

Impact of COVID-19 on pest birds (Silver Gulls *Larus novaehollandiae*) on a popular tourist island

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Abstract. During the COVID-19 pandemic, Rottnest Island, Western Australia, a popular tourist destination, was closed to the public for 72 days (from 25 March 2020 to 5 June), so that it could be used as a quarantine facility. Silver Gulls *Larus novaehollandiae* were surveyed in the main settlement area over 429 days, beginning at the commencement of the quarantine period, with a focus on a previously identified problem area, the shopping mall. These surveys allowed for the comparison of Silver Gull numbers with and without the presence of easily accessible anthropogenic food. The number of Gulls was extremely low during the quarantine period, followed by a 578% increase in the same period the following year when visitors returned. During the period of food scarcity, many of the Gulls appeared to have left the Island, which suggests that the number of pest birds on Rottnest Island can be influenced by the amount of anthropogenic food available to them.

Introduction

Globally, increased numbers of pest birds are often associated with human activity and increased availability of food and other resources (Marzluff *et al.* 1994; Lim *et al.* 2003; Wilson *et al.* 2015). What defines a pest is highly arbitrary, and typically specific to site and/or species. The term ‘pest’ is often used to describe individuals or groups of birds that exhibit behaviours that have or may have an adverse effect on humans or other species and their activities or the environment [Coulson & Coulson 1983; Hart *et al.* 1987; Belant 1997; ATSB 2003; Gingrich & Osterberg 2003; Auman *et al.* 2011; Stevenson 2011; Carr & Reyes-Galindo 2017; *Biosecurity and Agriculture Management Act 2007 (WA)*].

Such a situation exists on Rottnest Island, a tourist destination ~20 km off the coast of Perth, Western Australia. Like many tourist destinations, it hosts several native bird species that are considered pests (Saunders & de Rebeira 1993; Belant 1997; Stewart 1997; Temby 2000; Kaisanlahti-Jokimäki *et al.* 2012). The Rottnest Island Authority (RIA) defines pest birds as those that negatively impact the Island’s values (RIA 2019). The pest birds currently listed and managed by the RIA comprise the Silver Gull *Larus novaehollandiae*, Galah *Eolophus roseicapilla*, Rainbow Lorikeet *Trichoglossus moluccanus* and Australian Raven *Corvus coronoides* (Blythman & Sansom 2015; RIA 2019).

Silver Gulls on Rottnest Island can be aggressive and harass people for food, sometimes causing injuries to staff and visitors. They also predate on and compete with other wildlife for food and other natural resources (Saunders & de Rebeira 1993; RIA 2019; Sansom *et al.* 2019; Greenwell 2021). Saunders & de Rebeira (2009) noted that Silver Gulls had become less abundant on the Island since the landfill (rubbish tip) was closed and the bins around the Island were covered. As well as the landfill closure,

ongoing *ad hoc* attempts have been made to manage this population over the past 20+ years (RIA 2020).

The COVID-19 pandemic has been a period of unique human activity, allowing human interactions (or the lack thereof) with wildlife to be observed (Rutz *et al.* 2020; Soh *et al.* 2021). Before 2020, Rottnest Island had not been closed since 1940, when recreational visitors were restricted from accessing the Island for 5 years during World War II (rotnestisland.com 2023). Towards the beginning of the COVID-19 pandemic, the RIA was instructed by the Western Australian Government to vacate guests and non-essential staff and to facilitate the creation of a quarantine facility for travellers returning from areas affected by COVID-19 (RIA 2020).

In this study, we compared the number of Silver Gulls during the quarantine period, when no recreational visitors were permitted on Rottnest Island, through to the same period 1 year later, when visitors were again able to access the Island. As Silver Gulls were responsible for most complaints to the RIA by visitors and local businesses, they were the main focus of this study.

