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Seasonal survey of waterfowl (Anatidae), shags (Phalacrocoracidae) and fernbird (*Bowdleria punctata*) at Te Nohoaka o Tukiauau/Sinclair Wetlands, Otago: July 2015 – July 2018

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Abstract: Birds were surveyed once per season over three years from 2015–2018 at Te Nohoaka o Tukiauau/Sinclair Wetlands, Otago. Eight species of waterfowl were observed, including four native species: New Zealand scaup (*Aythya novaeseelandiae*), Australasian shoveler (*Anas rhynchotis*), paradise shelduck (*Tadorna variegata*), and grey teal (*Anas gracilis*). Native species made up 68% of all waterbirds counted. New Zealand scaup dominated at 53%. The highest total number of birds counted was 1167 in winter 2015, and the lowest was 76 in spring 2016. The counts for some species varied greatly from year to year and each species showed some seasonal variation. It appears that more waterfowl are using the lagoons now than 15 years ago. Shag numbers were never greater than 8 individuals. The estimated density of fernbird (*Bowdleria punctata*) along a 750 m transect varied from 1.0/ha in winter to 2.7/ha in summer. This survey of waterfowl, shags and fernbird provides a reference against which future comparisons investigating long-term trends in bird populations at the Sinclair Wetlands can be made.

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Key words: Sinclair Wetlands, seasonal counts, waterfowl, shags, fernbird

INTRODUCTION

Wetlands support a high diversity of birds, fish, invertebrates, algae and plants. They offer refuge to many threatened species and include naturally rare ecosystems. Many of New Zealand's native fauna rely on wetlands during all or part of their life cycle. Nationally, wetlands provide a variety of important ecosystem services including maintaining water quality, mitigation of flood effects and sequestering of carbon (Department of Conservation, 2020a). Threatened species such as the Australasian bittern (*Botaurus poiciloptilus*), brown teal (*Anas chlorotis*), fernbird (*Bowdleria punctata*), crakes (*Porzana* spp.), and white heron (*Ardea modesta*) all rely on the remnant wetlands present in New Zealand for their survival. Equally, wetlands provide habitat for highly mobile waterfowl which use a national network as part of their annual cycle (Sutton *et al*. 2002; Caithness *et al.* 2002).

The Te Nohoaka o Tukiauau/Sinclair Wetlands is part of the nationally important wetland complex of Lake Waihola and Lake Waipori on the Taieri Plain south of Dunedin. This larger complex is considered

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of national importance due to the size of the wetland and the diversity of habitats present (Stephenson *et al.* 1983; Cromarty & Scott 1995). Over 90% of New Zealand's wetlands have been drained or modified by human activities, resulting in a decline in flora and fauna that depend on wetland habitat (Myers *et al*. 2013; Department of Conservation 2020a). The conservation and restoration of what remains is essential to halt, and hopefully reverse, this decline (Department of Conservation 2020b).

Over 50% of the Sinclair Wetlands was originally drained for farming, but farming ceased in the 1960s and the area was re-flooded and regeneration of a matrix of native wetland plants occurred. In 1998 the property was returned to Ngāi Tahu and sustained restoration efforts began. Te Nohoaka o Tukiauau/Sinclair Wetlands Trust is actively overseeing restoration of the wetland, including removal of exotic weed species, re-planting with native vegetation, and mammalian predator control. A draft management plan has as its main objective "to implement a matauranga based mahinga kai focused management", along with monitoring of bird species and numbers. As part of the implementation of this plan, Birds New Zealand (Otago Region) was asked to obtain a current record of birds in the wetlands. The long-term objective is to provide a baseline reference point for future comparisons that can contribute to monitoring restoration and inform decisions about management of the wetlands. This in turn can ensure healthy habitats, ecological diversity, sustainable practices, and promote community engagement in the area.

This survey was the first time that an integrated programme to survey birds seasonally with specific methods for each taxonomic group was completed for this wetland. We used standardised methods to allow comparison of relative abundances within species in subsequent years if surveys were repeated. We chose species that we expected to be present in large numbers and that are amenable to being sampled by direct observation methods.

