Corella, 2020, 44: 38-43

Silvereye subspecies on Broughton Island, New South Wales

Greg Little[1], Judith Little[1], Rob Kyte[2] and Alan Stuart[3]

[1]PO Box 77, Boolaroo New South Wales 2284, Australia
[2]PO Box 396, Hamilton New South Wales 2303, Australia
[3]81 Queens Rd, New Lambton, New South Wales 2305, Australia.
Email: almarosa@bigpond.com

Received: 11 September 2019
Accepted: 27 May 2020

Three taxa of the Silvereye *Zosterops lateralis* were confirmed to occur on Broughton Island, New South Wales. In bird banding activities carried out in 2017-2019, we identified 404 Silvereyes to subspecies level. Subspecies *cornwalli* (*Z. lateralis cornwalli*) was present all year and some birds of that subspecies either were resident on the island or were regular visitors. The local Silvereye population on Broughton Island was swelled by two annual influxes. The migratory subspecies *westernensis* (from eastern Victoria and south-eastern New South Wales) and *lateralis* (from Tasmania) arrived in autumn and remained on the island for 4-6 months. In spring, the number of *cornwalli* on Broughton Island also increased substantially. The latter influx was probably in response to the abundant seasonal food supply, particularly the availability of berries of *Monotoca elliptica*, a native plant which is becoming widespread in parts of Broughton Island now that feral animals have been removed. In autumn and winter *c*. 15% of the trapped Silvereyes examined were of subspecies *lateralis* and there were 40-45% each of *cornwalli* and *westernensis*. The ratio of the migratory subspecies, *westernensis* and *lateralis*, was around 3:1 in every autumn and winter field trip. This suggests a regular migration pattern for both subspecies. We recorded biometric data for all three subspecies. On average, the tails of *westernensis* birds were longer than those of *cornwalli* and *lateralis*, but there were no other statistically significant biometric differences. It would be difficult to differentiate the three subspecies based on measurement, although *lateralis* and *westernensis* potentially could be differentiated on tail length.

INTRODUCTION

The Silvereye *Zosterops lateralis* is widely distributed in Australasia and the south-west Pacific and numerous subspecies are recognised (Mees 1969; Schodde and Mason 1999; Higgins *et al.* 2006). Three subspecies occur in south-eastern mainland Australia:

- *lateralis*, the nominate subspecies, breeding in Tasmania and the Bass Strait islands and wintering in coastal and sub-coastal south-eastern Australia extending as far north as central-eastern Queensland.
- *westernensis*, found in coastal to near-inland south-eastern Australia, extending northwards to around the Hunter River.
- *cornwalli*, occurring in coastal and sub-coastal central and eastern Australia, extending southwards to around the Hunter River.

Winter migration of the Silvereye within south-eastern Australia has long been known (e.g. see Mees 1969; Lane and Battam 1971; Lane 1972a, b; Fullagar *et al*. 1986). At the time of these publications *westernensis* and *lateralis* subspecies usually were grouped together as "Tasmanian type Silvereyes" (Lane 1972b). It is also known that not all the southern population of Silvereyes migrate, some of them remaining at their breeding grounds in winter (Chan and Kikkawa 1997; Chan 2001). Data from the BirdLife Australia Atlas showed that the pattern of movement of Silvereyes from Tasmania and southern Australia involved both coastal and inland routes (Griffieon and Clarke 2002). However, the latter study did not reveal if there were any differences in the movement patterns of the *lateralis* and *westernensis* subspecies. In part that may have been because of the difficulty for observers in the field in correctly identifying a Silvereye to subspecies level. Silvereyes are small and they move rapidly; the viewing opportunities for an observer usually are brief.

