

Continued increase in red-billed gulls (*Larus novaehollandiae scopulinus*) at Otago, southern New Zealand: implications for their conservation status and the importance of citizen science

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Abstract: A published national survey of red-billed gulls (*Larus novaehollandiae scopulinus*) in 2015 recorded about 28,000 nests in New Zealand, a 30% decrease in 50 years. We compared nest numbers in 2020 at Otago, south-eastern South Island, with published records for 1992–2011 and 2015. In contrast to trends further north, numbers at Otago have increased but the average annual rate of increase dropped from 6–10% for 1992–2011 to 2% for 2011–2020. Citizen science provided a valuable input in 2020 with records of breeding at previously undocumented urban locations. The about 6,000 nests at Otago in 2020 probably account for 20% of the national total.

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INTRODUCTION

Although widespread and apparently numerous around New Zealand, red-billed gulls (tarāpunga, *Larus* [*Chroicocephalus*] *novaehollandiae scopulinus*) are currently assigned as ‘At Risk–Declining’ in the New Zealand Threat Classification System (Robertson *et al.* 2021). Frost & Taylor (2018) recorded about 28,000 nests from a nationwide

survey in 2015, and concluded that there has been a likely one-third decrease through 50 years from the estimated 40,000 nests since the only previous comprehensive survey by Gurr & Kinsky (1965).

Contrary to the nation-wide trend of decline, red-billed gull nest numbers increased at Otago, south-eastern South Island, at an average annual increase of 6–10% through 20 years from 1992 to 2011 (Perriman & Lalas 2012). In particular, this increase at Otago corresponded to the decrease 350–500 km further northeast at Kaikoura,

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the location with the largest number of nests on South Island. Red-billed gulls are highly philopatric: for 10,851 chicks banded at Kaikoura and later found breeding, 99% nested at or within 25 km of Kaikoura (Mills *et al.* 2008). Perriman & Lalas (2012) found only one marked individual from Kaikoura breeding at Otago. They concluded that the paucity of breeding red-billed gulls from Kaikoura indicated that the concomitant population increase at Otago and decrease at Kaikoura was not caused by a southward emigration of birds from Kaikoura.

We have continued the annual counts of red-billed gull nests at Otago begun by Perriman & Lalas (2012). In 2020, we sought additional help to find any previously unknown nesting locations through the development of a citizen science project to encourage the wider community to share information about where the gulls are nesting. Citizen science, where the wider community is engaged in various aspects of the scientific process (Bonney *et al.* 2009), is a well known practice among the birding community and has contributed to much of our knowledge of avian species distributions (Sullivan *et al.* 2014).

Here we update trends for Otago and compare and contrast trends among locations within this region. Frost & Taylor (2018) made two major recommendations for the future monitoring of red-billed gulls: nation-wide trends could be deduced from monitoring several representative locations; and census data should be entered into a central repository. We report the outcomes from Otago for the selection of an appropriate representative location, and review the value of engaging with the wider community to detect previously-unknown nesting locations.

METHODS

Annual counts of red-billed gull nests at Otago begun by Perriman & Lalas (2012) for 2007 to 2010 were continued through the 10 years from 2011 to 2020. Our annual survey area encompassed a linear distance of about 200 km of the Otago coast from Waitaki River, the Otago regional boundary with Canterbury, south to Nugget Point (Fig. 1). Not all nesting locations were surveyed every year. Consequently, we concentrated our assessment of trends on the three years with reliable nest counts for the entire coast: for 2011 from data presented in Perriman & Lalas (2011); for 2015 from data collected by Chris Lalas and Lyndon Perriman and presented in Frost & Taylor (2018); and for 2020, the most recent survey year.

Red-billed gulls are colonial breeders but the number of nesting locations depends on the designation of minimum distance between neighbouring groups of nests. Frost & Taylor (2018)