METHODS

Survey area

The Sinclair Wetlands along with the associated Lakes Waihola and Waipori are distinctive in New Zealand in that they are a fluvial delta of the Waipori and Taieri Rivers. The wetlands are near sea level and consequently have occasional saltwater intrusion. The Sinclair Wetlands comprises 315 hectares situated on the northwest corner of the greater Lakes Waihola and Waipori wetland complex on the Taieri Plain 50 km south of Dunedin (45°59′S, 170°06′E; Fig. 1). The Sinclair Wetlands is now a matrix of natural marshes and pools as well as drainage ditches. The vegetation now includes many native wetland species such as sedges (*Carex* spp.), flaxes (*Phormium tenax*), raupō beds (*Typha orientalis*), and *Coprosma propinqua* shrubs.

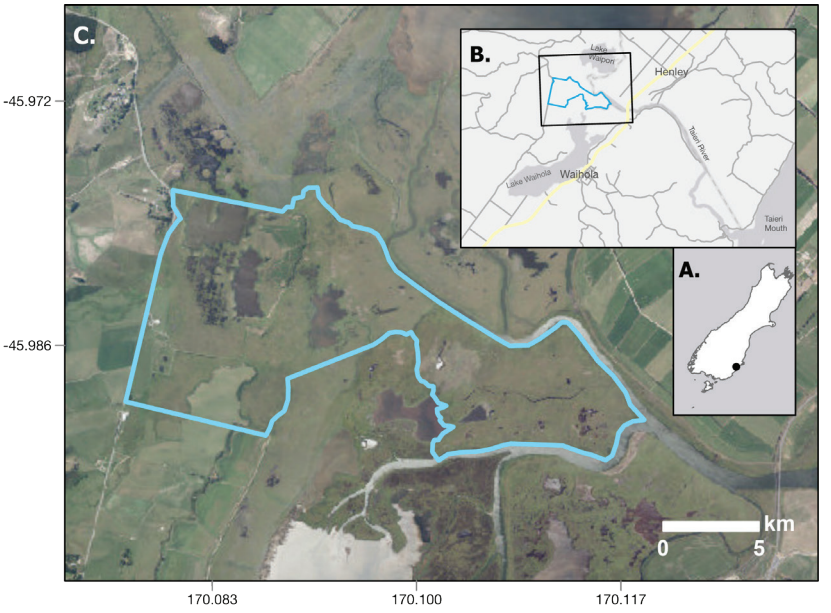

Figure 1. Location of Te Nohoaka o Tukiauau/Sinclair Wetlands. A. South Island of New Zealand; B. Lakes Waihola and Waipori wetland complex; C. Sinclair Wetlands with boundary shown in blue.

Table 1. Dates when seasonal bird surveys were done at the Sinclair Wetlands, 2015 – 2018.

Season	Dates			
Winter	11 July 2015	no survey	15 July 2017	7 July 2018
Spring	4 October 2015	15 October 2016	7 October 2017	-
Summer	30 January 2016	28 January 2017	27 January 2018	-
Autumn	9 April 2016	8 April 2017	7 April 2018	-

All surveys were carried out on calm, fine days between 0900 h and 1200 h to minimise variations of counts due to time or weather conditions. The species-specific surveys were completed by different teams. The counts were carried out on one day in each season for 3 years (Table 1). The autumn counts were completed in April each year well before the opening of the waterfowl hunting season in May. This survey did not set out to survey cryptic species such as Australasian bittern and crakes.

Waterfowl and shags

A point count methodology was used with count stations established on Lonely Island (45°59′07.0″S, 170°05′14.8″E), and at the western point (45°58′45.9″S, 170°05′14.3″E) and east side (45°58′54.2″S, 170°05′24.0″E) of Whakaraupuka/Ram Island; these stations have an elevation between 20 and 25 m a.s.l. and were chosen to overlook the major open water areas (Fig. 2). This covered nearly 90% of the open water of the ponds. Birds hidden in the reeds could not be counted. Spotting scopes with 20x magnification were used. All individual waterfowl and shags of each species seen from these observation points were counted. The total number counted per survey was used as the index of abundance: double counting was minimised by completing counts as fast as could be achieved and only counting birds when they were at rest and not being disturbed. Seasonal variation in behaviour, such as nesting within reeds, could lead to underestimates of total numbers of birds present and no correction was made for this. We were not able to distinguish between mallard, grey duck, and any hybrids or colour forms that were present in the wetland (Williams 2019) and so all birds that displayed these phenotypes are reported as 'mallard'.