The plumage differences of the three south-eastern Australian Silvereye taxa are subtle. Birds of the subspecies *cornwalli* have yellow throats and grey to buffish flanks. The flanks of *lateralis* and *westernensis* are more deeply coloured (varying from tawny to rufous/chestnut), a feature which readily differentiates them from *cornwalli* birds when visible. However, differentiating *lateralis* and *westernensis* is more difficult. The most useful difference for an observer is that *lateralis* birds have a grey throat and chin, whilst *westernensis* birds have a grey-yellow throat and chin. Figure 1 illustrates the differentiating plumage features of the three south-eastern Australian subspecies.

Most of the difficulties in the field of identifying a Silvereye to subspecies level are removed if the bird is in the hand and can be closely examined. We commenced a banding study on Broughton Island in June 2017, targeting terrestrial birds including the Silvereye. Since then almost 500 terrestrial birds have been captured and banded, with the majority being Silvereyes. The aim of the present study was to accurately classify each captured Silvereye to subspecies level using plumage information, determine the seasonal subspecies composition of the population on Broughton Island, collect and compare biometric data for the three subspecies and gain insights into the migratory behaviour of the *westernensis* and *lateralis* subspecies.

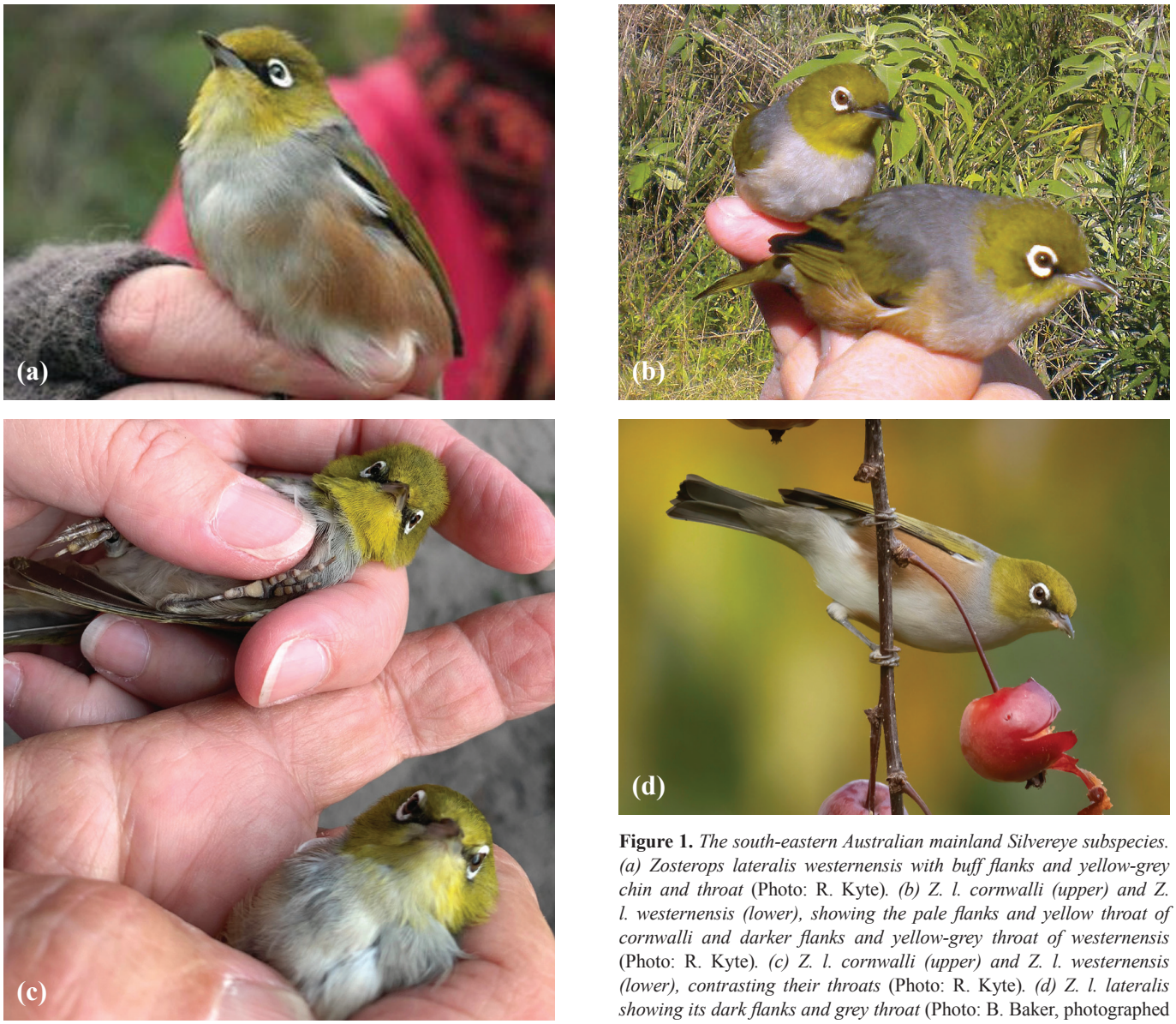

Figure 1. *The south-eastern Australian mainland Silvereye subspecies. (a) Zosterops lateralis westernensis with buff flanks and yellow-grey chin and throat* (Photo: R. Kyte). *(b) Z. l. cornwalli (upper) and Z. l. westernensis (lower), showing the pale flanks and yellow throat of cornwalli and darker flanks and yellow-grey throat of westernensis* (Photo: R. Kyte). *(c) Z. l. cornwalli (upper) and Z. l. westernensis (lower), contrasting their throats* (Photo: R. Kyte). *(d) Z. l. lateralis showing its dark flanks and grey throat* (Photo: B. Baker, photographed in Tasmania).