Methods and study area

Rottnest Island is a Class A reserve of ~1900 ha, managed by the Western Australian Department of Biodiversity, Conservation and Attractions to ensure that all fauna, flora and landforms are protected. As a popular holiday destination, it receives >400,000 visitors each year (RIA 2021). Almost all visitors enter via Thomson Bay, which is the site of the main settlement, with a range of accommodation and food and beverage outlets (Figure 1). The high levels of human activity here are attractive to some of the native fauna (Stewart 1997; Stevenson 2011). We, therefore, focused our sampling in this area.



Figure 1. Location of monitoring sites for pest birds in the Thomson Bay settlement area of Rottnest Island, 12 April 2020 to 15 June 2021.

Rottnest Island was closed to the general public for 72 days between 25 March and 5 June 2020 and repurposed as a COVID-19 quarantine facility. It was also closed to the public between 31 January and 5 February 2021 and 24 and 26 April 2021 because of COVID-19 lockdowns but was not used as a quarantine facility during these periods. These closures provided an opportunity to survey the number of Silver Gulls present at selected sites on the Island.

To help inform the selection of point-count monitoring sites, previous data from ranger reports, surveys of pest birds, and management programs were used (Storr 1964; Stevenson 2011; Oversby *et al.* 2018). All eight selected sites were within the Rottnest Island settlement area of Thomson Bay and were deemed representative as they included natural foraging areas and sites where Silver Gulls regularly feed on anthropogenic food (Table 1, Figure 1).

Between 12 April 2020 and 15 June 2021, 429 point-counts were conducted out of a possible 430 days across eight sites (Figure 1). Surveys commenced at 0830 h to coincide with the arrival of the first ferry when many guests and staff go to the shopping mall for food and drinks. Silver Gulls were counted using single point-counts for 5 minutes per site. Birds that had settled within the boundary of each site were recorded, but those flying overhead and that did not land in the defined area or flew between sites were not included. Site 3 (Garden Lake) was an exception as this site encompassed an entire salt lake; in this case, the observer cycled along the lake's southern edge to count birds on the water and at the lake's edge.

The number of people present was recorded at Site 5 (shopping mall), as this location had the most direct interactions occurring between Silver Gulls and visitors in the settlement area. Australian Ravens were counted in conjunction with Silver Gulls, but these results are not presented here. To maintain consistency, the same observer (RP) completed 61% (264/429) of the counts, with the remainder conducted by trained RIA staff.

The number of visitors to the Island was determined using the daily number of ferry passengers who paid the compulsory Island administration fee (landing fee). The number of visitors included tourists but did not include exempt passengers such as staff, contractors and some volunteers, nor did it include the number of arrivals via private vessels or planes.

A Spearman's rank correlation was calculated using Microsoft Excel software to assess the relationship between the number of ferry arrivals to Rottnest Island and the number of Silver Gulls counted across all sites during the study period.

Results

When monitoring began in April 2020, shortly after the Island was closed to visitors, the total number of Silver Gull at all sites was very low. On average, $2.8 \pm$ standard deviation 5.1 ($n = 54$) Gulls were recorded per day, increasing only slightly to 5.9 ± 7.3 ($n = 176$) Gulls/day in May 2020 (Table 2). Numbers increased 407% from

Table 1. Monitoring sites of pest birds on Rottnest Island in the period 12 April 2020 to 15 June 2021: habitat type, availability of anthropogenic food and comments about the site.

Site	Habitat type	Centre point	Description	Anthropogenic food availability	Comments
1	Urban	115°33'E, 32°00'S	Rottnest hotel and beachfront	High	Source of many complaints. Venue was not open/serving food until later in day, after surveys were completed.
2	Woodland	115°33'E, 32°00'S	50-m radius from front gate of Unit 249	Low	Natural woodland used as monitoring site for pest birds previously (Stevenson 2011).
3	Salt lake	115°32'E, 32°00'S	Garden Lake, including shoreline	Low	Natural foraging site.
4	Coastal heath and edge of salt lake	115°32'E, 32°00'S	50-m radius from Digby Drive and Geordie Bay Road intersection, excluding area east of Geordie Bay Road	Low	Natural foraging site.
5	Urban	115°32'E, 32°00'S	Length of shopping mall (30 m) including trees and rooftops. Did not extend into playground.	High	High human interaction; complaints on pest birds. High concentration of food outlets. Outdoor tables encourage visitors to consume food here.
6	Sandy beach	115°33'E, 32°00'S	Foreshore between fuel jetty and barge area	Low	Silver Gull roosting site.
7	Urban	115°33'E, 32°00'S	Base of ferry jetty (Barge area)	Medium	Silver Gulls attracted when freight stored at site.
8	Woodland	115°32'E, 32°00'S	Stand of Tuart trees <i>Eucalyptus gomphocephala</i> ; did not extend past Digby Drive	Medium	Natural woodland located between shopping mall and other food outlets.

