the rail species are cryptic and easily over-looked especially if they do not call.

Pairs of Australian Pied Oystercatcher have been recorded twice; both times the birds were on Providence Beach. The species is listed as Endangered under the NSW Biodiversity Conservation Act. Port Stephens is a stronghold for them (Fraser 2020) and the records might indicate newly-formed pairs from Port Stephens searching for suitable breeding territory. Both records have been in winter. Two other occasionally-visiting shorebirds have been Double-banded Plover, which migrates from New Zealand, and Ruddy Turnstone which migrates from the northern hemisphere. Five Ruddy Turnstones were present on Providence Beach on 1 December 2016 (Neil Fraser pers. comm.) and there also were some other Ruddy Turnstone records from the 2012-2016 surveys (Stuart *et al.* 2017).

1.4. Birds of prey

Table 6 is a list of the nine birds of prey (raptors) recorded since June 2017. Five species have been present on most if not all visits: Osprey, Black-shouldered Kite, Swamp Harrier, White-bellied Sea-Eagle, Whistling Kite. There also have been regular records of 1-2 Peregrine Falcons (mainly from the area around Pinkatop) and of a Brown Goshawk (mainly from around the BT8 area). In May 2019, two Brown Goshawks were caught and banded, with one of those birds being an adult female and the other an immature male, a much smaller bird. Two other species can be classified as occasional visitors, with four records of Brown Falcon and two records of Brahminy Kite.

Table 6. Birds of prey recorded since June 2017 (presented in taxonomic order).

Common Name	Scientific Name	Comments
Osprey [#]	<i>Pandion haliaetus</i>	4-8 birds regularly recorded
Black-shouldered Kite	<i>Elanus axillaris</i>	1-2 birds often recorded
Swamp Harrier [*]	<i>Circus approximans</i>	2-4 birds often recorded
Brown Goshawk	<i>Accipiter fasciatus</i>	Single birds often recorded
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	4-8 birds regularly recorded
Whistling Kite [*]	<i>Haliastur sphenurus</i>	2-4 birds regularly recorded
Brahminy Kite	<i>Haliastur indus</i>	Vagrant: single birds 18 Aug 2018; 25 Oct 2019
Brown Falcon	<i>Falco berigora</i>	Single birds 17 Aug & 2 Nov 2018; 11 May 2019; 6 June 2020
Peregrine Falcon	<i>Falco peregrinus</i>	1-2 birds often recorded

[#]2017-2020 breeding record/s ^{*}Pre-2017 breeding record/s only

The only breeding records for raptors in 2017-2020 have been for Osprey, which have a permanent nest built on the southern part of the island. On 21 December 2019, two Osprey chicks were banded and colour-banded in the nest, shortly before their expected date for fledging. The Osprey chick banding was carried out by registered banders (Greg Little, Rob Kyte) under the supervision of Greg Clancy, who leads a state-wide study. In June 2020, one of the colour-banded young birds was seen daily and often at locations around the island.

Figure 9. Immature colour-banded Osprey, banded at the nest 21 December 2019 shortly before fledging, recorded daily 6-8 June 2020 (photo: Alan Stuart 7 June 2020).



1.5. Seabirds

The focus of the Broughton Island study is terrestrial birds. However, the sets of nest boxes for Gould's Petrels and White-faced Storm-petrels near Pinkatop have been inspected on every non-winter field trip and there have been several other seabird records from Pinkatop and elsewhere, albeit some of those being opportunistic. For completeness, all available recent information about seabirds, including about birds banded at the nest boxes, is included in this report.

Seabird banding was carried out by registered banders (Tom Clarke, Greg Little, Emily Mowat, Rob Kyte) under the supervision of NPWS Ranger Susanne Callaghan.

Gould's Petrel

Six Gould's Petrels have been found in nest boxes and banded; one of those was a chick raised by at least one and probably two of the other banded birds. Also, a dead bird, unbanded, was found; it died after becoming caught in the burrow entrance as it attempted to leave the nest box. **Table 7** summarises the details, including the band numbers used for each bird, the nest box in which it was found, and the date/dates when the bird was confirmed to be in a nest box.

Table 7. Details for Gould's Petrels in nest boxes on Broughton Island.

Nest Box	Band No.	Date	Comments
2	063-17802	25 Oct 2019	With a Pycroft's Petrel. A band was placed on the bird's right leg.
		28 Dec 2019	Re-trap.
4	063-17803	5 Dec 2018	A band was placed on the bird's right leg.
4	–	28 Dec 2019	The bird had died (after becoming caught in the burrow)
4	063-15931	18 Dec 2019	A band was placed on the bird's left leg.
		31 Jan 2020	Re-trap. Biometrics recorded, see below.
5	063-17801	10 Dec 2018	A band was placed on the bird's right leg.
		13 Jan 2019	Re-trap. The bird was with 063-17805.
		18 Dec 2019	Re-traps. The bird was on egg.
		28 Dec 2019	
5	063-17805	5 Dec 2018	A band was placed on the bird's right leg.
		13 Jan 2019	The bird was with 063-17801.
		25 Oct 2019	Re-trap.
5	063-17806	31 Jan 2020	Chick, no adult bird present.
		9 March 2020	Chick. A band was placed on the bird's right leg.

At the time of writing, three of the six Gould's Petrel nest boxes have had no confirmed records – nest boxes 1, 3 and 6. It is not obvious as to why three nest boxes have been used, and three others not.

Two adult Gould's Petrels have been found in nest box 5, including they were together in the nest box on 13 January 2019. Both birds had bands placed onto them on different dates in December 2018. Since January 2019 there have been some further records of both birds in that nest box, and they are considered to be a pair. Bird 063-17801 was incubating an egg in December 2019; by late January, the egg had hatched. The chick was banded in March 2020, when near to fledging. This constitutes the first confirmed breeding record for Gould's Petrel on Broughton Island since 2009 (Carlile *et al.* 2012).

Three individual Gould's Petrels have investigated nest box 4. Unfortunately, one of those birds died in the burrow. It remains to be seen whether the other two birds (with band numbers 063-17803 and 063-15931) will form a pair and breed.

Figure 10. Gould's Petrel from nest box 4, 31 January 2020 (photo Alan Stuart).



Figure 11. Gould's Petrel chick from nest box 5, 31 January 2020 (photo: Rob Kyte)



As yet, only one Gould's Petrel is known to have investigated nest box 2. In the first record, that bird was sharing the nest box with a Pycroft's Petrel, which is not known to breed in Australia. In a later record, the bird was alone. The Gould's Petrel's behaviour (ie sharing a nest cavity with another seabird), and then being in the nest box again two months later, suggests it was in breeding mode; it will be interesting to see what unfolds during the 2020-2021 breeding season.