STUDY AREA AND METHODS

Broughton Island (32.616S 152.316E) lies ~15 km north-east of the entrance to Port Stephens in New South Wales (Fig. 2) and forms part of the Myall Lakes National Park. At its closest point, the island is less than three km from mainland parts of the National Park. It is an important seabird breeding site, especially for Wedge-tailed Shearwaters *Ardenna pacifica* and Short-tailed Shearwaters *A. tenuirostris*; small numbers of Little Penguins *Eudyptula minor* and Gould's Petrels *Pterodroma leucoptera* also breed there (Carlile *et al*. 2012).

Broughton Island's natural vegetation has been heavily impacted by feral animals and frequent fires, often deliberately lit, that occurred until recently (Carlile *et al.* 2012). These effects lasted a very long time; as long ago as 1883 the island was described as "entirely destitute of trees" (Pittman 1883). Since 2009, after completion of a program to remove rats and rabbits (Priddel *et al.* 2011), the island has been free of feral animals. Since then, the extent and diversity of vegetation on the island have increased (S. Callaghan pers. comm.).

A program to monitor the response of terrestrial birds to the island's changing vegetation commenced in early 2012. Twice-yearly surveys over 2012-2016 showed that the numbers of many native land birds, including Silvereyes, were increasing (Stuart *et al*. 2017). However, from the surveys it was unclear for some species whether they had resident populations on the island and, if so, what were the sizes of these populations. To try to gain better insights into these issues, we initiated a trapping and banding project on Broughton Island in 2017.

Our first visit for banding activities 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. Although several methods were used to trap or attempt to trap terrestrial birds, all the Silvereyes were caught using mist nets deployed at various