May to July 2020, to an average of 29.9 ± 18.3 ($n = 926$) Gulls/day, which coincided with a return of visitors to the Island, winter school holidays and the local Silver Gull breeding season (Figure 2). A year later, with no visitor restrictions in place, Gull numbers averaged 32.7 ± 14.6 /day ($n = 981$) across all sites in April and 32.4 ± 15.8 /day ($n = 1003$) in May 2021. The number of Gulls present from the time that we started our surveys (12 April) to the end of the quarantine period (5 June 2020) was 578% lower than in the same period in 2021.

There was an increase in the number of Gulls in July 2020, but numbers decreased over the 3 months from August to October 2020. The number of Gulls then increased steadily to a peak of 37.1 ± 14.9 /day ($n = 1150$) in March 2021, followed by a steady decline to 29.0 ± 17.2 /day ($n = 435$) in June 2021, when monitoring ceased (Table 2).

The greatest monthly increase occurred from June to July 2020, where numbers approximately tripled from 8.9 to 29.9 Gulls/day, and the largest decrease was from July to August 2020, from 29.9 to 20.3 Gulls/day (Table 2).

The combined daily count of Silver Gulls at all sites ranged from 0 to 79, with the highest count occurring on 9 January 2021 (Table 3). The number of Gulls at each site ranged from 0 to 64, with the maximum at Site 3 (Garden Lake), also on 9 January 2021 (Appendix 1).

When the Island was used as a quarantine facility, visitation was well below the 3-year average for that period (Figure 3). In April 2020, only 1269 people arrived on the Island, with a further 1405 visitors in May 2020. During this time, most people on the Island were quarantining visitors and essential staff who were not permitted to eat at the usual food outlets. Instead, food was supplied and delivered to their premises. Over the same period, 1 year later, 44,530 people disembarked in April and 22,359 in May 2021 (Figure 3); these people were free to visit food outlets and eat where they chose.

When the Island re-opened to visitors in June 2020, visitor arrivals increased to 7046, then 13,257 in July, coinciding with the winter school holidays. There was a slight decrease in August to 10,518 visitors, and then the visitation rate increased monthly to a peak of 84,932 in

Table 2. Average number of Silver Gulls counted per day at each of the eight survey sites, along with the daily average count of all sites on Rottnest Island combined. The total monthly count of all sites combined and the number of days when counts took place each month are shown. See details of sites in Table 1.