Figure 12. Gould's Petrel chick from nest box 5 being banded (by Emily Mowat) on 9 March 2020 (photo: Mick Roderick)



Pycroft's Petrel

On 25 October 2019, a probable Pycroft's Petrel was in nest box 2, along with an adult Gould's Petrel (which had band number 063-17802). A band (063-17804) was placed onto the Pycroft's Petrel, on its right leg. The bird was in the same nest box the following day, when its biometric measurements were taken (by Tom Clarke).

Pycroft's Petrels breed in New Zealand and there are no confirmed prior records for them in Australia. Hence the Broughton Island record must be assessed by the BirdLife Australia Records Committee (BARC) in order for it to become officially accepted. The Broughton Island record was submitted to BARC in late January 2020 and has been assigned case number 1108. At the time of writing (June 2020), no verdict has been received.

If the record from Broughton Island in 2019 is accepted, it will become either the first or second confirmed Australian record for Pycroft's Petrel. A report of a bird off Swansea in October 2002 was submitted to BARC in mid-January 2020 and is currently being assessed. If that bird is accepted as a Pycroft's Petrel, then it will be the first confirmed Australian record and the Broughton Island bird would become the second confirmed record.

The bird's biometric measurements are reported in **Table 8**, along with (for comparison) the measurements for a Gould's Petrel which was in nest box 4 in January 2020. The latter measurements were made by Rob Kyte. Overall, the Pycroft's Petrel was a smaller bird but it had longer wings.

Table 8. Some biometric measurements for Pycroft's Petrel and Gould's Petrel

	Pycroft's Petrel	Gould's Petrel
Date measured	26 Oct 2019	31 Jan 2020
Band No.	063-17804	063-15931
Weight (g)	140	182
Wing (mm)	216	205
Head-bill (mm)	61.9	64.4
Bill (mm)	24.4	23.0
Tarsus (mm)	28.5	–
Tail (mm)	–	93

Figure 13. Pycroft's Petrel from nest box 2, 25 October 2019 (photo: Alan Stuart).



Figure 14. Pycroft's Petrel and Gould's Petrel from nest box 2, 25 October 2019 (photo Alan Stuart).



Little Penguin

The Little Penguin colony on the western side of Providence Beach was visited around dusk during the October 2017, October 2019 and February 2020 visits, with 6-10 birds observed returning to burrows (and hence, they would have been breeding). However, the counts were not done rigorously and some birds could have been over-looked.

In the morning of 29 July 2019, there were footprints on the beach that indicated that at least two birds had come ashore overnight.

White-faced Storm-Petrel

Although there are some very old records of White-faced Storm-Petrel breeding on Broughton Island “in thousands”, a survey in 2009 found no birds and the population probably became extinct in 1958 (Carlile *et al.* 2012). However, there are nearby breeding colonies and re-colonisation might occur now that there are no rats on the island. A Storm-Petrel feather was found in a nest box in October 2017 but there have been no further developments at the Storm-Petrel nest boxes. However, a probable White-faced Storm-Petrel flew southwards over Providence Beach on 1 February 2020 (M. Schultz pers. comm.). That record suggests that birds might have returned to the island to breed, although using self-made burrows rather than artificial ones. This possibility has not yet been investigated further.

Wedge-tailed Shearwater

Many tens of thousands of Wedge-tailed Shearwaters were breeding on Broughton Island in 2009, with the population having increased substantially over the preceding three decades (Carlile *et al.* 2012). The population has further increased, based on observations from regular visits (S. Callaghan pers. comm.). In all non-winter field trips, Wedge-tailed Shearwaters have regularly been recorded but there have been no attempts at systematic counts.

Short-tailed Shearwater

Although several hundred pairs of Short-tailed Shearwaters were breeding on the island in 2009, the population was smaller than it had been previously (Carlile *et al.* 2012). Short-tailed Shearwaters have not been recorded in any of the field trips; however, they have often been heard calling from burrows during night-time frog surveys (S. Callaghan pers. comm.). Also, there were 13 beachcast birds at Esmeralda Cove 23 November 2019 (M. Roderick pers. comm.), which suggests that Short-tailed Shearwaters still visit the island in moderate numbers.

1.6. Breeding records

There have been breeding records in 2017-2020 for the following species: Brown Quail, Bar-shouldered Dove, Osprey, Sooty Oystercatcher, Gould’s Petrel, Wedge-tailed Shearwater, Golden-headed Cisticola, Welcome Swallow, Silver Gull, Crested Tern, and Silvereye. Little Penguins are also assumed to have bred in 2017-2020, based on sightings of birds returning to burrows in the normal breeding season. There are several pre-2017 records of penguin chicks in burrows on the island (S. Callaghan pers. comm.)

It should be noted that bird surveys and banding activities offer little spare time to search for nests or to notice other signs of breeding activity; most of the breeding records are chance observations.

2. Bird banding studies

2.1. Overview

In twelve field trips, more than 570 individual birds of 17 species have been captured and banded. In **Table 9** are details showing the number of individual birds banded for each species, the number of capture events, and the number of re-capture events (re-traps). Most re-traps have involved a banded bird being captured again in a mist net or trap; however, the table also includes visual records (by eye or by camera) in which the bird was able to be identified with complete certainty.

The most captured species has been the Silvereye, with 501 individual birds now part of the study group. Also, 37 individual Tawny Grassbirds and 19 individual Yellow-faced Honeyeaters have been processed. However, for all other species only small numbers of them have been captured.

Table 9. List of birds captured and retraps on Broughton Island (presented in taxonomic order).

Species	Capture events	Individuals	Retraps*
Brown Quail	5	5	0
Bar-shouldered Dove	8	7	1
Shining Bronze-cuckoo	1	1	0
Fan-tailed Cuckoo	1	1	0
Osprey (as a separate project)	2	2	3 ¹
Brown Goshawk	2	2	0
Sacred Kingfisher	1	1	0
Little Wattlebird	1	1	0
Yellow-faced Honeyeater	27	19	8
Olive-backed Oriole	1	1	0
Golden Whistler	1	1	0
Grey Fantail	1	1	0
Eastern Yellow Robin	1	1	0
Golden-headed Cisticola	1	1	0
Tawny Grassbird	52	37	15 ²
Welcome Swallow	9	9	0
Silvereye	615	501	103

*Totals include birds re-trapped in the same field visit in which they first were banded. ¹three visual records

²includes one visual record

2.2. Silvereye

Three subspecies of Silvereye have been recorded on Broughton Island; *cornwalli* which occurs in coastal and sub-coastal central and eastern Australia, extending southwards to around the Hunter River, and the migratory subspecies *westernensis* and *lateralis* (Little *et al.* 2020). Subspecies *lateralis* breeds in Tasmania and the Bass Strait islands and winters in coastal and sub-coastal south-eastern Australia extending as far north as central-eastern Queensland. Subspecies *westernensis* is found in coastal to near-inland south-eastern Australia, extending northwards to around the Hunter River, and in winter migrates northwards. The three Silvereye subspecies have subtle plumage differences which are difficult to see in the field but much easier when the bird is in hand (Little *et al.* 2020; also see **Figure 15**).