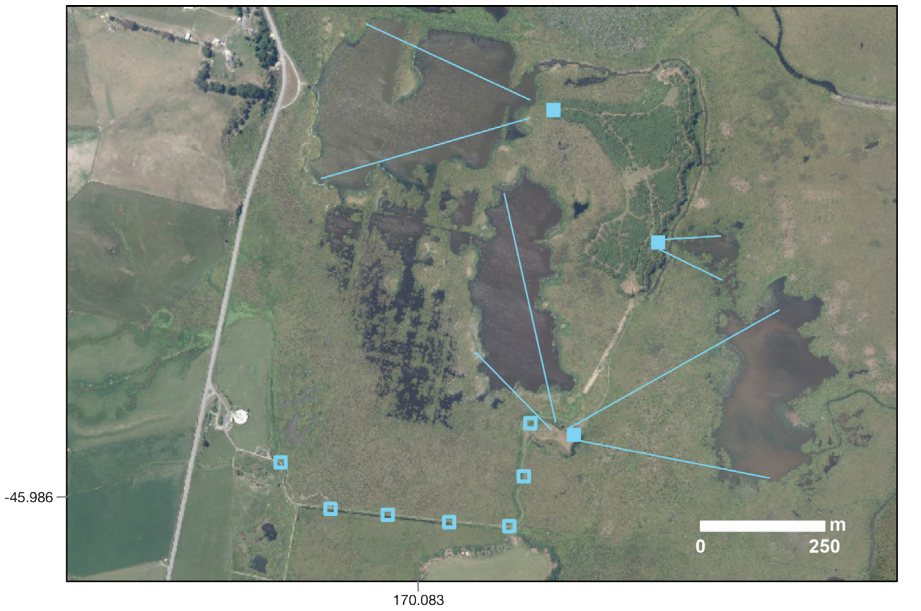

Figure 2. Satellite view of the section of the Sinclair Wetlands where the survey was done. Fernbird count stations are marked with open squares and waterfowl observation points are marked with closed squares.

Table 2. Seasonal counts of waterfowl at Sinclair Wetlands 2015–2018. The three separate seasonal counts and the total number of each species of waterfowl are shown. The mean for the seasonal counts was calculated. Percent abundance was calculated from the total number of each species as a percent of the total number of birds. Native species shown in bold typeface.

Species	Summer			Autumn			Winter			Spring			species total	% of total
	2016	2017	2018	2016	2017	2018	2015	2017	2018	2015	2016	2017		
New Zealand scaup	83	90	269	386	124	340	617	93	305	59	64	75	2,505	53.9
Mallard	35	9	77	43	55	57	299	55	52	3	2	5	692	14.9
Canada goose	25	45	51	83	55	37	31	16	30	10	0	12	395	8.5
Paradise duck	87	0	216	4	0	2	0	0	0	0	0	2	311	6.7
Black swan	27	7	2	38	4	42	97	8	29	29	3	22	308	6.6
Australasian shoveler	2	4	7	157	32	7	12	0	19	7	7	2	256	5.5
Grey teal	0	0	0	8	4	0	72	0	2	5	0	0	91	1.9
Greylag goose	0	4	6	0	3	9	39	3	14	5	0	6	91	1.9
Total number of birds	259	159	628	719	277	494	1,167	175	451	118	76	124	4,649	
Mean			348			372			598			106		

Fernbird

Fernbirds were counted along a 750 m transect along a footpath through the sedgeland with seven count stations positioned every 100 m (Fig. 2). Based on previous studies at the Sinclair Wetlands which mapped fernbird territory as 1.35 ha (Harris 1986) we assessed that a 100 m gap between count stations would reduce the risk of double counting between stations but would ensure sufficient coverage. Observers counted all fernbirds seen or heard during 5 minutes at each station, then played fernbird calls for one minute from a portable speaker (DiVoom iTour-30, 4.8W) on full volume and then counted any other fernbirds that responded. The largest total was recorded for each station and then the counts for all stations were combined to give the total count for the survey. To derive estimates of density we assumed that birds 50 m either side of this transect were included in the count, and thus the total area surveyed was *c.* 7.5 hectares.