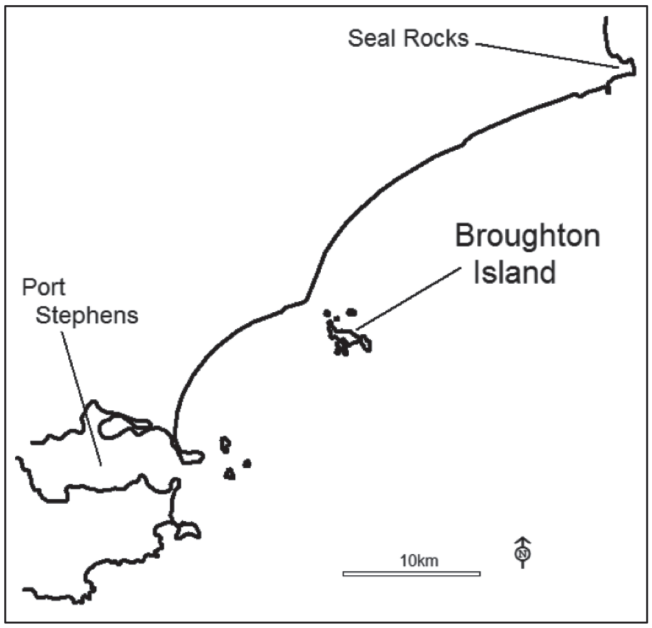

Figure 2. *Location of Broughton Island, New South Wales.*

locations around the central-western parts of the island. The locations were chosen because of observed higher levels of bird activity in a reconnaissance carried out at the start of each field trip. However, all locations (across all field trips) were within an approximate 500 m radius of one another. Most field trips involved a stay of two nights on Broughton Island, with mist-netting occurring 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. In June 2018 weather conditions limited us to a single night on the island, and so that trip involved just two half-days of banding activities. We did not record the specific number of hours or total net area of banding activities in each field trip. To compare seasons, we calculated the average number of Silvereyes captured per netting day.

All captured birds were banded and their biometric data and brood patch status were recorded (moult status was also assessed, but the findings are outside the scope of this report). The following biometric data were recorded for each Silvereye: weight (±0.1 g), wing-length (±0.5 mm), head-bill length (±0.1 mm) and tail length (±0.5 mm). Biometric data were obtained using conventional bird banders' equipment. Wing length measurements were obtained by the flattened chord method. Bare patch assessments used British Trust for Ornithology guidelines.

The subspecies of each captured Silvereye was assigned on the appraisal of all persons present (typically 2-3 people) and was based on plumage traits. With a Silvereye in hand, it was easy to assess its plumage carefully (i.e. the flanks and throat/chin) and decide as to its subspecies; all decisions were unanimous. Although it may be possible to differentiate male and female *lateralis* based on plumage differences (Kikkawa 1963), the method is probably not reliable (Higgins *et al*. 2006) and we did not attempt to do so.

We carried out one-way analyses of variance (ANOVA) on the biometric data for the three subspecies (alpha = 0.05).

Table 1

Silvereyes caught in mist nets on Broughton Island 2017-2019.

Year	Dates	Total birds	*cornwalli*	*westernensis*	*lateralis*	*unknown taxon*
2017	28-30 June	32	19	10	3	–
	13-15 Oct	79	77	1	–	1
2018	19-21 Jan	38	37	–	–	1
	20-22 April	21	9	10	2	–
	17-18 Aug	37	10	22	5	–
	2-4 Nov	72	72	–	–	–
2019	2-4 Feb	19	17	–	–	2
	11-13 May	39	15	17	7	–
	27-29 July	71	38	22	11	–
Total		408	294	82	28	4

RESULTS

Four hundred and eight Silvereyes, including re-trapped birds, were caught on Broughton Island in nine field trips between June 2017 and July 2019. Silvereyes were caught on every trip, with the highest number being 79 birds in October 2017, whilst only 17 birds were caught in February 2019. Table 1 summarises the results from each visit, including the number of birds caught of each of the three subspecies. Four birds were prematurely released and their subspecies thus could not be assigned.

Seasonal changes

Table 2 summarises the results by season. The spring and winter trips were more productive than those in other seasons. On average, we captured *c.* 38 Silvereyes per day in spring and 28 per day in winter, compared with 14-15 birds per day in the other seasons. The least number of birds captured per day occurred on the summer trips, an average of 14 Silvereyes per day. In summer, all the Silvereyes captured were *cornwalli* (Table 2) and that subspecies also dominated in the spring trips when 149 of the 150 classified birds were *cornwalli*. In the autumn and winter trips, *westernensis* and *lateralis* birds were present on Broughton Island and were captured together with *cornwalli*. The ratio of these two subspecies was around 3:1 in every autumn and winter trip (i.e. 40-45% of captured birds being *westernensis*, ~15% being *lateralis*, and the others being *cornwalli*).