Figure 15. The three Silvereye subspecies on Broughton Island (photos: Alan Stuart)



a) *cornwalli* (bright yellow throat, pale flanks)



b) *westernensis* (pale yellow throat, deep buff flanks)



b) *lateralis* (grey throat, deep buff flanks)

In the banding study, most of the captured Silvereyes were assessed to subspecies level. **Table 10** shows the numbers of each subspecies captured in the twelve field trips. Seven birds were released before they had been assessed to subspecies level.

Table 10. Subspecies assigned to Silvereyes caught in mist nets on Broughton Island 2017-2020 (the table includes re-trapped birds).

Year	Dates	Total birds	<i>cornwalli</i>	<i>westernensis</i>	<i>lateralis</i>	unknown taxon
2017	28-30 June	32	19	10	3	0
	13-15 Oct	79	77	1	0	1
2018	19-21 Jan	38	37	0	0	1
	20-22 April	21	9	10	2	0
	17-18 Aug	37	10	22	5	0
	2-4 Nov	72	72	0	0	0
2019	2-4 Feb	19	17	0	0	2
	11-13 May	39	15	17	7	0
	27-29 July	71	38	22	11	1
	25-27 Oct	163	157	4	0	2
2020	31 Jan – 2 Feb	6	6	0	0	0
	6-8 June	38	27	4	7	0
Total		615	483	90	35	7

The ratio on the island of the three subspecies has varied seasonally, and so too has the total number of birds present (as measured by the number of birds captured). Details of the seasonal results are presented in **Table 11**. In summer, all Silvereyes identified to subspecies level have been *cornwalli* birds whereas in the autumn and winter field trips all three subspecies have been present. Most birds in the spring visits have been *cornwalli*, with only a small number of *westernensis* birds captured. Although there have been differing ratios of *cornwalli* to *westernensis* birds from the autumn and winter visits, the differences were found not to be statistically significant (by the X² test). In both autumn and winter, 15% of the Silvereyes have been *lateralis* birds.

Table 11. Seasonal data for Silvereye subspecies on Broughton Island 2017-2019. The number of individuals processed is given for each subspecies, and with the percentage of the total catch which had an assigned subspecies given in parentheses.

	Summer Jan-Feb	Autumn Apr-May	Winter Jun-Aug	Spring Oct-Nov
<i>cornwalli</i>	60	24 (40%)	93 (52%)	306 (99%)
<i>westernensis</i>	–	27 (45%)	58 (33%)	5 (1%)
<i>lateralis</i>	–	9 (15%)	26 (15%)	–
<i>unknown taxon</i>	3	–	1	3
Total birds	63	60	178	314

Although there have been over 100 Silvereye re-traps, that included many instances where an individual was captured again during the same field trip in which it had been banded, and in no other field trip. However, 81 individuals have been recaptured in a different field trip to the one in which they were banded. All of those were *cornwalli* birds except for one *westernensis* bird banded in May 2019 and recaptured in July 2019. **Table 12** summarises the season captured, and season recaptured, for the 80 *cornwalli* birds. The analysis covers every re-capture event i.e. the table includes data for birds recaptured more than one time. The majority (56%) of birds that have been recaptured in a different field trip originally were captured and banded during a spring visit, and 27 of those 45 birds were recaptured during a spring field trip in a different year.

Table 12. Capture/recapture chart for *cornwalli* Silvereyes on Broughton Island (including 15 instances of birds recaptured in two or more visits). The table does not include birds recaptured within the same visit in which they were banded.

		Season recaptured				Total
		Winter	Spring	Summer	Autumn	
Season captured	Winter	1	6	2	5	14
	Spring	9	27	5	4	45
	Summer	4	2	1	5	12
	Autumn	7	1	1	–	9
Total		21	36	9	14	80

Fifteen *cornwalli* Silvereyes have been recaptured during more than one field trip; details are in **Table 13**. Most of those birds have been recaptured twice, however the bird with band number 01C05973, first banded in October 2017, was recaptured in three field trips in 2019 (summer, winter, spring) and again in the summer 2020 visit.

Table 13. Seasonal analysis of *cornwalli* Silvereyes with multiple re-trap events on Broughton Island (the analysis treats re-traps from within the same field visit as a single event).

Band	Caught	Season	Re-caught	Season	Interval (months)
01C05901	23 June 2017	Winter	3 Feb 2019	Summer	19
			13 May 2019	Autumn	23 (3)
01C05905	24 June 2017	Winter	3 Nov 2018	Spring	16
			3 Feb 2019	Summer	19 (3)
01C05922	25 June 2017	Winter	21 April 2018	Autumn	10
			13 May 2019	Autumn	23 (13)
01C05929	25 June 2017	Winter	13 Oct 2017	Spring	4
			26 Oct 2019	Spring	28 (24)
01C05935	13 Oct 2017	Spring	3 Nov 2018	Spring	13
			27 Oct 2019	Spring	25 (12)
01C05973	14 Oct 2017	Spring	3 Feb 2019	Summer	16
			27 July 2019	Winter	21 (5)
			25 Oct 2019	Spring	24 (3)
			1 Feb 2020	Summer	27 (3)
01C05979	14 Oct 2017	Spring	12 May 2019	Autumn	19
			28 July 2019	Winter	21 (3)
01C06001	15 Oct 2017	Spring	3 Nov 2018	Spring	12
			25 Oct 2019	Spring	24 (12)
01C06037	21 Jan 2018	Summer	3 Feb 2019	Summer	12
			27 Oct 2019	Spring	21 (9)
01C06096	2 Nov 2018	Spring	3 Feb 2019	Summer	3
			7 June 2020	Winter	19 (16)
01C21408	2 Nov 2018	Spring	27 Oct 2019	Spring	12
			7 June 2020	Winter	20 (8)
01C21468	3 Feb 2019	Summer	29 July 2019	Winter	6
			27 Oct 2019	Spring	9 (3)
01C21483	12 May 2019	Autumn	28 July 2019	Winter	3
			1 Feb 2020	Summer	9 (6)
01C21504	13 May 2019	Autumn	28 July 2019	Winter	3
			26 Oct 2019	Spring	6 (3)
01939416	26 Oct 2019	Spring	2 Feb 2020	Summer	3
			7 June 2020	Winter	8 (5)

Four birds originally captured and banded in winter have been recaptured twice; none of those recapture events were in winter (**Table 13**). Similarly, both of the birds originally banded in an

autumn field trip (in May 2019) have twice since been re-trapped in non-autumn visits. The two birds banded in summer were re-caught the following summer and in another season. Seven birds banded in a spring visit have been recaptured at least twice. For four of those birds, at least one of the re-trap events was in the spring field trip of a later year.