RESULTS

Waterfowl

Eight species of waterfowl were seen, which included four native species (Table 2). A total of 4,649 birds were counted. The highest number seen at one count was 1,167 for winter 2015, and the lowest was 76 for spring 2016. There was a high variability for numbers of certain species from year to year within a season; numbers were low in winter of 2017 (total: 175) and very high in winter of 2015 (total: 1,167). All native species combined made up 68% of the waterfowl observed. Overall, New Zealand scaup (*Aythya novaeseelandiae*) dominated the count totals, accounting for 53% of all observed waterfowl, with the next most abundant being the introduced species, mallard (*Anas platyrhynchos* x *supercilliosa*) at 15% followed by Canada goose (*Branta canadensis*) at 8.5%, and black swan (*Cygnus atratus*) at 6.6%. Greylag geese (*Anser anser*) were uncommon in the surveys, making up 1.9% of the total counted, with the highest count in winter 2015.

To compare the pattern of seasonal variation of the six most abundant waterfowl species the mean number for each species for each season across the three years was used (Fig. 3). All species except paradise shelduck (*Tadorna variegata*) and grey teal (*Anas gracilis*) were present all year, but in varying numbers. New Zealand scaup, black swan, and mallard occurred in greatest numbers in winter. Paradise shelduck were present in significant numbers only in summer, although there were none for one summer count; only one or two paradise shelducks were seen on the lagoons in other seasons. The highest number of Australasian shoveler (*Anas rhynchotis*) was in autumn. Grey teal were only seen once in high numbers (72 in 2015) and that was in winter.

Fernbird

The highest count for fernbird was recorded in summer and the lowest in winter (Table 3). The estimated density ranged from 1 bird/ha in winter to 2.7 bird/ha in summer.

Other water birds

Small numbers of black shag (*Phalacrocorax carbo*) and little pied shag (*Phalacrocorax melanoleucos*) were counted (Table 4). The highest number of little pied shag was in autumn. Other birds using the lagoon area, but not surveyed, were pukeko

(*Porphyrio melanotus*), coot (*Fulica altra*; only one seen during the survey), and marsh crake (*Porzana pusilla*) and spotless crake (*Porzana tabuensis*), which were reported occasionally at the wetlands during the survey period.

DISCUSSION

Our survey reinforces the value of Te Nohoaka o Tukiauau/Sinclair Wetlands as part of the larger Lakes Waihola and Waipori wetland complex and its contribution to populations of wetland species