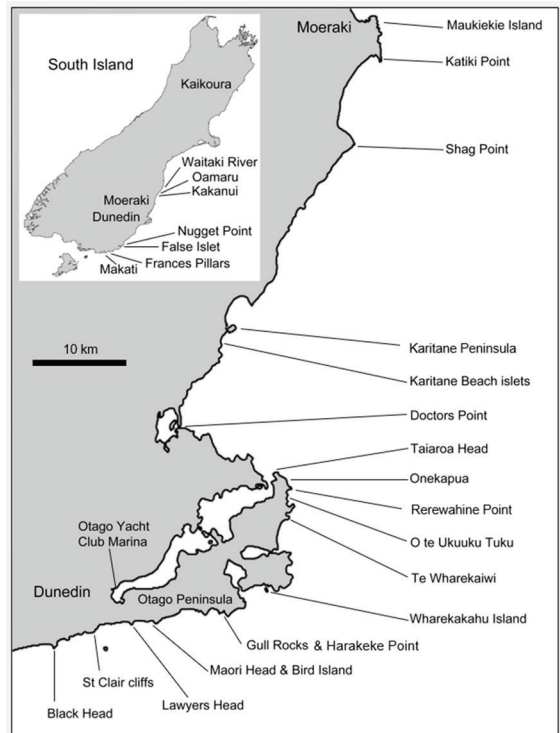


Figure 1. Maps of South Island, New Zealand, and the Otago coast from Moeraki to Dunedin showing locations mentioned in the text. The Otago coast extends about 250 km from Waitaki River to Makati (Chaslands Mistake).

did not address this issue in their recent assessment of the status of red-billed gulls. Instead, they applied four terms: ‘sites’, ‘locations’, ‘colonies’ and ‘aggregations’. They designated locations with <500 nests as ‘colonies’ but designated locations with ≥ 500 nests as ‘breeding aggregations’ because these largest numbers could consist of several closely-spaced ‘colonies’. To keep things simple we followed Perriman & Lalas (2012) and used ‘location’ as the only spatial term: at Otago we allocated nests to the nearest named location, with neighbouring nesting locations at least 1 km apart.

We made nest counts from land, sea or air using eye, binoculars, spotter scope or photographs, with most counts were made from land. Counts from a small boat were done from the vicinity of Doctors Point south along Otago Peninsula to Te Wharekaiwi (Fig. 1). Our surveys in 2020 included a flight on 20 November 2020 from St Clair south to Makati (Chaslands Mistake), the Otago regional boundary with Southland (Fig. 1). This survey provided our only accurate assessment of nest numbers along a linear distance of about 40 km of the Otago coast south of Nugget Point.

Nest counts were allocated to the calendar year of the start of the breeding season. We attempted to time annual nest counts to coincide with maximum nest numbers by following breeding activity at Taiaroa Head and at Katiki Point. Survey dates typically ranged from 20 November to 10 December and were restricted to one count per location with nearby locations counted on the same day. The stage of breeding during the nest count at each location typically ranged from adults sitting tight on nests (presumably on eggs) to chicks aged up to 2–3 weeks. Values for annual counts at each location were presented as a best estimate bounded by a (non-statistical) likely range in an attempt to account for imprecision and ambiguity in counts. Consequently, the values we present as best estimates for nest numbers are approximations rather than exact numbers.

In mid 2020, a citizen science project was created by the Otago Peninsula Trust's education team at the Royal Albatross Centre and funded by the Otago Participatory Science Platform (<http://scienceintoaction.nz/current-projects/>). The purpose of this project, entitled *Red-billed Gulls—love them or lose them*, was to involve the wider community in caring for and gathering data that could help inform population size and management of the species at Otago. This project was promoted through a range of media (public talks, newspaper and newsletter articles, social media, posters) and the wider community was asked to report sightings of red-billed gulls nesting to inform our understanding about current and historic nesting locations. People were encouraged to share their observations through personal discussions, email, or to upload photographs to the *Red-billed Gull Nests in Otago* website, a 'project' we created on iNaturalist (<https://inaturalist.nz/projects/red-billed-gull-nests-in-otago>). iNaturalist, a citizen science platform for identification and recording of biodiversity, was promoted over eBird as it caters for species-specific projects and is used by a broad range of people. eBird, although well known to avid birders, is not as well-known and typically is used for site-specific multispecies bird counts. We reviewed entries for red-billed gulls at Otago from both eBird and iNaturalist for evidence of nesting. We downloaded and analysed records for red-billed gulls at Otago on 4 June 2021 from the eBird website (<http://ebird.org/media/catalog?taxonCode=silgul2&mediaType=p®ionCode=NZ-OTA&q=Silver%20Gull>) and on 24 June 2021 from the iNaturalist website (https://inaturalist.nz/observations?order=asc&order_by=observed_on&place_id=6839&subview=table&taxon_id=144507). After the completion of our analyses we added photos of breeding locations in Otago for 2020 in the *Red-billed Gull Nests in Otago* iNaturalist project website.