Biometric data were taken for most of the captured Silvereyes. The main details have been reported elsewhere (Little *et al.* 2020) and so are not repeated in this report. The tails of *westernensis* birds were found to be longer than tails of either of the other two subspecies, with the differences shown to be statistically significant. There were no other significant differences in the measured biometrics of any of the subspecies.

2.3. Tawny Grassbird

To date, 37 individual Tawny Grassbirds have been captured and banded, ten of which have been re-trapped in mist nets including two birds each re-captured three times and eight birds each re-captured once i.e. there have been 51 mist net capture-events. One other banded bird has been confirmed present from a visual sighting on a different field trip to the one in which it became banded, hence there have been 52 records overall.

It sometimes is possible to sex a Tawny Grassbird, e.g. adult males often have longer tails than do the females. It is also possible to identify juvenile and immature birds, based on their plumage differences from adult birds. Six definite males have now been banded, and three females. Ten of the other birds were adults but could not be assigned to a sex, and 18 juvenile or immature birds have been caught. **Table 14** presents a seasonal analysis of when birds in those four categories were captured. Tawny Grassbirds have been far more likely to be trapped in spring and summer, those seasons comprising 23% and 63% of the total birds, respectively. All of the females and unsexed adults have been captured in the spring and summer field visits, and 87% of the juvenile / immature birds.

Table 14. Seasonal analysis of the age and sex of Tawny Grassbirds captured or re-captured on Broughton Island in field visits 2017-2020.

	Season				Total
	Winter	Spring	Summer	Autumn	
Males	3	5	6	1	15
Females	–	2	1	–	3
Unsexed adults	–	4	6	–	10
Juveniles/immatures	3	2	19	–	24
Total	6	13	32	1	52

Similarly, re-traps have occurred more often during the summer trips than any other season, as presented in **Table 15**. Excluding birds re-captured in the same field trip that they were banded, there have been seven re-trapped birds: four males, a female and two birds which were unable to be sexed; both were young birds. Two of the males have each been re-captured three times. Thus, there have been 11 re-capture events. Details are provided in **Table 16**. The table also shows that five birds (three males, a female and an immature bird unable to be sexed) have had intervals of twelve months or more between banding and re-capture. Furthermore, three of those birds were re-captured in a different season to the one in which they first were banded.

Table 15. Capture/recapture chart for Tawny Grassbirds on Broughton Island (including two instances of birds recaptured in two or more visits). The table does not include birds recaptured within the same visit in which they were banded.

		Season recaptured				Total
		Winter	Spring	Summer	Autumn	
Season captured	Winter	–	2	1	–	3
	Spring	–	–	2	–	2
	Summer	1	1	3	1	6
	Autumn	–	–	–	–	–
Total		1	3	6	1	11

Table 16. Seasonal analysis of Tawny Grassbirds with multiple re-trap events on Broughton Island (the analysis treats re-traps from within the same field visit as a single event).

Band	Sex	Caught	Season	Re-caught	Season	Interval (months)
03737002	M	25 June 2017	Winter	13 Oct 2017	Spring	4
				27 Oct 2019	Spring	28 (24)
				1 Feb 2020	Summer	31 (3)
03737014	M	21 Jan 2018	Summer	17 Aug 2018	Winter	7
				4 Feb 2019	Summer	12 (5)
				13 May 2019	Autumn	15 (3)
03737017	M	4 Nov 2018	Spring	3 Feb 2019	Summer	3
03737029	M	4 Feb 2019	Summer	2 Feb 2020	Summer	12
03737008	F	19 Jan 2018	Summer	26 Oct 2019	Spring	20
03737020	U	3 Feb 2019	Summer	1 Feb 2020	Summer	12
03737032	U	27 Oct 2019	Spring	1 Feb 2020	Summer	3

2.4. Yellow-faced Honeyeater

Thus far, 19 individual Yellow-faced Honeyeaters have been banded, eight of which have been re-trapped each once i.e. 27 birds have been caught overall. Six males and 13 females have been banded (these figures include three birds for which the assignment of their sex was tentative). **Table 17** provides a seasonal analysis of the sex of trapped and re-trapped birds.

Table 17. Seasonal analysis of the sex of Yellow-faced Honeyeaters captured or re-captured on Broughton Island in field visits 2017-2020.

	Season				Total
	Winter	Spring	Summer	Autumn	
Males	4	3	–	3	10
Females	3	7	5	2	17
Total	7	10	5	5	27

Although more birds have been caught in spring than in any other season, the difference was found to not be statistically significant. The spring captures include four first-year birds – a male caught twice in October 2019 and two different females in October 2017 and October 2019. No males have been caught in summer. There are not enough data to test if that is of statistical significance.

Excluding a bird re-captured in the same field trip that it was banded, there have been seven re-trapped birds: three males and four females. A seasonal analysis of capture/re-capture of those birds is presented in **Table 18**.

Table 18. Capture/recapture chart for Yellow-faced Honeyeaters on Broughton Island. The table does not include a bird recaptured within the same visit in which it was banded.

		Season recaptured				Total
		Winter	Spring	Summer	Autumn	
Season captured	Winter	–	1	–	1	2
	Spring	2	–	2	–	4
	Summer	–	–	1	–	1
	Autumn	–	–	–	–	–
Total		2	1	3	1	7

Five birds (three males and two females) have had intervals of ten months or more between banding and re-capture (see **Table 19** for details). Four of those birds were re-captured in a different season to the one in which they first were banded.

Table 19. Seasonal analysis of re-trapped Yellow-faced Honeyeaters on Broughton Island. The table does not include a bird recaptured within the same visit in which it was banded.

Band	Sex	Caught	Season	Re-caught	Season	Interval (months)
02730301	M	24 June 2017	Winter	22 April 2018	Autumn	10
02730303	M	15 Oct 2017	Spring	29 Jul 2019	Winter	21
02730315	M	4 Nov 2018	Spring	7 June 2020	Winter	19
02730310	F	3 Nov 2018	Spring	1 Feb 2020	Summer	15
02730311	F	3 Nov 2018	Spring	3 Feb 2019	Summer	3
02730317	F	4 Feb 2019	Summer	2 Feb 2020	Summer	12
02730325	F	29 July 2019	Winter	27 Oct 2019	Spring	3

2.5. Other species

Seven individual Bar-shouldered Doves and nine individual Welcome Swallows have been banded, with one of the Bar-shouldered Doves, an adult bird, re-trapped three months after it first had been banded. There are not enough data for either species for any detailed analysis of results.

