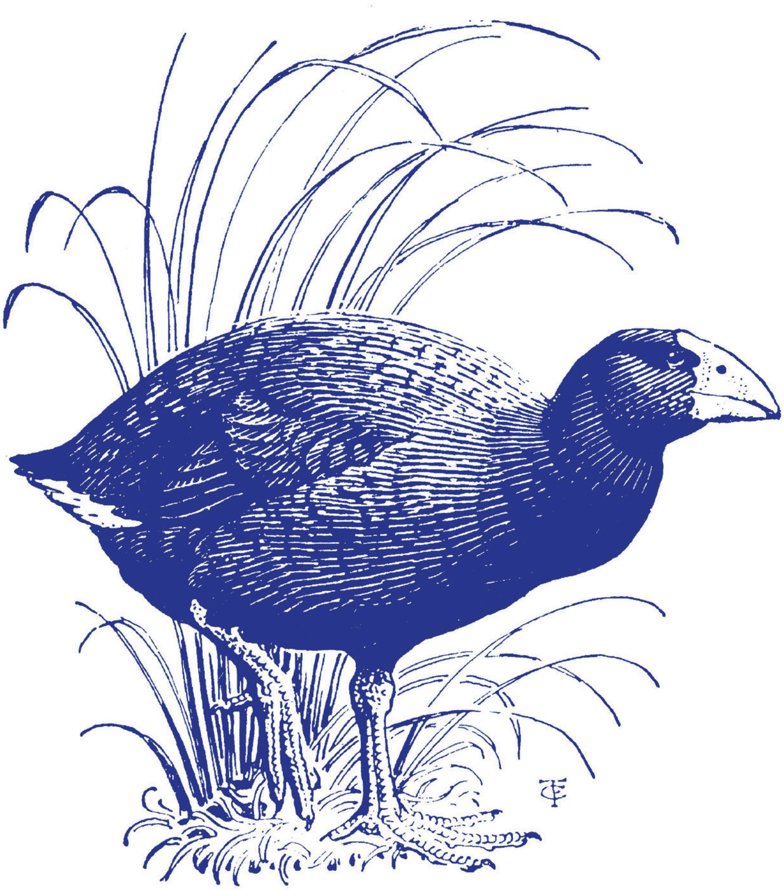
NOTORNIS

Ornithology of the Southern Pacific



Volume 71 Part 3
September 2024
Journal of the Ornithological Society of New Zealand

NOTORNIS
ISSN 0029-4470
71 (3): 69 -127

NOTORNIS

Scope *Notornis* is published quarterly by the Ornithological Society of New Zealand Inc. The journal publishes original papers and short notes on all aspects of field or laboratory ornithology, and reviews of ornithological books and literature, student research, and reports of specialist ornithological events. *Notornis* concentrates on the birds of the ocean and lands of the Southern Pacific, with special emphasis on the New Zealand region. It seeks to serve professional, amateur and student ornithologists alike, and to foster the study, knowledge and enjoyment of birds.

Submission of manuscripts Manuscripts submitted for consideration for publication in *Notornis* should be prepared in accordance with the Instructions to Authors obtainable from the web page *http://osnz.org.nz* (abbreviated instructions are on the inside back cover of each issue). Submissions may be sent by email to The Managing Editor, *Notornis*, E-mail: *editor.notornis@birdsnz.org.nz*

The Ornithological Society of New Zealand Inc. exists to create a nation-wide study group with individual members or groups working on different aspects of ornithology as suits their interests or circumstances and all contributing to the sum of ornithological knowledge. This aim cannot be achieved in a day or a decade but each year brings a variety of new accomplishments and insights into the biology of birds.

The objects of the Society are:

- To encourage, organise and promote the study of birds and their habitat use particularly within the New Zealand region.
- To foster and support the wider knowledge and enjoyment of birds generally.
- To promote the recording and wide circulation of the results of bird studies and observations.
- To produce a journal and any other publication containing matters of ornithological interest.
- To effect co-operation and exchange of information with other organisations having similar aims and objects.
- To assist the conservation and management of birds by providing information, from which sound management decisions can be derived.
- To maintain a library of ornithological literature for the use of members and to promote a wider knowledge of birds.
- To promote the archiving of observations, studies and records of birds particularly in the New Zealand region.
- To carry out any other activity which is capable of being conveniently carried out in connection with the above objects, or which directly or indirectly advances those objects or any of them.

Notornis, Vol. 4, No. 1 (July 1950) (ISSN 0029-4470)
In continuation of Reports and Bulletins (1939-1942) and New Zealand Bird Notes (1942-1950)

Vol. 71, No.3 (September 2024) (Published December 2024)

Full details of the **Ornithological Society of New Zealand** can be obtained from the Secretary,
PO Box 834, Nelson 7040, New Zealand, New Zealand or from the Society web page at *https://www.birdsnz.org.nz*
Notornis is on-line at *https://www.notornis.osnz.org.nz/publications*

NOTORNIS

Journal of the
Ornithological Society of New Zealand

Volume 71 Part 3 September 2024

Notornis, Vol. 4, No. 1 (July 1950) (ISSN 0029-4470)

In continuation of Reports and Bulletins (1939-1942) and New Zealand Bird Notes (1942-1950)

Vol. 71, Part 3 (September 2024) (Published December 2024)

Editor: JAMES SAVAGE
Associate Editor: COLIN MISKELLY

Ornithological Society of New Zealand, Inc.

The Ornithological Society of New Zealand, Inc. exists to create a nation-wide study group with individual members or groups working on different aspects of ornithology as suits their interests or circumstances and all contributing to the sum of ornithological knowledge. This aim cannot be achieved in a day or a decade but each year brings a variety of new accomplishments and insights into the biology of birds.

The aims and objectives of the Society are:

- To encourage, organise and promote the study of birds and their habitat use particularly within the New Zealand region.
- To foster and support the wider knowledge and enjoyment of birds generally.
- To promote the recording and wide circulation of the results of bird studies and observations.
- To produce a journal and any other publication containing matters of ornithological interest.
- To effect co-operation and exchange of information with other organisations having similar aims and objects.
- To assist the conservation and management of birds by providing information, from which sound management decisions can be derived.
- To maintain a library of ornithological literature for the use of members and to promote a wider knowledge of birds.
- To promote the archiving of observations, studies and records of birds particularly in the New Zealand region.
- To carry out any other activity which is capable of being conveniently carried out in connection with the above objects, or which directly or indirectly advances those objects or any of them.

Notornis, 2024, Vol. 71: 69-75
0029-4470 © The Ornithological Society of New Zealand Inc.

Where do some Aotearoa New Zealand seabirds go? Records of *Thalassarche* albatrosses and *Procellaria* petrels in Ecuadorian waters.

ENZO M. R. REYES
Marine Bycatch and Threats Team, Department of Conservation, National Office, Wellington, Aotearoa New Zealand.

SIMONE GIOVANARDI
School of Natural Sciences, Massey University, Albany Campus, Auckland, Aotearoa New Zealand.

GIOVANNY SUAREZ-ESPIN
Ecuador Seabird Bycatch Program, Ocean and Islands program, American Bird Conservancy, Salinas, Ecuador.

BEN HAASE
Museo de Ballenas, Salinas, Ecuador.

KALINKA REXER-HUBER
GRAHAM PARKER
Parker Conservation, Dunedin, Aotearoa New Zealand.

PAUL SAGAR
Marine Ecology Group, National Institute of Water and Atmospheric Research, Aotearoa New Zealand.

JOHANNES H. FISCHER
Marine Bycatch and Threats Team, Department of Conservation, National Office. Wellington, Aotearoa New Zealand.

Abstract: Albatrosses and petrels are among the most endangered seabird species worldwide. They face threats such as plastic ingestion, bycatch in fisheries, invasive predators at breeding sites, light pollution, and climate change. Many seabird species from Aotearoa New Zealand migrate to the eastern Pacific waters during the non-breeding season, following the abundant food availability of the Humboldt current. In this article, we compile observations of *Thalassarche* and *Procellaria* petrels in Ecuadorian waters from five information sources such as incidental tourist vessel observations, incidental fishermen observations, beach patrols, seawatching and GLS loggers. We provide strong evidence of the presence of Salvin's albatross and White-chinned petrel in Ecuador, two species previously considered hypothetical for the country's official bird list. Additionally, we present photographic evidence of a live Southern Buller's albatross in Ecuador and document further observations of the black petrel, including its interactions with local fisheries. These records emphasize the importance of enhancing monitoring efforts to gain a deeper understanding of the ecology and conservation of Ecuador's seabirds. They also highlight the necessity and advantages of collaboration between New Zealand and Ecuador concerning highly mobile bird species.

Resumen. Los albatros y petreles son unas de las especies más amenazadas en el planeta. Las amenazas para estas especies incluyen ingestión de plásticos, pesca incidental, especies invasoras en colonias de reproducción, contaminación lumínica y cambio climático. Muchas de las aves marinas de Nueva Zelanda migran al Océano Pacifico este durante la época no reproductiva siguiendo la abundancia de alimentos de la corriente oceánica de Humboldt. En este articulo usamos cinco diferentes fuentes de información tales como observaciones incidentales de botes turísticos, botes de pesca, patrullas de palayas, seawatching y GLS para compilar observaciones de albatros *Thalassarche* y petreles *Procellaria* que visitan aguas ecuatorianas. Nosotros presentamos evidencia robusta sobre la presencia del albatros de Salvin y el petrel barba blanca en Ecuador, las mismas que son consideradas hipotéticas para la lista oficial de aves de Ecuador. Adicionalmente, presentamos evidencia fotográfica de un individuo vivo del albatros de Buller del sur en el país y añadimos más observaciones del petrel de Parkinson y las interacciones que esta especie tiene con las pesquerías locales. Estos registros destacan la importancia de aumentar los esfuerzos de monitoreo para comprender mejor la ecología y conservación de las aves marinas de Ecuador. También resaltan la necesidad y los beneficios de la colaboración entre Nueva Zelanda y Ecuador en relación con las especies marinas migratorias.

Reyes, E.M.R.; Giovanardi, S.; Suarez-Espin, G.; Haase, B.; Rexer-Huber, K.; Parker, G.; Sagar, P.; Fischer, J.H. 2024. Where do some Aotearoa New Zealand seabirds go? Records of *Thalassarche* albatrosses and *Procellaria* petrels in Ecuadorian waters. *Notornis 71(3)*: 69–75.

Keywords: *Thalassarche, Procellaria*, Ecuador, New Zealand, distribution, GLS, osteology.

Received 20 December 2023; accepted 13 November 2024

*Correspondence: enzorreyesb@gmail.com

INTRODCUTION

Procellariiforms are one of the most threatened groups of birds, facing numerous risks including plastic ingestion, fisheries bycatch, invasive predators at breeding sites, light pollution, and climate change (e.g., Dias *et al.*, 2019). Aotearoa New Zealand, known as the seabird capital of the world, boasts a rich diversity and abundance of procellariiforms and other seabird species (Taylor 2000). The majority of the albatross and petrel species breeding in Aotearoa New Zealand are highly migratory, spending part of their lives in the upwelling zones of the Humboldt Current off the west coast of South America during the pre- and non-breeding periods (Robertson *et al.*, 2013; Fischer *et al.*, 2023). Although a recent global assessment categorised this area as low-risk for plastic exposure compared to other regions in the Pacific (Clark *et al.*, 2023), these non-breeding grounds still expose albatrosses and petrels to significant human-induced threats, particularly fisheries bycatch (Coello *et al.*, 2010; Anderson *et al.*, 2011; Good *et al.*, 2020). Understanding the presence and distribution of these vulnerable species in international waters and the jurisdictions they rely on is essential for mitigating threats such as fisheries bycatch (Fischer *et al.*, 2023).

At least three procellariiforms species breeding in Aotearoa New Zealand are recorded as recurrent in Ecuadorian waters: Buller's albatross (*Thalassarche bulleri*), Buller's shearwater (*Ardenna bulleri*), and black petrel (*Procellaria parkinsoni*) (Haase 2019). All three species are of high conservation interest, as all are prone to bycatch and all are considered Vulnerable (IUCN Red List 2023). Additionally, the black petrel is the flagship species for a bilateral Memorandum of Understanding between the Aotearoa New Zealand and Ecuadorian Governments to address threats and improve the conservation status of Aotearoa New Zealand migratory birds. One of the objectives of this Memorandum of Understanding is to identify the vulnerable species within Ecuadorian waters that would benefit from bycatch mitigation efforts. In this article, using fishermen and vessel observation, skull morphology from carcasses, and GLS analysis we confirm the presence of another two Aotearoa New Zealand seabird species in Ecuadorian waters, which were considered hypothetical for Ecuador's official bird list (Freile *et al.*, 2022): Salvin's albatross (*T. salvini*) and white-chinned petrel (*P. aequinoctialis*). Furthermore, we present new records of southern Buller's albatross (*T. b. bulleri*) and black petrels in Ecuador's waters, that further reinforce the importance of Ecuadorian waters for these species.

MATERIAL AND METHODS

We compile opportunistic observations by tourist vessels, Ecuadorian fishermen, beach patrols, seawatching and GLS logger data from *Thalassarche* albatrosses (known generally as 'grey albatross' by Ecuadorian fishermen, including *T. salvini*, *T. bulleri* and *T. melanophris)* and *Procellaria* petrels in Ecuador. Observations were compiled in three different categories: sightings of live animals from vessels and seawatching, records of dead specimens found in beach patrols, and GLS tracking data from alive individuals. Vessel-based sightings were performed in two locations; offshore Santa Elena peninsula and from Puerto Lopez village to La Plata Island. Beach patrols were undertaken on the south of the Santa Elena peninsula at the localities of Mar Bravo and Punta Carnero beaches.

For two unconfirmed Salvins' albatross specimens recovered from beach patrols, in Ecuador, we applied the skull morphology measurements detailed by Piro & Acosta-Hospitaleche (2019) and compared both specimens with identified specimens from the collections in the Auckland Museum (AM) in Aotearoa New Zealand, the morphosource.org (MS) (Bjarnason & Benson 2021), and private collections in Ecuador (EC). We compared the skulls from the two unconfirmed Salvin's albatross with 13 specimens (skull) from four confirmed albatross species: two Salvin's albatross (AM), four waved albatross (*Phoebastria irrorata*) (EC & MS), four Buller's albatross (AM & EC) and three black-browed albatross (*T. melanoprhis*) (AM & EC). After taking measurements, seven out of 24 morphometric measures were excluded due to incomplete skulls. The measures removed from the dataset were: length of the *fossa glandulae nasalis* (FGL); minimum width between the *ossa frontali* (FW); minimum width between *fossae glandulae nasalis* (MFF); length of the *ramus mandibulae* (ML); *apertura nasi ossea* length (NL); preorbital width at the level of the *processus supraorbitalis* of the *os lacrimale* (PrW), and total length from the *preminetia cerebellaris* to the tip of the beak (TL). To reduce error, all measurements were taken two times by the same person. After computing the average between the first and second measurement a traditional Principal Component Analysis (PCA) was performed.

To analyse the GLS data, we processed the light, immersion, and temperature data, collected by C330 GLS tag (Migrate Technologiesin) in the R package *probGLS* (Merkel *et al.* 2016) as per Fischer *et al.* (2023) to infer location data.

RESULTS

Salvin's albatross

The species is widely distributed in the northern Humboldt upwelling systems off the coast of Peru

(Fischer *et al*., 2023). A published record of a stranded bird and a preserved skull in a museum collection are the only records of the species for Ecuador (Haase 2019). Nevertheless, another skull recovered from a beached bird (Fig. 1) on September 2022 in Salinas is believed to belong to this species. Notably, this bird showed indications of an anthropogenic blunt-force trauma to the upper mandible, which may be related to fisheries interactions (Gianuca *et al*., 2020). The skull morphology measurements analysis show the first two components covered 56.5% of the total morphological variance in the dataset. By plotting these results, we found that the two skulls believed to be Salvin's albatross (Skull 1 and 2; Fig. 2) cluster most closely with measurements from the Salvin's albatross specimens in the Auckland Museum. Despite the clustering more data may be needed to draw better conclusions.

Figure 1. Salvin's albatross carcass found on Mar Bravo beach in September 2022. Photo credit: Giovanny Suarez.

To further corroborate the presence of Salvin's albatross in Ecuador, we present a GLS track of a breeding adult tagged on Hauriri Bounty Islands on the colony of Proclamation Island, Aotearoa New Zealand in October 2018 and retrieved the subsequent year (Sagar *et al.* 2018; Thompson *et al.* 2020). The location data illustrated that this bird most likely reached Ecuadorian waters in July 2019. However, some caution is needed when interpreting these data as locations inferred from GLS tags are surrounded by considerable error (~145 km; Merkel *et al.* 2016) (Fig. 3). The data of this track and other individuals tracked from Hauriri Bounty Islands can be accessed online (dataset 2077 on https://www.seabirdtracking.org/).

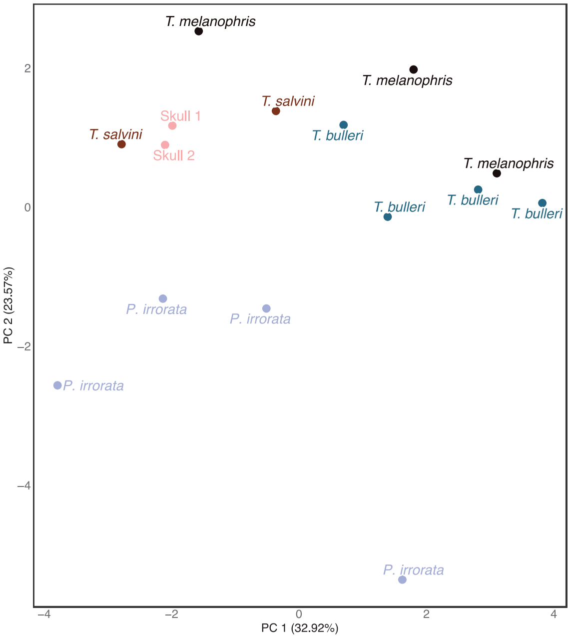


Figure 2. PCA of 13 skull specimens of albatross recorded for Ecuador. Skull 1 and 2 correspond to the two specimens found in Ecuadorian coast.

We compiled verbal and photographic observations from artisanal fishermen of 'grey albatross' in Ecuadorian waters. In doing so, we found a record of a juvenile Salvin's albatross in August 2022 observed 22 km from the Santa Elena Peninsula that was confirmed by a photograph (Fig. 3). Fishermen interviewed highlight that 'grey albatross' are fairly common in Ecuadorian waters from July to October every year. However, these observations could also overlap with the more common Buller's or black-browed albatross. Additionally, a live individual was observed during the seawatching monitoring of the Museo de Ballenas on 30 Jul 2024. Despite no photographs being taken, the observer's previous experience with the species, along with the distinct wing and beak colouration, confirmed the identification. Here, we present enough evidence to affirm that Salvin's albatross utilise or pass through Ecuadorian waters as the species have previously been reported north of the Equator in Hawai'i (Robertson *et al.* 2005), Alaska (Howell *et al.* 2014), California (del Hoyo *et al.* 2020) and Costa Rica (Arias 2024); and thus this species should be added to the country's bird list.

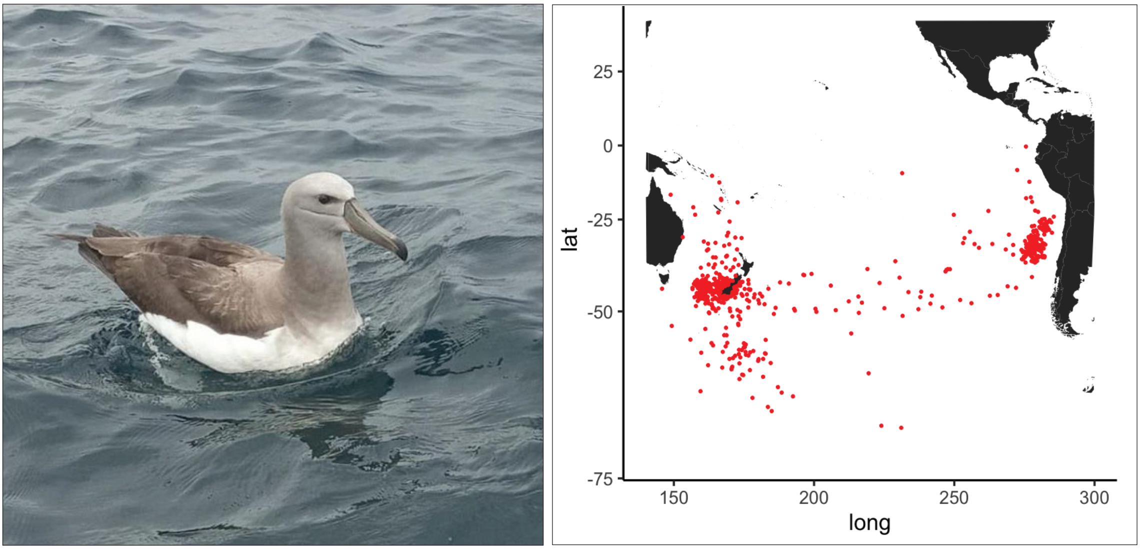


Figure 3. a) Juvenile Salvin's albatross observed in August 2022 offshore of Santa Elena Peninsula. b) Salvin's albatross track during October 2018 to October 2019 from New Zealand Hauriri Bounty Islands colonies in the subantarctic islands to South America and reaching Ecuadorian waters. Photo credit: Giovanny Suarez.

Southern Buller's albatross

The species is considered rare in Ecuador, but this may reflect a lack of pelagic monitoring. As mentioned above, fishermen possibly record this species more often than thought in Ecuadorian waters. Recently, more information has become available on the genetic and plumage differentiation between the two subspecies of Buller's albatross (Wold *et al*., 2021; Wold *et al*., 2018, Quiñones *et al.* 2023), the northern Buller's albatross (*Thalassarche b. platei)* and the southern Buller's albatross (*Thalasarche b. bulleri*). The previous two published Ecuadorian records of Buller's albatross (Haase 2019) do not specify the records to subspecies level, as these records were obtained from beached individuals in which only the beak colouration was used as an identification feature to species level. In this article, we used the skull morphology of Buller's albatross without differentiating between subspecies as the skulls used were cleaned of plumage after being collected from the Ecuadorian beaches. Nevertheless, a recent study in Peruvian waters shows that the most abundant taxon was the northern subspecies (Quiñones *et al*., 2023). Here, we report an individual southern Buller's albatross sighted from a tourist boat and identified by EMRR 20 km from the shore of Puerto Lopez village on the way to La Plata Island. The individual was recorded in October 2023 feeding on a dead seabird. The plumage and beak colouration of the individual corresponded to an adult southern Buller's albatross based on the identification features presented in Quiñones *et al.* (2023) (Fig. 4). This is the first documented record of a live individual of this species for Ecuador. We hypothesise that the northern subspecies is also present in the country, but photographic evidence is needed to confirm its presence.

Figure 4. Adult southern Buller's albatross photographed offshore from Puerto Lopez village in October 2023. Photo credit: Simone Schraven.