Date (month, year)	Site no.								Total monthly count	No. days counted	Overall daily average
	1	2	3	4	5	6	7	8			
Apr. 20	0.1	0.0	0.0	0.0	0.1	1.5	1.1	0.0	54	19	2.8
May 20	0.8	0.5	1.5	0.0	0.0	1.3	1.8	0.0	176	30	5.9
Jun. 20	0.7	0.1	1.7	0.0	0.4	5.1	0.9	0.0	267	30	8.9
Jul. 20	1.9	0.0	0.8	0.6	15.0	9.6	2.6	0.0	926	31	29.9
Aug. 20	0.4	0.0	2.3	0.0	15.3	3.6	0.7	0.0	629	31	20.3
Sep. 20	1.7	1.2	1.0	1.0	9.9	3.6	1.6	0.1	456	30	15.2
Oct. 20	1.7	0.0	1.8	0.2	4.8	7.6	2.1	0.2	465	31	15.0
Nov. 20	1.7	0.0	1.0	1.0	7.9	14.0	1.4	0.0	747	30	24.9
Dec. 20	1.9	0.0	1.0	0.0	3.5	20.1	1.5	0.0	829	31	26.7
Jan. 21	1.6	0.1	13.5	0.0	0.8	15.0	1.1	0.0	956	31	30.8
Feb. 21	1.5	0.0	12.8	0.0	2.5	15.3	1.1	0.1	934	28	33.4
Mar. 21	1.7	0.0	4.7	0.1	1.8	22.6	6.7	0.0	1150	31	37.1
Apr. 21	1.7	0.1	1.4	0.0	2.4	24.5	2.5	0.0	981	30	32.7
May 21	2.0	0.0	1.8	0.0	2.3	22.5	3.8	0.0	1003	31	32.4
Jun. 21	1.1	0.0	4.7	0.0	1.2	21.3	2.3	0.0	435	15	29.0

January 2021. The number of arrivals more than halved in February 2021 to 31,657, coinciding with the 7-day COVID-19 lockdown when the Island closed and guests had to leave, but numbers then increased in March and April 2021. Monthly visitation to the Island during the study period was slightly lower than average for the previous 3 years, possibly from the lack of international visitors who were absent because of COVID-19 regulations that restricted international travel to Australia. The number of people at Site 5 (shopping mall) followed a similar trend as the overall visitation, providing a suitable indicator of how many visitors were on the Island (Figure 3).

Shopping mall

Very few Silver Gulls were recorded at Site 5 (shopping mall) during the quarantine period (25 March–5 June 2020). In April 2020, an average of just 0.1 ± 0.5 ($n = 2$) Gull/day were recorded. None were recorded in May, and 0.4 ± 1.2 /day ($n = 13$) in June. Numbers increased in July 2020 to 15 ± 12.0 Gulls/day ($n = 465$). Numbers at Site 5 peaked in August 2020 but then decreased to fewer than 5 Gulls/day, on average, for the following months except November 2020 (Figure 4).

In April, May and June 2021, the average daily numbers of Gulls were 2.4 ± 3.4 ($n = 72$), 2.3 ± 2.9 ($n = 71$) and 1.2 ± 1.2 ($n = 10$), respectively (Figure 4). Surprisingly, in January, when visitation was at its highest, the number of Gulls was one of the lowest for the year (Figure 4). The highest single count at Site 5 was 38 Gulls on 12 July 2020, with the second highest (30 birds on a single day) in August and September 2020.

The Spearman's rank correlation calculation indicated a significant positive correlation [$r(13) = 0.75$, $P = 0.001$] between the number of visitors arriving on Rottnest Island and the number of Silver Gulls counted across all sites.

Discussion

The number of Silver Gulls recorded across all sites within the settlement area during the COVID-19 quarantine period was significantly lower when compared with the corresponding months the following year. However, numbers did not decrease during the brief 7-day lockdown in January–February 2021, nor was there a noticeable decline during the 3-day lockdown in April 2021.

This study shows that the number of Silver Gulls in the Rottnest Island settlement area responded to the fluctuating