Although Brown Quail are a target species for the overall study, of interest because of their abundance on the island, only five birds have been able to be banded thus far. Two of those were immature birds, caught in a low shelf of a standard mist net. An adult bird was caught on the same occasion, in the uppermost shelf. The capture of these three birds was a chance event. They were part of a larger group of quail that flushed when an attendant approached to check the net. Another adult bird was caught in a walk-in trap (a modified rat trap) that contained crushed Weet-Bix as bait. Similar traps, and also a Clap trap, were set on many of the other field visits but these all failed to attract any quail. Walk-in traps baited with cheese or tinned tuna also were set several times hoping to catch Buff-banded Rails or Lewin's Rails; these all were unsuccessful.

A problem with the various attempts at trapping Brown Quail has been that there was never any certainty that any birds were or would remain in the specific area where the net or trap had been placed. In October 2019, a new method for catching them was developed. After a bird was identified (because it was calling) as being close to a walking track, some beaters went in and drove the bird towards a 6m mist net held by its poles by two attendants on the track. The attendants were able to manoeuvre the mist net so that the bird was kept between the beaters and the net; when the bird

eventually flushed, it flew into the net and was quickly grabbed by a third net attendant. There have not been any further opportunities to test the “mobile net” trapping method.

Another target species for the overall study is the Golden-headed Cisticola, of interest because of their abundance on the island. However, despite some effort, only one bird has been caught.

Figure 16. Golden-headed Cisticola, photographed on Broughton Island (photo: Alan Stuart)



Discussion

1. Breeding records

Although there are many species with breeding records on Broughton Island, there are relatively few records overall. A contributing factor is that there has been very little spare time in the field trips to survey specifically for evidence of breeding activity. Most of the breeding records have been opportunistic.

Nevertheless, it seems remarkable that it is not yet confirmed that Tawny Grassbirds breed on the island. Almost certainly, they do; there have been several times when birds were seen carrying food, but they have always been very cautious about their movements. There has been limited time to observe Tawny Grassbirds in such circumstances (because of the priorities given to the surveying and banding activities) and that probably explains the lack of confirmed breeding records.

At least three species of raptor perhaps breed on Broughton Island. There are historical records of Whistling Kites nesting (in the casuarina grove near Pinkatop); there seems to be suitable breeding habitat on the island for Swamp Harriers, and Peregrine Falcons are suspected would nest on the cliffs below Pinkatop but as yet there is no evidence for it.

In 2019, Sooty Oystercatcher breeding on Broughton Island was re-confirmed after almost 20 years without any records. However, the gap in records is almost certainly because of lack of survey effort not because of lack of breeding effort. Possibly it is a similar situation for the Australian Pied Oystercatcher and the Red-capped Plover; the only known breeding activities by these species occurred in 2012 and 2010 respectively (Stuart *et al.* 2017) but it seems quite plausible that there would have been other breeding events (particularly for the Red-capped Plovers, which are always present).

The recent discovery of a probable Eastern Reef Egret nest is exciting, as there has not been a confirmed breeding record for this species from anywhere within the Hunter Region for almost 110 years. Cameras have been installed and it is hoped these will capture aspects of courtship behaviour and breeding biology; time will tell.

2. Newly recorded species

Sixteen species had no confirmed records prior to June 2017. The species completely new to the modern Broughton Island bird list were: White-throated Needletail; Fork-tailed Swift; Channel-billed Cuckoo; Horsfield's Bronze-Cuckoo; Fan-tailed Cuckoo; Pallid Cuckoo; Pycroft's Petrel; Australasian Darter; Scarlet Honeyeater; Spotted Pardalote; Olive-backed Oriole; Black-faced Cuckoo-shrike; White-winged Triller; Eastern Yellow Robin; Brown Songlark; Tree Martin.

All 16 species were only recorded during one field trip although sometimes on more than one day of that field trip. Currently, they are considered to be vagrants i.e. their presence on Broughton Island was brief and perhaps unintentional. Possibly however, some of those species eventually will colonise or re-colonise the island now that there are no feral predators.

3. Emerging terrestrial species

For five terrestrial species, their status from the 2012-2017 surveys was unclear. However, when viewed overall i.e. also using the 2012-2020 data, some patterns may be emerging.

Shining Bronze-Cuckoo: There now are records from field trips in September 2012, August 2018 and July 2019. A bird was captured and banded on 29 July 2019 and identified as subspecies *plagosus*. The subspecies is interesting, as what might have been expected to be present was subspecies *lucidus*,

which breeds in New Zealand and migrates annually between Australia and New Zealand (Menkhorst *et al.* 2017).

With so few records overall, assigning a status for Shining Bronze-Cuckoo is problematic. However, a likely scenario seems to be that it is an occasional passage migrant, with subspecies *plagosus* confirmed and the presence of subspecies *lucidus* still considered to be a possibility.

Brown Goshawk

A Brown Goshawk was first recorded on the island on 9 April 2013 with additional records in September 2013, March 2014 and April 2016. Since June 2017 there have been many records. All sight records have been of single birds; however, two birds (an adult female and an immature male) were captured and banded in May 2019.

A likely scenario seems to be that Brown Goshawk was an occasional visitor to the island during the early years of the overall study, but that 1-2 birds now are regular visitors or perhaps even are resident on the island. The food supply for Brown Goshawks on the island will have improved, since their main prey items include small passerines, which overall have increased in numbers.

Brown Falcon

A Brown Falcon was first recorded on the island in August 2012 (during a reconnaissance visit to plan future surveys). There was also a March 2014 record. In the June 2017 – June 2020 study, there have been records from four of the 12 field visits.

Golden Whistler

A Golden Whistler was first recorded on the island on 18-19 April 2016. There have been additional records from five of the 12 field visits since June 2017, all of them as reports of a single bird. In the June 2017 visit, a Golden Whistler was captured and banded; the bird was identified as an immature bird of unknown sex.

It would be easy to overlook a Golden Whistler if it were inhabiting the dense shrubs in the central parts of the island and not calling. A likely scenario seems to be that at least one bird has moved permanently to the island. A focus for future visits will be to monitor if additional birds arrive and if there is any evidence of colonisation / re-colonisation.

Grey Fantail

A Grey Fantail was first recorded on the island on 9 April 2013, with further records for 25 September 2013 and 18-19 April 2016. There have been additional records from five of the 12 field visits since June 2017, all of them as reports of a single bird. However, although a Grey Fantail was captured and banded on the island in July 2019, a bird seen in June 2020 had no band. Thus, there have been at least two birds on the island.