Black petrel

The presence of this vulnerable species is widely documented for Ecuadorian waters. Several hundred individuals have previously been observed offshore of Santa Elena Peninsula during a sea watching project on the Ecuadorian coast (Haase 2019). Additionally, a group of at least ten individuals was recorded near the Ecuadorian shores during a wreck event in 2016 (Reyes *et al.*, 2017) and a raft of individuals has also been observed in the Galapagos Islands (Gaskin, *et al.*, 2016). Here we add several more records of the species. One individual was observed 18 km off the shore of Puerto Lopez on the way to La Plata Island in September 2023. This individual was observed following a trawling fishing boat alongside other seabird species such as guanay cormorant (*Leucocarbo bougainvillii*), sooty shearwaters (*Ardenna grisea*), brown pelicans (*Pelecanus occidentalis),* magnificent frigatebirds (*Fregata magnificens*) and brown noddy (*Anous stolidus*). Additionally, in March 2024 a flock of around 25 individuals were observed by BH in a pelagic tour 34 km southwest from Santa Elena peninsula. One individual in particular was observed with nylon attached to its beak presumably as a release from a bycatch (Figure 5). Finally a dead specimen was found by BH around 150 metres from the coast on the Mar Bravo Salt pools in June 2024, representing the first case of the species reported inshore in the country.

Figure 5. Black petrel observed offshore from Santa Elena peninsula. Note the nylon thread attached to the beak of the individual presumably as a release from bycatch. Photo credit: Ben Haase.

White-chinned petrel

This species is considered rare in Ecuadorian waters (Ridgely & Greenfield 2001) and hypothetical by the Ecuadorian Committee of Ornithological Records (Freile *et al.*, 2022). Nevertheless, an analysis of the global distribution of the species showed that white-chinned petrels from various colonies spend their non-breeding period (May to September) off western South America in a zone between Ecuador and Chile, with birds from Maukahuka Auckland Island visiting Ecuadorian waters before returning to Aotearoa New Zealand in October (Elliott *et al.*, 2020; Rexer-Huber 2017) (Fig. 6). Here, we report two individuals of unknown origin found during beach patrols on Mar Bravo beach in Ecuador. One was found in 2020 and the other on 20 September 2023. Both individuals were mummified (bones, dry skin, and feathers), but the size and the characteristic white patch underneath and around the base of the beak (Fig. 7) confirmed this species. As these two individuals were found in different years, the presence of the species in Ecuadorian waters may not be associated with El Niño Southern Oscillation events, but be more reflective of the usual distribution of the species, as was suggested by Rexer-Huber (2017). To the best of our knowledge, the records presented in this note are the first documented for the country.

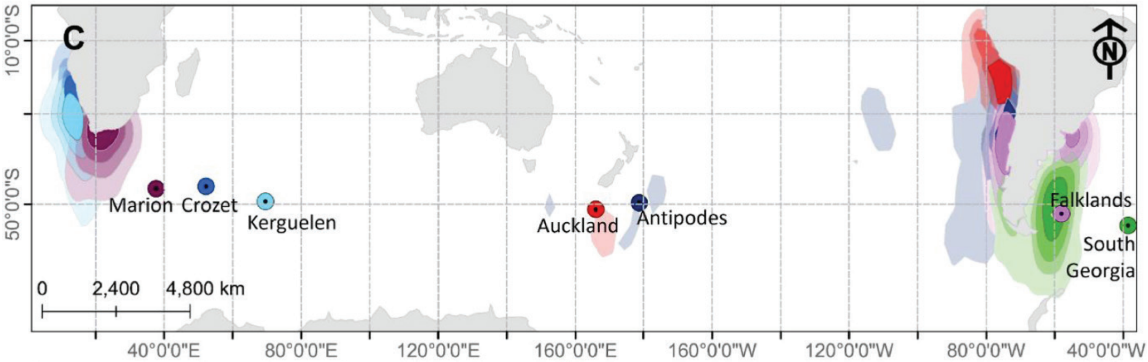


Figure 6. Global distributions of white-chinned petrel island populations over nonbreeding stages (May-September). Colour dots represent breeding colonies while coloured areas represents nonbreeding grounds of the species corresponding to a particular breeding site. Reproduced with permission from Rexer-Huber (2017).

Figure 7. White-chinned petrel carcass found on Mar Bravo Beach in August 2023. Photo credit: Enzo Reyes.

DISCUSSION

In this article, we removed uncertainty around the presence of two oceanic and highly migratory Aotearoa New Zealand seabirds in Ecuador: Salvin's albatross and white-chinned petrel. We present robust evidence from a variety of data sources and recommend the change from the hypothetical status for these two species in Ecuador, and recommend them to be fully listed on the country's species list. Furthermore, we also document the first live record of southern Buller's albatross for the country and provide further evidence of the common presence of the black petrel in Ecuadorian waters. We highlight the threats faced by black petrels from fisheries activities, as demonstrated by the individual found with nylon attached (Fig 5), likely from a snood or branch line of a pelagic longline fishing line. The location of the line suggests that the hook is still inside the bird's mouth or digestive tract, which could have detrimental or fatal consequences.

In general, data on the distribution and conservation status of many seabird species in Ecuador are scarce due to the lack of standardised monitoring at sea or coordinated beach patrols, and the fact that tracking data are heavily biased towards breeding adults (e.g., Carneiro *et al.* 2020, Fischer *et al.* 2023). This note further highlights the seabird diversity that depends on Ecuadorian waters, and indicates that further research into the ecology and conservation of these species in these waters is required. This need for further research is particularly pertinent given the sensitivity of these albatross and petrel species to fisheries interactions, highlighted by the anthropogenic blunt-force trauma recorded in the Salvin's albatross in Fig. 1. We hope that further work, both in Aotearoa New Zealand through tracking, and in Ecuador through surveys, will improve insights into the ecology and conservation of Ecuador's seabirds. Additionally, we highlight the need and benefit for collaboration between countries, with regard to highly mobile bird species.

ACKNOWLEDGMENTS

We thanks the Ecuadorian fishermen for sharing their insights on the occurrence of *Thalassarche* albatross in Ecuadorian waters, Josie Galbraith from Auckland Museum for the access to the museum vertebrate collection, to Igor Debski for his comments on the beached Salvin's albatross, to Simone Schraven for allow us to use their picture of the southern Buller's albatross, and finally to Leon Billows for proofreading the manuscript.

LITERATURE CITED

Anderson, O.R.; Small, C.J.; Croxall, J.P.; Dunn, E.K.; Sullivan, B. J.; Yates, O.; Black, A. 2011. Global seabird bycatch in longline fisheries. *Endangered Species Research 14*(2): 91-106.

Arias, S. 2024. Primer registro del albatross de Salvin (*Thalassarche salvini*) y nuevos registros del albatross de Galapagos (*Phoebastria irrorata*) en Costa Rica. *Zeledonia 28*(1): 59-58.

Birdlife International 2023. https://data.seabirdtracking.org/dataset/2077

Bjarnason, A.; Benson R.B.J. 2021. A 3D geometric morphometric dataset quantifying skeletal variation in birds. *MorphoMuseuM* 7(1).

Clark, B.L.; Carneiro, A.P.B.; Pearmain, E.J. *et al.* 2023. Global assessment of marine plastic exposure risk for oceanic birds. *Nature Communications 14*: 3665.

Carneiro *et al.* 2020. A framework for mapping the distribution of seabirds by integrating tracking, demography and phenology. *Journal of Applied Ecology 57*(3): 514-525.

Coello, D.; Herrera, M.; Calle, M.; Castro, R.; Medina, C.; Chalen, X. 2010. Incidencia de tiburones, rayas, aves, tortugas y mamiferos marinos en la pesca artesanal con enmalle de superficie en la Caleta Pesquera de Santa Rosa (proviencia de Santa Elena). Intituto Nacional de Pesca. *Boletin Especial 2*(3) 1-55.

Del Hoyo, J.; Collar, N.; Kirwan, G.M. 2020. Salvin's albatross (*Thalassarche salvini*), version 1.0. *In* Birds of the World (del Hoyo, J.; Elliott, A.; Sargatal, J.; Christie, D.A.; de Juana, E, eds.) Cornell Lab of Ornithology, Ithaca, USA

Dias, M.P.; Martin, R.; Pearmain, E.J.; Burfield, I. J.; Small, C.; Phillips, R.A.; Yates, O.; Lascelles, B.; Borboroglu, P.G.; Croxall, J.P. 2019. Threats to seabirds: a global assessment. *Biological Conservation* 237: 525–537.

Elliott, G.P.; Walker, K. J.; Parker, G.C.; Rexer-Huber, K.; Miskelly, C.M. 2020. Subantarctic Adams Island and its birdlife. *Notornis* 67(1): 153–187.

Fischer, J.H.; Bose, S.; Romero, C.; Charteris, M.; Crowe, P.; Parker, G.C.; Ray, S.; Rexer-Huber, K.; Sagar, P.M.; Thompson, D.R.; Bell, E. A.; Debski, I.; Quiñones, J. 2023. Combining tracking with at-sea surveys to improve occurrence and distribution estimates of two threatened seabirds in Peru. *Bird Conservation International 33:* e41.

Freile, J.F.; Brinkhuizen, D.M.; Greenfield, P.J.; Lysinger, M.; Navarrete, L.; Nilsson, J.; Olmstead, S.; Ridgely, R. S.; Sanchez-Nivicela, M.; Solano-Ugalde, A.; Athanas, R.; Ahlman, R.; Boyla, K.A. 2022. Lista de las aves del Ecuador / Checklist of the birds of Ecuador. Comité Ecuatoriano de Registros Ornitológicos.

Gaskin, C.P.; Harrison, P.; Baird, K.A.; Cunninghame, F.; Ismar, S.M.; Bell, E.A. 2016. An opportunistic sighting of a flock of black petrels (*Procellaria parkinsoni*) at Galápagos Islands, Ecuador. *Notornis 63*: 54–56.

Gianuca, D.; Bugoni, L.; Jimenez, S.; Daudt, N.; Miller, P.; Canani, G.; Silva-Costa, A.; Faria, F. A.; Bastida, J.; Seco-Pon, J.P.; Yates, O.; Serafini, P.P.; Bond, A. 2020. Intentional killing and extensive aggressive handling of albatross and petrels at the sea in the southwestern Atlantic Ocean. *Biological Conservation 252*: 108817

Good, S.D.; Baker, J.B.; Gummery, M.; Votier, S.C.; Philips, R.A. 2020. National Plans of Action (NPOAs) for reducing seabird bycatch: Developing best practice for assessing and managing fisheries impacts. *Biological Conservation 247*: 108592

Haase, B.J.M. 2019. *Guide to the sea and coastal birds of Ecuador, the Ecuasal lakes and the Galapagos Islands*. Guayaquil. Ecuador.

Howell, S.; Lewington, I.; Russell, W. 2014. Rare birds of North America. *Princeton University Press,* Princeton, USA

IUCN 2023. Black petrel. The IUCN Red List of Threatened Species. Version 2022-2.

Merkel, B.; Phillips, R.A.; Descamps, S.; Yoccoz, N.G.; Moe, B.; Strøm, H. 2016. A probabilistic algorithm to process geolocation data. *Movement Ecology 4*(1): 1-11.

Piro, A.; Acosta-Hospitaleche, C. 2019. Skull morphology and ontogenetic variation of the southern giant petrel *Macronectes giganteus* (Aves: Procellariiformes). *Polar Biology 42*(1): 27–45.

Quiñones, J.; Zavalaga, C.; Robertson, C.J.R. 2023. Identifying northern Buller ́s albatross (*Thalassarche bulleri* subsp.) in offshore waters of southern Perú. *Notornis 70*: 49–59.

Rexer-Huber, K. 2017. White-chinned petrel distribution, abundance and connectivity have circumpolar conservation implications. PhD Thesis, Otago University. Dunedin, New Zealand.

Reyes, E.M.R.; Suarez-Spin, G.; Bell, E.A. 2017. La Niña signal? Unusual inshore sightings of black petrel (*Procellaria parkinsoni*) in Santa Elena Province, Ecuador. *Notornis 64*: 24–26.

Ridgely, R.S.; Greenfield, P.J.; 2001. *The birds of Ecuador*, vol. 1. Cornell University Press, Ithaca, NY.

Robertson, C.J.R.; Klavitter, J.; McCarthy, R. 2005. Salvin's albatross (*Thalassarche salvini*) on Midway Atoll. *Notornis 52*(4): 236-237.

Robertson, H.A.; Dowding, J.E.; Elliott, G.P.; Hitchmough, R.A.; Sagar, P.M.; Scofield, R.P.; Taylor, G.A. 2013. Conservation status of New Zealand birds, 2012. (New Zealand Threat Classification Series 4). Department of Conservation. Wellington, New Zealand.

Sagar, P.; Charteris, M.; Parker, G.; Rexer-Huber, K.; Thompson, D.; 2018. Salvin's albatross: Bounty Islands population project. Ground component. National Institute of Water & Atmospheric Research. Wellington, New Zealand.

Taylor, G.A. 2000. Action plan for seabird conservation in New Zealand. Part A, Threatened seabirds. Threatened Species Occasional Publications No 16. Department of Conservation. Wellington, New Zealand.

Thompson, D.; Sagar, P.; Briscoe, D.; Parker, G.; Rexer-Huber, K.; Charteris, M. 2020. Salvin's albatross: Bounty Islands population project. Ground component. National Institute of Water & Atmospheric Research. Wellington, New Zealand.

Wold, J.R.; Robertson, C.J.R.; Chambers, G.K.; Ritchie, P.A. (2018). Phylogeographic structure and a genetic assignment method for Buller's albatross ssp. (*Thalassarche bulleri* ssp.*). Notornis 65*: 152–163.

Wold, J.R.; Robertson, C.J.R.; Chambers, G.K.; Van Stijn, T.; Ritchie, P.A. 2021. Genetic connectivity in allopatric seabirds: Lack of inferred gene flow between northern and southern Buller's albatross populations (*Thalassarche bulleri* ssp.*). Emu - Austral Ornithology 121*(1–2): 113–123.

Notornis, 2024, Vol. 71: 77-92
0029-4470 © The Ornithological Society of New Zealand Inc.

Breeding biology of kawau pāteketeke | New Zealand king shags (*Leucocarbo carunculatus*)

HELEN GUMMER
c/o Department of Conservation, PO Box 10420, Wellington 6140, New Zealand

GRAEME A. TAYLOR*
Department of Conservation, PO Box 10420, Wellington 6140, New Zealand

DAN PALMER
Department of Conservation, PO Box 161, Picton 7250, New Zealand

MIKE BELL
Toroa Consulting Ltd, 11 Maple Close, Blenheim, New Zealand

Abstract: Kawau pāteketeke | New Zealand king shag (*Leucocarbo carunculatus*) nest occupancy, breeding, and offspring survival was studied for the first time at four colonies in 2018 and 2019, by analysing field camera still images. Nesting territories were retained year-round. Nest-building was underway by Mar and observed through much of the year. Successful pairs with stable nests were elevated and central to nest areas. Inter-colony asynchronous first clutches occurred over six months, with laying spanning 5–10+ weeks at single colonies (2019). Clutches of 2–3 eggs took ≤13 days to complete. Incubation commenced with first eggs; asynchronous hatching was 28–32 days later with brood reduction at early nestling stage and occasional replacement clutches observed. Chicks were unattended at 3–4 weeks, showing strong creche behaviour thereafter, and were fully feathered at 65 days, fledging soon after. Breeding outcome was most influenced by height above sea-level (waves), exposure (weather), and boat/landing disturbance. Most young disappeared from images at 4.5–5 months, their fate—dispersed or perished—unknown. Some resided at the colony into/beyond the subsequent breeding season, sometimes interacting with presumed parents. Any predation (by gulls) was seen as opportunistic during disturbances, or of eggs not in nests.

Gummer, H.; Taylor, G.A.; Palmer, D.; Bell, M. 2024. Breeding biology of kawau pāteketeke | New Zealand king shags (*Leucocarbo carunculatus*). *Notornis 71(3)*: 77–92.

Keywords: New Zealand king shag, *Leucocarbo carunculatus*, breeding biology, brood reduction, remote monitoring, trail camera

INTRODUCTION

The kawau pāteketeke | New Zealand king shag (*Leucocarbo carunculatus*), hereafter NZKS, is a marine, pink-footed cormorant (Family: Phalacrocoracidae), one of three remaining endemic blue-eyed shags from the genus *Leucocarbo* remaining on the Aotearoa New Zealand mainland (Rawlence *et al*., 2017), and is currently restricted to Te Tauihu-o-te-Waka/Marlborough Sounds.

With low productivity and juvenile survival (Bell 2022) and <800 mature birds in a restricted and relictual range forecast to further decline with climate change, the species remains at a conservation status of Nationally Endangered (Robertson *et al*., 2021). The species is also highly vulnerable to human-induced threats (Nelson 1971; Taylor 2000). Recent annual estimates suggest 300 breeding NZKS pairs (2019–2021), spread across up to a

---

Received 8 July 2024; accepted 18 November 2024
*Correspondence: gtaylor@doc.govt.nz

dozen dynamic colonies in a total population of 784 individuals (Bell 2022), within the previous range of 645–839 birds counted between 1992 and 2015 (Schuckard *et al*., 2015). NZKS are sedentary and mostly breed in winter on small, exposed islands with 80% of the population breeding lower than 14 m above sea-level (Schuckard 2013, 2022). Pairs are monogamous, in territories just out of reach of neighbours, and produce altricial, nidicolous nestlings (Marchant & Higgins 1990).

In response to growing concerns on the potential impacts of regional aquaculture on NZKS, and to enable informed decision-making regarding resource consents, the Marine Farming Association (MFA) formed a King Shag Working Group, which included industry representatives, Ministry for Primary Industries (MPI), Ngāti Koata iwi, Marlborough District Council, and the Department of Conservation (DOC) (*marinefarming.co.nz/king-shag-project/*). Wildlife Management International (WMIL) and sibling company Toroa Consulting Ltd conducted a three-year project researching life history (sightings of marked chicks), and movement and foraging behaviour of NZKS at sea (Global Positioning System [GPS] tracking of adults) (Bell 2019, 2020, 2022).

Population dynamics and breeding biology were identified as research priorities for NZKS (Taylor 2000), yet few studies had been previously conducted due to the species' extreme sensitivity to disturbance. Knowledge of the breeding cycle is essential for predictive population modelling. A study on NZKS breeding was initiated by DOC in 2018, to run in parallel with the chick banding and adult tracking project, and was facilitated through advances in remote, field camera technology. The study also aimed to record disturbances and other events to further define threats at breeding sites, as well as banded bird observations. A detailed report on the results of image analysis was presented to the King Shag Working Group (Gummer 2021), and key findings are summarised in this paper.

METHODS

Images with data were successfully collected from ten static field/trail cameras across four different NZKS colonies—Duffers Reef, Kuru Pongi/North Trio (Trio Islands), Tawhitinui, and White Rocks—in Marlborough Sounds (refer to map and colony details in Schuckard *et al*., 2018), situated primarily on marine rock plateaus and steep rock faces. Duffers Reef, Kuru Pongi/North Trio (hereon referred to as Kuru Pongi), and White Rocks were chosen because they were the largest known breeding colonies—all have Wildlife Sanctuary status, but Kuru Pongi is privately owned. The main colony Duffers Reef, along with the only mainland colony Tawhitinui (part of Kenny Isle Scenic Reserve) were sites where the marking of birds could be achieved. Nesting areas at Kuru Pongi and Tawhitinui were more elevated at approximately 10–15 m above sea-level, while the White Rocks nesting site was estimated to be 5–10 m, and Duffers Reef the lowest lying at <5 m above sea-level.

Cameras were deployed at different periods from 10 Aug 2018 (DOC and WMIL/Toroa Consulting) with most image files collected by 26 Nov 2019 (Table 1). Files were stored on SD cards which had to be retrieved and replaced, influencing dates of deployment. With limited options for camera placement, personnel aimed for wide angles covering many nests at some locations, and close-up views of a smaller number of nests at others, while considering sun direction (sunstrike) and height above sea-level (storm surges). Use of multiple cameras at a single site aimed to cover different angles and views of each nesting area, although limited vantage points restricted coverage at some locations e.g., Duffers Reef. Cameras were mounted on metal posts hammered into the ground or glued into rock or tied to a tree (one site).

Mostly, cameras were set to take still images at set intervals throughout the day and turned off during the night to conserve battery power. However, image frequency varied between files (on the same camera) and/or cameras and in some cases was experimental. Different programming included: a) Daytime: half-hourly (most common) or quarter-hourly, from pre-dawn (dark) to mid-evening (dark); b) Nighttime: either no night shots; or shots taken less frequently through the night; or more night shots in winter; c) Some with multiple (eight) frames/every 30 mins; or d) Motion sensor settings (approx. 12 frames/min) which were unintentional and represented four days (Duffers Reef) and five days (Tawhitinui) of activity in Dec 2018 (17,472 of 104,477 usable images for these two colonies).

Trail camera properties considered important for this project were: durability in a hostile, marine environment; flexibility for mounting and positioning; image storing capacity and power output enabling longer periods between servicing, minimising colony disturbance; and internal software to suit project demands.

Methods were developed to manage viewing and analysing large numbers of images. Unusable images were eliminated as thumbnails and usable image viewing managed using a custom-made image library index. One or more master images was selected for each camera view for reference, usually when birds were incubating. Nests were assigned alphabetical labels in each master image, and nest label overlays applied to all relevant images in that file. Image data from every camera file were exported into data spreadsheets enabling

Table 1. Cameras deployed, and bird and nest numbers in still images at four New Zealand king shag colonies.

	Duffers Reef		**Kuru Pongi/ North Trio**	**Tawhitinui**		**White Rocks**	
Camera number and operating date range; date blocks in Gummer (2021)	3 cameras / 6 date blocks 13 Dec 2018–26 Nov 2019		2 cameras / 2 date blocks 04 Apr–26 Nov 2019	3 cameras / 6 date blocks 10 Aug 2018–26 Nov 2019		2 cameras / 4 date blocks 25 Aug 2018–31 Oct 2019	
Total images with data	1280		701	1191		821	
Breeding season	**2018**	**2019**	**2019**	**2018**	**2019**	**2018**	**2019**
Max head count (ads/ juvs)	50 (Dec)	See Dec 2018	n/a	-	56 (Mar)	-	80 (Jul)
2018 juvs as 1 y birds in early 2019	-	4 (Jan) to 1 (Apr)	5 (Apr) to 10 (mid-May)	-	5 up to Apr	-	Few, no obs after Mar
(Total colony nest count)[1]	*(78)*	*(89)*	*(48)*	*(23)*[2]	*(26)*	*(31)*	*(30)*
Labelled nests in images	-	15	10	20	15	28	28
Nests followed (through season)	-	15	9	20	12	27	27
Breeding attempts	-	-	8	Min.10	Min.10	-	26
Non-breeding pairs	-	-	1	-	1	-	1
Nests with unknown status	-	3	-	10[3]	1	-	-
Nest failures egg/nestling	-	-	1	-	1	-	10
Nest failures downy, mobile chick	-	3	-	-	2	-	3
(Chicks with bands)[1]	-	*(23)*	-	*(11)*	*(13)*	-	-
Nest failures at fledging	-	-	-	-	-	-	1-3
Chicks in Jul	-	12	11	-	-	-	15
Juvs in Aug	-	-	≥8	11	14 (banded)[4]	-	12
Juvs in Sep	-	18 (banded)	≥8	9	12 (banded)[4]	10	11
Juvs in Oct	-	17 (banded)	≥7	10	10 (banded)[4]	7	8-10
Juvs in Nov	-	14 (banded)	-	10	9 (banded)[4]	5	-
Juvs in Dec	5-6	-	-	9	-	3	3

[1] Bell (2022) – boat-based surveys; chick banding operations.

[2] Bell (2019) – boat-based surveys.