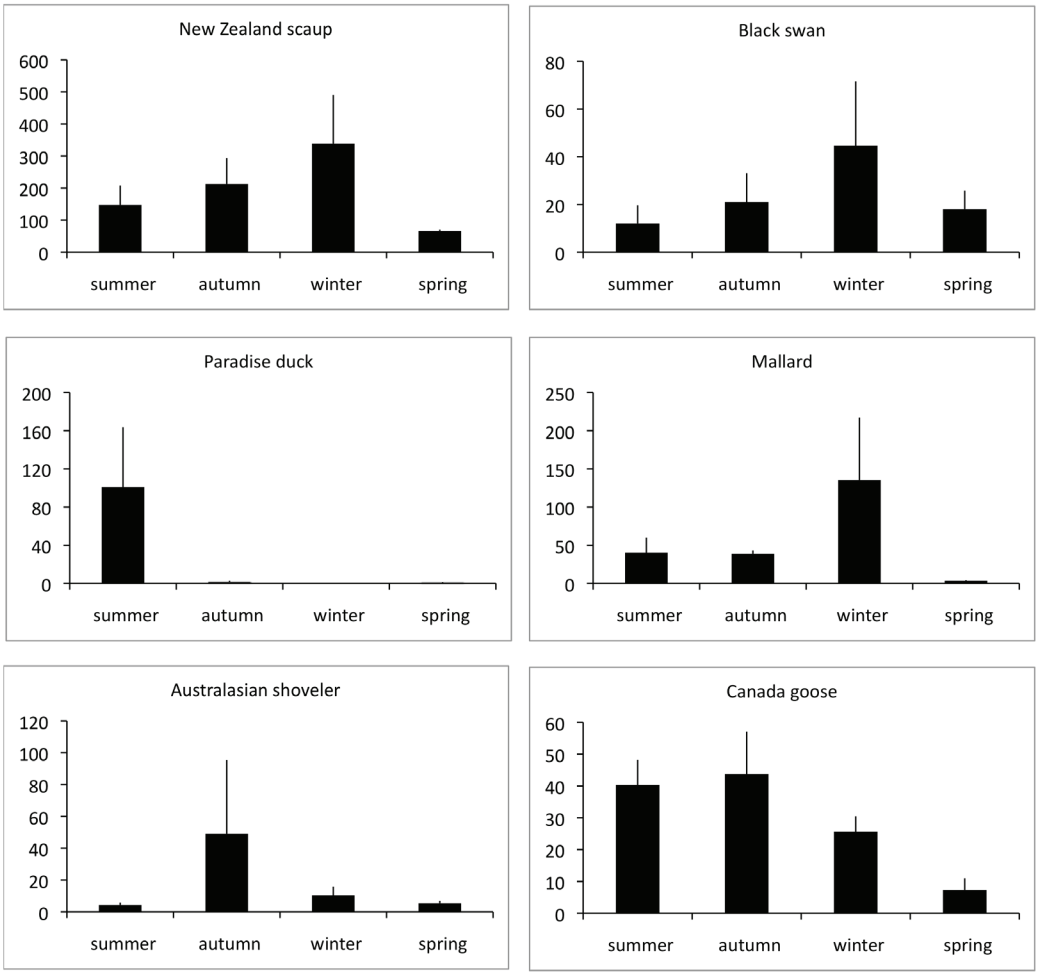

Figure 3. Comparison of pattern of seasonal numbers of waterfowl counted at Sinclair Wetlands 2015–2018. Counts were done in summer (January), autumn (April), winter (July) and spring (October) (Table 1). Bars show mean and whiskers show standard error of mean of counts for the top six most abundant species. Note scales are different for each species.

Table 3. Seasonal counts of fernbirds at Sinclair Wetlands 2015–2018. Total numbers encountered along the 750 m transect, covering 7.5 ha. *counted by a different observer from the other surveys.

	Summer			Autumn			Winter			Spring		
	2016	**2017**	**2018**	**2016**	**2017**	**2018**	**2015**	**2017**	**2018**	**2015**	**2016***	**2017***
Fernbird counts	32	14	15	14	12	6	6	13	4	19	7	4
Mean ± standard error	20.3 ± 5.8			10.6 ± 2.4			7.7 ± 2.7			10.0 ± 4.6		
Density (mean number/ha ± standard error)	2.70 ± 0.78			1.42 ± 0.32			1.02 ± 0.36			1.33 ± 0.61		

Table 4. Seasonal counts of shag species at Sinclair Wetlands 2015–2018.

	Summer			Autumn			Winter			Spring		
	2016	2017	2018	2016	2017	2018	2015	2017	2018	2015	2016	2017
Black shag	1	1	2	0	0	0	1	0	0	1	0	0
Little pied shag	1	3	1	3	8	8	3	1	1	1	3	2

regionally and nationally. The data presented here support the contention that the Sinclair Wetlands is sufficiently large enough to provide a variety of habitats for significant numbers of native species of waterfowl, with the endemic New Zealand scaup being the dominant species by numbers year-round. In addition, it supports a viable population of South Island fernbird. The Sinclair Wetlands also potentially provides suitable habitats for threatened birds such as bitterns and crakes.