It would be easy to overlook a Grey Fantail if it were inhabiting the dense shrubs in the central parts of the island and not calling. A likely scenario seems to be that at least two birds have moved to the island, perhaps both of them permanently. A focus for future visits will be to monitor if additional birds arrive and if there is any evidence of colonisation / re-colonisation.

4. Silvereyes, Tawny Grassbirds and Yellow-faced Honeyeaters

The species most commonly caught in mist nets have been Silvereyes, Tawny Grassbirds and Yellow-faced Honeyeaters. These birds also were often recorded in the bird surveys.

Silvereye

For a mobile species such as the Silvereye, the method of deploying mist nets used in the study most likely was accurately sampling the numbers of birds on the island at the time and also the subspecies present (Little *et al.* 2020). In confirmation of the latter point, it was often found that, when several Silvereyes were caught at the same time in a particular mist net, more than one subspecies had been captured.

All the birds present in summer were *cornwalli*. An influx of *westernensis* and *lateralis* subspecies birds occurred in autumn and winter. The daily capture rate for Silvereyes in winter was approximately double that in summer, reflecting the influx of the southern birds. The ratio of *westernensis* to *lateralis* birds did not vary greatly across any autumn or winter trip.

An influx of *cornwalli* birds occurred in spring. The daily capture rate for Silvereyes was approximately trebled in the spring trips compared to the summer ones. Only five *westernensis* birds were captured in a spring visits, perhaps late-departing birds i.e. the spring influx of Silvereyes was dominated by *cornwalli*. The influx seemed to be linked with fruiting of Tree Broom Heath *Monotoca elliptica*. Examination of excreta in the bags in which Silvereyes were held prior to post-capture processing revealed that *M. elliptica* berries formed a large part of the Silvereye diet on Broughton Island in spring. Another important part of their diet, again determined from inspection of excreta, was fruit of the introduced plant Inkweed *Phytolacca octandra*.

There has been no evidence of any individual *westernensis* or *lateralis* birds returning to Broughton Island in a different year from that in which they were banded. A total of 125 birds of these two subspecies were banded on the island from June 2017 to June 2020 (90 *westernensis*, 35 *lateralis*). The absence of any inter-year re-traps suggests that it is uncommon for *westernensis* or *lateralis* birds to return to the island.

The pattern of re-traps across seasons shows that many *cornwalli* Silvereyes regularly visit Broughton Island or are resident there. One bird has been re-trapped four times now, in three different seasons spanning 27 months since it first was captured. Fourteen other birds have been re-captured twice, often in different seasons to the one in which they were banded. Eleven of the birds that have been re-trapped twice have had periods of 19-28 months between the date of being banded and the date of most recent trapping.

Based solely on quarterly field trips, it is not possible to conclusively differentiate between the two possibilities of some Silvereyes being resident on the island and of them making regular visits to it. However, the number of recaptures and the lengths of time between some of the captures and recaptures does suggest that some Silvereyes are resident.

Prior to the present study, there was one confirmed breeding record for Silvereyes on Broughton Island, when a pair had a nest with young in October 2016 (Stuart *et al.* 2017). The breeding pair was not identified to subspecies level, but the timing of the observation suggests that they would have been *cornwalli* birds. In October 2019, a nest with eggs of a pair of *cornwalli* birds was discovered. There has also been considerable circumstantial evidence of breeding activity by *cornwalli*. For example, in spring visits, many birds had strongly vascularised brood patches, indicating that they were brooding. In summer visits, the wrinkled yellow-brown brood patches on numerous birds suggested that they only recently had finished brooding. Also, two birds were carrying eggs when captured. The above information suggests that *cornwalli* breeds on Broughton Island. Moreover, 21 of

the 400+ *cornwalli* Silvereyes examined in the study were recorded as first-year birds (based upon gape and/or plumage assessments).

The percentage of re-trapped Silvereyes within a field trip offers an insight into the size of the total population (resident and visiting) in the study area. For the *cornwalli* subspecies, it has been estimated that 1,000–2,000 birds have lived on or visited Broughton Island in the banding study (Little *et al.* 2020).

Tawny Grassbird

To date, 47% of all of the Tawny Grassbirds caught have been immature and juvenile birds, and in summer they have comprised 59% of the total catch. However, only two of those birds were re-trapped in a different field visit to the one in which it was banded, and one of those re-traps was within the same season (a bird banded in October 2019 and re-trapped in February 2020). In contrast, four of the five banded males have been re-captured at least once, and also one of the two confirmed females has been re-captured. The pattern of re-traps and non-re-traps seems to fit with the following scenario:

- The nets have been erected at mostly the same places on every visit, and some of those locations have overlapped with male territories; hence it has been more likely that those males be re-captured. That might explain the instance of the re-captured female too.
- Young birds stay within their parent male's territory initially but afterwards they disperse. The high capture rate for young birds in summer reflects that the adults had recently bred and there are many young birds present. The low re-capture rate for young birds after summer reflects that they have dispersed from the territories where they were hatched and raised, and no longer encounter the nets.

Using this scenario, it seems probable that the unsexed adults in the study have been females, living within or near to a male's territory. If they were males, the territorial (dominant) male would likely have driven them away.

It is unclear whereabouts the dispersing young Tawny Grassbirds go. Possibly they move to other parts of the island, but those other areas are already well-populated with grassbirds so that postulated outcome may be unlikely. Also, the ongoing bird surveys have not detected any noticeable increase in the overall population. Perhaps young Tawny Grassbirds cross to the mainland, or perhaps most of them perish.

It may not be viable as yet to make a population estimate for Tawny Grassbirds. Because they are known to have small territories, they will be less mobile than species such as Silvereye and Yellow-faced Honeyeater, and thus the mist net locations do not equate to random sampling of the overall population. However, 28 different adult birds have been banded from an area of approximately 300m radius i.e. 28 ha. The total vegetated area of Broughton Island is 117 ha (Stuart *et al.* 2017). Extrapolation suggests a population of 100-150 adult birds on the island, with similar numbers of young birds. This tentative estimate assumes that the density of birds is similar across the whole island.

Yellow-faced Honeyeater

Four of the captured individuals were first year birds. The other 15 birds have been adults. The first-year birds all were trapped during spring field visits. Although there was one re-trap that occurred during the same field trip that the bird was banded. None of the young birds has been re-trapped in a different field visit to the one in which the bird was banded. This suggests that the young birds disperse after they have become independent, either to other parts of the island or to the mainland.