[3] Contents of Tawhitinui nests in 2018 could not be seen; nests of unknown status include those belonging to non-breeders, or pairs that failed early on.

[4] Includes 2018 banded juvenile.

observations to be entered directly next to the relevant image number and date/time taken. Images were coded for data content and sorted after data collection, to facilitate analyses.

Data and observations were documented for each camera view at each colony on: 1) breeding biology; 2) banded birds—chicks banded at Tawhitinui (2018 & 2019) and Duffers Reef (2019), and adults fitted with back-mounted GPS devices at Duffers Reef (Bell 2019, 2020), 3) bird behaviours—including reactions to disturbance; and, 4) threats—all events impacting on NZKS. Gender roles are described in Gummer (2024) after sexually dimorphic plumage variation was identified.

Details on nest-building, egg-laying, incubation, hatching, and chick development were captured well in the more close-up images at Kuru Pongi, Duffers Reef and Tawhitinui, with images from the latter two sites producing good sightings of readable leg bands. Nests at Kuru Pongi provided the most accurate observations of clutch and brood size because camera angle allowed the best viewing of nest contents. While chick ages were known here, viewing was difficult closer to fledging time and ceased soon after due to obstruction by growing vegetation in spring.

Tawhitinui and Duffers Reef offered good viewing of downy, mobile chicks to fledglings/juveniles, but exact ages were unknown because of a break in camera operation mid-winter at both sites and lack of continuity between views during the incubation and downy chick-rearing phase.

Wide-angle views at White Rocks were ideal to monitor movements, breeding effort and productivity of the whole colony as well as nest site occupation throughout the year. A wide view here, and from some Tawhitinui cameras, gave better viewing of disturbances to the colonies.

RESULTS

A total of 131,946 usable images recorded from ten cameras were viewed—104,477 of these at Duffers Reef and Tawhitinui—; data were collected from 3995 images (Table 1). Camera deployment date ranges are summarised in Table 1; within these periods, cameras were serviced and not operating continually. Unusable images were discarded for the following reasons: loss of view caused by camera drop in severe weather conditions—Duffers Reef (one camera); nests obscured by spring vegetation—Kuru Pongi (both), Tawhitinui (one); and camera malfunction—White Rocks (one).

Number of nests seen during the breeding season in any one camera view ranged from nine at Kuru Pongi (less than a fifth of all nests counted there from boat-based surveys; Bell *et al*., 2022) to 28 at White Rocks (all but two of the total nests recorded by Bell *et al*., 2022), with up to 80 NZKS, including juveniles and non-breeders, counted at White Rocks when birds moved into camera view from loafing areas normally beyond it (Table 1). Between seven and 17 chicks could be followed through to independence at different sites in 2018 and 2019.

Courtship and nest building

Images taken over summer 2018/2019 revealed NZKS nest sites are retained through the off-season but not strongly defended by the end of the year (2018), a time when the 2018 juveniles were also disappearing. Old nests from the 2018 season in the form of muddy mounds (accumulated guano and vegetation) were obvious at Duffers Reef and Tawhitinui in early 2019. At Duffers Reef, these started to wash away with the onset of autumn weather, leaving bare rock, whereas some of the 2018 nest mounds at the more sheltered Tawhitinui remained through to the 2019 breeding season and were added to with fresh material. At the more exposed White Rocks, stained rock indicated the presence of nests at most territories in the 2018 season, but there were no mounds at all.

Nest site occupation and nest building in the 2019 season can be outlined as follows and includes inter-colony variation. In the late spring/summer (Dec–Jan), a pair might leave their site unoccupied during the day, but roost loosely there or nearby at night. By late summer/early autumn (Jan–Mar), distinct sites were occupied by birds and some nest material was present, although the pattern of nest occupation was sporadic; and, at some territories, first-year birds would be regularly seen with pairs (presumed parents). Shifts commenced by Mar–Apr when the nest site was occupied by at least one bird in the day; and, only during disturbances were nests left completely unattended.

Once the early stages of nest-building were underway (Feb–Apr, commonly Mar), adults began to sit during the day, probably as a way of anchoring the collected nest material—land vegetation and/or seaweed depending on location—; nests then increased in size and were more likely to withstand the elements. Prior to this, birds rarely sat down on land. Night images showed all birds standing on or next to nests when roosting, before eggs were laid.

While the disappearance of all nests at exposed sites was known to coincide with bad weather, often material would disappear soon after adults had positioned it. Where wind was not suspected (interpreting bird postures), and where conditions were dry (no rain to wash material away), it was suspected nest material was stolen by other birds, a behaviour only captured on two images. Pairs were only occasionally seen in aggressive postures with neighbours during nest-building, e.g. when re-establishing territories after a bad weather event.

Pairs occupying central and/or elevated sites, buffered by other pairs/nests—seemed to be more successful in building larger, longer-lasting nests, were less often seen carrying nest material or arranging nests and were rarely seen in courtship display postures during this time. They sat much more than some of the peripheral pairs, their nests started from scratch less than a handful of times in two months of early-season nest-building activity.

Pairs at peripheral nest sites, including those close to cameras, were presumed to be less established, often the slowest to start nest-building (White Rocks, Tawhitinui) and taking longer to coordinate nest attendance. Consequently, their nests were more prone to disappearing, and they appeared less experienced, building numerous nests from scratch—up to 15 times in two months from mid-Mar. These pairings showed more courtship behaviour (Duffers Reef), some not previously described for the species in Marchant & Higgins (1990), such as 'biting' (head or nape), 'neck-crossing' (often after 'biting') and mutual 'sky-pointing' (refer Fig. 1 [bottom left photo] in Gummer (2024) for latter two displays).

Nests of breeding pairs thickened up just before egg laying and throughout incubation. Nest building happened at clusters of nests simultaneously—multiple nests were added to, with the same type of material, on a particular day—as well as on an individual basis, though few images showed birds carrying material or arranging nests. Copulation events, not captured often, were seen over one month to one day before their first eggs were laid.

Nest-building was a behaviour that could be seen for many months, from late Jan (Tawhitinui) right through to Oct (Duffers Reef), the latter being very late second breeding attempts.

Egg laying, incubation, and hatching

Egg-laying periods for first clutches spanned a minimum of five weeks (Kuru Pongi) to more than ten weeks (White Rocks), laying from mid-Mar in 2019 (Table 2). Earliest eggs were laid in nests higher up slopes (Tawhitinui, Duffers Reef), and some of the latest clutches were laid in peripheral nests near to cameras and at lower elevations.

Observing the standing and sitting behaviour of birds at night—2–3 h after dark and the same before dawn—proved to be the fastest method of establishing when a pair was laying (Fig. 1). Both adults in a pair stood at night right up until the night or night before first egg laying. Birds tended to sit at nests continuously from the time the first egg was laid with limited standing, if any, at night only. The pale blue eggs (appearing white in images) were rarely captured being laid in images but suspected from behaviour as laid between midnight and dawn, although some were laid during daylight hours too.

Clutch sizes in 56 nests where data could be collected on egg laying—White Rocks (26 nests), Kuru Pongi (16), Duffers Reef (10), Tawhitinui (4)—ranged from 1–3 eggs, with at least 40 (71%) confirmed to have 2–3 eggs. A single egg was laid and abandoned on bare rock at a peripheral site at one colony (then opportunistically preyed on by a red-billed gull *Chroicocephalus novaehollandiae*). Four or more eggs were never seen in any one nest.

Females laid each egg within a first clutch at roughly 3–4-day intervals: three clutches of three eggs each took six, seven and eight days to be laid, although a fourth took 13 days from the latest lay date of the first egg to the earliest lay date of the third (Fig. 1).

Hatching outcome could be observed at 34 nests at three colonies (2019). Accurate hatch dates could not be recorded at most nests because parents were rarely standing in images. In addition, dark grey nestlings were hard to see in dark nests in the shadow of parents (particularly White Rocks). Hatches were usually first detected by observations of clear brooding behaviour (adult sitting, loosely held wings), when chicks might already be >1 day old. On occasion, hatches were ascertained when eggshell appeared on the nest rim.

Accurate first egg hatch dates as well as first egg lay dates were only known for two nests (Duffers Reef, Kuru Pongi); the period spanning laying and hatching was 31 and 33 days, respectively.

Table 2: First clutch laying periods at four New Zealand king shag colonies in 2019.

Colony	Earliest possible first egg lay date	Latest possible final egg lay date	Maximum laying period (days inclusive)	Comments
Duffers Reef	21 Apr	5 Jun	46	Replacement clutches also observed.
Kuru Pongi	2 May	9 or 14 Jun	39 or 44	9 Jun one pair; 8-14 Jun another pair.
Tawhitinui	19 Mar	>31 May	>74	Second egg laid by estimated 4 Jun.
White Rocks	30 Mar	26 May	58	Replacement clutches also observed.

Figure 1. New Zealand king shag (*Leucocarbo carunculatus*) breeding at White Rocks (left) and Kuru Pongi/North Trio (right) in 2019. Clockwise from top left: incubating adults sitting at night and adults yet to lay standing on or next to nests, with group of juveniles roosting on left edge of nest area (12 Apr); three-egg clutch, with mostly males with dorsal 'saddles' attending other nests (Gummer, 2024) (8 May); chicks outside front nest unguarded and mobile for first time, and three chicks from two nests in creche (top right) in warm temperatures (26 Jul); downy chicks and feathered juveniles in supervised creches, adult incubating second clutch, black-backed gull scavenging king shag chick corpse (likely already perished in recent wet weather), and red-billed gulls foraging amongst nests (20 Jul). (Photographs taken by static field cameras).

First hatch and lay dates, both to within one day were known for a single nest only (Kuru Pongi), also with 31–33 days between events. Six other pairs showed a maximum period of 29–39 days between accurate first egg lay and latest possible first hatch dates. Date ranges larger than this were disregarded in any analysis. Therefore, the incubation period for NZKS eggs is likely to be 28–32 days, excluding day of hatch.

Of the 29 viewed pairs confirmed hatching eggs, three were known to produce single chicks, 12 pairs clearly produced two or more, and the remainder were likely to have produced more than one chick, but initial brood sizes could not be confirmed. Some three-chick broods were probably produced but were never seen in nests on images. The only evidence was seen later in the season (Tawhitinui): one nest with two large, well-developed, banded siblings and a third smaller sibling that eventually perished.

Replacement clutches

NZKS pairs laid replacement (second) clutches but only after failure at either egg or young nestling stage and no later, despite some pairs showing further courtship and/or nest-building behaviour after loss of older chicks. None of the second attempts by seven pairs (Duffers Reef, White Rocks) were successful in 2019.

First clutches at the lower lying Duffers Reef nesting area, vulnerable to weather disruptions, were very late due to continual wave washouts Mar–May 2019, and only two breeding attempts were still underway in late Jul, both failing at nestling stage. The timing between failure of one pair's first attempt (Aug) and re-lay (Sep) was 32 days; the continual and consistent presence of two birds at the site indicated the same pairing but neither were identified by markings. Both second clutches contained two eggs laid six days apart; one clutch soon disappeared, and the other was incubated to mid-Oct but was depredated during a disturbance.

Replacement clutches at four of five nests at White Rocks were all likely to have been laid late May–late Jun, not much later than the last breeding pairs laying first clutches at Kuru Pongi. Time between first clutch failure (May) and re-lay (Jun) was 28–33 days for one pair and was indicated by standing/sitting behaviour at night.

Table 3: Ages and date ranges of key events during growth and development of New Zealand king shag chicks in camera view in 2019, summarised from Gummer (2021). (Number of chicks with data in parentheses.)

Key events: First visible in nest = Chick sitting next to (not under) sitting adult in nest (i.e., not brooded); chicks can be seen before this only if adult is standing / First out of nest = first time chick seen sitting outside nest scrape/bowl / First time creche = chick joined by or joining another chick from another nest / Fully feathered = no traces of down left / First flight = absence of fully feathered juveniles from camera view then preening on return / Last seen at natal nest = disappearances occurring more than 2 days before end of viewing, allowing for temporary absence of night or two.

Colony	**Chick(s) first visible at nest**	**Chick(s) first seen unguarded**	**Chick(s) first out of nest**	**Chick(s) first time creche**	**Chick(s) near size of parent**	**Juv1 fully feathered**	**Juv2 fully feathered**	**Juv(s) estimated first flight**	**Juv(s) last seen at natal nest**
Chick ages (Kuru Pongi)	12–15 days (n=4)	20–29 days (n=4)	24–25 days (n=2)	26–39 days (n=4)	No data	65 days (n=1)	65 days (n=1)	No data (vegetation)	No data
Kuru Pongi dates	20 Jun–23 Jul (n=6)	10 Jul–6 Aug (n=7)	7 Jul–1 Aug (n=6)	20 Jul–16 Aug (n=5)	12–15 Jul (n=2)	29 Jul–8 Sep (n=5)	15 Aug–8 Sep (n=2)	No data (vegetation)	No data
Tawhitinui dates[1]	No data	18 Jul–8 Aug (n=6)	18 Jul (n=1)	19 Jul (n=2)	19–27 Jul (n=5)	7 Aug–20 Sep (n=6)	11 Aug–20 Sep (n=6)	20 Aug–3 Sep (n=3)	-
White Rocks dates	31 May–11 Jul (n=10)	16 Jun–23 Jul (n=14)	18 Jun–23 Jul (n=13)	21 Jun–24 Jul (n=12)	30 Jun–25 Jul (n=5)	15 Jul–23 Aug (n=7)	n/a	23 Jul–26 Aug (n=5)	6–28 Oct (n=4)
Duffers Reef dates[1]	No data	No data	2 Aug (n=1, youngest)	No data	No data	8 Aug–21 Sep (n=2, oldest, youngest)	No data	No data	6–22 Nov (n=9)

[1] Images only available from 18 Jul at Tawhitinui and 24 Jul at Duffers Reef.

Chick data

Dates for one or more key events during growth and development were recorded for chicks in 33 nests mainly at three colonies—White Rocks (17 nests); Tawhitinui (nine); Kuru Pongi (seven)—and are summarised in Table 3. Initial brood sizes could not be established because of limited opportunities to view nest contents around hatching and early nestling stage. Commonly just one or two chicks were followed per nest.

Juvenile alphanumeric plastic bands were read clearly in images and provided valuable data for about 18 chicks/juveniles at Tawhitinui in 2018 and 2019 (200 sightings), and 18 at Duffers Reef in 2019 (119 sightings) at and away from natal nests, although exact ages of these chicks were unknown — there were no images from either site during the early breeding season.

With so few accurate hatching dates, it was difficult to ascertain precise chick age at key development stages; most were estimated. Accurate hatch dates (within 1–2 days) were captured at some colonies, but data could not be collected from these known-aged chicks for reasons associated with camera operation or positioning. However, at Kuru Pongi, there were two nests with reliable hatch dates to within 1–3 days, and ages could be calculated at events up to feather completion in juveniles, mainly in one nest.

Nestlings and downy, mobile chicks

Brooded chicks' heads were visible from approx. one week of age. Chicks were around two weeks old before they were no longer brooded by day and adults stood next to the nest, brooding only at night.

Two known-age chicks (Kuru Pongi nest) were 20–21 days old when first left alone by parents (Fig. 1). Most other chicks were unguarded for the first time at roughly one month old. Chicks might only be left alone by parents up to 2 hrs at most to begin with but were unguarded for several hours at a time by mid-Jul 2019 (Kuru Pongi).

Occasionally, chicks left their nest bowl before being unguarded, i.e., could be seen sitting next to the nest with an adult, but this was uncommon. Robust data at White Rocks showed that chicks left the nest for the first time either on the same day or within four days after the day they were first left unattended, the same as one of the known-age two-chick broods at Kuru Pongi. Increased chick mobility—moving away from natal nest and beyond adjacent nest(s)—was apparent from around five weeks.

Creche behaviour was prevalent at White Rocks, especially when most adults vacated the colony (Fig. 1). All chicks showed this behaviour, either before they had left their nest (other chicks joining them in their natal nest) or within a week of leaving their nest (joining up with other groups of chicks). It was also commonly observed at Duffers Reef where single downy chicks were often with a neighbouring chick at night, rather than with parents. Adults seemed very tolerant of other pairs' chicks. Little obvious aggression between adjacent pairs at this time was captured on images, just occasional threat postures. Creche behaviour appeared less common at Tawhitinui.

The strong creche behaviour shown by NZKS young from an early age made it hard to keep track of individuals without bands. To add confusion, mobile chicks, leaving the vicinity of the natal and adjacent nests, appeared to roam sporadically by day, often not seen back at the natal nest until nightfall. Some chicks roosted away from natal nests at night—during viewing hours—but would be back at their nests with parents the next day. The odd chick would have a spell (days and nights) rarely seen back at the nest. It is not known if parents called chicks back to feed them, or if chicks were occasionally fed away from the nest by parents or other adults. All downy, mobile chicks would roost standing up at night by mid-Aug 2019 at Tawhitinui.

At all sites, chicks reached the size of their parents at around 5–6 weeks and were downy with feathers emerging. Most broods successfully reared to this stage were single chicks in 2019, and so any known second (and even third) nestlings that hatched had perished early on during brooding. However, at least two broods of two chicks were raised to juvenile stage at Kuru Pongi (2019), with others likely but obscured by vegetation. At least one brood of two chicks was closely followed at Tawhitinui (2019) after a third (smaller) sibling in the nest died. Two juveniles were usually seen together at one White Rocks nest in 2018, but there were no two-chick broods in 2019. It required many consistent observations to determine two-chick broods at sites where creche behaviour was prevalent, especially if the camera started mid-season.

Plumage development and fledging

At any one time in the breeding season, chick ages were spread across 5–6 weeks at each site (Table 3), e.g., youngest chicks immobile in the nest while others were nearly fully feathered. Very occasionally, within a brood, there may have been slightly staggered chick sizes or plumage development.

Chicks were fully feathered by around two months of age (oldest and youngest chicks) at White Rocks. Two known-age siblings showed no traces of down at 65 days (Kuru Pongi). Plumage development was only loosely followed at Duffers Reef as the focus was recording banded chicks.

Juveniles were distinguishable from first-year birds by their immaculate plumage.

Fledging was best observed at Tawhitinui and White Rocks where there were wider fields of view, although fledglings were never really seen taking off, in flight, or landing in images. Fledging occurred in winter and spring, e.g., late Jul (earliest at White Rocks 2019), early Oct (latest at Tawhitinui 2018).

The first (oldest) birds were suspected to have fledged based on observations of their nests, around the time they had shed all down. The youngest chick at White Rocks (2019) fledged three days after the last traces of down were gone. A typical first sign was the absence of a chick for short periods, e.g., an hour mid-morning to noon, and preening activity (sometimes over an hour) immediately on return, after likely contact with water.

Fledging behaviour of two of the younger siblings at a nest closer to a camera (Tawhitinui) showed parents away much of the day in late Aug, leaving their fully feathered chicks at the nest site alone, potentially attempting to force the young to fledge. Two days later, both chicks left the nest for around an hour in the middle of the day, most likely flying by this stage. In early Sep, often the entire nest area was deserted in the middle of the day for an hour or so, suggesting that all adults and juveniles were out at sea, and that all young had fledged. In 2018, most Tawhitinui young were considered to have fledged by the end of Sep, later than in 2019, with the youngest two fledging in Oct after being left alone at the site.

When both fledglings and downy chicks were present at White Rocks, movements to/from sea were typically noted in the following order in late Jul 2019: females departed (early morning) followed by males and all fledglings (mid-late morning); young chicks were in a creche with few or no attending adults (middle of day); adults and juveniles trickled in (afternoon/early evening); young chicks left creches and returned to natal nests (early evening). Adults and juvenile sometimes returned at the same time (early afternoon), indicating they had perhaps been to sea together, although this could never be confirmed. In total, 11 juveniles fledged from 11 nests before Sep at White Rocks in 2019.

Juvenile movement and disappearance

Adults began to abandon their young in Aug (White Rocks) and Sep (Kuru Pongi) in 2019, likely forcing independence. Sometimes creches of juveniles were left roosting alone at White Rocks at night (good or bad weather); parents were back at the site by morning, but not always. By Oct, adults were occasionally seen back at the Kuru Pongi nest site but not interacting with juveniles.

On land, juveniles started to wander much farther away from natal nests after fledging. Most of the sightings of banded 2019 juveniles at Duffers Reef were made from Sep onwards; they were only passing through camera views briefly and did not socialise with any birds from monitored nests.

Groups of adults and juveniles appeared to move to and from sea independently by early Sep (White Rocks 2018), late Sep/early Oct (Tawhitinui 2019), and Oct (Duffers Reef, White Rocks 2019), with juveniles typically departing in the morning, often earlier than adults, and arriving back late morning to early afternoon (immediately preening) before the adults began to return. Two pairs, each with one offspring, were followed closely to confirm this. In one family, the juvenile departed 2–3 hrs after the first parent, just before the second and was back at the colony more in sync with the second adult; while in the other family, an older juvenile departed before both parents and returned in between parents by mid-afternoon.

At White Rocks, a few adults were commonly present with juveniles at the site in the middle of the day, when most other adults were away (Fig. 1). The most common time for a colony to be empty during Sep and Oct was around late morning and/or early afternoon. However, nesting areas at Tawhitinui and Duffers Reef were rarely completely deserted; if they were, a complete exodus was often around late morning and/or early afternoon and may have been due to disturbance (e.g., boats).

Occasionally, adults and juveniles appeared to be separated at night. For example, when all birds vacated the White Rocks nesting site during a night of bad weather in Sep 2018, around nine juveniles, unaccompanied by adults, were the first birds to arrive back at the site the following late morning. After a similar event in Nov, adults were back at the site by dawn without young.

The timing of observed declines in juvenile numbers at each colony is summarised in Table 1. Presumed independence did not occur before 2.5 months after fledging at White Rocks (two juveniles 2019); occasional feathered young disappearing earlier than this did not fit the common pattern and were thought to have perished. More commonly, juvenile sightings decreased as they reached 4.5–5 months of age, through Oct–Dec in 2018. Juvenile land movements away from natal nest sites peaked in Nov 2019 when many previously unseen banded juveniles entered one Duffers Reef camera view for the first time. Most juveniles still visited natal sites, mainly only at night and sometimes sporadically, until they permanently disappeared.

It was impossible to determine actual fate—dispersed or perished—of any juveniles that were no longer seen with parents or at natal nest sites, in this study. Dates of last sightings of 2019 juveniles at their natal nests are summarised in Table 3 but data are limited due to obscuring vegetation and camera retrieval in late Nov. Young from nests in camera view present just before cameras were removed in 2019 were as follows: one at Duffers Reef (24 Nov), seven at Tawhitinui (24–26 Nov), and six at White Rocks (29–31 Oct).

For remaining juveniles, begging behaviour, and parent-juvenile feeding events were so rarely caught on any of the cameras taking one image per half-hour at any of the colony sites, e.g., only two images from one Tawhitinui camera showed young begging, and no images showed any juveniles being fed by parents. Begging behaviour by fully feathered juveniles at White Rocks was only noticed in a handful of images, and actual feeding of juveniles by adults was only seen twice.

Contrastingly, on cameras set to motion sensor in Dec 2018 (multiple frames per minute) there were numerous events captured of different juveniles at Tawhitinui and Duffers Reef harassing adults, and getting fed. Some interactions looked almost aggressive, with the juvenile ambushing the adult as soon as it landed, and the adult fleeing afterwards, sometimes pursued by the juvenile. Each interaction ranged from 2–5 mins (juvenile fed), or 1–8 mins (no feed). Ten harassments were counted on one day, half of these resulting in parental feeds. Some of the less aggressive interactions lasted for over an hour (following presumed parent and begging). Actual feeding events (juveniles head inside parent's bill) lasted up to 30 seconds.