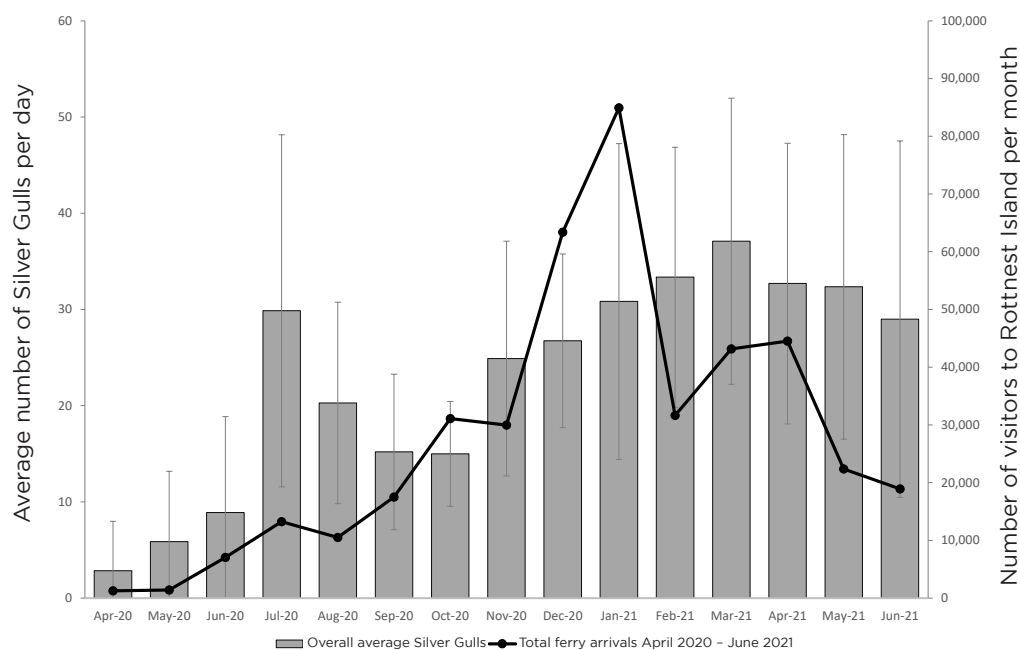


Figure 2. Average (mean \pm standard deviation) count of Silver Gulls per day recorded over all sites surveyed on Rottnest Island, compared with the total number of visitors arriving by ferry between April 2020 and June 2021.

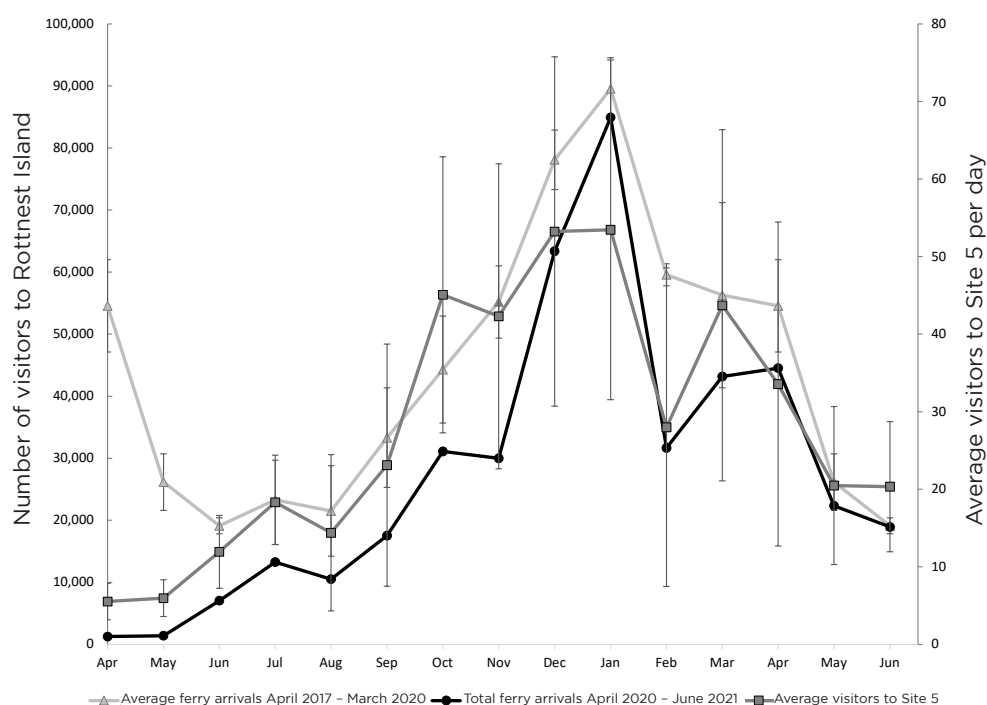


Figure 3. Average number (mean \pm standard deviation) of visitors arriving by ferry to Rottnest Island per month between April 2017 and March 2020 and total monthly number arriving during the study period (April 2020 to June 2021), as well as average number of people counted at Site 5 per day during the study period.