Our calculations for temporal trends in nest numbers followed Perriman & Lalas (2012). Trends were derived from exponential curves of best fit in the form $N_t \propto e^{\lambda t}$ (where N_t = number of nests in year t , and λ = average annual exponential rate), and presented as average annual arithmetic rates = $e^{\lambda} - 1$.

RESULTS

Trends in nest numbers at Otago

The best estimate for total number of red-billed gull nests from Waitaki River to Nugget Point dropped from 4,898 in 2011 to 4,611 in 2015 then rose to 5,957 in 2020 (Table 1). Nest numbers increased by 22% ($= [5,957 - 4,898] / 4,898$) overall through the 10 years 2011–2020, an annual increase of 2.2%. We surveyed the Otago coast south of Nugget Point only in 2020 and found red-billed gulls nesting at two locations: False Islet with 27 nests and Frances Pillars, Tautuku Peninsula, with 30 nests (Fig. 1). Consequently, the 5,957 nests documented in Table 1 account for 99% of the Otago total 6,014 nests in 2020.

The number of locations at Otago with at least 1,000 nests increased from one in 2011, Taiaroa Head (at the mouth of Otago Harbour) with 2,423 nests, to three in 2020: Taiaroa Head with 2,800 nests, Katiki Point with 1,315 nests, and Otago Yacht Club Marina (in the Dunedin metropolitan area at the head of Otago Harbour, 19 km southwest of Taiaroa Head) with 1,250 nests. The likelihood of predation by introduced mammals has been mitigated by trapping at each of these three most important sites. Predator control at Taiaroa Head by Department of Conservation and at Katiki Point by Penguin Rescue and Te Rūnanga o Mōeraki were instigated before gulls began breeding there (Perriman & Lalas 2012). In contrast, predator control at Otago Yacht Club Marina by Dunedin City Council was instigated in 2017, several years after gulls began breeding there (Aalbert Renegan, *pers. comm.*).

The distribution and abundance of red-billed gull nests at Otago displayed two major changes since 2011, with both more distinct through the most recent five years. First was an increased numbers of nests concentrated into fewer locations. Here gulls nested at 19 locations in 2011 and in 2015, with respective averages of 258 and 243 nests per location. Nesting subsequently reduced to 10 locations by 2020 with more than doubling in the average size to 596 nests per location (Table 1). The most dramatic change was the initiation and rapid increase in nests at Otago Yacht Club Marina, most likely beginning in 2010 with eight nests on a boat (Benson 2010), and rising by 2020 to 1,250 nests, practically all on a breakwater.

The second major change was a northward movement in both the relative and absolute abundance of red-billed gull nests at Otago from Waitaki River to Nugget Point. The proportion of

Table 1. Locations and best estimates for annual numbers for red-billed gull nests at Otago from Waitaki River to Nugget Point for 2011 (updated from Perriman & Lalas 2012), 2015 (updated from Perriman & Lalas data in Frost & Taylor 2018) and 2020 (this study); and the maximum best estimate recorded for each location through the 14 consecutive breeding seasons from 2007 to 2020.

Location	Calendar year (start of breeding season)				
	2011	2015	2020	Maximum	Year
Waitaki River at river mouth	116	0	0	936	2019
Waitaki River 4–5 km from mouth	105	0	0	721	2018
Oamaru Harbour	0	150	0	239	2017
Oamaru town, on buildings	0	0	250	250	2018–20
Kakanui, north end	0	0	48	48	2020
Maukiekie Island	49	0	42	49	2011
Katiki Point	317	535	1,315	1,315	2020
Shag Point	274	304	0	502	2012
Hawksbury Lagoon	25*	25*	25	25	2020
Karitane Peninsula	21	6	0	152	2007
Karitane Beach islets	114	39	0	114	2011
Doctors Point	8	25	0	38	2017
Taiaroa Head	2,423	2,145	2,800	2,863	2019
Onkapua	0	120	0	120	2015
Rerewahine Point	0	120	0	120	2015
O te Ukuuku Tuku	153	60	0	208	2007
Te Wharekaiwi	0	0	0	15	2018
Otago Yacht Club Marina	20*	250*	1250	1,250	2020
Wharekakahu Island	50	0	0	80	2007
Gull Rocks and Harakeke Point	50	18	120	120	2020
Maori Head and Bird Island	15	26	0	499	2007
Lawyers Head	238	274	19	306	2010
St Clair cliff and islet	120	30	0	120	2011
Black Head	280	10	9	420	2018
Tirohanga islets	0	1	79	180	2018
Nugget Point mainland and islets	520	473	0	520	2011
Total number of nests: Best estimate	4,898	4,611	5,957		
Range	Not done	4,252–5,298	5,373–6,751		
Total number of breeding locations	19	19	10		
Average number of nests per location	258	243	596		