A proportion of 2018 juveniles (at least 16 at three sites) remained at their natal colony into 2019. They were often observed allopreening, presumably with parents, but also with other immature birds suspected as being either siblings or other same-age birds they 'creched' with as chicks/juveniles. Most of the six banded juveniles at Tawhitinui left natal nests to loaf and roost at the edge of the nesting area by Apr 2019. Four of five juveniles at Duffers Reef dispersed from natal sites Jan–Apr. Five juveniles at Kuru Pongi were seen loafing at the edge of the nesting area to May when they were joined nightly by more first-year birds—most likely from other nests outside camera view. (White Rocks had no camera operating Jan to mid-Mar 2019.)

First-year birds

First-year birds (2018 juveniles) were distinguishable from the immaculate 2019 juveniles by their scruffier feathers, and more defined white alar (wing) markings. At Duffers Reef, juveniles seemed to have greyish feet Aug–Oct, while first-year birds had pinkish feet. After this, some first-year birds started to look more like adults in certain light, with dark chocolate-coloured feathers instead of black (one with dull blue eyes).

At least two first-year birds (one each at Tawhitinui and Duffers Reef) were known to stay at natal nest sites to late Nov 2019, when cameras stopped operating. The bird staying with parents at Tawhitinui was not the last chick to be reared at this site in 2018. From mid-Jul 2019, the pair was assumed to be non-breeding based on behaviour and the presence of their 2018 offspring; however, Bell (2019) recorded them as failed breeders in Jun. The feeding of this bird by parents was never captured on images. The immature bird would commonly loaf alone at the nest by day. The first-year bird seen regularly at Duffers Reef at an unlabelled nest site was sometimes with an apparently non-breeding adult, their last interaction noted in Aug 2019. First-year birds were not seen associating with any of the current season breeding pairs or young at any of the colonies.

Breeding failures

At 34 monitored nests with eggs—White Rocks (26 nests), Kuru Pongi (seven), Duffers Reef (one)—in 2019, around one-third (first clutches, all at White Rocks) were thought to have failed before, during or very shortly after hatch. Two nests failed at egg stage, four nests at early nestling stage (dead chicks visible in two nests, a chick missing in another, and clear brooding behaviour ceasing at the fourth nest), and five nests failed at unknown stage as adults were rarely seen standing. It was impossible to deduce causes of failure at most nests, but staggered hatching was suspected as being a contributing factor to the loss of young nestlings. Two early losses coincided with bad weather. Four pairs here went on to lay replacement clutches.

The death of one of the two youngest nestlings at Tawhitinui was likely associated with researcher disturbance (capture of chicks for banding, Jul 2019). The other perished soon after this event but was the smallest chick in a three-chick brood. A young nestling corpse was seen at Duffers Reef on in Jul 2019 when the camera was reset following a similar chick banding event but may have been already deceased when the team arrived on the island.

Failures at downy, mobile chick stage were far fewer than those at early nestling stage and while some were to unknown causes (one each at Duffers Reef and White Rocks), others were mainly attributed to bad weather (one each at Duffers Reef and White Rocks) and/or chicks going missing—i.e., wandering away from nests and potentially suffering misadventure or predation—particularly following researcher disturbance. The event of accessing the colony to capture and band chicks was likely to have caused the premature displacement and loss of three mobile chicks at Tawhitinui and one at Duffers Reef; the youngest was unlikely to have been unguarded or to have ventured away from the nest prior to this disturbance. A black-backed gull was seen scavenging one chick corpse at White Rocks, and so predation was a possibility although never seen.

Potential failures at juvenile post-fledging stage could only be investigated at White Rocks (2019) by observing roosting behaviour of known-aged (unbanded) fledglings with parents at natal nests and comparing with other pairs rearing young of the same age. Just one fledgling disappeared mid-Sep, 3 weeks before any other young and was thought to have perished.

All failed breeding pairs at all colonies were still regularly occupying their nesting sites right through to the end of the breeding season (e.g., 31 Oct at White Rocks). There was evidence that at least one White Rocks pair had divorced following breeding failure. One failed breeding pair was seen in courtship postures in late Aug, where breeding pairs rearing chicks Jul–Nov were never spotted in such postures. A failed breeding pair was the first to be suspected of commencing moult in early Oct 2019 (Duffers Reef)—white feathers in the nest bowl.

Non-breeding birds

'Floating' non-breeding adults and first-year birds were the hardest demographic to count in the breeding season because they were usually only seen sporadically on the edges of or beyond the main nesting area at all sites.

There was usually at least one nest site in most camera views (all colonies) where there was limited or no nest-building at the start of the breeding season but where through the rest of season one or two adults sporadically visited, sometimes nest-building (nest not always present) but not breeding. Pairs with failed early breeding attempts could be interpreted as non-breeders if there were no images of the early breeding season.

At one peripheral White Rocks nest, an unpaired bird roosting alone in Mar acquired a mate in late Apr (two birds roosting together), and nest-building commenced in May. The site was not always occupied, and a nest not always present. This newly established pairing continued to occupy the nest site right through to end of Oct (end of camera operation).

Potential threats to New Zealand king shag breeding

Major disturbances at colonies usually caused all birds to leave the site. There were a few occasions (e.g., Tawhitinui) where it was hard to distinguish between a potential morning disturbance or mass exodus of birds to sea to feed. It was also unclear during some disturbances whether birds had fled the colony or if they had just moved out of camera view until it was safe to return.

Bad weather events were not seen to affect nesting behaviour at Tawhitinui (two seasons), and none was reported for Kuru Pongi (2019) during the time of camera operation. In contrast, many bad weather events were recorded at White Rocks and Duffers Reef, with impacts on breeding. In the off-season, sites might be vacated by all birds during extreme weather. At the start of the breeding season, heavy winds and rain overnight often resulted in many birds leaving their nests if there were no eggs/chicks present, to roost relatively tightly together, sometimes close to the camera where perhaps it was more sheltered. Birds resiliently started rebuilding immediately after a nest was lost. During the incubation and rearing phase, it was more likely that one adult remained at the nest while the partner roosted elsewhere out of camera view. Juveniles would form creches and shelter together through a rough night, even if parents failed to return until the following day.

Bad weather had a significant negative impact on the NZKS breeding cycle at the low-lying nesting area on Duffers Reef where nesting attempts were thwarted (nests/eggs/chicks lost) and delayed by multiple wave washout events, pushing repeat nesting attempts late into the season. Sometimes even adults would vacate the site for a night/day. Contrastingly, at the apparently more sheltered, elevated nesting area on Duffers Reef, birds did not move away from nests in response to any bad weather, nest material never seemed to be blown away, and birds were rarely forced to roost away from the site.

Camera setting/servicing/removal and the capture of chicks for marking were clearly the most disturbing events. Cameras were serviced by day at times when the most NZKS were out feeding, minimising disturbance. Adults returned to the nesting area 3 hrs after research personnel departed Tawhitinui in Dec 2018 (off-season), and 2 hrs at White Rocks in Mar 2019 (pre-breeding). On the chick banding day (Jul 2019), adults took 15–30 mins to return to their nests after personnel left Tawhitinui, but chicks took 1–3.5 hrs to return; it was then 24 and 48 hrs before two more chicks were reunited with parents, and three chicks remained missing. Single adults and mobile chicks at Duffers Reef had returned to most nests within approx. 1 hr of people leaving after banding chicks.

Presence of cameras may have affected NZKS behaviour to a small degree at night only but did not directly disrupt any breeding. Birds nesting nearest to cameras at all sites were deduced to be less established pairs on the edge of the main nesting area, behaving like other peripheral pairs.

Boats were seen near or approaching three sites on several occasions with no major impact. If birds were displaced from the site, they were usually back

Table 4. Comparison of clutch size and incubation period in *Leucocarbo* shags in the New Zealand region.

Species	Clutch size (eggs)	Incubation (days)	Reference
Auckland Island shag *L. colensoi*	3	28–32	Marchant & Higgins, 1990
Bounty Island shag *L. ranfurlyi*	2–3	No data	Marchant & Higgins, 1990
Campbell Island shag *L. campbelli*	2	No data	Heather & Robertson, 2005
Chatham Island shag *L. onslowi*	2–4	c.30	Heather & Robertson, 2005; Bell, 2022
King shag *L. carunculatus*	2–3	28–32	This study
Macquarie Island shag *L. purpurascens*	1–3	No data	Marchant & Higgins, 1990
Foveaux shag *L. stewarti*	1–3	No data	McKinlay & Rawlence, 2022a
Otago shag *L. chalconotus*	1–3	No data	McKinlay & Rawlence, 2022b

in the next image or two. The longest times birds were kept away from the site by an approaching boat was 1–2 hours in Mar 2019 before egg-lay (White Rocks), and up to an hour in Oct 2019 (Duffers Reef). There were no such apparent events during incubation or young nestling stage and so there were no consequences on breeding efforts. Boat sightings at Tawhitinui were more common, but most were passing and there was no discernible impact on the shags, particularly during the off-season when many birds were normally absent from the colony in the middle part of the day.

Only two fur seals (*Arctocephalus forsteri*) entering colony nesting areas were captured on camera (White Rocks and the low-lying area on Duffers Reef) with a third incident suspected, outside the NZKS breeding season. One seal displaced the shags from their territories for up to 4 hrs. A sheep (*Ovis aries*) caused all shags to leave Tawhitinui one Sep day for at least an hour. Here, a common brush-tailed possum (*Trichosurus vulpecula*) was captured on camera on four nights Mar–Aug 2019 but not entering the nesting area (cameras were not operating all night). Predators such as rats and mustelids were not noted in any images at this mainland site.

There was no single incident where the death of a chick could be directly attributed to predation by southern black-backed gulls (*Larus dominicanus*) or red-billed gulls. Black-backed gulls were only seen at White Rocks scavenging one chick (2019). Only two images featured this species in Jul–Nov 2019 at Duffers Reef. Any eggs known or suspected as being consumed by either gull species were opportunistic when eggs were left exposed in nests due to another disturbance or were already lying on bare rock outside nests.

Western weka (*Gallirallus australis australis*) was not identified as a threat to king shag productivity on Tawhitinui in this analysis, despite appearing in the nesting area on six nights Mar–Apr 2019.

DISCUSSION

For the first time, details on nest occupancy, breeding, and survival of young have been captured for a sample of the NZKS population, by analysing data collected from still images. Field camera technology is now commonly used for the remote monitoring of threatened seabirds in New Zealand (e.g., Bell *et al.*, 2013; Fischer *et al.*, 2017; Black 2018) and facilitated sampling from four different colonies in this study in 2018 and 2019.

NZKS nesting territories were retained year-round but were not strongly defended by Dec. Bell (2022) confirmed high mate fidelity; this, along with defence of nest sites throughout the year seen in this study, enabled birds to retain prime nesting locations across seasons. This study shows prime sites to be the most elevated, and central to each colony with larger, more stable nests and more established pairings. Nest-building commonly began in Mar as seen by Schuckard (1994) and extended over many months, particularly at exposed, low-lying nesting areas vulnerable to wave surges. Peripheral and low-lying nest sites at all locations were sporadically occupied by less experienced pairings, with uncoordinated nest attendance, later and more frequent nest-building, and more courtship postures, some described for the first time—'sky-pointing', 'biting', and 'neck-crossing' (or entwining)—the latter occurring in other cormorants/shags for pair-bond maintenance (Marchant & Higgins 1990). Limited images suggested NZKS steal nest material from others, a behaviour also reported for Foveaux (*Leucocarbo stewarti*) and Otago shags (*L. chalconotus*) (McKinlay & Rawlence 2022a, b).

There was both inter- and intra-colony asynchronous egg laying with first eggs laid across all colonies between mid-Mar and early Jun 2019, and over periods ranging 5–10+ weeks at a single colony. A 5- to 6-week laying period is reported for similar species (e.g., Bernstein and Maxson 1984).

With occasional replacement clutches laid around one month following failure at either egg or young nestling stage, incubation of second clutches was still underway in mid-Oct 2019 (Duffers Reef) extending the NZKS egg period to seven months. McKinlay & Rawlence (2022a, b) report a laying period May–Sep in Foveaux and Otago shags. Asynchronous laying occurred in European shags (*Phalacrocorax aristotelis*) because older birds at better nesting sites laid five weeks earlier than younger birds at poor sites (Potts *et al*., 1980). While ages were unknown, NZKS reflected this with apparently more experienced central pairs laying earlier than less-stable pairings at peripheral sites. Sapoznikow & Quintana (2009) suggest the extended and asynchronous egg laying period (3–4 months) and high re-nesting rate in rock shags (*Leucocarbo magellanicus*) indicates a stable and predictable food source. An asynchronous laying strategy in NZKS colonies is likely to be linked to food supply but has yet to be investigated for this species.

Clutches of 2–3 eggs were commonly laid. Three-egg clutches were observed to take 6–13 days to complete for different females, similar to egg-laying intervals of 48–96 h recorded for Auckland Island shag (*Leucocarbo colensoi*) (Marchant & Higgins 1990). Incubation was 28–32 days, excluding hatch date, commencing after the first egg was laid. Data are compared with other New Zealand *Leucocarbo* shags in Table 4. Clutch size and lay-to-hatch intervals were very similar for the Antarctic shag (*L. bransfieldensis*), where staggered hatches accounted for the loss of many nestlings (Shaw 1984). Hatching asynchrony is commonly seen in Pelecaniformes (Nelson 2005). The facultative brood reduction strategy promotes early death (within the first week) of the smallest Phalacrocoracidae chick(s) in a nest due to starvation through unequal distribution of food by parents, probably representing an adaption to variability in food availability, individual foraging proficiency, and hatching failure (Drummond 1987) and is likely to explain the high rate of nestling loss in NZKS nests. All second clutches were unsuccessful. Replacement clutches are known to be laid in other similar species, e.g., Macquarie Island shag (*L. purpurascens*), Marchant & Higgins (1990); rock shag, Sapoznikow & Quintana 2009.

A brooding period of around two weeks fits with similar species, e.g., South Georgia shag (*L. georgianus*) 12–15 days (Bouglouan, n.d.).

Chicks were unguarded from 3–4 weeks, left the nest soon after (usually within four days), and showed strong creche behaviour from then onwards, with nestlings grouping in, or later between nests, and then anywhere in the nesting area including on the periphery. Creche behaviour in downy chicks was suspected to be for warmth, particularly at exposed sites, as noted for other cormorants (Carter & Hobson 1988), as there was no observed pressure from predators or perceived adult (conspecific) aggression at any of the colonies—other hypotheses for creche formation in shags (Velando 2001). However, it was also strongly suspected to be for socialisation—temperatures recorded on images were sometimes not cold enough to warrant such thermoregulatory behaviour, e.g., during daytime (Fig. 1). Shag creches are thought to facilitate the development of social skills (Velando 2001) and the learning of fledging behaviours in groups (Carter & Hobson 1988).

Chicks were adult size by six weeks and fully feathered at nine weeks, fledging shortly after this in groups from late Jul (2019) to mid-Oct (2018) across all colonies. Fledging period (around 65 days) is 1–2 weeks longer than for the pied shag (*Phalacrocorax varius*) (Marchant & Higgins 1990), but the same as similar species (Shaw 1984; Bouglouan, n.d.). Once flying, young birds generally departed the nesting area daily in loose groups with other juveniles, although there was some indication that fledglings may have departed with males in the morning and possibly even returned with some adults. With the spacing of images over time, it was hard to ascertain if young took off or landed at the same time as adults. Otherwise, juveniles were seen returning together by early afternoon before adults; Bernstein & Maxson (1985) also reported recently fledged blue-eyed shags returned to their nests in all-juvenile groups approximately one hour before adults and were then fed by parents in the afternoon. Juvenile NZKS also moved independently from adults during bad weather events.

Productivity could only be calculated for White Rocks (2019) up to fledging in this study: 37% of nests produced single fledglings (not yet independents) from 30 nests—26 pairs in camera view and an additional four pairs from boat-based counts (Bell 2022). Marchant & Higgins (1990) state that Auckland Island shags usually raise two chicks, and while this may have occurred at the other NZKS colonies, this species commonly reared just one fledgling at White Rocks. Loss of downy, mobile chicks was mainly attributed to bad weather; no chick disappearances resulted from human disturbance—banding was not undertaken at White Rocks.

Young ventured farther from natal nests on land by Nov (banded chicks at Duffers Reef) and sightings then gradually decreased, reflected by a gradual rate of juvenile mortality (up to 25% of young perishing) seen up to Dec by Bell (2022). Many young disappeared at 4.5–5 months, their actual fate—dispersed or perished—unknown in this study. Bell (2022) found an average period of 4.9 months of parental care before young disappeared from boat-based observations, and that juvenile mortality was highest in Jan–Feb when young were 5–7 months old—presumably when young birds were learning to forage— stabilising by Mar. NZKS appear to have a period of at least three months of post-fledging parental care, 1–2 weeks longer than for pied shags (Marchant & Higgins 1990). Burger (1980) attributed prolonged aftercare in shags to be necessary in order to develop specific skills for the difficult activity of catching fish. The vigorous, persistent begging observed in NZKS juveniles is known in other cormorants, peaking during the transition to independence (Drummond 1987).

A proportion of 2018 juveniles resided at each colony site until they permanently left natal nests by Apr–May 2019, and were either never seen again, or observed loafing with other young birds at the edge of the nesting area, also observed by Bell (2022). As first-year birds, two offspring at different colonies stayed with parents through the 2019 breeding season, with one directly observed by Bell (2019) being fed by parents every month Jan–Jun 2019. These birds were still associating with parents after attaining full adult plumage by 18 months, and Bell (2022) established that 28.3 months was the longest period of parental association.

The more productive nesting areas in 2019 appeared to be the sheltered Tawhitinui colony (inner-Sounds), and elevated Kuru Pongi where most of the two-chick broods were successfully reared (to near fledging stage when viewing ceased) and where there were relatively fewer disturbances noted. Bell (2022) also found adverse weather was the key influence on NZKS productivity and reported the best output at these two sites in 2019—0.83 and 0.85 fledglings/pair for Kuru Pongi and Tawhitinui respectively. Chick losses caused by disruption during chick banding events (Duffers Reef, Tawhitinui) was almost unavoidable given the staggered breeding season and range of chick ages on the colony but was considered an acceptable risk for the significant gain in knowledge from having marked known-aged birds in the population. This was the first ever banding of nestlings attempted for this species.

White Rocks generally received less overall disturbance than other sites—alert birds were rarely seen over two seasons—but appeared more exposed to the elements (outer-Sounds) which may be why creche behaviour was prevalent here and pairs reared only single chicks in 2019.

The most vulnerable nesting area, subject to most disruption—rough seas, seal intrusion, and unexplained disturbances causing temporary exodus from camera view or alerted/alarmed postures—was the low-lying area at Duffers Reef. With no breeding output at nests in this camera view, and some disruption caused by the chick banding operation, breeding output (0.51 fledglings/pair, Bell 2022) would have been attributed to pairs in the slightly more elevated nesting area at this colony in 2019. Nest site quality proved critical to breeding success, as seen in other shags (Potts *et al*., 1980).

Estimating productivity in NZKS colonies proved to be difficult from fixed cameras, with views obscured by vegetation growth or cameras failing at critical times, and because of chick mobility. Shaw (1984) found that mean clutch size varied little from year to year in the Antarctic shag whereas annual chick survivorship fluctuated substantially, and this may also be the case for NZKS, being characteristic of the facultative brood reduction strategy, where third, and sometimes second chicks serve an insurance function as well as providing an additional chick when feeding circumstances are favourable.

Causes of disturbance could not always be ascertained at colonies with close-up camera views (Duffers Reef, Tawhitinui) but were likely to be passing boats (fishing or recreational). Bell (2022) found tracked (GPS) individuals were disturbed (birds left land, flying or swimming, but not to forage) on average 0.6 times/day, for 4–44 mins with most (84%) less than 20 mins, at four colonies including Duffers Reef, Kuru Pongi and Tawhitinui over several seasons. Boat disturbance remains a high risk to breeding NZKS from Mar (first clutches) to at least Aug (most replacement clutches).

Large mammals (seals, sheep) did not access NZKS nesting areas during the vulnerable early breeding season during this study, but images capturing these events provided an insight into the negative impact of such appearances at three colony locations. Fur seals are increasing in numbers (main colonies) and range in New Zealand (Ministry for Primary Industries 2017), and so increased disturbance by this species is likely. NZKS sit tightly through the night during egg and small nestling stage, so possums or weka at mainland sites are unlikely to have an opportunity to take eggs and young. Black-backed gulls were seen more as scavengers in this study. Red-billed gulls were opportunistic predators of eggs laid or displaced outside established nests—they were regularly present foraging in and around nests and could even play a beneficial role in removing parasites from nests (Fig. 1). Either species was suspected to have taken eggs in at least one exposed nest. The degree of impact of gulls on NZKS will be influenced by colony disturbance and potentially by proximity and size of nearest gull roosts/colonies.

This study corroborates the assumption that NZKS sitting in horizontal positions on nests during winter aerial surveys are highly likely to be breeding (incubating or brooding) or intending to breed (first or replacement clutch), confirming that these birds can be included as breeders in the annual census. The study also suggests that empty nests attended by birds in premium nesting locations at a colony nesting area (e.g., elevated, central) are also likely to be of breeding status—pairs about to lay, already failed, or rearing mobile chicks that are temporarily absent from the natal nest—solving a query regarding empty nest status by Schuckard *et al*. (2018).

ACKNOWLEDGEMENTS

This study was funded by the Marine Species Team, Biodiversity Group, Department of Conservation. Karen Middlemiss assisted with logistical support. The King Shag Working Group, coordinated by the Marine Farming Association, supported the project concept and some members assisted with the field work. Staff from Wildlife Management International Ltd helped with marking birds. DOC Picton Office staff provided boat transport when placing and recovering cameras. We acknowledge the support of Ngāti Koata for this project (especially the owners of Kuru Pongi).

LITERATURE CITED

Bell, M. 2013 [updated 2022]. Chatham Island shag | papua. In Miskelly, C.M. (*ed.*) *New Zealand Birds Online*. https://www.nzbirdsonline.org.nz/species/chatham-island-shag

Bell, M. 2019. King shag research project: Year One update report. Unpubl. Wildlife Management International Technical Report to the Marine Farming Association and Seafood Innovations Limited.

Bell, M. 2020. New Zealand King Shag research project: Year Two update report. Unpubl. Toroa Consulting Technical Report to the Marine Farming Association and Seafood Innovations Limited.

Bell, M. (*ed.*). 2022. Kawau pāteketeke/King Shag (*Leucocarbo carunculatus*) Research 2018-2022. Final report on the Marine Farming Association and Seafood Innovations Limited King Shag research project. Unpubl. Toroa Consulting Technical Report to the Marine Farming Association and Seafood Innovations Limited.

Bell, M.; Tuanui, L.; Gummer, H. 2013. Use of trail cameras to monitor Chatham petrels (*Pterodroma axillaris*) returning to Chatham Island following translocation. *Notornis 60*: 115–116.

Bernstein, N.P.; Maxson, S.J. 1984. Sexually distinct daily activity patterns of blue-eyed shags in Antarctica. *The Condor 86*: 151–156.

Bernstein, N.P.; Maxson, S.J. 1985. Reproductive energetics of blue-eyed shags in Antarctica. *The Wilson Bulletin 97(4)*: 450–462.