Re-trapped birds

Although there were *c*. 50 re-trapped Silvereyes in the nine trips, this figure included many instances where the bird was recaptured during the same trip in which it had been banded. Thirty-four birds had longer intervals before they were re-captured; all were *cornwalli*, except for one *westernensis*. Three *cornwalli* birds were each recaptured on two different trips; all three were first banded in June 2017. The only *westernensis* bird re-trapped on a different trip was first banded in May 2019 and then re-captured in July 2019. Of the 32 Silvereyes banded in June 2017, five different individuals have since been re-trapped, and eight of the 79 individuals banded in October 2017 have since been re-trapped.

Table 2

Seasonal data for Silvereye subspecies on Broughton Island 2017-2019. Number of individuals is given for each subspecies, with the percentage of the total catch given in parentheses.

		Summer Jan-Feb	Autumn Apr-May	Winter Jun-Aug	Spring Oct-Nov
Total birds		57	60	140	151
No. visits		2	2	3	2
No. half-days		8	8	10	8
Ave. birds/day		14	15	28	38
No. of birds	*cornwalli*	54 (100%)	24 (40%)	67 (48%)	149 (>99%)
No. of birds	*westernensis*	–	27 (45%)	54 (39%)	1 (<1%)
No. of birds	*lateralis*	–	9 (15%)	19 (14%)	–
No. of birds	*unknown taxon*	3	–	–	1

Table 3 indicates in which season, or seasons, a Silvereye was recaptured after it had originally been banded on a winter, spring, summer or autumn trip. For Silvereyes re-captured more than once, each re-capture event is treated separately. Thus, Table 3 is based upon 42 re-capture events involving 34 Silvereyes, of which four birds have each been re-captured twice. The table shows that 16 birds banded in spring have been re-captured, whilst 8-9 birds banded in winter, summer and autumn have been re-captured.

Biometrics of the three Silvereye subspecies on Broughton Island

In general, there was considerable overlap among subspecies in the ranges of each biometric variable (Fig. 3). However, the tails of *westernensis* birds (n = 82) were significantly longer than those of the other subspecies (n = 294 for *cornwalli*, n = 28 for *lateralis*). On average, the *westernensis* tail was 1.42 cm longer than the tail of a *cornwalli* bird ($P < 0.01$) and 1.95 cm longer than the tail of a *lateralis* bird ($P < 0.01$). There was no statistically significant difference in the tail lengths of *cornwalli* and *lateralis* birds ($P > 0.05$).

Brood patches and breeding records

None of the *lateralis* Silvereyes had visible brood patches; however, brood patches were present on five of the 84 *westernensis* birds assessed. All five of these birds were from the July 2019 trip. For four of the birds, the brood patch was not vascularised, but for the fifth bird slight vascularisation was apparent.

In contrast, 148 of the 294 assessed *cornwalli* Silvereyes had a brood patch and an egg was visible in two other birds (in October 2017 and January 2018). Twenty-two of the *cornwalli* birds had large ventral bare patches, which were yellow-brown in colour and wrinkled, indicating that brooding had recently finished (Australian Bird Studies Association 2017). All 22 of these birds were captured on the two summer trips in January

Table 3

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

		Season recaptured				
		Winter	Spring	Summer	Autumn	Total
Season Captured	Winter	–	2	2	5	9
	Spring	5	4	3	4	16
	Summer	3	–	1	5	9
	Autumn	7	–	–	1	8
	Total	15	6	6	15	42

2018 and February 2019. Another twenty-four *cornwalli* birds had large bare areas, deep red in colour and strongly vascularised, indicating that they were brooding (Australian Bird Studies Association 2017). Most of these instances were in the spring visits (October 2017 and November 2018). However, one bird in February 2019 was also assessed as brooding.