*Not counted: these entries are interpolated from earlier and/or later counts (see text).

nests in North Otago (nests from Waitaki River to Doctors Point) rose from 21% (=1,029/4,898) in 2011 to 28% (=1,680/5,957) in 2020; the proportion of nests in the vicinity of Dunedin and Otago Peninsula (nests from Taiaroa Head to Black Head) rose from 68% (=3,349/4,898) in 2011 to 70% (=4,198/5,957) in 2020; but the proportion of nests in the vicinity of Nugget Point (mainland and islets at Nugget Point and islets at nearby Tirohanga)

fell from 11% (=520/4,698) in 2011 to 1% (=79/5,957) in 2020. The corresponding nest numbers and average annual changes in nest numbers through the 10 years 2011–2020 were for North Otago an increase from 1,029 to 1,680 nests at 5.6% annually; for the vicinity of Dunedin and Otago Peninsula an increase from 3,349 to 4,198 nests at 2.5% annually; and for Nugget Point a dramatic decrease from 520 to 79 nests at 18.9% annually.

Inconsistencies in use of locations

We found that use of red-billed gull nesting locations could vary unpredictably, a feature best indicated by three examples from North Otago (Table 1). First, discontinuous use of locations—we did not find any nests at Waitaki River in our 2015 or 2020 surveys but recorded up to almost 1,000 nests in intervening years on shingle islands at the river mouth and/or 4–5 km upstream. Here an absence of nesting in some years might be related to high water flow. Second, creation of new locations—prior to 2015 we did not record any nesting along the about 55 km of coast between Waitaki River and Moeraki: our first record for nesting here was at Oamaru Harbour in 2015 where nesting was abandoned after only three years; all nesting since 2018 has been about 1 km away on buildings in the town centre (our only records for nesting on buildings). Third, abandonment of established locations—the large increase in nest numbers at Katiki Point between 2015 and 2020 coincided with the decrease and subsequent cessation of nesting 9 km further south at Shag Point. Our first record for nesting at Shag Point was 274 nests in 2011 (Perriman & Lalas 2012), numbers peaked in 2012 with 502 nests, with the last record in 2018 with six nests (Table 1).

Contribution from citizen science

From the eBird website we verified nesting by red-billed gulls at Otago in 44 records from six locations, with records spread through all 11 years from 2010 to 2020. Taiaroa Head (around the Royal Albatross Centre, a major tourist destination) predominated with 38 records of nesting, followed by two records for Katiki Point and one record for each of the other four locations: Oamaru Harbour, Kakanui, Shag Point, and Black Head. From the iNaturalist website we verified nesting by red-billed gulls at Otago in 48 records from four locations, with records spread through 12 of the 17 years from 2004 to 2020. Taiaroa Head again predominated with 41 records of nesting, followed by five records for Katiki Point and one record for each of the other two locations; Lawyers Head and Nugget Point. Our *Red-billed Gull Nests in Otago* project on iNaturalist failed to raise a substantial response: there were only four entries of which three were trial entries by us. None of the records from eBird or iNaturalist provided nest numbers.

Only one record downloaded from eBird or iNaturalist was not already accounted for in our data for the 14 consecutive years from 2007 to 2020: Robin Corcoran depicted red-billed gulls nesting at Shag Point on 27 October 2010 (<http://ebird.org/checklist/S49839254>) but these must have deserted because we (CL) recorded none nesting there during our North Otago census day on 12 November 2010. Consequently, our record for initiation of nesting

at Shag Point in 2011 (Perriman & Lalas 2012) is one year late. We have one other definitive record for red-billed gulls deserting nests here. Two years later during our North Otago census day on 25 November 2012 we recorded a total of 491 nests in four groups at Shag Point. Subsequently, on 5 December 2012 we recorded partial desertion (one group of 71 nests) at Shag Point and the creation of a new group of about 20 nests 9 km further north at Katiki Point.