Black, C.E. 2018. Spying on seabirds: a review of time-lapse photography capabilities and limitations. *Seabird 31*: 1–4.

Bouglouan, N. (n.d.) South Georgia Shag *Leucocarbo georgianus*. Retrieved March 2024 from https://www.oiseaux-birds.com/card-south-georgia-shag.html

Burger, J. 1980. The transition to independence and post-fledging parental care in seabirds. *In*: Burger, J.; Olla, B.L.; Winn, H.E. (eds.) *Behaviour of marine animals, Vol 4. Marine birds*. Plenum Press, New York. 367–447.

Carter, H.R.; Hobson, K.A. 1988. Creching behavior of Brandt's cormorant chicks. *Condor 90*: 395–400.

Drummond, H. 1987. A review of parent-offspring conflict and brood reduction in the Pelecaniformes. *Colonial Waterbirds 10(1)*: 1–15.

Fischer, J.H.; Debski, I.; Taylor, G.A.; Wittmer, H.U. 2017. Assessing the suitability of non-invasive methods to monitor interspecific interactions and breeding biology of the South Georgian diving petrel (*Pelecanoides georgicus*). *Notornis 64*: 13–20.

Gummer, H. 2021. Breeding biology of king shags from analysis of field camera images. Unpubl. report for Marine Species Team, Biodiversity Group, Department of Conservation, Wellington. 54p. https://www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/marine-conservation-services/reports/202122-annual-plan/king-shag-breeding-biology-report-gummer-2022.pdf

Gummer, H. 2024. Sexual dimorphism in plumage, and gender roles in breeding kawau pāteketeke/New Zealand king shags (*Leucocarbo carunculatus*). *Notornis 71*: 115–120.

Heather, B.D.; Robertson, H.A. 2005. *The field guide to the birds of New Zealand*. Penguin Books, Auckland.

Marchant, S.; Higgins, P.J. (*eds*). 1990. *Handbook of Australian, New Zealand birds and Antarctic birds*. Vol. 1. Ratites to ducks, Part B. Melbourne, Oxford University Press.

McKinlay, B.; Rawlence, N.J. 2022a. Foveaux shag | mapo. *In* Miskelly, C.M. (ed.) *New Zealand Birds Online*. https://www.nzbirdsonline.org.nz/species/foveaux-shag

McKinlay, B.; Rawlence, N.J. 2022b. Otago shag | matapo. *In* Miskelly, C.M. (ed.) *New Zealand Birds Online*. https://www.nzbirdsonline.org.nz/species/stewart-island-shag

Michaux, B. 2013 [updated 2022]. Macquarie Island shag. *In* Miskelly, C.M. (ed.) *New Zealand Birds Online*. https://www.nzbirdsonline.org.nz/species/macquarie-island-shag

Ministry for Primary Industries (MPI) 2017. New Zealand fur seals. In: *Aquatic Environment and Biodiversity Annual Review 2017*. Compiled by the Fisheries Science Team, Ministry for Primary Industries, Wellington, New Zealand. p 104–126.

Nelson, A. 1971. King shags in the Marlborough Sounds. *Notornis 18*: 30–37.

Nelson, J. B. 2005. *Pelicans, cormorants, and their relatives. The Pelecaniformes*. Oxford University Press, Oxford, UK.

Potts, G.R.; Coulson, J.C.; Deans, I.R. 1980. Population dynamics and breeding success of the shag, *Phalacrocorax aristotelis*, on the Farne Islands, Northumberland. *The Journal of Animal Ecology 1*: 465–484.

Rawlence, N.J.; Till, C.E.; Easton, L.J.; Spencer, H.G.; Schuckard, R.; Melville, D.S.; Scofield, R.P.; Tennyson, A.J.D.; Rayner, M.J.; Waters, J.M.; Kennedy, M. 2017. Speciation, range contraction and extinction in the endemic New Zealand king shag complex. *Molecular Phylogenetics and Evolution 115*: 197–209.

Robertson, H.A.; Baird, K.A.; Elliott, G.P.; Hitchmough, R.A.; McArthur, N.J.; Makan, T.; Miskelly, C.M.; O'Donnell, C.J.; Sagar, P.M.; Scofield, R.P.; Taylor, G.A.; Michel, P. 2021. Conservation status of birds in Aotearoa New Zealand 2021. *New Zealand Threat Classification Series 36*. Department of Conservation, Wellington. 43 p.

Sapoznikow, A.; Quintana, F. 2009. Asynchronous laying and renesting in the rock shag (*Phalacrocorax magellanicus*): an evidence of the characteristics of their food sources? *El Hornero 24(01)*: 21–30.

Schuckard, R. 2013 [updated 2022]. New Zealand king shag. In Miskelly, C.M. (ed.) *New Zealand Birds Online*. https://www.nzbirdsonline.org.nz/species/new-zealand-king-shag

Schuckard, R.; Bell, M.; Frost, P.; Taylor, G.; Greene, T. 2018. A census of nesting pairs of the endemic New Zealand king shag (*Leucocarbo carunculatus*) in 2016 and 2017. *Notornis 65*: 59–66.

Schuckard, R.; Melville, D.S.; Taylor, G. 2015. Population and breeding census of New Zealand king shag (*Leucocarbo carunculatus*) in 2015. *Notornis 62*: 209–218.

Schuckard, R. 1994. New Zealand king shag (*Leucocarbo carunculatus*) on Duffers Reef, Marlborough Sounds. *Notornis 41*: 93–108.

Shaw, P. 1984. Factors affecting the breeding performance of the Antarctic blue-eyed shag (*Phalacrocorax atriceps bransfieldensis*), Durham theses, Durham University. Available at Durham E-Theses Online: http://etheses.dur.ac.uk/7469/

Taylor, G. 2000. Action plan for seabird conservation in New Zealand. Part A: Threatened seabirds. *Threatened Species Occasional Publication 9*. Department of Conservation, Wellington. 81–83.

Velando, A. 2001. Post-fledging crèche behaviour in the European shag. *Journal of Ethology 19*: 121–127.

Notornis, 2024, Vol. 71: 93-114
0029-4470 © The Ornithological Society of New Zealand Inc.

Amendments to the 5th edition (2022) of the *Checklist of the Birds of New Zealand*

COLIN M. MISKELLY*
Museum of New Zealand Te Papa Tongarewa, PO Box 467, Wellington 6140, New Zealand

NATALIE J. FORSDICK
Manaaki Whenua – Landcare Research, Private Bag 92170, Auckland 1142, New Zealand

RICARDO L. PALMA
Museum of New Zealand Te Papa Tongarewa (retired), PO Box 467, Wellington 6140, New Zealand

NICOLAS J. RAWLENCE
Otago Palaeogenetics Laboratory, Department of Zoology, University of Otago, Dunedin 9016, New Zealand

ALAN J.D. TENNYSON
Museum of New Zealand Te Papa Tongarewa, PO Box 467, Wellington 6140, New Zealand

Abstract: Since the publication of the fifth edition of the *Checklist of the Birds of New Zealand* in 2022, 3 new vagrant species (2 terns and a storm petrel) have been accepted as occurring in New Zealand as at 31 December 2023, and 11 species that became extinct more than *c*. 1 million years ago have been described. These comprised 3 waterfowl, 1 owlet-nightjar, 1 tropicbird, 3 penguins, 1 albatross, 1 petrel, and a 'false-colie' (the latter is considered unrelated to any known group of birds). These 11 new fossil species were found in deposits of the following epochs: Paleocene (3), Miocene (6), and Pliocene (2). The richest areas for discovering new species were Miocene lacustrine deposits of the St Bathans region of Central Otago (5 species), and Paleocene marine deposits from the eastern South Island (3 species). Two Pliocene seabirds were from marine sediments in south Taranaki, and a Miocene albatross was found in a limestone quarry in South Canterbury. Recent publications potentially affecting the taxonomy, nomenclature, classification and arrangement of New Zealand birds are assessed, and recommendations are made that affect 56 taxa. This includes splitting Tibetan sand plover *Anarhynchus atrifrons* from Siberian sand plover *A. mongolus*, and Pyramid prion *Pachyptila pyramidalis* from fulmar prion *P. crassirostris*, thereby adding a further two species to the New Zealand bird list. The total number of bird species, including fossil species, now accepted from the New Zealand region is 502.

Miskelly, C.M.; Forsdick, N.J.; Palma, R.L.; Rawlence, N.J.; Tennyson, A.J.D. 2024. Amendments to the 5th edition (2022) of the *Checklist of the Birds of New Zealand*. *Notornis 71(3)*: 93–114.

Keywords: new species, vagrant birds, extinct; fossil birds, New Zealand, taxonomy, nomenclature, synonymy

---

Received 24 May 2024; accepted 19 September 2024

**Correspondence:* Colin.Miskelly@tepapa.govt.nz

INTRODUCTION

Many articles that potentially affect the scientific and common names of New Zealand birds have been published or assessed since the publication of the fifth edition of the *Checklist of the Birds New Zealand* (Checklist Committee 2022). This article summarises the conclusions of the Birds New Zealand Checklist Committee, which has drawn on publications that deal with the classification and names of birds, and suggested additions to the New Zealand list. A key source of new information was the most recent report of the Birds New Zealand Records Appraisal Committee (Miskelly, Crossland *et al.* 2023). There have also been several phylogenetic reviews of taxa that affect the names or taxonomic hierarchies of New Zealand birds (e.g. Dos Remedios *et al.* 2015; Kirchman *et al*. 2021; Černý & Natale 2022; Shepherd *et al*. 2022; Wei *et al*. 2022).

All the changes summarised here are incorporated in the online sixth edition of the *Checklist of the Birds of New Zealand* (Checklist Committee 2024), which is otherwise based on the fifth edition (Checklist Committee 2022).

The Checklist Committee currently consists of five members. Recommendations are drafted by Committee members, assigned a reference number based on the calendar year, and circulated for comment and voting. Our terms of reference state that for a change to be adopted, at least four of the five Committee members must agree. A high 'bar' for adopting changes was set because we follow the International Commission on Zoological Nomenclature in advocating taxonomic stability as a core principle.

Major changes to the *Checklist of the Birds of New Zealand* are listed here in the same taxonomic order as they are presented in the revised checklist (Checklist Committee 2024). The recommended taxonomic order of new extant species added to the list, relative to species already in the list, is based on Dickinson & Remsen (2013) and Dickinson & Christidis (2014). Taxa with minor changes to their text (e.g. amended taxonomic synonymies, updated publication dates or distribution records, or additional references) that do not otherwise appear in the main text are listed on pp. 104–105.

This manuscript, and the Checklist webpages, were improved by comments received from the editor and two anonymous reviewers.

Symbols and Abbreviations

➤ Indicates a species (cf. subspecies)

† Indicates an extinct taxon

SYSTEMATIC ACCOUNT

This section summarises the main changes to species names and other information, compared to the *2022 Checklist.*

Order **GRUIFORMES**: Rails and Cranes

Family **RALLIDAE** Rafinesque: Rails, Gallinules, and Coots

We follow the taxonomic hierarchy proposed for Rallidae by Kirchman *et al*. (2021).

Subfamily HIMANTORNITHINAE Verheyen: Coots, Gallinules, Swamphens, and Crakes

Himantornithinae Verheyen, 1957: *Bull. Inst. Roy. Sci. Nat. Belgique 33*(21): 25 – Type genus *Himantornis* Hartlaub, 1855. [Not Himanthornithinae Gray, 1871, which was based on type genus "2036. *Himanthornis*, Temm." *in* Bonaparte (1854: 150) (*nomen nudum*).]

Tribe FULICINI Nitzsch: Coots and Gallinules

Fulicariae Nitzsch, 1829: *Observationes de avium arteria carotide communi*: 17 – Type genus *Fulica* Linnaeus, 1758.

Genus ***Tribonyx*** du Bus de Gisignies

Genus ***Porzana*** Vieillot

Genus ***Gallinula*** Brisson

Gallinula tenebrosa is moved ahead of *G. chloropus*.

Genus ***Fulica*** Linnaeus

Tribe PORPHYRIONINI Reichenbach: Swamphens

Porphyrioninae Reichenbach, 1849: *Avium Syst. Nat*: pl. XIX – Type genus *Porphyrio* Brisson, 1760.

Genus ***Porphyrio*** Brisson

Tribe ZAPORNINI Des Murs: Crakes

Zaporniinae Des Murs, 1860: *Traité Gen. d'oologie Ornithologique: 521* – Type genus *Zapornia* Leach, 1816.

Genus ***Zapornia*** Leach

Zapornia pusilla is moved ahead of *Z. tabuensis*.

Subfamily RALLINAE Rafinesque: Rails

Tribe RALLINI Rafinesque: Rails

Rallia Rafinesque, 1815: *Analyse de la Nature*: 70 – Type genus *Rallus* Linnaeus, 1758.

We follow Dickinson & Remsen (2013), Garcia-R *et al*. (2020), and Kirchman *et al*. (2021) in separating *Hypotaenidia* from *Gallirallus*, with New Zealand species *H. dieffenbachii*, and *H. philippensis*. However, we retain *Cabalus* as a monotypic genus (contra Garcia-R *et al*. 2014, 2017; Garcia-R & Matzke 2021, and Kirchman *et al*. 2021) pending further genetic information.

Genus ***Crex*** Bechstein

Genus ***Lewinia*** G.R. Gray

Genus †***Diaphorapteryx*** Forbes

Genus ***Gallirallus*** Lafresnaye

Ocydromus Wagler, 1830: *Natur. Syst. Amphib. Säug. Vögel*.: 98 – Type species *Ocydromus australis* = *Gallirallus australis* (Sparrman). Junior homonym of *Ocydromus* Schellenberg, 1806.

Gallirallus Lafresnaye, 1841: *Revue Zool.* 1841: 243 – Type species (by monotypy) *Gallirallus brachypterus* Lafresnaye = *Gallirallus australis* (Sparrman).

Brachypteryx Owen, 1848: *Proc. Zool. Soc. London 1848* (16): 2, 7 – Type species *Rallus australis* Sparrman = *Gallirallus australis* (Sparrman). Junior homonym of *Brachypteryx* Horsfield, 1821.

Species: *G. australis.*

Genus ***Hypotaenidia*** Reichenbach

Hypotaenidia Reichenbach, 1853 (*fide* Dickinson, Overstreet, Dowsett & Bruce 2011 *Priority!*: 133): *Avium Syst. Nat.* 2(1): 23 – Type species (by original designation) *Rallus pectoralis* Gould = *Hypotaenidia philippensis* (Linnaeus) (*fide* Stone 1894, *Proc. Acad. Nat. Sci. Phil. 46*: 136), not *Rallus pectoralis* Temminck.

Nesolimnas Andrews, 1896: *Novit. Zool. 3*: 260, 266 – Type species (by monotypy) *Rallus dieffenbachii* G.R. Gray = *Hypotaenidia dieffenbachii* (G.R. Gray).

Species: *H. dieffenbachii*, and *H. philippensis*.

Genus †***Cabalus*** Hutton

Genus †***Capellirallus*** Falla

Order **CHARADRIIFORMES**: Waders, Skuas, Gulls, and Terns

Suborder CHARADRII: Plovers and Dotterels

Family **CHARADRIIDAE** Leach: Plovers, Lapwings, and Dotterels

Several phylogenetic studies have revealed *Pluvialis* plovers to be deeply divergent from other charadriids (Barth *et al*. 2013; Dos Remedios *et al.* 2015; Černý & Natale 2022), which we recognise by placing them in a separate subfamily. These same studies revealed the large genus *Charadrius* to be paraphyletic, with one clade (including wrybill *Anarhynchus frontalis*, New Zealand dotterel *Charadrius obscurus*, banded dotterel *Ch. bicinctus*, and sand plovers) more closely related to lapwings (*Vanellus*) than they are to *Charadrius sensu stricto*. Shore plover (formerly *Thinornis novaeseelandiae*) and black-fronted dotterel (formerly *Elseyornis melanops*) group with the now narrowly defined *Charadrius* (which includes semipalmated plover *Ch. semipalmatus*), and are returned to that genus. All remaining species of '*Charadrius*' on the New Zealand list are moved to *Anarhynchus*, which is the earliest name available and applicable to this clade.

Insert new subfamily Pluvialinae before Charadriinae.

Subfamily PLUVIALINAE MacGillivray: Grey Plover and Golden Plovers

Pluvialinae MacGillivray, 1852: *Hist. Brit. Birds*: 58 – Type genus *Pluvialis* Brisson, 1760

Genus ***Pluvialis*** Brisson

Change sequence to: *Pluvialis squatarola, P. dominicus, P. fulva.*

Subfamily CHARADRIINAE Leach: Plovers and Dotterels

Genus ***Charadrius*** Linnaeus

Charadrius Linnaeus, 1758: *Syst. Nat., 10th edition 1*: 150 – Type species (by tautonymy*) Charadrius hiaticula* Linnaeus.

Aegialitis Boie, 1822: *Isis von Oken*, Heft 5: col. 558 – Type species (by subsequent designation) *Charadrius hiaticula* Linnaeus.

Thinornis G.R. Gray, 1845: *in* Richardson & J.E. Gray (*Eds*), *Zool. Voy. 'Erebus' & 'Terror', Birds 1*(8): 11 – Type species (by monotypy) *Thinornis rossii* G.R. Gray = *Charadrius novaeseelandiae* Gmelin.

Elseya Mathews, 1913: *Birds Australia. 3*: 125 – Type species (by original designation*) Charadrius melanops* Vieillot. Junior homonym of *Elseya* J.E. Gray, 1867.

Elseyornis Mathews, 1914: *Austral Avian Rec. 2*: 87. *Nomen novum* for *Elseya* Mathews, 1913.

List in sequence: *Charadrius semipalmatus, Ch. melanops, Ch. novaeseelandiae.*

Genus ***Vanellus*** Brisson

Genus ***Erythrogonys*** Gould

Genus ***Anarhynchus*** Quoy & Gaimard

Anarhynchus Quoy & Gaimard, 1830: *in* Dumont d'Urville, *Voyage Astrolabe Zool. 1*: 252 – Type species (by monotypy) *Anarhynchus frontalis* Quoy & Gaimard.

Eupoda Brandt, 1845: *in* Tchihatcheff, *Voy. Sci. Altai Orient*.: 444 – Type species (by monotypy) *Charadrius asiaticus* Pallas = *Anarhynchus asiaticus* (Pallas).

Ochthodromus Reichenbach, 1852: *Avium Syst. Nat. 3*: 18 – Type species (by original designation) *Charadrius wilsonia* Ord = *Anarhynchus wilsonia* (Ord).

Cirrepidesmus Bonaparte, 1856: *Compt. Rend. Séa. Acad. Sci., Paris 43*: 417 – Type species (by tautonymy) *Charadrius cirrhepidesmus* Wagler = *Anarhynchus mongolus* (Pallas).

Leucopolius Bonaparte, 1856: *Compt. Rend. Séa. Acad. Sci., Paris 43*: 417 – Type species (by subsequent designation) *Charadrius marginatus* Vieillot = *Anarhynchus marginatus* (Vieillot).

Pluviorhynchus Bonaparte, 1856: *Compt. Rend. Séa. Acad. Sci., Paris 43*: 417 – Type species (by subsequent designation) *Charadrius obscurus* Gmelin = *Anarhynchus obscurus* (Gmelin).

Hyetoceryx Heine & Reichenow, 1890: *Nom. Mus. Hein. Ornith*.: 336. Unnecessary *nomen novum* for *Pluviorhynchus* Bonaparte, 1856.

Pagoa Mathews, 1913: *Birds Australia 3*: 82 – Type species (by original designation) *Charadrius geoffroyi* Wagler = *Anarhynchus leschenaultii* (Lesson).

Eupodella Mathews, 1913: *Birds Australia 3*: 83. Unnecessary *nomen novum* for *Eupoda* Brandt, 1845.

Nesoceryx Mathews, 1920: *Bull. Brit. Ornith. Club 41*: 35 – Type species (by original designation) *Charadrius bicinctus* Jardine & Selby = *Anarhynchus bicinctus* (Jardine & Selby).

Anarynchus Quoy & Gaimard; Mathews 1930, *Emu 29*: 280. Unjustified emendation.

Anarhyncus Quoy & Gaimard; Stead 1932, *Life Histories New Zealand Birds*: 91. Unjustified emendation.

We follow Wei *et al.* (2022) in recognising three species of sand plovers, here listed as Siberian sand plover *A. mongolus*, Tibetan sand plover *Anarhynchus atrifrons*, and greater sand plover *A. leschenaultii*. This requires the addition of Tibetan sand plover to the New Zealand list, and revision of the entry for *A. mongolus*.

➤***Anarhynchus mongolus*** (Pallas) **Siberian Sand Plover**

Charadrius mongolus Pallas, 1776: *Reise durch verschiedene Provinzen des Russischen Reichs 3*: 700 – "salt lakes towards Mongolian border".

Cirrepidesmus mongolus (Pallas); Mathews 1927, *Syst. Avium Australasianarum 1*: 158.

Charadrius mongolus Pallas; Checklist Committee 1990, *Checklist Birds N.Z.*: 135.

Anarhynchus mongolus (Pallas); Sangster *et al.* 2016, *Ibis 158*: 209.

Breeds in eastern inland Russia, Kamchatka, the Commander Islands, and the Chukotsk Peninsula, wintering between Taiwan and Australia (Marchant & Higgins 1993; Wei *et al.* 2022; Schweizer *et al.* 2023). Two subspecies are recognised: *A. m. mongolus* and *A. m. stegmanni* (Portenko, 1939). Siberian sand plovers are uncommon visitors to New Zealand. The first record was one at Farewell Spit, Nelson in Jan. 1961 (Bell *et al.* 1961). Recorded from Parengarenga Harbour to coastal Southland, usually as single birds (Marchant & Higgins 1993). Favoured northern sites are Kaipara and Manukau Harbours. Two records (before 1968 and Jul. 1976) at Norfolk Island (Marchant & Higgins 1993). One purported record (Dec. 1987) at Chatham Islands (Müller 1989; Freeman 1994).

➤***Anarhynchus atrifrons*** (Wagler) **Tibetan Sand Plover**

Charadrius atrifrons Wagler, 1829: *Isis von Oken*, Heft 6: col. 650 – Bengala.
Anarhynchus atrifrons (Wagler); Schweizer *et al.* 2023, *Dutch Birding 45*: 326.

Breeds in central Russia, the Himalayas, and southern and eastern Tibet, wintering from Africa through India to the Greater Sunda Islands (Marchant & Higgins 1993; Wei *et al*. 2022; Schweizer *et al*. 2023). Three subspecies are recognised: *A. a. atrifrons*, *A. a. pamirensis* (Richmond, 1896), and *A. a. schaeferi* (de Schaunesee, 1938). The sole New Zealand record was a bird at Big Sand Island, Kaipara Harbour in Apr. 1999 (Parrish 2000a), which was not identified to subspecies.

As a result of moving seven species from *Charadrius to Anarhynchus*, the following new combinations have been added to the end of the synonymic list for each of the respective taxa:

Anarhynchus veredus (Gould, 1848); Sangster *et al*. 2016, *Ibis 158*: 209.
Anarhynchus leschenaultii leschenaultii (Lesson, 1826); Sangster *et al*. 2016, *Ibis 158*: 209.
Anarhynchus bicinctus bicinctus (Jardine & Selby, 1827); Černý & Natale 2022, *Mol. Phyl. Evol. 177* (107260): 14.
Anarhynchus bicinctus exilis (Falla 1978); Clements *et al*. 2023, *The eBird/Clements checklist of Birds of the World*: v2023.
Anarhynchus obscurus aquilonius (Dowding, 1994); Clements *et al*. 2023, *The eBird/Clements checklist of Birds of the World*: v2023.
Anarhynchus obscurus obscurus (Gmelin, 1789); Černý & Natale 2022, *Mol. Phyl. Evol. 177* (107260): 14.
Anarhynchus ruficapillus (Temminck, 1821); Clements *et al*. 2023, *The eBird/Clements checklist of Birds of the World*: v2023.