Yellow-faced Honeyeaters have been captured at about the same rate in every season and the re-capture pattern also is uniform across seasons (albeit without much data). These points indicate that there are no seasonal influxes, which implies a stable population. Three birds have had long intervals between banding and re-capture (21 months, 19 months, 15 months), and in each case banding and re-capture occurred in different seasons. These points indicate that at least some of the Yellow-faced Honeyeaters are resident on the island or visit it regularly.

There have been eight re-traps of 19 banded individuals; hence the re-trap ratio currently is 42%. That re-trap ratio implies a population of about 45 birds (i.e. 19 divided by 42%). However, based on that population estimate, it would therefore be expected to have re-captured at least three birds twice by now (i.e. eight multiplied by 42%) and therefore the population might be somewhat greater than 45 birds. The difference between re-capturing three birds twice and no birds twice is not statistically significant.

5. Declining or apparently-declining species

There is evidence that the populations of two species have declined, Golden-headed Cisticola and Pheasant Coucal. **Tables 20-21** show the Reporting Rates for both species for the surveys from the periods August 2012-October 2016 and June 2017-June 2020, for the terrestrial sites for which there have been records. Pheasant Coucal has only been recorded in two of the three 500m area sites, BT8 and BT9, and two of the 2ha sites located within BT8. For comparison purposes, data for Brown Quail are presented in **Table 22**. Summary information about the Reporting Rates for all three species is also presented in **Figure 17**.

Table 20. Reporting Rates (RR) for Golden-headed Cisticola at the nine terrestrial sites for the periods 2012-2016 and 2017-2020.

Site	2012-2016			2017-2020		
	No. surveys	No. records	RR (%)	No. surveys	No. records	RR (%)
BT7	23	22	95.7	19	14	73.7
BT8	27	25	92.6	21	20	95.2
BT9	19	16	84.2	15	14	93.3
BT1	26	20	76.9	15	10	66.7
BT2	26	21	80.8	13	5	38.5
BT3	24	18	75.0	13	4	30.8
BT4	25	22	88.0	12	5	41.7
BT5	20	17	85.0	9	3	33.3
BT6	17	15	88.2	13	9	69.2

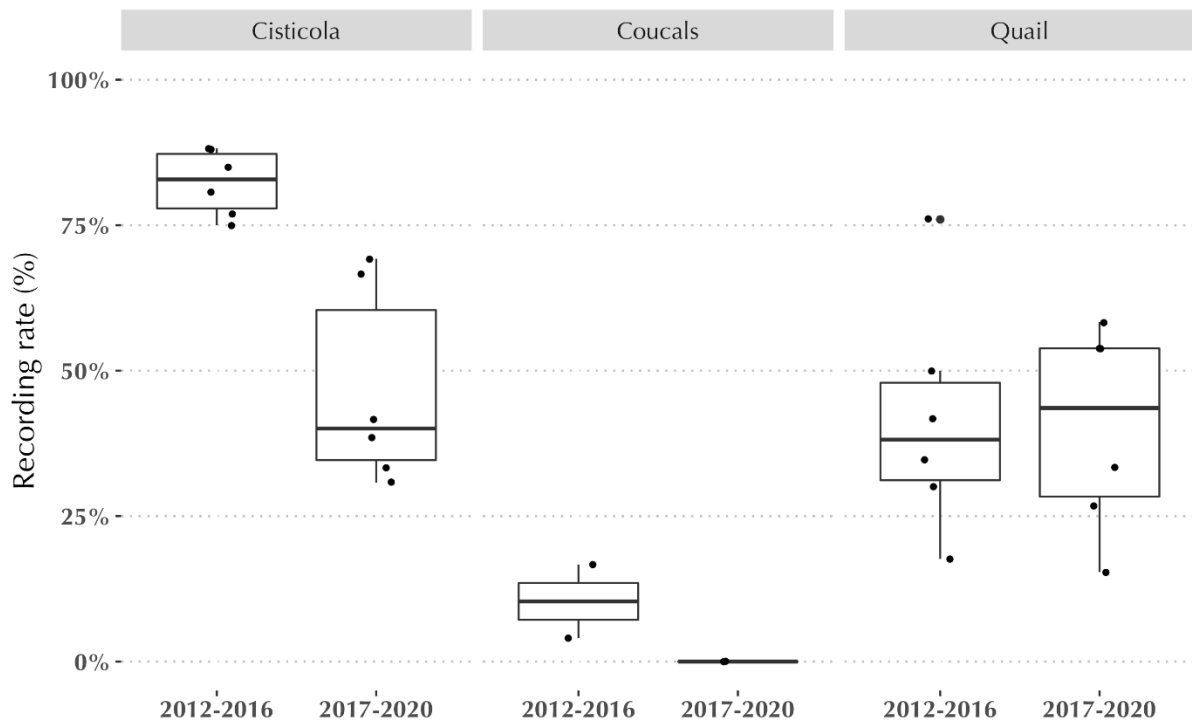
Table 21. Reporting Rates (RR) for Pheasant Coucal at the four terrestrial sites with records, for the periods 2012-2016 and 2017-2020.

Site	2012-2016			2017-2020		
	No. surveys	No. records	RR (%)	No. surveys	No. records	RR (%)
BT8	27	7	25.9	21	4	19.0
BT9	19	3	15.8	15	0	0
BT3	24	4	16.7	13	0	0
BT4	25	1	4.0	12	0	0

Table 22. Reporting Rates (RR) for Brown Quail at the nine terrestrial sites for the periods 2012-2016 and 2017-2020.

Site	2012-2016			2017-2020		
	No. surveys	No. records	RR (%)	No. surveys	No. records	RR (%)
BT7	23	21	91.3	19	12	63.2
BT8	27	21	77.8	21	15	71.4
BT9	19	14	73.7	15	10	66.7
BT1	26	9	34.6	15	4	26.7
BT2	26	13	50.0	13	7	53.8
BT3	24	10	41.7	13	7	53.8
BT4	25	19	76.0	12	7	58.3
BT5	20	6	30.0	9	3	33.3
BT6	17	3	17.6	13	2	15.4

Figure 17. Reporting Rates for Golden-headed Cisticola (for six 2-ha sites), Pheasant Coucal (for the four sites with records) and Brown Quail (for six 2-ha sites) for the periods 2012-2016 and 2017-2020.



The RRs for Brown Quail for each site are similar across the two survey periods, which creates confidence in the data set. For the Golden-headed Cisticola, the RRs from the 500m sites have not changed greatly. However, the 500m surveys span large areas (*c.* 80 ha) and have time periods usually of several hours. The opportunities for encountering a Golden-headed Cisticola at some point during such a survey are considerable. In contrast, the 2 ha surveys sample a smaller area and only span a 20-minute period. **Table 20** shows that the RRs for Golden-headed Cisticola have more than halved for sites BT2-BT5 in the second set of surveys, but that they are little changed for sites BT1 and BT6.