Discussions with the wider community during 2020 revealed two nesting locations at Otago previously unknown to us. One location was relatively small: Aalbert Renergen (Dunedin City Council) reported about 25 nests for Hawkesbury Lagoon (Table 1). The other location, Otago Yacht Club Marina with 1,250 nests, turned out to be the third largest number of nests in Otago in 2020 (Table 1). Although the presence of the birds was well known to the yacht club members, they regarded them as a pest and had no idea anyone might be interested in recording the number of nests. Input from others improved the accuracy of the records for two other locations in 2020: Tom Waterhouse (Department of Conservation) for Oamaru, where red-billed gulls have been nesting on buildings since 2018, and Francesca Cunningham (Forest & Bird) for Harakeke Point (Table 1).

Precision in records of nest counts

Perriman & Lalas (2012) recorded only exact numbers, the best estimates, for red-billed gull nests from Waitaki River to Nugget Point in 2011. We recorded nest numbers for the subsequent two surveys in 2015 and 2020 not only as best estimates but also as likely ranges for each location. The best estimate of 4,611 nests in 2015 was bounded by a likely range from 4,252 to 5,298 nests (Table 1). This equated to a range from 8% less ($=[4,252-4,611]/4,611$) to 15% more ($=[5,298-4,611]/4,611$) than the best estimate. The best estimate of 5,957 nests in 2020 was bounded by a likely range from 5,373 to 6,751 nests (Table 1). This equated to a range from 10% less to 13% more than the best estimate. Here the lower likely limit of 5,373 nests for 2020 was only slightly higher than the upper likely limit of 5,298 nests for 2015, and could indicate that the number of nests did not increase substantially from 2015 to 2020.

The accuracy of our pre-2020 records in Table 1 was further lessened because we had to guess at nest numbers for Hawkesbury Lagoon and Otago Yacht Club Marina, the two nesting locations previously unknown to us. For Hawkesbury Lagoon we entered a best estimate of 25 nests (range 19–29) from photos and descriptions by Aalbert Renergen for 2020. We retained this best estimate of 25 nests for the backdated entries for 2011 and 2015 but

broadened the range to 0–50 nests. Following advice from Otago Yacht Club members we were able to trace the first record of nesting here to a report in the local newspaper (*Otago Daily Times*)—eight nests on a boat moored at the Otago Yacht Club Marina in 2010 (Benson 2010). From this we guessed at 20 nests for the next year, 2011. From a photo and descriptions by Aalbert Renergen for 2017 we concluded that nest numbers had about tripled in the three years from 2017 to 2020. Extrapolating this trend back two years from 2017, we settled on a best estimate of 250 nests for 2015 (Table 1) and went broad with a range of 50–500.

Dispersion of nests within locations

The three locations with the largest number of red-billed gull nests at Otago in 2020, Taiaroa Head, Katiki Point and Otago Yacht Club Marina, showed the greatest differences in dispersion of nests. Nests at Taiaroa Head (best estimate 2,800, range 2,615–2,995) were spread through about 2.5 ha (roughly a square with 150 m sides) in 22 distinct groups that varied in size from three (range 3–4) to 602 (range 560–645) nests. Nests at Katiki Point (best estimate 1,315, range 1,076–1,554) were divided into two groups; 539 (range 444–634) were spread through 0.2 ha along about 150 m of the west side of the mainland, and separated by about 150 m from 776 (range 632–920) nests on a 0.3 ha islet 30 m off the southern tip of the mainland. Nests at Otago Yacht Club Marina (best estimate 1,250, range 1,171–1,490) were separated between 1,220 (range 1,156–1,430) along the outer 280 m of the 350 m southern breakwater bordering the 3.2 ha marina, and 10 (range 5–30) on posts and 20 (range 10–30) on 2–3 boats within the marina.

DISCUSSION

The trend of increase in red-billed gull nest numbers at Otago documented by Perriman & Lalas (2012) has continued but the average annual rate of increase has dropped from 6–10% for 1992 to 2011 (Perriman & Lalas 2012) to 2% for 2011 to 2020. Locations from Waitaki River south to Nugget Point totalled 5,957 nests in 2020. This accounted for 99% of the entire Otago regional total of 6,014 nests for the linear distance of about 250 km from Waitaki River to Makati (Chaslands Mistake). Recent patterns of change in nest numbers differed within the region, with North Otago increasing at an average 5.6% annually to 1,680 nests in 2020; the vicinity of Dunedin and Otago Peninsula increasing at an average 2.5% annually to 4,198 nests in 2020; but, further south, the vicinity of Nugget Point decreasing at an average 19.8% annually to 79 nests in 2020.