The species sequence recommended within *Anarhynchus* follows Clements *et al.* (2023): *A. veredus, A. mongolus, A. atrifrons, A. leschenaultii, A. bicinctus, A. frontalis, A. obscurus, A. ruficapillus.*

Suborder LARI: Pratincoles, Skuas, Auks, Gulls, Terns, and Skimmers

Family **LARIDAE** Rafinesque: Noddies, Gulls, and Terns

Subfamily STERNINAE Bonaparte: Terns

Genus ***Chlidonias*** Rafinesque

➤***Chlidonias niger*** (Linnaeus) **Black Tern**

Breeds in marshes across Europe, western Asia, and North America; migrates to western and southern Africa, and South America, with occasional vagrants elsewhere (del Hoyo *et al.* 1996). Two subspecies recognised; there are three accepted records of the American subspecies (*C. n. surinamensis*) from Australia (Higgins & Davies 1996; Menkhorst *et al.* 2017).

Chlidonias niger niger (Linnaeus) **Black Tern**

Sterna nigra Linnaeus, 1758: *Syst. Nat.*, 10th edition, *1*: 137 – Europa, restricted to near Uppsala, Sweden (*fide* Peters 1934, *Check-list Birds World* 2: 328).
Sterna fissipes Linnaeus, 1766: *Syst. Nat.*, 12th edition *1*: 228 – Europa.
Viralva nigra (Linnaeus); Stephens 1826, *in* G. Shaw, *General Zool. 13*(1): 167.

Hydrochelidon fissipes Gray ex Linnaeus 1849 [sic]; Coues 1862, *Proc. Acad. Nat. Sci. Philad. 14*: 554. In part.

Hydrochelidon nigra (Linnaeus, 1758); Mathews & Iredale 1913, *Ibis 1* (10th series): 242.

Chlidonias nigra nigra (Linnaeus, 1758); Peters, 1934, *Check-list Birds World 2*: 328.

Sterna niger; Cox, Percival & Colwell 1994, *Technical Rep. Florida Cooperative Fish & Wildlife Research Unit 50*: 38.

Chlidonias nigra (Linnaeus, 1758); Pérez del Val 2001, *Manuales Técnicos de Museología*, Madrid *11*: 37.

Chlidonias niger (Linnaeus, 1758); Banks, Cicero *et al*. 2006, *The Auk 123*: 927.

Chlidonias niger niger (Linnaeus, 1758); Dickinson & Remsen 2013, *Howard & Moore Complete Checklist Birds World*, 4th edition, *1*: 231.

Breeds in marshes across Europe and western Asia, migrating to western and southern Africa (del Hoyo *et al.* 1996). One accepted record of a single bird on the Kapiti coast and then at Plimmerton, Wellington, Jan.–Feb. 2022 (Thomas & Hunt 2023). There is one record from Papua New Guinea; not known from Australia (Finch 1986; Higgins & Davies 1996; Menkhorst *et al.* 2017).

Insert after ***Chlidonias leucopterus.***

Genus ***Sterna*** Linnaeus

➤***Sterna sumatrana*** Raffles **Black-naped Tern**

Breeds on islands in tropical western Pacific and Indian Oceans (del Hoyo *et al.* 1996). Two subspecies recognised, with *S. s. mathewsi* in the western Indian Ocean (Dickinson & Remsen 2013).

Sterna sumatrana sumatrana Raffles **Black-naped Tern**

Sterna sumatrana Raffles, 1822: *Trans. Linn. Soc. London 13*(2): 329 – Sumatra, Indonesia.

Sterna sumatrana sumatrana Raffles, 1822; Peters 1934, *Check-list Birds World 2*: 336.

Breeds on islands in tropical western Pacific, including on the Great Barrier Reef and around New Caledonia (Higgins & Davies 1996). The single New Zealand record was of a bird seen alive and then found dead at Muriwai, west Auckland, in Feb. 2022 (Auckland Museum specimen LB15957; Miskelly *et al.* 2023).

Insert after ***Sterna striata.***

Order **SPHENISCIFORMES**: Penguins
Family **SPHENISCIDAE** Bonaparte: Penguins

Genus ***Eudyptula*** Bonaparte

➤***Eudyptula minor*** (J.R. Forster) **Little Penguin**

Eudyptula minor minor (J.R. Forster) **New Zealand Little Penguin | Kororā**

Aptenodytes minor J.R. Forster, 1781: *Comment. Phys. Soc. Reg. Sci. Gottingensis 3:* 135 – Dusky Sound, Fiordland, and Queen Charlotte Sound, Marlborough Sounds, restricted to Queen Charlotte Sound (*fide* Miskelly, Shepherd *et al.* 2023, *Zootaxa 5228* (1): 92).

Miskelly, Shepherd *et al.* (2023) nominated a neotype for *Eudyptula minor*, based on a specimen from Queen Charlotte Sound genotyped as being of the New Zealand clade (cf. *E. m. novaehollandiae*, which is sympatric with *E. m. minor* in the southern South Island).

Order **PROCELLARIIFORMES**: Albatrosses, Petrels, and Shearwaters

Family **HYDROBATIDAE** Mathews: Northern Storm Petrels

Genus ***Hydrobates*** Boie

➤***Hydrobates matsudairae*** (N. Kuroda, Sr) **Matsudaira's Storm Petrel**

Oceanodroma melania matsudariae Kuroda, 1922: *Ibis 4* (11th series): 311 – Sagami Bay, Honshu, Japan.
Cymochorea melania matsudairae (Kuroda); Mathews 1934, *Novit. Zool. 39*(2): 190.
Cymochorea matsudairae (Kuroda); Mathews & Hallstrom 1943, *Notes Procellariiformes*: 28.
Cymochorea (Bianchoma) matsudairae (Kuroda); Mathews & Hallstrom 1943, *Notes Procellariiformes*: 29.
Oceanodroma matsudeirae; Palmer 1962, *Hand. North Amer. Birds 1*: 239. Misspelling.
Oceanodroma matsudairae Kuroda, 1922: Jouanin & Mougin 1979, *in* Peters, *Check-list Birds World 1* (2nd edition): 117.
Halocyptena matsudairae (Kuroda, 1922); Penhallurick & Wink 2004, *Emu 104:* 137.
Hydrobates matsudairae (Kuroda, Sr, 1922); Dickinson & Remsen 2013, *Howard & Moore Complete Checklist Birds World*, 4th edition, *1*: 174.
Oceanodroma matsudariae Kuroda, 1922; Johnstone, Darnell & Travouillon 2021, *Checklist Birds Western Australia*: 13.

Note: We are not using the original spelling of this species, as we invoke Article 33.3.1 – prevailing use in the ICZN Code (1999).

Breeds on islands south-east of Japan and migrates to the tropical Indian Ocean (Harrison *et al*. 2021). One New Zealand record: Maukatia Bay, Auckland west coast, May 2022 (Auckland Museum specimen LB16104; Miskelly *et al.* 2023).

Insert before ***Hydrobates leucorhous.***

Family **PROCELLARIIDAE Leach**: Fulmars, Petrels, Prions, and Shearwaters

Genus ***Pterodroma*** Bonaparte

➤***Pterodroma heraldica*** (Salvin) **Herald Petrel**

Pterodroma neglecta heraldica (Salvin); Plaza *et al*. 2023, *Frontiers Ecol. Evol. 11*: 13.

Plaza *et al*. (2023) regarded *Pt. heraldica* as a subspecies of *Pterodroma neglecta* and, on the same page, as a full species in the invalid combination "*Pterodroma heraldica alba*". Hence, we do not agree with their taxonomic treatment of *Pt. heraldica*.

➤***Pterodroma alba*** (Gmelin) **Phoenix Petrel**

Pterodroma heraldica alba (Gmelin); Plaza *et al*. 2023, *Frontiers Ecol. Evol. 11*: 13. Invalid combination.
Pterodroma neglecta alba (Gmelin); Plaza *et al*. 2023, *Frontiers Ecol. Evol. 11*: 13. Invalid combination.

Plaza *et al*. (2023) regarded *Pt. alba* as a subspecies of two species: *Pterodroma heraldica* and *Pterodroma neglecta*. Combining the same taxon with two different species in the same page of a publication is contradictory. Also, Plaza *et al*. (2023) contradicted the Law of Priority by placing *Pt. alba*, the oldest described taxon, as a subspecies of two younger species. Hence, we do not agree with these subspecific combinations, and regard them as invalid.

Genus ***Pachyptila*** Illiger

➤***Pachyptila turtur*** (Kuhl) **Fairy Prion | Tītī Wainui**

Shepherd *et al*. (2022) analysed genomic diversity in the fairy prion + fulmar prion complex, and found neither of these previously-recognised species to be monophyletic. We follow Shepherd *et al*. (2022) in recognising two subspecies of fairy prion, with the nominate *turtur* confined to New Zealand (other than Antipodes Islands), south-eastern Australia, and St Paul Island, Indian Ocean, and the subantarctic fairy prion *P. t. eatoni* breeding on Kerguelen Islands, Heard Island, and the Antipodes Islands, and likely on Falkland Islands, South Georgia, Marion and Prince Edward Islands, Crozet Islands, and Macquarie Island. Shepherd *et al*. (2022) clarified the uncertain taxonomic status of prions breeding on Heard Island, i.e. that they are fairy prions rather than fulmar prions *Pachyptila crassirostris* (see Cox 1980; Marchant & Higgins 1990; Tennyson & Bartle 2005). The synonymies and breeding locations for *Pachyptila turtur* have now been split between *Pachyptila turtur turtur* (Kuhl) and *Pachyptila turtur eatoni* (Mathews).

Pachyptila turtur turtur (Kuhl) **Northern Fairy Prion | Tītī Wainui**

Procellaria turtur Kuhl, 1820: *Beitr. Zool. vergl. Anat. 1*: 143 (ex Banks MS) – no locality = Bass Strait, Australia (*fide* Mathews 1912, *Birds Australia 2*: 219).
Prion Turtur (Kuhl); Gould 1844, *Ann. Mag. Nat. Hist., London 13*: 366.
Prion brevirostris Gould, 1855: *Proc. Zool. Soc. London 1855* (23): 88, pl. 93 – Madeira or Desertas Islands, North Atlantic Ocean, error for South Atlantic Ocean (*fide* Mathews 1912, *Birds Australia 2*: 220).
Halobaena typica Bonaparte, 1857: *Consp. Gen. Avium 2*: 194 – “Insula Waigiou”, error for ?Bass Strait, Australia (*fide* Mathews 1912, *Birds Australia 2*: 219).
Prion ariel Bonaparte, 1857: *Consp. Gen. Avium 2*: 194 (ex Gould) – Australia? = Bass Strait, Australia (*fide* Salvin 1896, *Cat. Birds Brit. Mus. 25*: 436).
Procellaria ariel Gould [sic]; G.R. Gray 1862, *Ibis 4*: 247.
Pseudoprion turtur (Banks) [sic]; Coues 1866, *Proc. Acad. Nat. Sci. Philad. 18*: 166.
Pseudoprion ariel (Gould) [sic]; Coues 1866, *Proc. Acad. Nat. Sci. Philad. 18*: 166.
? *Pseudoprion brevirostris* (Gould); Coues 1866, *Proc. Acad. Nat. Sci. Philad. 18*: 167.
Prion ariel Gould [sic]; Finsch 1870, *Journ. für Ornith. 18*: 374.
Prion (*Pseudoprion*) *turtur* (Smith) [sic]; G.R. Gray 1871, *Hand-list Birds 3*: 108.
Prion (*Pseudoprion*) *ariel* (Gould) [sic]; G.R. Gray 1871, *Hand-list Birds 3*: 108.
Prion turtur Solander [sic]; Hutton 1872, *Ibis 2* (3rd series): 249.
Prion turtur (Kuhl); Buller 1873 (Mar.), *History of the Birds of N.Z.*, 1st edition (part 5): 309.
Pachyptila Ariel (Gould) [sic]; Cabanis & Reichenow 1876, *Journ. für Ornith. 24*: 328.
Pseudoprion turtur huttoni Mathews, 1912: *Birds Australia 2*: 220 – Chatham Islands.
Pseudoprion turtur turtur (Kuhl); Mathews 1913, *List Birds Australia*: 40.
Pseudoprion turtur nova Mathews, 1916: *Austral Avian Rec. 3*: 55 – Sydney, New South Wales, Australia.
Pseudoprion turtur (Kuhl); Mathews 1920, *Austral Avian Rec. 4*: 68.
Pseudoprion turtur brevirostris (Gould); Bennett 1926, *Ibis 2* (12th series): 317.
Pachyptila turtur turtur; Oliver 1930, *New Zealand Birds*, 1st edition: 115. In part.
Pachyptila turtur fallai Oliver, 1930: *New Zealand Birds*, 1st edition: 114 – Otago.
Heteroprion belcheri fallai (Oliver); Mathews 1931, *Ibis 1* (13th series): 44.
Pseudoprion turtur steadi Mathews, 1932: *Bull. Brit. Ornith. Club 52*: 146 – “Cundy, Woman’s and Betsy Islands”, off Stewart Island, restricted to Herekopare Island (*fide* Miskelly 2012, *Notornis 59*: 9).
Pseudoprion turtur oliveri Mathews, 1932: *Bull. Brit. Ornith. Club 52*: 147 – Motunau Island, Canterbury.

Pseudoprion turtur fallai (Oliver); Mathews 1934, *Novit. Zool. 39*(2): 174.
Pseudoprion turtur dertrum Mathews, 1938: *Emu 37*: 281 – Bunbury, Western Australia.
Pachyptila (*Pseudoprion*) *turtur huttoni* (Mathews); C.A. Fleming 1939, *Emu 38*: 400.
Pachyptila (*Pseudoprion*) *turtur turtur* (Kuhl); Falla 1940, *Emu 40*: 234.
Pachyptila (*Pseudoprion*) *turtur fallai* (Oliver); Falla 1940, *Emu 40*: 234.
Pachyptila (*Pseudoprion*) *turtur*; C.A. Fleming 1941, *Emu 41*: 143.
Pseudoprion turtur mangarei Mathews & Hallstrom, 1943: *Notes Procellariiformes*: 23 – Mangare Island = Mangere Island, Chatham Islands.
Pseudoprion turtur benchi Mathews & Hallstrom, 1943; *Notes Procellariiformes*: 23 – Bench Island, off Stewart Island.
Pseudoprion turtur armiger Mathews & Hallstrom, 1943: *Notes Procellariiformes*: 23 – Poor Knights Islands.
Pachyptila turtur (Kuhl); Checklist Committee 1953, *Checklist N.Z. Birds*: 20.
Pachyptila turtur turtur; Oliver 1955, *New Zealand Birds*, 2nd edition: 117.

Breeds in Australia on islands off Victoria and around Tasmania (P. Harper 1980; Marchant & Higgins 1990) and Roche Quille (St Paul Island). Breeds on many islands in and near the New Zealand region: Poor Knights; Stephens / Takapourewa, Trios, Jag Rocks, Sentinel Rock, The Haystack / Moturaka, Ninepin Rock, The Brothers (all Cook Strait); Motukiekie Rocks, Open Bay Island, Motunau Island, Banks Peninsula islets, Dunedin coastal cliffs and nearby islands, islands in Foveaux Strait and off Stewart Island / Rakiura; Snares Islands / Tini Heke; and Chatham Islands (Mangere, Little Mangere, Rabbit, Kokope, Murumurus, Star Keys, The Sisters) (P. Harper 1976; Powlesland 1989a; Imber 1994; D. Brown 1995; Stuart-Menteath 1996; Loh 2000; G. Taylor 2000b; G. Baker *et al*. 2002; Jamieson *et al.* 2016; Shepherd *et al.* 2022). Recently found breeding on mainland cliff ledges at Dunedin, South Island (Loh 2000), and has begun breeding on Mana Island, off Wellington, after a successful introduction programme (Miskelly & Gummer 2013). Ranges in subtropical seas, including the Tasman Sea and throughout the New Zealand region (Marchant & Higgins 1990). Reaches further north in winter; straggler to New Guinea, South America, and southern Africa (Marchant & Higgins 1990). Birds banded in the Cook Strait region have been recovered as far away as Australia and the Chatham Islands (Marchant & Higgins 1990). Medway (2002b) clarified the identity of Kuhl's type material. Late Pleistocene–Holocene bones and midden records on North, South, Stewart / Rakiura, and Chatham Islands (Millener 1991; Worthy 1998c).

Pachyptila turtur eatoni (Mathews) **Subantarctic Fairy Prion**

Pseudoprion turtur eatoni Mathews, 1912: *Birds Australia 2:* 220 – Kerguelen Island, south Indian Ocean.
Pachyptila turtur turtur (Kuhl); Oliver 1930, *New Zealand Birds*, 1st edition: 114. In part.
Pachyptila turtur crassirostris (Mathews); Oliver 1930, *New Zealand Birds*, 1st edition: 115. In part.
Pachyptila (Pseudoprion) turtur eatoni (Mathews); Falla 1937, *BANZARE Reports, ser. B,* 2: 203.
Pachyptila (Pseudoprion) eatoni eatoni (Mathews); C.A. Fleming 1939, *Emu 38*: 396, 398.
Pachyptila (Pseudoprion) eatoni aff. *eatoni* (Mathews); C.A. Fleming 1939, *Emu 38*: 396, 398.
Pachyptila (Pseudoprion) crassirostris eatoni (Mathews); Falla 1940, *Emu 40*: 228, 234.
Pachyptila (Pseudoprion) crassirostris; C.A. Fleming 1941, *Emu 41*: 143. In part.
Fulmariprion crassirostris eatoni; Mathews & Hallstrom 1943, *Notes Procellariiformes*: 26.
Pachyptila crassirostris eatoni (Mathews); Checklist Committee 1953, *Checklist N.Z. Birds*: 20.
Pachyptila crassirostris crassirostris (Mathews); Oliver 1955, *New Zealand Birds*, 2nd edition: 115. In part.
Pachyptila turtur subantarctica Oliver, 1955: *New Zealand Birds,* 2nd edition: 119 – Antipodes Island.
Pachyptila turtur eatoni; Cox 1980, *Rec. South Austr. Museum 18*: 119. In part.

Pachyptila crassirostris flemingi Tennyson & Bartle, 2005: *Notornis 52*: 49. In part.

Pachyptila turtur eatoni (Mathews); Shepherd *et al.* 2022, *PLoS ONE 17*(9): e0275102, p. 17.

Breeds on Kerguelen Islands, Heard Island, and Antipodes Islands (Shepherd *et al.* 2022). Presumed to be the form of fairy prion that breeds on Beauchêne Island (Falkland Islands), South Georgia, Marion and Prince Edward Islands, Crozets (Hog, Penguin, East), Macquarie Island, and Bishop and Clerk Islands; and possibly on islets off Campbell Island / Motu Ihupuku (G. Taylor 2000b; G. Baker *et al.* 2002; Tennyson *et al*. 2002; Jamieson *et al*. 2016; Shepherd *et al.* 2022). Ranges in subantarctic and subtropical seas, including the Tasman Sea and throughout the New Zealand region (Marchant & Higgins 1990).

➤***Pachyptila pyramidalis*** C.A. Fleming **Pyramid Prion**

The genomic analyses by Shepherd *et al*. (2022) referred to above revealed fulmar prion *Pachyptila crassirostris* to be paraphyletic, with populations from the Chatham Islands more closely related to *Pachyptila turtur* than they were to nominate *crassirostris*. Due to their morphological distinctiveness and the proximity of their breeding sites within the Chatham Islands, we consider *turtur* and *pyramidalis* to be full species. *Pachyptila pyramidalis* has been inserted between *P. turtur* and *P. crassirostris* in the updated *Checklist*.

➤***Pachyptila crassirostris*** (Mathews) **Fulmar Prion**

As explained under the two preceding species, we follow Shepherd *et al.* (2022) in treating Pyramid prion (previously *Pachyptila crassirostris pyramidalis*) as a full species, and in recognising the prions that breed on Heard Island as being a form of fairy prion *Pachyptila turtur* (they were previously considered to be *Pachyptila crassirostris flemingi*). We therefore recognise just two subspecies of fulmar prions (*crassirostris* and *flemingi*), with the species endemic to New Zealand. *P. c. flemingi* is now recognised as being confined to the Auckland Islands / Maukahuka when breeding.

Order **STRIGIFORMES**: Owls

We follow Salter *et al*. (2020) in recognising two subfamilies within Strigidae (Striginae and Surniinae), with both *Ninox* and *Athene* included within subfamily Surniinae.

Subfamily SURNIINAE Bonaparte: Hawk-owls

Surninae Bonaparte, 1838, *Geogr. Comp. List. Birds*: 6 – Type genus *Surnia* Duméril, 1805.

Order **PSITTACIFORMES**: Cockatoos, Parrots, and Parakeets

Family: **STRIGOPIDAE** Bonaparte: Kākāpō, and Kākā and Kea

Subfamily STRIGOPINAE Bonaparte: Kākāpo

Genus ***Strigops*** G.R. Gray

➤***Strigops habroptilus*** G.R. Gray **Kākāpō | Kakapo**

We follow Savage & Digby (2023) in treating *Strigops* as masculine (contra ICZN 1955: 262 and Checklist Committee 2022), hence the species name should be *Strigops habroptilus* (not *S. habroptila*).

Order **PASSERIFORMES**: Passerine (Perching) Birds
Suborder PASSERES (or POLYMYODI): Oscines (Songbirds)
“PASSERIDA”: Eurasian and New World Songbirds
Family **HIRUNDINIDAE** Rafinesque: Swallows and Martins

Genus ***Petrochelidon*** Cabanis

➤***Petrochelidon nigricans*** (Vieillot) **Tree Martin**

Replace text with:

The population breeding in Tasmania (*P. n. nigricans*) migrates to the eastern Australian mainland. Another population breeding throughout southern Australia (*P. n. neglecta*) also migrates north. The differentiation is between the mainland and Tasmanian populations rather than eastern and western populations (Schodde & Mason 1999). Also present on Lesser Sunda Islands and Timor (*P. n. timoriensis*). A returning Tasmanian bird overshot to Macquarie Island (Schodde & Mason 1999). Which subspecies reaches New Zealand needs further investigation. Vagrant to New Zealand, usually singly or two birds together, but also flocks of up to 30 (Henley 1974). At least 39 records from throughout the country since 1851 (Watola 2023), including: Wakapuaka, Nelson, summer 1851 (Buller 1868); Taupata, Golden Bay, Mar. 1856 (Buller 1869, 1872–73; Hutton 1871); Opaoa River, Blenheim, Jun. and Jul. 1878 (Buller 1879a, b); Grovetown, Blenheim, Apr. 1879 (Buller 1884). Later records considered confirmed or probable by Watola (2023) included: Morton Mains, east of Invercargill, Oct. 1914; Featherston, May to Sep. 1946; 6 at Spring Creek, Blenheim, Mar. 1947; Farewell Spit, Jan. 1960 (2), Oct. 1978, Jan. 1988, and Dec. 2019; Otatara, Invercargill, Nov. 1963–Mar. 1964; up to 5 at Waitaki River mouth, Canterbury / Otago, Jun.–Jul. 1972; Lake Waituna, Southland, Jan. 1973; Hicks Bay, Gisborne, Apr.–Jul. 1974 (30–35 birds, Henley 1974); Waipori, Lake Waihola, Otago, 1975; 20 at Rangitukia, Gisborne, 9 Apr. 1975; Wainono Lagoon, Canterbury, Jun. 1976 and Oct. 2020; Matata, Bay of Plenty, Apr. 1977; Punakaiki, Westland, Jun. 1977; Miranda, Firth of Thames, Feb. 1979; Vernon Lagoons, Marlborough, Apr. 1980; Nelson Haven Nov. 1981 and Nov. 1982; 3 at Lake Holm, Otago, Dec. 1981–Mar. 1984; Eglinton Valley, Fiordland, Oct. 1983; Pukete, Hamilton, Feb. 1992; Torrent Bay, Nelson, Dec. 1999; Lake Ohakuri, Waikato, Nov. 2004; Bromley, Christchurch, Feb. 2017; and Lake Ellesmere / Te Waihora, Canterbury, Feb. 2020. Also recorded at Chatham Islands, Nov. 1988 (Miskelly *et al.* 2006); Snares Islands / Tini Heke, Feb. 1969 (2), Aug.–Oct. 1982 (2), Feb. 1984 (2), and Dec. 2014 (2) (Warham & Keeley 1969; Miskelly *et al.* 2001a; Miskelly, Crossland *et al.* 2017); and Enderby Island, Auckland Islands, Feb. 2023 (Unusual Bird Report database, viewed Dec. 2023).