DISCUSSION

For a mobile species such as the Silvereye, we consider that our method of deploying mist nets was effectively accurately sampling the numbers of birds on the island at the time and the subspecies present. In confirmation of the latter point, we often found that, when several Silvereyes were caught at the same time in a particular mist net, more than one subspecies had been captured. The Silvereyes appeared to travel in mixed subspecies flocks, perhaps driven more by shared advantages in finding food and in evading predators than by any preference for inter-taxon association.

Seasonal changes

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 one *westernensis* was captured in a spring trip, perhaps a late-departing bird 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*. After the removal of feral animals, this tall shrub now forms a major component of the vegetation in the central-western parts of Broughton Island (S. Callaghan pers. comm.). 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*.

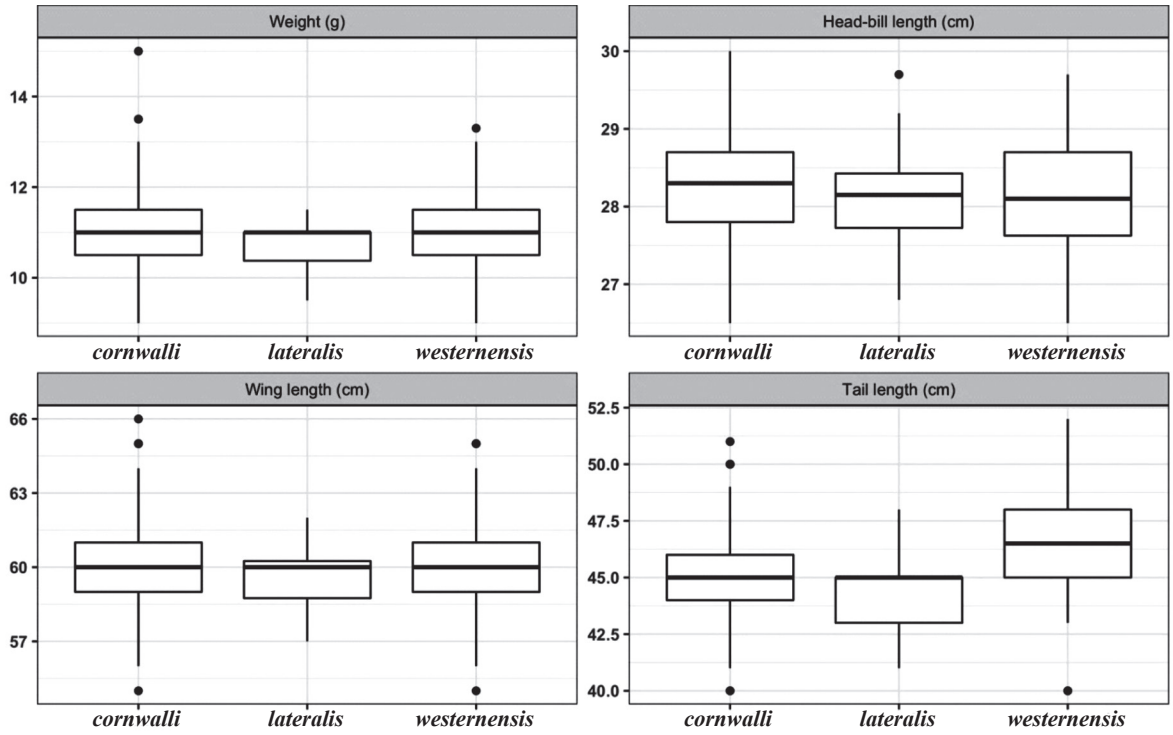

Figure 3. *Silvereye measurements by subspecies. Medians are represented as horizontal lines between the interquartile ranges (boxes), and 1.5*interquartile ranges (whiskers). Outlier values are presented individually (•).*