The continued increase in red-billed gull nests at Otago contrasts with the overall nation-wide

decline in New Zealand reported by Frost & Taylor (2018). Comparisons of trends within and between locations are complicated by likely incompatibilities in use of terms. Following Perriman & Lalas (2012), we separated nesting locations by applying a nominal spacing of at least 1 km between locations. In contrast, Frost & Taylor (2018) did not apply a spatial factor and instead regarded nesting locations (or sites) either as individual colonies or aggregations of colonies. These ambiguities preclude detailed comparisons but one trend is clear—the number of locations/colonies with >1,000 red-billed gull nests at Otago tripled from one of six nation-wide in 2015 (Frost & Taylor 2018) to three by 2020.

The importance of citizen science was exemplified by public input leading to our embarrassing discovery of substantial nesting by red-billed gulls at a previously undocumented location. Here in Otago Harbour at Otago Yacht Club Marina, within the Dunedin city metropolitan area, 1,250 nests were hiding in plain sight and accounted for 21% of the Otago total. As observed in other studies (Ward *et al.* 2015), the citizen science data proved to be useful to complement existing data sets and filling in data gaps when other surveys are absent. As scientists often concentrate their biodiversity survey efforts in natural habitats (Martin *et al.* 2012), it was interesting to note that the two nesting locations we missed were in urban settings, highlighting where the contribution of citizen science may be most valuable (Sánchez-Clavijo *et al.* 2021).

We found that personal communication was more effective than the on-line platforms for gathering information from the public. This in part was due to our unfamiliarity with the specific iNaturalist ‘project’ function to record nesting locations of red-billed gulls in Otago. For for a ‘project’ to be effective, participants need to know it exists (Kirchhoff *et al.* 2021) and so we plan to increase awareness with more-targetted promotion through media. The lack of engagement in the ‘project’ function may also reflect the observation that participants are less likely to engage with more complex and lengthy data collection and entry protocols (Davis *et al.* 2019). Feedback through the ‘journal’ function on iNaturalist has been shown to be an effective way to keep project participants updated about the results of a project (Kirchhoff *et al.* 2021) and so we plan to implement this in the future. Uploading of the data to iNaturalist ensures open access to both scientists and citizen scientists, a critical component to the success of citizen science projects (Bonney *et al.* 2009).

Two features of chronological trends among red-billed gull nesting locations at Otago precluded meaningful intra-regional or inter-regional comparisons among individual locations. First,

our records dating back to 1992 (Perriman & Lalas 2012) indicate that few if any locations are used consistently each year. Second, through recent years the increasing number of nests have condensed into fewer locations, thus inflating the growth rate at locations with the largest number of nests. Frost & Taylor (2018) recommended that nation-wide trends for the red-billed gull population could be deduced from monitoring several representative locations. Unfortunately, the lack of consistency in trends among locations means that Otago lacks this shortcut. Instead, for Otago we recommend using total nest numbers from Waitaki River to Nugget Point (99% of Otago total nests) for inter-regional comparisons.

Predation by introduced mammals has been considered a major cause for the decline in red-billed gulls nation-wide (Frost & Taylor 2018), and more specifically for the decline at Kaikoura beginning in 1994 (Mills *et al.* 2018), and both studies emphasised the importance of predator control. Predation has not been a major problem at Otago since control measures were implemented at the important nesting locations but this alone is unlikely to account for increases at Otago coinciding with decreases further north. Frost & Taylor (2018) attributed the greatest contribution towards the nation-wide decline in red-billed gulls since the 1960s to massive decreases in nest numbers at Three Kings Islands and Mokohunau Islands off northern North Island. Both these island groups now lack predatory mammals: none were introduced to Three Kings Islands (Bellingham *et al.* 2010) and Mokohunau Islands only had kiore (*Rattus exulans*), with the last eradicated 30 years ago (McFadden & Greene 1994). Consequently these northern declines in nest numbers cannot be attributed to predation.

The recent update for the conservation status of New Zealand birds added 'Climate Impact' as a potential cause for decreases in populations and allocated this as the only qualifier for the national population decline in red-billed gulls (Robertson *et al.* 2021). Perriman & Lalas (2012) found that increases at Otago coincided with changes in the marine environment and so continued monitoring of red-billed gulls here may prove worthwhile as a test for the effect of climate change on New Zealand seabirds.

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