Waterfowl

Interpreting our results for the waterfowl is complex as each species uses the wetlands to different extents for feeding, breeding, moulting and shelter depending on their seasonal cycles. For example, the use of the Sinclair Wetlands by Australasian shoveler is within the context of having one population that moves nationally within a period of weeks (Caithness *et al.* 2002; Sutton *et al.* 2002). Some of our methods would not be fit to investigate these patterns. Nevertheless, baseline counts using standardised repeatable methods have value in determining the overall contribution of the Sinclair Wetlands to the national pattern of mobile species of waterfowl and as a basis for more species-specific studies.

The findings reported here underline the value of the Sinclair Wetlands for native species of waterfowl. Native species made up 68% of total numbers counted. In many other wetlands, mallard (including grey duck, and mallard x grey hybrids), and Canada goose dominate (e.g. Gill & West 2016; Williams 2017), but here they were less than 23% of the total waterfowl counted. The overall low numbers of birds on the open water in spring could be because birds were hidden in reeds nesting, or they could have moved away to breed. The method used for the survey would not have located any nesting birds so the spring count is assumed to be an underestimate. Evidence of breeding was observed for all the waterfowl but the current survey was not designed to measure the extent or success of breeding and this should be the subject of future studies.

New Zealand scaup, the endemic diving duck, was present in high numbers and was over 50% of all waterfowl counted in all seasons. This appears to be an invasion into this wetland as summary reports from four decades ago indicate that New Zealand scaup were rarely seen in the Waihola and Waipori wetlands at that time (Drey 1990). Twenty years later, when another survey was done in summer New Zealand scaup were present, but in low numbers (Kissling 2002). The presence of New Zealand scaup throughout the year suggests they have now colonised these wetlands and occupy them as resident year-round. The numbers were highest in winter, which may indicate these wetlands are a site to which inland birds also migrate for over-wintering, though this needs further investigation.

Paradise shelduck were only seen once in large numbers and this was in summer, and it is hypothesised to have coincided with moulting. However, it is unlikely that the Sinclair Wetlands is a regionally important moult site for paradise shelduck as there was no obvious communal flocking of these birds seen during the summer counts done in Janaury. To determine if the Sinclair Wetlands is a moult site for paradise shelduck would require more counts during the moulting season.

The other native duck species present, Australasian shoveler and grey teal, were also not in great numbers, but these species are highly mobile during autumn and winter, and migrate to and from coastal areas (e.g. Caithness *et al*. 2002; Sutton *et al*. 2002), and probably use the wetlands irregularly. The Otago coast has extensive estuarine habitat that is used by Australasian shoveler and grey teal in winter (eBird 2020).

The numbers of black swan were not as high as expected because, at times, they are very numerous on the nearby open water of Lakes Waihola and Waipori (eBird 2020). The highest consistent counts were in winter, which may indicate the use of the Sinclair Wetlands complex as a wintering site before dispersing for nesting in spring. The data do not support the contention that the Sinclair Wetlands is a significant moulting or breeding site for black swan as may be the case for neighbouring Lakes Waihola and Waipori (Cromarty & Scott 1995). Canada goose are present throughout the year and in slightly greater numbers than swans but also appear to disperse in spring.

Although the aim of the present survey was to provide baseline counts for subsequent surveys, it is relevant to compare the current survey with a previous survey done at the Sinclair Wetlands during the summer of 2001/2002 (Kissling 2002).

The methodologies were slightly different, but it is possible to compare the numbers of waterfowl on the lagoons in the summer of 2002 with the summers of 2015–2018. There is a notable increase from 46–67 birds then, to 159–628 (mean 348) now. Then as now, in the summer New Zealand scaup were the most numerous, making up 64% of all waterfowl in 2002 and 42% now. It appears that more waterfowl are using the lagoons now than 15 years ago. Increased numbers of all the native waterfowl species would indicate the continued value of the wetlands for them. Although none of these native waterfowl species currently using the wetlands has a conservation status of threatened (Robertson *et al.* 2017) it is important to maintain suitable wetland habitat for them to continue to thrive.