Re-trapped birds

To date we have found no evidence of any individual *westernensis* or *lateralis* birds returning to Broughton Island in a different year from that in which they were banded. One hundred and ten birds of these two subspecies were banded on the island from June 2017 to July 2019 (82 *westernensis*, 28 *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 suggests that many *cornwalli* Silvereyes regularly visit Broughton Island or are resident there. It is not possible to conclusively differentiate between those two possibilities based solely on quarterly visits to the island. However, the length of time between some of the captures and recaptures does suggest longer-term residency. In the future, radio-tracking techniques such as Motus (Taylor *et al*. 2017) may help to determine if any individual *cornwalli* Silvereyes remain on Broughton Island all year or if they come and go.

Biometrics of the Silvereye taxa on Broughton Island

Higgins *et al*. (2006) summarised Silvereye biometric data from a very large number of studies. Although the reported data suggest that *lateralis* may be marginally larger than the *cornwalli* and *westernensis* subspecies, there was considerable variability even within a subspecies. Hence, comparisons with our Broughton Island results are not straightforward. However, the reported tail lengths for *cornwalli* birds from other studies have been smaller than the *cornwalli* tail lengths in our study. Mean tail lengths of 41.1 mm, 41.9 mm, 42.1 mm and 43.7 mm were reported in four previous studies (Higgins *et al*. 2006), compared to a mean tail length of 45.0 mm in our study. However, comparisons among such data sets should really be conducted with appropriate statistical analysis and might anyway not be valid because of the potential for differences in measurement technique, differences in measurements on skins and live birds, and differing sex ratios in the samples.

We found that the tails of *westernensis* birds were significantly longer than the tails of *cornwalli* and *lateralis* birds. This observation warrants further investigation as it potentially could provide a means other than plumage differences of differentiating *westernensis* birds from the other two subspecies. It would not be possible to differentiate the three taxa based on weight, head-bill length or wing length.

Breeding

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* (in our study the other two Silvereye taxa had departed by spring). In the present study, we found considerable evidence of breeding activity by *cornwalli*. 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 22 birds suggested that they only recently had finished brooding. Also, two birds were carrying eggs when captured.

The above information suggests that *cornwalli* now breeds on Broughton Island. However, we also note that no Silvereye

nests were detected in the 2017-2019 visits to the island, although we did not specifically search for them. Furthermore, of the 284 *cornwalli* Silvereyes examined in the study, only three were aged as first-year birds (based upon growth bars in their tails). If *cornwalli* Silvereyes are breeding on Broughton Island, it may be that their fledged young often do not remain on the island, hence the low numbers of first-year birds. Another explanation for the data could be that some mainland breeding Silvereyes undertake short-duration visits to Broughton Island to feed there. In the future, we hope that radio tracking may help resolve such questions.

Preliminary population estimate

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. At this stage of a long-term study, we merely make a preliminary observation about the *cornwalli* population on Broughton Island. In the July 2019 trip, 38 *cornwalli* birds were captured, and eight of them (i.e. 21%) were re-trapped birds. By the end of the July 2019 trip, 294 *cornwalli* Silvereyes had been banded since the project commenced in June 2017. Extrapolating using the 79:21 ratio leads to an estimate of 1,400 birds. It does not seem extreme to conclude that 1,000–2,000 *cornwalli* Silvereyes have lived on or visited Broughton Island in the two years of the banding study.

ACKNOWLEDGEMENTS

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). We thank Susanne Callaghan, the National Parks and Wildlife Service (NPWS) Ranger for Broughton Island, for her enthusiastic and unwavering support for our project and the preceding 2012-16 survey work. She also arranged NPWS funding for our main travel, accommodation and catering costs and for the purchase of a dedicated set of trapping equipment, e.g. mist nets and poles, for us to use on Broughton Island. Robyn Stuart (Burnet Institute, University of Copenhagen Mathematical Science Department) generated the box plots for us and carried out the statistical analyses using the R software application. We also are grateful to Nicky Shirley, Fred van Gessel and Emily Mowat for assistance during some banding trips, Barry Baker for a photograph of *Z. l. lateralis* and for the comments and suggestions made by the referees, Danny Rogers and Sonya Clegg.