number of visitors. Although not recorded as part of this study, anecdotal evidence suggests that Gull numbers were at typical levels (i.e. similar to 2021: Figure 2) before the 2020 quarantine period, and began decreasing in the days leading up to the start of the quarantine period when visitors and non-essential staff were vacating the island. The evacuation of Rottnest Island began on 25 March 2020, although counts did not begin until 12 April, almost

3 weeks later. This delay meant that the likely tapering of Gull numbers was not captured in the survey data. However, the decrease was observed almost immediately and was the catalyst for beginning this study (RP pers. obs.).

It is most likely that the decrease in Gulls in the settlement area during the quarantine period was caused by reduced food availability caused by the lack of visitors.

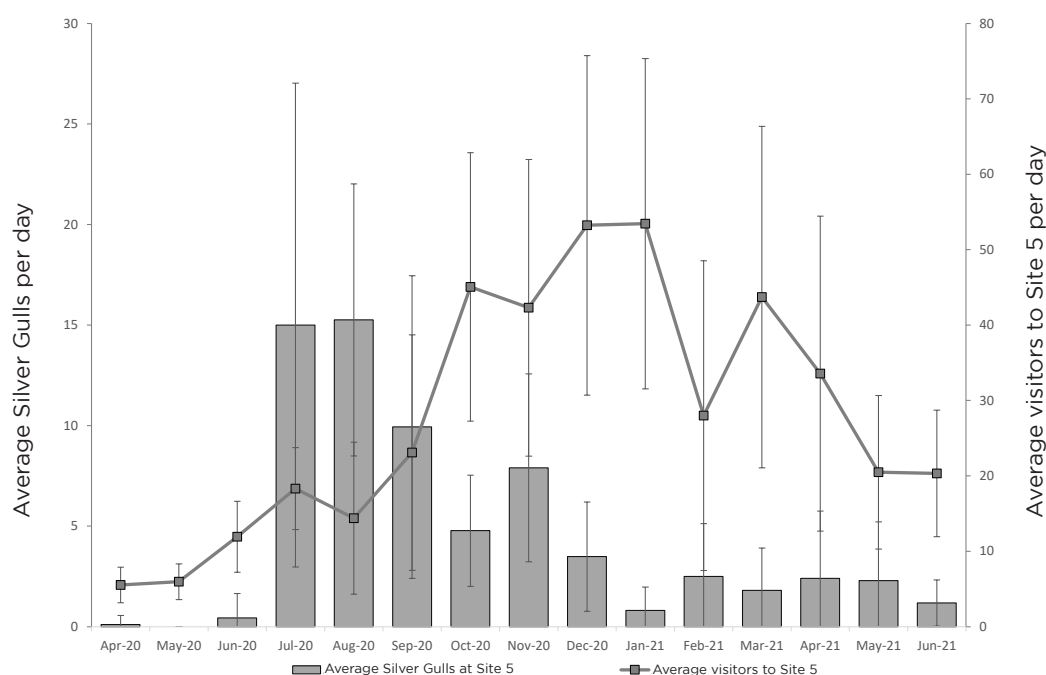


Figure 4. Daily average (mean \pm standard deviation) number of Silver Gulls recorded at Site 5, the Rottnest Island shopping mall, compared with the daily average number of visitors to that site during the study period, April 2020 to June 2021.