Taxa with minor changes to their texts

In addition to the entries above, the following 25 taxa in the 2024 *Checklist* have synonymy data or publication dates that differ from those in the 2022 *Checklist*:

ANSERIFORMES: ANATIDAE: *Biziura delatouri.*

GRUIFORMES: RALLIDAE: *Crex crex, Cabalus modestus.*

CHARADRIIFORMES: CHARADRIIDAE: *Anarhynchus obscurus aquilonius = Charadrius obscurus aquilonius.* **LARIDAE:** *Chlidonias.*

SPHENISCIFORMES: SPHENISCIDAE: *Aptenodytes patagonicus.*

PROCELLARIIFORMES: PROCELLARIIDAE: *Pachyptila desolata, P. pyramidalis, P. crassirostris crassirostris, P. c. flemingi, Pelecanoides urinatrix exsul.*

STRIGIFORMES: STRIGIDAE: *Ninox albifacies albifacies*.

FOSSIL BIRDS (APPENDIX 1)

APTERYGIIFORMES: APTERYGIDAE: *Apteryx littoralis*.

PHOENICOPTERIFORMES: PALAELODIDAE: *Palaelodus*.

COLUMBIFORMES: COLUMBIDAE: *Deliaphaps, D. zealandiensis*.

GRUIFORMES: RALLIDAE: *Priscaweka, P. parvales, Litorallus, L. livezeyi.*

CHARADRIIFORMES: THINOCOROIDEA: *Hakawai, H. melvillei.*

SPHENISCIFORMES: ?*Crossvallia waiparensis.*

PROCELLARIIFORMES: DIOMEDEIDAE: *Aldiomedes, A. angustirostris*.

In addition to the entries above, the following 74 taxa have amended texts (mainly distribution records and additional references) in the 2024 *Checklist* that differ from texts in the 2022 *Checklist*:

ANSERIFORMES: ANATIDAE: *Dendrocygna eytoni, Cygnus atratus, Cereopsis novaehollandiae, Anser anser, Branta canadensis, Biziura delatouri, Tadorna variegata, T. tadornoides, Chenonetta jubata, Hymenolaimus malacorhynchos, Anas gracilis, A. castanea, A. chathamica, A. chlorotis, A. nesiotis, A. acuta, A. platyrhynchos, A. p. platyrhynchos, A. superciliosa, Spatula rhynchotis, S. clypeata, Aythya australis, A. novaeseelandiae.*

PODICIPEDIFORMES: PODICIPEDIDAE: *Poliocephalus rufopectus, Tachybaptus novaehollandiae novaehollandiae.*

COLUMBIFORMES: COLUMBIDAE: *Streptopelia chinensis tigrina.*

CUCULIFORMES: CUCULIDAE: *Cuculus optatus, Eudynamys taitensis.*

CHARADRIIFORMES: CHARADRIIDAE: *Charadrius obscurus aquilonius.* **SCOLOPACIDAE:** *Numenius minutus, Calidris tenuirostris, C. pugnax, C. subminuta, C. mauri, Phalaropus lobatus, Tringa incana.* **STERCORARIIDAE:** *Stercorarius maccormicki, S. longicaudus.* **LARIDAE:** *Anous stolidus pileatus, A. minutus minutus, Onychoprion fuscatus serratus, O. lunatus, O. anaethetus, Gelochelidon nilotica, Chlidonias hybridus javanicus, Sterna hirundo longipennis, Thalasseus bergii cristatus.*

PHAETHONTIFORMES: PHAETHONTIDAE: *Phaethon lepturus dorotheae.*

SPHENISCIFORMES: SPHENISCIDAE: *Aptenodytes patagonicus, Pygoscelis adeliae, Eudyptes filholi, E. chrysolophus schlegeli.*

PROCELLARIIFORMES: DIOMEDEIDAE: *Thalassarche carteri, T. chrysostoma.* **OCEANITIDAE:** *Garrodia nereis.* **PROCELLARIIDAE:** *Thalassoica antarctica, Pterodroma solandri, Pt. neglecta neglecta, Pt. mollis, Pt. externa, Pt. cervicalis, Pt. longirostris, Pt. pycrofti, Pt. leucoptera caledonica, Pt. brevipes, Ardenna pacifica pacifica, A. gravis, A. creatopus, Puffinus elegans.*

SULIFORMES: FREGATIDAE: *Fregata minor palmerstoni, F. ariel ariel.* **SULIDAE:** *Sula sula, S.s. rubripes.* **ANHINGIDAE:** *Anhinga melanogaster novaehollandiae.*

APPENDIX 1: Fossil Birds of New Zealand

This section summarises new fossil bird species described from New Zealand during 2022 and 2023, and other information on New Zealand's fossil birds that is additional to information presented in the 2022 *Checklist*. Eleven species that became extinct more than c. 1 million years ago were described during these 2 years. These comprised 3 waterfowl, an owlet-nightjar, a tropicbird, 3 penguins, an albatross, a petrel, and a 'false-colie'. These 11 new fossil species were found in deposits of the following epochs: Paleocene (3 species), Miocene (6 species), and Pliocene (2 species). The richest areas for discovering new species were the lacustrine deposits of the St Bathans region of Central Otago (5 Miocene species), and Paleocene marine deposits from the eastern South Island (3 species). Two Pliocene seabirds were from marine sediments in south Taranaki, and a Miocene albatross was found in a limestone quarry in South Canterbury.

SYSTEMATIC ACCOUNT

Order **ANSERIFORMES**: Duck-like Birds

Suborder ANSERES: Swans, Geese, and Ducks

Family **ANATIDAE** Leach: Swans, Geese, and Ducks

Subfamily ANSERINAE Vigors: Swans and Geese

Genus †***Notochen*** T. Worthy, Scofield, Hand, De Pietri & Archer

Notochen T. Worthy, Scofield, Hand, De Pietri & Archer, 2022: *Zootaxa 5168*: 45 – Type species (by original designation) *Notochen bannockburnensis* T. Worthy, Scofield, Hand, De Pietri & Archer.

➤†***Notochen bannockburnensis*** T. Worthy, Scofield, Hand, De Pietri & Archer **Bannockburn Swan**

Notochen bannockburnensis T. Worthy, Scofield, Hand, De Pietri & Archer, 2022: *Zootaxa 5168:* 45 – St Bathans, Central Otago.

Known from the Altonian Stage (early Miocene; 19–16 Ma) St Bathans assemblage from the lower Bannockburn Formation, Manuherikia Group; near St Bathans, Otago (Worthy, Scofield, Hand *et al.* 2022).

Insert before subfamily Oxyurinae.

Subfamily OXYURINAE J.C. Phillips: Stiff-tailed Ducks

Genus †***Manuherikia*** T. Worthy, Tennyson, Jones, McNamara & Douglas

➤†***Manuherikia primadividua*** T. Worthy, Scofield, Salisbury, Hand, De Pietri, Blokland & Archer **St Bathans Diving Duck**

Manuherikia primadividua T. Worthy, Scofield, Salisbury, Hand, De Pietri, Blokland & Archer, 2022: *Geobios 70*: 96 – St Bathans, Central Otago.

Known from the Altonian Stage (early Miocene; 19–16 Ma) St Bathans assemblage from the lower Bannockburn Formation, Manuherikia Group; near St Bathans, Otago (Worthy, Scofield, Salisbury *et al.* 2022a). The stratigraphic location of the fossils indicate that they are younger than *M. lacustrina*, which is found in lower beds within the same formation (Worthy *et al.* 2019).

Insert after ***Manuherikia douglasi.***

Subfamily TADORNINAE Reichenbach: Shelducks
Tribe TADORNINI Reichenbach: Shelducks
Genus † ***Miotadorna*** T. Worthy, Tennyson, Jones, McNamara & Douglas

➤†***Miotadorna catrionae*** Tennyson, Greer, Lubbe, Marx, Richards, Giovanardi & Rawlence
Catriona's Shelduck

Miotadorna catrionae Tennyson, Greer, Lubbe, Marx, Richards, Giovanardi & Rawlence, 2022: *Taxonomy* 2: 139 – St Bathans, Central Otago.

Known from the Altonian Stage (early Miocene; 19–16 Ma) St Bathans assemblage from the lower Bannockburn Formation, Manuherikia Group; near St Bathans, Otago (Tennyson *et al.* 2022). Worthy, Scofield, Hand *et al.* (2022) suggested that the referred material was from large males of *M. sanctibathansi*. It is included here as a distinct species pending further information.

Insert after ***Miotadorna sanctibathansi.***

Order **APODIFORMES**: Swifts, Hummingbirds, and Owlet-nightjars
Family **AEGOTHELIDAE** Bonaparte: Owlet-nightjars
Genus ***Aegotheles*** Vigors & Horsfield

➤†***Aegotheles zealandivetus*** T. Worthy, Scofield, Salisbury, Hand, De Pietri & Archer
St Bathans Owlet-nightjar

Aegotheles zealandivetus T. Worthy, Scofield, Salisbury, Hand, De Pietri & Archer, 2022: *Journ. Ornith. 163*: 646 – Manuherikia River, St Bathans, Otago.

Worthy *et al.* (2007) referred a specimen from the St Bathans assemblage to *Aegotheles* sp. but did not name it. The species was named after further referable material was found (Worthy, Scofield, Salisbury *et al.* 2022b). From the Altonian Stage (early Miocene; 19–16 Ma), lower Bannockburn Formation, Manuherikia Group; near St Bathans, Otago.

Replaces *Aegotheles* sp. indet**.**

Order **PHAETHONTIFORMES**: Tropicbirds
Family *INCERTAE SEDIS*: Fossil tropicbirds

In addition to *Clymenoptilon novaezealandicum* listed below, Mayr & Scofield (2015) and Mayr *et al.* (2023) referred to a smaller, as yet undescribed, fossil tropicbird specimen from the Waipara Greensand, Waipara River, Canterbury.

Genus †***Clymenoptilon*** **G.** Mayr, De Pietri, Love, Mannering, Crouch, Reid & Scofield

Clymenoptilon G. Mayr, De Pietri, Love, Mannering, Crouch, Reid & Scofield, 2023: *Alcheringa 47*: 316 – Type species (by original designation) *Clymenoptilon novaezealandicum* Mayr, De Pietri, Love, Mannering, Crouch, Reid & Scofield.

➤†***Clymenoptilon novaezealandicum*** G. Mayr, De Pietri, Love, Mannering, Crouch, Reid & Scofield **Zealandian Tropicbird**

Clymenoptilon novaezealandicum G. Mayr, De Pietri, Love, Mannering, Crouch, Reid & Scofield, 2023: *Alcheringa 47*: 316 – Waipara River, Canterbury.

Described from a partial skeleton including the skull, vertebral column, right wing, pectoral girdle elements, and pelvis from the lower part of the Stormont Member, Waipara Greensand (late early Paleocene to early late Paleaocene, c. 62–58 Ma), in the Waipara River valley, Canterbury (Mayr *et al.* 2023).

Insert before Order Sphenisciformes

Order **SPHENISCIFORMES**: Penguins

Families *INCERTAE SEDIS*: Fossil penguins

Genus †***Kumimanu*** G. Mayr, Scofield, De Pietri & Tennyson

➤ †***Kumimanu fordycei*** Ksepka, Field, Heath, Pett, Thomas, Giovanardi & Tennyson **Fordyce's Penguin**

Kumimanu fordycei Ksepka, Field, Heath, Pett, Thomas, Giovanardi & Tennyson, 2023: *Journal of Paleontology* 2022.88: 3 – Hampden Beach, Otago.

Described from a partial skeleton from the late Paleocene Moeraki Formation (59.5–55.5 Ma) near Oamaru (Ksepka, Field *et al.* 2023).

Insert after ***Kumimanu biceae.***

Genus †***Petradyptes*** Ksepka, Field, Heath, Pett, Thomas, Giovanardi & Tennyson

Petradyptes Ksepka, Field, Heath, Pett, Thomas, Giovanardi & Tennyson, 2023: *Journal of Paleontology* 2022.88: 7 – Type species (by original designation) *Petradyptes stonehousei* Ksepka, Field, Heath, Pett, Thomas, Giovanardi & Tennyson.

➤†***Petradyptes stonehousei*** Ksepka, Field, Heath, Pett, Thomas, Giovanardi & Tennyson **Stonehouse's Penguin**

Petradyptes stonehousei Ksepka, Field, Heath, Pett, Thomas, Giovanardi & Tennyson, 2023: *Journal of Paleontology* 2022.88*:* 7 – Hampden Beach, Otago.

Described from a humerus and part femur (plus three other referred specimens containing multiple skeletal elements) from the late Paleocene Moeraki Formation (59.5–55.5 Ma) near Oamaru (Ksepka *et al.* 2023).

Insert after ***Kumimanu fordycei.***

Family **SPHENISCIDAE** Bonaparte: Penguins

Genus ***Eudyptula*** Bonaparte

The reference to a "*Eudyptula* fossil in New Zealand about 24 mya" (A. Baker *et al.* 2006) appears to refer to a specimen of a small penguin from near the Hakaratarameа River, Waitaki Valley, that has no close affinity with *Eudyptula*, as discussed by Fordyce & Jones (1990), Fordyce (1991b), and Acosta Hospitaleche et al. (2004). Simpson (1975) claimed possible late Pliocene records of the extant *E. minor* (localities not stated); however, Thomas *et al.* (2023) found no referable material, and suggested that the record(s) likely referred to Pleistocene infill deposits.

➤***Eudyptula minor*** (J.R. Forster) **Little Penguin**

Delete from Appendix 1.

➤†***Eudyptula wilsonae*** Thomas, Tennyson, Marx & Ksepka **Wilson's Penguin**

Eudyptula wilsonae Thomas, Tennyson, Marx & Ksepka, 2023: *Journal of Paleontology 97*: 712 – Tangahoe Formation, southern Taranaki.

Known from two late Pliocene (3.36–3.06 Ma) skulls found on the south Taranaki coast (Thomas *et al.* 2023). The age of these fossils precedes the proposed molecular divergence between *E. minor minor* and *E. m. novaehollandiae* at 1.34 Ma (Cole *et al.* 2022).

Add as the only fossil species in genus *Eudyptula*.

Order **PROCELLARIIFORMES**: Albatrosses, Petrels, and Shearwaters

Family **DIOMEDEIDAE** G.R. Gray: Albatrosses

Genus †***Plotornis*** Milne-Edwards

Plotornis Milne-Edwards, 1874: *Ann. Soc. Géol. 11*(3): 4, 5 – Type species (by monotypy) *Plotornis delfortrii* Milne-Edwards.

➤†***Plotornis archaeonautes*** Ksepka, Tennyson, Richards & Fordyce **Hakataramea Albatross**

Plotornis archaeonautes Ksepka, Tennyson, Richards & Fordyce, 2023: *Journ. Roy. Soc. NZ. 54:* 647 – Mount Harris Formation, Hakataramea Quarry, South Canterbury (online 13 November 2023).

Known from an early Miocene (22.7–22.0 Ma) partial skeleton and two other fragments found in the Hakataramea Quarry, Hakataramea River valley, South Canterbury (Ksepka, Tennyson *et al.* 2023). The authors placed *Plotornis* in family "Pan-Diomedeidae" outside the clade of extant albatrosses (Ksepka, Tennyson *et al.* 2023). We include it within Diomedeidae as their Fig. 4 shows branching within Pan-Diomedeidae to be shallower than within Procellariidae.

Insert before ***Aldiomedes angustirostris***.

Family **PROCELLARIIDAE** Leach: Fulmars, Petrels, Prions, and Shearwaters

Genus ***Macronectes*** Richmond

Ossifraga Hombron & Jacquinot, 1844: *Compt. Rend. Séa. Acad. Sci., Paris 18*: 356 – Type species (by monotypy) *Procellaria gigantea* Gmelin. Junior homonym of *Ossifraga* Wood, 1835.

Macronectes Richmond, 1905: *Proc. Biol. Soc. Washington 18*: 76. *Nomen novum* for *Ossifraga* Hombron & Jacquinot, 1844.

➤†***Macronectes tinae* Tennyson & Salvador** **Tina's Giant Petrel**

Macronectes tinae Tennyson & Salvador, 2023: Taxonomy 3: 61 – Tangahoe Formation, Hāwera, southern Taranaki.

Known from a late Pliocene (3.36–3.06 Ma) skull and humerus found on the south Taranaki coast (Tennyson & Salvador 2023).

Insert before ***Procellaria altirostris.***

Order **Incertae sedis**

Family **ZEALANDORNITHIDAE** T. Worthy, Scofield, Salisbury, Hand, De Pietri & Archer: False-colies

Genus †***Zealandornis*** T. Worthy, Scofield, Salisbury, Hand, De Pietri & Archer

Zealandornis T. Worthy, Scofield, Salisbury, Hand, De Pietri & Archer, 2022: *Journ. Ornith. 163*: 650 – Type species (by original designation) *Zealandornis relictus* T. Worthy, Scofield, Salisbury, Hand, De Pietri & Archer.

➤†***Zealandornis relictus*** T. Worthy, Scofield, Salisbury, Hand, De Pietri & Archer **Zealandian False-colie**

Zealandornis relictus T. Worthy, Scofield, Salisbury, Hand, De Pietri & Archer, 2022: *Journ. Ornith. 163*: 650 – Manuherikia River, St Bathans, Otago.

Known from the Altonian Stage (early Miocene; 19–16 Ma) St Bathans assemblage from the lower Bannockburn Formation, Manuherikia Group; near St Bathans, Otago (Worthy, Scofield, Salisbury *et al.* 2022b).

Insert after ***Pikaihao bartlei.***

APPENDIX 3

Alternative English, Māori, and Moriori names for New Zealand birds

The following 'non-bold' names are additional to those presented in Appendix 3 in the 2022 *Checklist*, or are earlier examples of use of the name:

***Anas superciliosa* grey duck, pārera**, perēre (Deighton 1889)
***Apteryx rowi* rowi, Okarito brown kiwi**, Ōkārito kiwi (Rowe *et al.* 2022)
***Charadrius novaeseelandiae* shore plover, tuturuatu**, tchūriwat' (Cubrinovska *et al.* 2022), tūturuatu (Cubrinovska *et al*. 2022)
***Cyanoramphus auriceps* yellow-crowned parakeet, kākāriki**, kakariki kowhai (Verry *et al*. 2022)
***Cygnus sumnerensis* New Zealand swan, matapu; *C. s. chathamicus* Chatham Island swan, poūwa**, pōuwa (Verry *et al*. 2022)
***Fregetta grallaria* white-bellied storm petrel**, white-fringed storm petrel (Mathews 1933)
***Fregetta maoriana* New Zealand storm petrel, takahikare-raro**, Maori storm petrel (Mathews 1933)
***Hemiphaga chathamensis* parea, Chatham Island pigeon**, parea (Deighton 1889)
***Ninox novaeseelandiae* ruru, morepork**, New Zealand morepork (Tsang *et al*. 2022), Tasman morepork (Tsang *et al*. 2022)
***Pachyptila pyramidalis* Pyramid prion**, The Pyramid prion (Shepherd *et al.* 2022).
***Prosthemadera novaeseelandiae* tūī, tui**, kogo (Latham 1782), New Zealand creeper (Latham 1782), poë-bee-eater (Jennings 1828), poë-bird (Latham 1782), poe-honey-eater (Jennings 1828)

Additional common names (of vagrant species, species splits, and newly-described fossil species) appearing elsewhere in this document have also been added to Appendix 3.

Additional references (Appendix 3)

Cubrinovska, I.; Steeves, T.; Houston, D.; Collen, R. & Richardson, A. 2022. Managing inbreeding depression in captive breeding for translocation of tchūriwat' ǀ tūturuatu, a nationally critical shorebird. p.18 *in* NZ Bird Conference 2022, Christchurch, 4–6 June, programme & abstracts. 29 pp.

Deighton, S. 1889. A Moriori vocabulary. *Appendices to the Journal of the House of Representatives* G5. 7 pp.

Jennings, J. 1828. *Ornithologia, or The birds: a poem in two parts, with an introduction to their natural history; and copious notes*. London, Sherwood, Gilbert, and Piper. 468 pp.

Mathews, G.M. 1933. On *Fregetta* Bonaparte and allied genera. *Novitates Zoologicae 39*: 34–54.

Rowe, S.; Stott, M. & Dhami, M. 2022. The impacts of soil as a probiotic in altering the gut microbiome of the Ōkārito kiwi (*Apteryx rowi*) in hatcheries. p. 28 *in* NZ Bird Conference 2022, Christchurch, 4-6 June, programme & abstracts. 29 pp.

Shepherd, L.D.; Miskelly, C.M.; Bulgarella, M.; Tennyson, A.J.D. 2022. Genomic analyses of fairy and fulmar prions (Procellariidae: *Pachyptila* spp.) reveals parallel evolution of bill morphology, and multiple species. *PLoS ONE 17*(9) e0275102. *doi.org/10.1371/journal.pone.0275102* (14 pp).

Tsang, L.R.; Carlile, N.; O'Dwyer, T.; Eldridge, M.D.B.; Frankham, G.J. & Bower, H. 2022. A recent specimen of a Tasmanian boobook *Ninox leucopsis* recovered on Lord Howe Island. *Australian Field Ornithology 39*: 143–157. p.143.

Verry, A.J.F.; Lubbe, P.; Mitchell, K.J. & Rawlence, N.J. 2022. Thirty years of ancient DNA and the faunal biogeography of Aotearoa New Zealand: lessons and future directions. *Journal of the Royal Society of New Zealand*. doi.org/10.1080/03036758.2022.2093227. 23 pp.

ADDITIONAL REFERENCES

The following list contains only those references cited above that are not already in the 2022 *Checklist*.

Barth, J.M.I.; Matschiner, M.; Robertson, B.C. 2013. Phylogenetic position and subspecies divergence of the endangered New Zealand dotterel (*Charadrius obscurus*). *PLOS One 8*(10): e78068.