REFERENCES

Australian Bird Study Association (2017). *Bird in the Hand (2nd edition.)*. https://absa.asn.au/bird-in-the-hand-2nd-edition Accessed March 2017.

Carlile, N., Priddel, D. and Callaghan, S. (2012). Seabird Islands No. 18/1. Broughton Island, New South Wales. *Corella* **36**: 97-100.

Chan, K. (2001). Partial migration in Australian landbirds: a review. *Emu* **101**: 281-292.

Chan, K. and Kikkawa, J. (1997). A Silvereye dilemma: to migrate or not to migrate? *Emu* **97**: 91-93.

Fullagar, P. J., Lowe, K. W. and Davies, S. J. J. F. (1986). Intracontinental migration of Australian birds. In: *Acta XIX Congressus Internationalis Ornithological. Vol. 1*, pp. 791–801. University of Ottawa Press, Ottawa.

Griffieon, P.A. and Clarke, M.F. (2002). Large-scale bird-movement patterns evident in eastern Australian atlas data. *Emu* **102**: 99-125.

Higgins, P.J., Peter, J.M. and Cowling, S.J. (Eds.) (2006). *Handbook of Australian, New Zealand and Antarctic Birds Volume 7: Boatbills to Larks*. Oxford University Press, Melbourne.

Kikkawa, J. (1963). A sexual difference in the plumage of the Silvereye, *Zosterops lateralis*. *Emu* **63**: 32-34.

Lane, S. G. (1972a). A review of the Co-operative Silvereye Project. *Australian Bird Bander* **10**: 3–6.

Lane, S. G. (1972b). Tasmanian type Silvereyes in New South Wales. *Australian Bird Bander* **10**: 33–34.

Lane, S. G. and Battam, H. (1971). Silvereye movement in eastern Australia. *Australian Bird Bander* **9**: 80–82.

Mees, G.F. (1969). A systematic review of the Indo-Australian Zosteropidae (Part III). *Zoologische Verhandelingen* **102**: 1-390.

Pitman, E.F. (1883). Report on Broughton Island. In *Annual Report, Department of Mines, New South Wales*, **1883**: 157.

Priddel, D., Carlile, N., Wilkinson, I. and Wheeler, R. (2011). Eradication of exotic mammals from offshore islands in New South Wales, Australia. In: *Island Invasives: Eradication and Management*. (Eds. Veitch, C. R., Clout, M. N. and Towns, D. R.). International Union for Conservation of Nature, Gland, Switzerland.

Pyke, G. H. and Recher, H. F. (1988). Seasonal patterns of capture rate and resource abundance for honeyeaters and Silvereyes in heathland near Sydney. *Emu* **88**: 33–42.

Schodde, R. and Mason, I.J. (1999). *The Directory of Australian Birds. Passerines*. CSIRO Publishing, Canberra, Australia.

Stuart, A., Clarke, T., van Gessel, F., Little, G., Fraser, N. and Richardson, A. (2017). Results from surveys for terrestrial birds on Broughton Island, 2012-2016. *The Whistler* **11**: 46-53.

Taylor, P. D., Crewe, T. L., Mackenzie, S. A., Lepage, D., Aubry, Y., Crysler, Z., Finney, G., Francis, F., Guglielmo, C. G., Hamilton, D. J., Holberton, R.L., Loring, P. H., Mitchell, G. W., Norris, D. R., Paquet, J., Ronconi, R. A. Smetzer, J. R., Smith, P. A., Welch, l. J. and Woodworth, B. K. (2017). The Motus Wildlife Tracking System: A Collaborative Research Network to Enhance the Understanding of Wildlife Movement. *Avian Conservation and Ecology* **12** (1): 8