This observation is supported by the increased number of Gulls, coinciding with increased visitor numbers, which remained high during the same period the following year. Similar relationships were demonstrated by Temby (2004), who identified anthropogenic food availability as a major factor contributing to the increase in Silver Gulls across Australia. He suggested that removing the availability of anthropogenic food would help reduce Gull numbers. In his study of Australian Ravens, Stewart (1997) showed that the number of Ravens present at popular sites within King's Park, a tourist location in Western Australia, was also highest in areas with the highest visitation. Although it is possible that some Silver Gulls coincidentally left Rottnest Island during the quarantine period for alternative purposes (i.e. breeding on other islands: Wooller & Dunlop 1979), it is unlikely that this alone explains their mass exodus from the Island. If this were the case, we would have expected to see a similar decrease over the same period the following year, and such a dramatic seasonal fluctuation in Gull numbers would undoubtedly have been detected during the previous decades of pest management conducted on the Island.

After the peak period of visitors arriving on the Island (January 2021), numbers of Gulls did not decrease in line with the decrease in visitation. Instead, they remained relatively stable within the settlement area. Gull numbers at Site 5 were high during the July–September 2021 breeding period (when visitor numbers were low) but then decreased when visitation increased. It is possible that numbers at this site peaked during the breeding season when Gulls sought food to rear their chicks. The shopping mall might also have been disproportionately targeted because of the higher probability of obtaining food and a learned behaviour of associating humans with food (Goumas *et al.* 2020). The age of the birds was not recorded in our study, but the peak might also have been a result of increased numbers of juvenile birds coming to the site. Saunders & de Rebeira

(1993) recorded Silver Gulls breeding on Rottnest Island from April to November, with peaks in laying during late August and early September. Further studies would help to clarify whether the peak numbers of Gulls at Site 5 in the present study correlate more strongly with the timing of breeding or with Island visitation rates.

Altered behaviour because of food availability

Storr (1964) noted that Silver Gulls fed on Brine Shrimps *Artemia* spp. in the salt lakes on Rottnest Island but also visited the settlement for anthropogenic food scraps. Storr (1963) also suggested that on Rottnest Island this species was largely dependent on local resources, which is why he did not see many traversing between Rottnest Island and the mainland. In contrast, Silver Gulls regularly moved to and from Carnac Island (32°07'S, 115°40'E) and the mainland, over a distance of 10 km, where they obtained most of their food.

In the current study, it was anticipated that, when anthropogenic food scraps became unavailable, Silver Gulls would move from Site 5 to Site 3 (Garden Lake) to feed on brine shrimps, but such a movement was not apparent. This suggests that the Gulls may need to move to alternative foraging areas if food is unavailable in the settlement. The 3- and 7-day lockdown periods did not appear long enough to force the Gulls off the Island to find food elsewhere because of hunger.

Although the movements of Gulls could not be determined during the quarantine period, the Gulls were notably absent from the settlement area, including the nearby salt lakes that provide a natural food source. Although it is possible that the Gulls moved elsewhere on the Island, they were not observed by rangers working on the Island (RP pers. obs.).

Thus, they most likely moved to the Australian mainland or other islands nearby. The Australian Bird and Bat Banding Scheme provided seven records of Silver Gulls that were banded on Rottnest Island between 1956 and 1993 and later recaptured or resighted on the mainland: at Cape Lewin (265 km from Rottnest Island), Capel (171 km), Woodlands (30 km), Hillary's (29 km), South Fremantle (25 km), Cottesloe (24 km) and Scarborough Beach (25 km). Based on these limited data, it is possible that the Gulls in the present study might have travelled similar distances to find food during the quarantine period.

Impact on local fauna

On Rottnest Island, Silver Gulls are known to disturb some species of significant conservation concern. Australian Fairy Terns *Sternula nereis nereis*, a nationally threatened (Vulnerable) taxon (Commonwealth of Australia 2020), nested on Rottnest Island in January 2021, coinciding with the peak in Silver Gull numbers recorded during the present study. This Tern colony was monitored as part of a study of feeding ecology (Greenwell 2021). Although no nest predation by Gulls was observed directly, they are known nest predators and were driven away from the colony by swooping Terns, potentially leaving their nests vulnerable to other threats (Greenwell 2021).