Statistical analysis reveals that across sites BT1–BT6, the RR for Golden-headed Cisticola over 2017–2020 was 58% the RR for 2012–2016 (95% Confidence Interval: 37–94%). For sites BT2-BT5, the differences between the 2012-2016 and 2017-2020 survey results for each individual site were not statistically significant at a 95% confidence level (X^2 Test). However, the X^2 Test analyses are affected by the relatively small numbers of 2017-2020 surveys at each site. Examining sites BT2-BT5

collectively, the decline in Golden-headed Cisticola RR is statistically highly significant ($p < 0.01$; 78 records from 95 surveys 2012-2016; 17 records from 47 surveys 2017-2020).

The vegetation at sites BT1 and BT6 appears not to have changed greatly across the two survey periods, whereas for sites BT2-BT5 the extent of shrubs (area and height of shrubs) has noticeably increased. The increase in the extent of shrubs might explain the decline in Golden-headed Cisticolas at those sites.

There have been no recent records for Pheasant Coucal from site BT9 and its RR in site BT8 has decreased (and in the two embedded 2ha sites BT3 and BT4). However, there are very few records and at this stage, the changes are not statistically significant.

Recommendations

1. Continue with both aspects of the present study – bird surveys and bird banding.

Several changes to the terrestrial bird populations on Broughton Island have already been identified through a combination of surveys and bird banding e.g. the increasing numbers of Silvereyes, the probable colonisation or recolonisation of the island by Grey Fantail and Golden Whistler, the decline in Golden-headed Cisticola and Pheasant Coucal populations. Also, the project is beginning to shed some light onto the sizes of the Tawny Grassbird and Yellow-faced Honeyeater populations.

The project is gradually building up the overall picture of the island's birdlife and how it is changing. It is a long-term project.

2. Continue to monitor the seabird nest boxes and include winter inspections.

Regular visits to the nest boxes in the past three years have led to many interesting discoveries, and such visits should be continued. Winter inspections have not been a priority because winter it is not the breeding season for Gould's Petrels or White-faced Storm-Petrels. However, there are other seabird species which are winter breeders. The Pycroft's Petrel (in spring) was unexpected; possibly there will be other unexpected visitors in the future.

3. Introduce a colour-banding program for certain species, such as Tawny Grassbird and Yellow-faced Honeyeater.

Many juvenile and immature Tawny Grassbirds have been banded in the project, but there have not been re-traps of them, presumably because they eventually disperse from their parents' territory to locations away from the net lanes. It would be easier for surveyors to spot colour-banded birds, which should help to develop insights about the dispersal process. Colour-banding could also lead to understandings about the sizes of male and female Tawny Grassbird territories on the island and perhaps some behavioural information as well.

Similarly, colour-banding of Yellow-faced Honeyeaters would help to understand the dispersal process for young birds and how adult birds use the island's resources. There may be some other species for which colour-banding would help e.g. Golden-headed Cisticola, Grey Fantail, Golden Whistler, Willie Wagtail, Welcome Swallow, Brown Quail. The cases for and against colour-banding such species should be analysed.

4. Use GPS trackers on Brown Quail, Lewin's Rails and Buff-banded Rails.

These three species have proved difficult to trap and band (no rail species have been trapped). The chances therefore of re-trapping any birds seem extremely low, and the chances of learning much about them seem even lower. It is not known if these species stay on the island all the time or if they make excursions to the mainland. If they are island-bound, they might have been isolated from the mainland for a long time, which would be a very interesting situation to study.

GPS trackers have minimum weights of around 2-3 g, hence cannot be used on small birds. However, Brown Quail and the two rail species are large enough for this technique to be applicable. With GPS trackers, birds do not have to be recaptured, because the data from the trackers can be downloaded by Bluetooth connection when in sufficient proximity to the receiver. The downloaded data would be a complete record of the bird's movements on the island and where it went if it departed it.

5. Use the Motus radio-tracking technique to monitor whether species such as Silvereye and Yellow-faced Honeyeater remain on the island all the time.

There is now considerable evidence that some Yellow-faced Honeyeaters and many of the *cornwalli* Silvereyes are on the island regularly. However, it is not known if they stay on the island all the time or if they make frequent visits. The spring influx of *cornwalli* birds shows that movements to and from Broughton Island are easily achieved by Silvereyes. Nineteen different Yellow-faced

Honeyeaters have been banded but on any field trip there seem to be fewer birds than that present, so possibly there are interchanges of birds to the mainland.

The Motus technique involves placing a pulsed VHF transmitter (a “nano-tag”) onto a bird and tracking the signal using a receiver and fixed-point antenna. As a minimum, the presence of a signal is confirmation that the bird is within reception range of the receiver; directional and distance information potentially can also be available. Hence, Motus tracking should prove that a bird is resident on the island, and if it is not, the pattern of signals would reveal how frequently it visits the island.

Nano-tags are modestly priced but there are lots of birds on Broughton Island. To control costs, nano-tags initially could be placed only on Yellow-faced Honeyeaters (onto every trapped bird) and re-trapped *cornwalli* Silvereyes (i.e. only onto birds that are candidates to be classified as resident). An expanded Motus program can be considered later.

6. Continue with the Eastern Reef Egret nest-cam study

The discovery of a probable Reef Egret nest is a golden opportunity to study many things about the breeding biology of this species. Although it is a common coastal species in northern Australia, and its breeding behaviour there is reasonably well known, it is less common in southern Australia and there may well be differences in the breeding biology of southern compared with northern birds.

7. Introduce dedicated spring/summer breeding surveys.

The quarterly visits for banding and general bird surveys have led to some breeding records, but not many of them and no records so far for Tawny Grassbirds, nor for any raptors nor any shorebirds other than Sooty Oystercatcher. Most of the breeding records have been opportunistic ones.

The issue is that there is very little spare time in the quarterly visits for close monitoring of birds’ behaviour, which is the usual way for finding signs of breeding. It seems worthwhile to include 1-2 extra visits in spring and early summer i.e. the main breeding time, with the focus for those visits being to look for nests and any other evidence of breeding activity.

8. Reconsider the strategy for studying Golden-headed Cisticolas.

Although it has now become clear that Golden-headed Cisticolas have declined in the central parts of the island (where the banding activities have been focussed), they remain a common species elsewhere on it. They should be part of the banding study, otherwise the study overlooks an important member of Broughton Island’s bird community.

9. Do night-time surveys for White-faced Storm-Petrels

There is a tiny amount of evidence that White-faced Storm-Petrels might have resumed breeding on the island. Surveys for them at night in summer (i.e. during the breeding season) seem warranted. Such surveys should be carried out by someone with previous experience, perhaps accompanied by some local birders (for training purposes).

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