Fernbird

Fernbirds were noted at most of the count sites along the transect, which was through an area of sedgeland with emergent coprosma bushes and flaxes, typical of the preferred habitat of fernbird (Best 1979; Harris 1986). The estimated densities ranged from 1 to 2.7 birds/ha depending on season. The variability of the counts is likely related to detectability, as it has been noted that at times fernbird are quiet for no apparent reason (Barlow 1983). The apparently lower count in winter was probably due to the less territorial behaviour of the birds in this season so that they did not respond so readily to call play-back and were therefore less conspicuous. The higher count in summer may include juveniles still present in the parents' territory.

A previous study of fernbird breeding ecology in a comparable area of the Sinclair Wetlands mapped fernbird territories at an average of 1.35 hectares per pair (range 0.46–3.73) (Harris 1986); this would give an estimated density of 1.48 birds/ha, which is similar to that of the current study during spring (1.33 birds/ha). In another study (Kissling 2002), fernbird were surveyed over the 2001/2002 summer along the same transect as our study. The mean density reported was 1.15 birds/ha. The comparable summer density of fernbird for the current survey was 2.7 birds/ha. Overall, these results indicate that the Sinclair Wetlands have maintained a healthy population of fernbirds over the last four decades and is a valuable site for fernbird conservation. Currently the fernbird has a threat classification of 'at risk, declining' (Robertson *et al.* 2017).

It is difficult to extrapolate from our counts to an estimate of the total population of fernbird in the whole of the wetland as the current study did not sample all the available habitat, nor was territory mapping used. Nevertheless, an estimate of the area of suitable habitat made from examination of aerial views suggest that the Sinclair Wetlands could provide about 200 hectares of suitable habitat, giving an estimate of about 130 territories of about 1.5 ha each (260 breeding fernbirds). Smaller fernbird territory sizes have been reported at other locations, e.g. 0.15 ha/pair (Barlow 1983), 0.52 ha/pair (Parker 2002), and 0.67 ha/pair (Elliott 1978). If enhanced wetland habitat leads to a decrease in territory size, then these wetlands would have the potential to support a higher population of fernbird. Factors determining population density include resource availability, predation, and competition with other species. In the Sinclair Wetlands there is potentially competition for invertebrates during the breeding season from numerous introduced bird species that also use the area such as chaffinch (*Fringilla coelebs*), dunnock (*Prunella modularis*), common redpoll (*Carduelis flammea*), yellowhammer (*Emberiza citronella*), and common starling (*Sturnus vulgaris*). Additionally, fernbirds may come to avoid the habitat available to them near the walking tracks as these become busier. This could be assessed in future studies by comparing transects through undisturbed areas of the wetland with those along the walking track.

Other wetland species

The Sinclair Wetlands does not appear to be used to any great extent by shags, nor by wading birds such as herons and stilts, which primarily inhabit the tidal mudflats at the northern end of the main lakes (eBird 2020). Three native species that are cryptic (i.e. rarely seen even if present) - marsh crake (*Porzana pusilla*), spotless crake (*Porzana tabuensis*), and Australasian bittern - were not target species of this survey nor were they encountered during the surveys. However, because of their threat classification of 'at risk, declining' (crakes) and 'nationally critical' (bittern) (Robertson *et al.* 2017), it is important that future surveys include them as healthy wetlands are crucial to their survival. Different survey methods would be needed to target this group of birds such as those recently proposed (O'Donnell & Williams 2015; Williams 2017). These species have been reported occasionally at the wetlands over the survey period. The presence of Australasian bittern in the Sinclair Wetlands has been confirmed by automatic recording devices that were deployed in the wetlands during October and November each year from 2011 to 2016 (Thompson 2015). These recorded bittern boom trains on up to 70% of nights (MPT *unpubl. data*). A pair of marsh crake successfully fledged two chicks in a pond near the visitor centre during October–December 2017 (Thompson 2017). Further species-specific research is required to establish how important these wetlands are to these threatened native species.

Subsequent surveys carried out every 7–10 years following the same methodology used for this survey would allow trends in waterfowl and fernbird populations to be determined to inform decisions about management of the wetlands and ensure that recreational use, restoration efforts, and predator control continues to support native species.

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