Adult and juvenile Rock Parrots *Neophema petrophila*, which are perilously close to localised extinction, are also subjected to ongoing disturbance and harassment by Silver Gulls during the breeding season (Sansom et al. 2019). Presumably, the reduction in Silver Gulls during the quarantine period would have resulted in less disturbance and competition with these and other native species on the Island (Harris & Wanless 1997). The results of our study support the hypothesis that if anthropogenic food were limited year-round, especially in the lead-up to and during the key breeding months of vulnerable species, there could be direct conservation, resulting from less disturbance by Silver Gulls.

Conclusions

This study has demonstrated a positive correlation between the number of tourists and pest birds in the settlement area of Rottnest Island. It suggests that their numbers are likely to decrease if visitor-related food resources were less available to the Silver Gulls, particularly in high-traffic areas such as the shopping mall. It also suggests that Silver Gulls may leave the Island altogether if anthropogenic food were less available to them. This could have positive implications for visitor experiences and environmental benefits, such as less disturbance to other native species on the Island. The outcomes of this study are likely to have implications elsewhere, especially in tourist destinations where native species require management because of increased anthropogenic food availability.

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Appendix 1. Minimum, maximum, mean and combined counts of Silver Gulls (for Site 5, numbers of visitors in parentheses) at each survey site on Rottneest Island from April 2020 to June 2021.

Date	Site 1			Site 2			Site 3			Site 4			Site 5			Site 6			Site 7			Site 8			Combined		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
Apr. 20	0	2	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	16	1.5	0	6	1.1	0	0	0	0	17	2.8
May 20	0	5	0.8	0	6	0.5	0	24	1.5	0	0	0	0	0	0	0	8	1.3	0	15	1.8	0	0	0	0	33	5.9
Jun. 20	0	4	0.7	0	2	0.1	0	15	1.7	0	0	0	0	0	0	0	32	5.1	0	7	0.9	0	0	0	0	33	8.9
Jul. 20	0	6	1.9	0	0	0	0	6	0.8	0	7	0.6	0	0	0	0	30	9.6	0	22	2.6	0	0	0	1	70	29.9
Aug. 20	0	3	0.4	0	0	0	0	7	2.3	0	0	0	3	0	0	0	18	3.6	0	4	0.7	0	0	0	4	45	20.3
Sep. 20	0	5	1.7	0	3	1.2	0	3	1	1	1	1	0	0	0	0	15	3.6	0	4	1.6	0	1	0.1	4	36	15.2
Oct. 20	0	6	1.7	0	0	0	0	11	1.8	0	1	0.2	0	11	4.8	1	20	7.6	0	4	2.1	0	1	0.2	2	26	15.0
Nov. 20	0	15	1.7	0	0	0	0	6	1	1	1	1	3	25	7.9	0	38	14	0	7	1.4	0	1	0	5	51	24.9
Dec. 20	0	9	1.9	0	1	0	0	4	1	0	0	0	0	11	3.5	0	38	20.1	0	24	1.5	0	0	0	7	44	26.7
Jan. 21	0	4	1.6	0	1	0.1	0	64	13.5	0	0	0	0	4	0.8	2	46	15	0	4	1.1	0	1	0	6	79	30.8
Feb. 21	0	6	1.5	0	0	0	1	35	12.8	0	0	0	0	10	2.5	0	38	15.3	0	6	1.1	0	1	0.1	14	60	33.4
Mar. 21	0	5	1.7	0	1	0	0	32	4.7	0	2	0.1	0	8	1.8	0	51	22.6	0	52	6.7	0	0	0	6	72	37.1
Apr. 21	0	7	1.7	0	2	0.1	0	10	1.4	0	0	0	0	18	2.4	1	50	24.5	0	14	2.5	0	0	0	5	63	32.7
May 21	0	9	2	0	0	0	0	10	1.8	0	0	0	0	13	2.3	0	63	22.5	0	33	3.8	0	0	0	7	72	32.4
Jun. 21	0	3	1.1	0	0	0	0	35	4.7	0	0	0	0	4	0.7	0	45	21.3	0	4	2.3	0	0	0	3	76	29.0