Bell, B.D.; McKenzie, H.R.; Sibson, R.B.; Hogg, M.J.; Wiblin, R. 1961. Field study course at Farewell Spit 22–29/1/1961. *Notornis 9*: 145–156.

Buller, W.L. 1869. Notes on Herr Finsch's review of Walter Buller's essay on New Zealand ornithology. *Transactions and Proceedings of the New Zealand Institute 1*: 49–57.

Buller, W.L. 1879a. On a further occurrence of the Australian tree swallow (*Hylochelidon nigricans*) in New Zealand. *Transactions and Proceedings of the New Zealand Institute 11*: 360.

Buller, W.L. 1879b. Further contributions to the ornithology of New Zealand. *Transactions and Proceedings of the New Zealand Institute 11*: 366– 376.

Buller, W.L. 1884. On some rare species of New Zealand birds. *Transactions and Proceedings of the New Zealand Institute 16*: 308–318.

Černý, D.; Natale, R. 2022. Comprehensive taxon sampling and vetted fossils help clarify the time tree of shorebirds (Aves, Charadriiformes). *Molecular Phylogenetics and Evolution 177*: 107620.

Checklist Committee (C.M. Miskelly, Convener). 2022. *Checklist of the Birds of New Zealand* (5th edition). Ornithological Society of New Zealand Occasional Publication No. 1. Wellington, Ornithological Society of New Zealand. https://www.birdsnz.org.nz/wp-content/uploads/2022/05/checklist-2022.pdf

Checklist Committee (C.M. Miskelly, Convener). 2024. *Checklist of the Birds of New Zealand* (6th edition). Ornithological Society of New Zealand. https://www.birdsnz.org.nz/society-publications/checklist/

Clements, J.F.; Rasmussen, P.C.; Schulenberg, T.S.; Iliff, M.J.; Fredericks, T.A.; Gerbracht, J.A.; Lepage, D.; Spencer, A.; Billerman, S.M.; Sullivan, B.L. & Wood, C.L. 2023. The eBird/Clements Checklist of Birds of the World: v2023. Downloaded from https://www.birds.cornell.edu/clementschecklist/download/

Cole, T.L.; Zhou, C.; Fang, M.; Pan, H.; Ksepka, D.T.; Fiddaman, S.R.; Emerling, C.A.; Thomas, D.B.; Bi, X.; Fang, Q.; Ellegaard, M.R.; Feng, S.; Smith, A.L.; Heath, T.A.; Tennyson, A.J.D.; Borboroglu, P.G.; Wood, J.R.; Hadden, P.W.; Grosser, S.; Bost, C.-A.; Cherel, Y.; Mattern, T.; Hart, T.; Sinding, H.S.; Shepherd, L.D.; Phillips, R.A.; Quillfeldt, P.; Masello, J.F.; Bouzat, J.L.; Ryan, P.G.; Thompson, D.R.; Ellenberg, U.; Dann, P.; Miller, G.; Boersma, P.D.; Zhao, R.; Gilbert, M.T.P.; Yang, H.; Zhang, D.-X.; Zhang, G. 2022, Genomic insights into the secondary aquatic transition of penguins. *Nature Communications 13*, 3912, https://doi.org/10.1038/s41467-022-31508-9.

Cox, J.B. 1980. Some remarks on the breeding distribution and taxonomy of the prions (Procellariidae: *Pachyptila*). *Records of the South Australian Museum 18*: 91–121.

Cubrinovska, I.; Steeves, T.; Houston, D.; Collen, R.; Richardson, A. 2022. Managing inbreeding depression in captive breeding for translocation of tchūriwat' | tūturuatu, a nationally critical shorebird. p.18 *in* NZ Bird Conference 2022, Christchurch, 4-6 June, programme & abstracts. 29 pp.

Deighton, S. 1889. A Moriori vocabulary. *Appendices to the Journal of the House of Representatives G5*. 7 pp

Dos Remedios, N.; Lee, P.L.M.; Burke,T.; Székely, T.; Küpper, C. 2015. North or south? Phylogenetic and biogeographic origins of a globally distributed avian clade. *Molecular Phylogenetics and Evolution 89*: 151–159.

Finch, B.W. 1986. Black tern *Chlidonias niger* at Moitaka settling ponds, Central Province – first record for the New Guinea Region. *Muruk 1*: 26–28 (reprinted in 1990 with page numbers 27–29).

Garcia-R, J.C.; Joseph, L.; Adcock, G.; Reid, J.; Trewick, S.A. 2017. Interisland gene flow among populations of the buff-banded rail (Aves: Rallidae) and its implications for insular endemism in Oceania. *Journal of Avian Biology 48*: 679–690.

Garcia-R, J.C., Lemmon, E.M.; Lemmon, A.E.; French, N. 2020. Phylogenomic reconstruction sheds light on new relationships and timescale of rails (Aves: Rallidae) evolution. *Diversity 12*: 70.

Garcia-R, J.C.; Matzke, N.J. 2021. Trait-dependent dispersal in rails (Aves: Rallidae): historical biogeography of a cosmopolitan bird clade. *Molecular Phylogenetics and Evolution 159*: 107106.

Harrison, P.; Perrow, M.R.; Larsson, H. 2021. *Seabirds; the new identification guide*. Barcelona, Lynx Edicions. 600 pp.

Henley, J.C. 1974. Australian tree martins near Te Araroa. *Notornis 21*: 266–267.

Jennings, J. 1828. *Ornithologia, or The birds: a poem in two parts, with an introduction to their natural history; and copious notes*. London, Sherwood, Gilbert, and Piper. 468 pp.

Kirchman, J.J.; McInerney, N.R.; Giarla, T.C.; Olson, S.L.; Slikas, E.; Fleischer, R.C. 2021. Phylogeny based on ultra-conserved elements clarifies the evolution of rails and allies (Ralloidea) and is the basis for a revised classification. *American Ornithology 138*: 1–21. DOI: 10.1093/ornithology/ukab042

Ksepka, D.T.; Field, D.J.; Heath, T.A.; Pett, W.; Thomas, D.B.; Giovanardi, S.; Tennyson, A.J.D. 2023. Largest-known fossil penguin provides insight into the early evolution of sphenisciform body size and flipper anatomy. *Journal of Paleontology 2022.88*: 1–20.

Ksepka, D.T.; Tennyson, A.J.D. Richards, M.D.; Fordyce, R.E. 2023. Stem albatrosses wandered far: a new species of *Plotornis* (Aves, Pan-Diomedeidae) from the earliest Miocene of New Zealand. *Journal of the Royal Society of New Zealand 54*: 643–659 (published online 13 November 2023).

Mayr, G.; De Pietri, V.L.; Love, L.; Mannering, A.; Crouch, E.; Reid, E.; Scofield, R.P. 2023. Partial skeleton from the Paleocene of New Zealand illuminates the early evolutionary history of the Phaethontiformes (tropicbirds). *Alcheringa: an Australasian Journal of Palaeontology 47:* 315–326.

Menkhorst, P.; Rogers, D.; Clarke, R.; Davies, J.; Marsack, P.; Franklin, K. 2017. *The Australian bird guide*. London, Bloomsbury, Christopher Helm. 566 pp.

Miskelly, C.M.; Crossland, A.C.; Saville, I.; Southey, I.; Tennyson, A.J.D.; Bell, E.A. 2023. Vagrant and extra-limital bird records accepted by the Birds New Zealand Records Appraisal Committee 2021–2022. *Notornis 70*: 60–73.

Miskelly, C.M.; Shepherd, L.D.; Tennyson, A.J.D. 2023. Designation of a neotype for *Eudyptula minor* (Aves: Spheniscidae). *Zootaxa 5228* (1): 92–96.

Müller, H.H. 1989. Beitrag zur avifauna der Chatham Island (Neuseeland). *Seevogel 10*: 47–62.

Plaza, P.; Cristofari, R.; Gouin, N.; Soto-Gamboa, M.; Luna-Jorquera, G. 2023. A melting-pot for *Pterodroma* petrels on Rapa Nui: ecological divergence and reproductive isolation in a contact zone. *Frontiers in Ecology and Evolution 11*: 1123288.

Rowe, S.; Stott, M.; Dhami, M. 2022. The impacts of soil as a probiotic in altering the gut microbiome of the Ōkārito kiwi (*Apteryx rowi*) in hatcheries. p. 28 *in* NZ Bird Conference 2022, Christchurch, 4-6 June, programme & abstracts. 29 pp.

Salter, J.F.; Oliveros, C.H.; Hosner, P.A.; Manthey, J.D.; Robbins, M.B.; Moyle, R.G.; Brumfield, R.T.; Faircloth, B.C. 2020. Extensive paraphyly in the typical owl family (Strigidae). *The Auk 137*: ukz070.

Savage, J.L.; Digby, A. 2023. Nomenclatural Note. *Strigops habroptilus* Gray, 1845 is the valid scientific name of the kākāpō (Aves, Strigopidae). *Bulletin of Zoological Nomenclature 80*: 112–115.

Schweizer, M.; Bakewell, D.N.; Liu, Y. 2023. Taxonomy, phylogenetic history and identification of the sand plover complex. *Dutch Birding 45*: 326–335.

Shepherd, L.D.; Miskelly, C.M.; Bulgarella, M.; Tennyson, A.J.D. 2022. Genomic analyses of fairy and fulmar prions (Procellariidae: *Pachyptila* spp.) reveals parallel evolution of bill morphology, and multiple species. *PLoS ONE 17*(9) e0275102.

Tennyson, A.J.D.; Greer, L.; Lubbe, P.; Marx, F.G.; Richards, M.D.; Giovanardi, S.; Rawlence, N.J. 2022. A new species of large duck (Aves: Anatidae) from the Miocene of New Zealand. *Taxonomy 2*: 136-144.

Tennyson, A.J.D.; Salvador, R.B. 2023. A new giant petrel (*Macronectes*, Aves: Procellariidae) from the Pliocene of Taranaki, New Zealand. *Taxonomy 3*: 57–67.

Thomas, D.B.; Tennyson, A.J.D.; Marx, F.G.; Ksepka, D.T. 2023. Pliocene fossils support a New Zealand origin for the smallest extant penguins. *Journal of Paleontology 97*: 711–721.

Thomas, O.J.W.; Hunt, E.K.S. 2023. Year of the tern: the first record of black tern (*Chlidonias niger*) from New Zealand. *Notornis 70*: 93–95.

Tsang, L.R.; Carlile, N.; O'Dwyer, T.; Eldridge, M.D.B.; Frankham, G.J.; Bower, H. 2022. A recent specimen of a Tasmanian boobook *Ninox leucopsis* recovered on Lord Howe Island. *Australian Field Ornithology 39:* 143–157.

Verry, A.J.F.; Lubbe, P.; Mitchell, K.J.; Rawlence, N.J. 2022. Thirty years of ancient DNA and the faunal biogeography of Aotearoa New Zealand: lessons and future directions. *Journal of the Royal Society of New Zealand. 54*, 75–97.

Watola, G.V. 2023. An historical review of tree martin (*Petrochelidon nigricans*) records in New Zealand. *Notornis 70*: 170–181.

Wei, C.; Schweizer.; M.; Tomkovich, P.S.; Arkhipov, V.Y.; Romanov, M.; Martinez, J.; Lin, X.; Halimubieke, N.; Que, P.; Mu, T.; Huang, Q.; Zhang, Z.; Székely, T.; Liu, Y. 2022. Genome-wide data reveal paraphyly in the sand plover complex (*Charadrius mongolus/leschenaultii*). *Ornithology 139*: ukab085.

Worthy, T.H.; Scofield, R.P.; Hand, S.J.; De Pietri, V.L.; Archer, M. 2022. A swan-sized fossil anatid (Aves: Anatidae) from the early Miocene St Bathans Fauna of New Zealand. *Zootaxa 5168*: 39–50.

Worthy, T.H.; Scofield, R.P.; Salisbury, S.W.; Hand, S.J.; De Pietri, V.L.; Archer, M. 2022b. Two new neoavian taxa with contrasting palaeobiogeographical implications from the early Miocene St Bathans Fauna, New Zealand. *Journal of Ornithology 163*: 643–658.

Worthy, T.H.; Scofield, R.P.; Salisbury, S.W.; Hand, S.J.; De Pietri, V.L.; Blokland, J.C.; Archer, M. 2022a. A new species of *Manuherikia* (Aves: Anatidae) provides evidence of faunal turnover in the St Bathans Fauna, New Zealand. *Geobios 70*: 87-107.

References to delete

Garner, M.; Lewington, I. & Slack, R. 2003. Mongolian and lesser sand plovers: an identification overview. *Birding World 16*: 377–385.

Wright, A. 1960. Rare birds at Farewell Spit: tree martins. *Notornis 8*: 260–261.

Notornis, 2024, Vol. 71: 115-120
0029-4470 © The Ornithological Society of New Zealand Inc.

SHORT NOTE

Sexual dimorphism in plumage, and gender roles in breeding kawau pāteketeke | New Zealand king shags (*Leucocarbo carunculatus*)

HELEN GUMMER
c/o Department of Conservation, PO Box 10420, Wellington 6140, New Zealand

The kawau pāteketeke | New Zealand king shag (*Leucocarbo carunculatus*) is a marine cormorant endemic to Aotearoa New Zealand and currently restricted to Te Tauihu-o-te-Waka/Marlborough Sounds. It is the most northerly of the three remaining *Leucocarbo* species on the mainland (Rawlence *et al*. 2017) and the most under threat of all shags in the New Zealand region (Robertson *et al*. 2021). Recent population estimates and fluctuations are described by Bell (2022), and summarised in Gummer *et al*. (2024).

New Zealand king shags are large, black-and-white marine birds belonging to the pink-footed, blue-eyed shags of the genus *Leucocarbo* (Kennedy & Spencer 2014; Checklist Committee 2022). Birds have black plumage extending from forehead, crown, and nape, down the dorsal area of mantle, scapulars, back and tail; a pair of dorsal patches, or a single dorsal patch of white feathering features on some birds (Marchant & Higgins 1990; Schuckard 2013[2022]). Dorsal patches are described as ‘sometimes occurring’ in several other blue-eyed shags (Rasmussen 1984; Marchant & Higgins 1990; Miskelly & Cooper 2020). Apart from white wing or alar patches forming a stripe near the leading edge of the inner wing, the wings are black; when wings are folded, together with white scapulars, the alar stripes can appear more extensive.

New Zealand king shags are sexually dimorphic in size with males larger and heavier than females (Nelson 2005). Pairs are monogamous; both adults participate in incubation (Marchant & Higgins 1990) and feeding of young for extended periods (Bell 2022; Gummer *et al*. 2024).

This short note reports on differences in the white dorsal patches of breeding New Zealand king shags at two colonies in 2019, and how these were identified for the first time as a sexually dimorphic plumage feature, using static field camera technology in a Department of Conservation (DOC)-initiated study investigating breeding biology and threats to productivity. Details of study sites, fixed camera deployment (dates, fields of view, etc.) and image analysis (methods, results) are described by Gummer *et al*. (2024). The timing of the appearance of dorsal markings in an immature bird is described, and gender differences in activity during breeding are clarified.

Cameras at two of the four New Zealand king shag breeding colonies—Duffers Reef and White Rocks—provided images with robust data on breeding biology at egg-laying, incubation, and nestling stage because they looked down onto colonies from above and allowed viewing of nest contents. It was during analyses of these images that differences in the white dorsal markings between birds in breeding pairs was first observed. Data were collected on these markings for 35 pairs when birds were sitting on nests in a horizontal position, wings relaxed, during incubation or brooding.

Received 8 July 2024; accepted 20 September 2024
*Correspondence: hellyg@outlook.co.nz

Dorsal plumage markings are usually concealed by folded wings in standing birds.

Variation in dorsal markings was noticed because daily sex-related behavioural rhythms exhibited by the species meant the colony was attended by one gender only at two specific times of the day during the incubation period, revealing a uniform change in the size and pattern of the white patch(es) at most nests between early morning and early afternoon. Schuckard (1994) predicted that adult New Zealand king shags feeding chicks and departing colonies at sunrise and arriving back about midday were likely to be females, and that the second departure of birds to sea shortly after were likely to be males, akin to sex-influenced foraging patterns commonly described for the family Phalacrocoracidae (Marchant & Higgins 1990). Thus, distinctive plumage differences were linked to gender through birds' rhythmic daily colony attendance, and later confirmed by observations of copulation and egg-laying events.

Nine of the ten monitored pairs in the Duffers Reef camera view comprised one bird with a white dorsal saddle and in the other case two large, almost merging white spots, and at all nests their partners had two separate, relatively smaller white patches referred to as spots (Table 1). The birds with a saddle were deduced to be males: they were slightly larger than their partners, incubating during the morning shift (Fig. 1), and one was seen on top during a copulation event. The birds with two spots were females: they were slightly smaller than

Table 1. Dorsal plumage markings in New Zealand king shag breeding pairs at Duffers Reef (2019).

	White dorsal marking	
Nest	**Male**	**Female**
B	Saddle	Two spots
C	Saddle	Two spots
D	Saddle	Two spots
E	Saddle	Two spots
F	Saddle	Two spots
G	Saddle	Two spots
H	Big spots, almost merging	Two spots
I	Saddle	Two spots
J	Saddle	Two spots
K	Saddle	Two spots

Figure 1. New Zealand king shag (*Leucocarbo carunculatus*) dorsal plumage patches, Duffers Reef, 2019. Clockwise from left: Pair during courtship/nest-building with 'saddled' male (note smaller caruncles) and 'spotted' female (18 Apr); incubating male New Zealand king shags in rain showing 'saddles' (10:36h, 05 Jun); pre-laying females during nest-building phase (same nest sites as above) showing 'spots' (19:06h, 15 Mar). (Photographs taken by static field cameras).

their partners, attending nests during the afternoon (Fig. 1), and one was underneath during a copulation event. Genders were reaffirmed when an egg was seen to be laid in the afternoon when a 'two-spotted' bird was at the nest; its 'saddled' mate was not present at the time.

At White Rocks, males sitting on nests from early morning through to the middle of the day exhibited the following range of dorsal markings: a saddle (eight males); or two large almost-merging white spots (two males); or two big or medium-sized separate spots (14 males), or in one case only small, clearly separated white spots (Table 2). These birds also seemed marginally larger than their partners in body size.

White Rocks females on nests through the afternoon to early evening exhibited the following: two medium-sized, or two small, or two tiny, separated white spots, the latter barely visible (predominantly black back). In nearly all cases, females showed smaller white spots than their male partners.

One pairing at a third study site (Tawhitinui) had a banded male (confirmed using feather DNA; Bell 2020) with distinct medium-sized spots while his mate had a small-medium patch of slightly merged spots, the only female showing this marking; the comparative patch sizes still reflected the trend for larger markings in males.

Inter-colony variation in dorsal markings was observed, with Duffers Reef males and females showing dorsal markings larger than White Rocks males and females. While 90% of monitored males had saddles at Duffers Reef, only 32% of monitored White Rocks males had saddles; more White Rocks males (15 of 25 birds) had two distinct white spots.

White Rocks females had spots less conspicuous than those on Duffers Reef females. Further study is required to determine the extent of inter-colony differences, which may reflect genetic variation. Saddles were noted as predominant on males at nests in camera view at a fourth study site, Kuru Pongi, during retrospective observations (refer Fig. 1 in Gummer *et al*. 2024).

Prior to this study, the significance of dorsal patches in blue-eyed shags as a sexually dimorphic plumage feature has remained largely undetected, although Marchant & Higgins (1990) briefly link white dorsal patches to male Auckland (*Leucocarbo colensoi*) and Bounty Island shags (*Leucocarbo ranfurlyi*). Nelson (2005) described cormorants and shags as sexually monomorphic in plumage. There is no description of variation in patterns on dorsal patches in New Zealand king shags in Marchant & Higgins (1990), possibly because the dorsal patch is a plumage feature often concealed by closed wings on museum specimens (Miskelly & Cooper 2020).

Plumage variation was not previously picked up in aerial census photographs (Schuckard *et al*. 2018) because the focus of analyses was counting birds, but also flight elevation and shadowing caused by low winter sun angles may have made it

Table 2. Dorsal plumage markings in New Zealand king shag breeding pairs at White Rocks (2019). All spots clearly separate unless otherwise stated.

	White dorsal marking			White dorsal marking	
Nest	**Male**	**Female**	**Nest**	**Male**	**Female**
A	Big spots, almost merging	Small spots	O	Big spots	Medium spots
B	Big spots	Small spots	P	Big spots	Small spots
C	Saddle	Small spots	Q	Saddle	No data
D	Big spots	Small spots	R	Saddle	Medium spots
E	Saddle	Small spots	S	Saddle	No data
F	Saddle	Medium spots	U**	Medium spots	Medium spots
G	Medium spots	Small spots	V**	Medium spots	Medium spots
H	Saddle	No data	W**	Medium spots	Medium spots
I	Big spots	No data	X	Big spots, almost merging	Small spots
K	Medium spots	Medium spots	Y	Saddle	Small spots
L	Medium spots	Tiny spots *	Z	Big spots	Small spots
M	Small spots	Tiny spots	@	Big spots	Small spots
N	Big spots	Tiny spots *			

* Tiny spots were barely visible. ** Unsuccessful pairings—any marginal difference in patch size could not be detected at distance, or possible female-female pairings if shortage of males as observed in other seabirds (Taylor, 2024). Nest U was known to have two eggs laid in the season. Nest W pair divorced in Aug with new adult roosting there from Sep.

hard to observe this level of detail (G. Taylor, pers. comm. 2024). Perhaps most significant was that aerial photographs were taken in the middle of the day when birds would have been swapping nest duties with partners, and sitting birds of both sexes may have shown a mix of both saddles and spots, rather than one common pattern on all birds of the same gender.

Dorsal patches are described, and may be sexually dimorphic features, in other blue-eyed shags. For example, Rasmussen (1994) noted that a white dorsal patch was present in about one-half of the adult imperial shags (*Leucocarbo atriceps*), and that similar proportions occurred each season.

The function of dorsal markings is not known, but a different back pattern in females may provide an additional sexual cue or stimulant for courting and copulating males as her patterning will be most visible in the mating posture (G. Taylor, pers. comm. 2024). Individual patterns possibly aid new partner recognition and/or provide guidance to landing birds in new pairings.

The development of dorsal plumage markings was easiest to follow in a chick banded on 10 Aug 2018 at Tawhitinui (White03) and observed to have fledged before 28 Aug at a minimum age of two months (Bell 2019; Gummer *et al.* 2024). It was estimated to be around 9.5 months old in early Apr 2019 when the dorsal patches were noticeable in one image. By mid-Aug 2019, plumage was generally a dark chocolate colour, the white alar patches not extensive or well defined in images, but the bird was suspected as being male with two large dorsal white spots almost touching. These, and the alar patches, were very well defined by mid-Oct, and black feathers were also coming through, with some brown still on the wings. By mid-Nov 2019 (at least 17 months old), the transition into full adult plumage seemed complete.

Marchant & Higgins (1990) stated that juvenile New Zealand king shags had no alar, scapular, or back patch. However, white markings were discernible in several juveniles that were as young as ten months of age in this study, but not as sharply demarcated from surrounding feathers as in adults (Fig. 2), giving patches a pale brown or sandy appearance as described for imperial and Chatham Island shag juveniles (Rasmussen 1994; Marchant & Higgins 1990). Dorsal patches were well-defined at 14 months, and so post-juvenile moult is likely to commence before the 15-month age given by Marchant & Higgins (1990).

This study was able to confirm sex-related foraging behaviour in breeding New Zealand king shags, with females leaving the colony at first light, returning in the middle of the day, and males then departing, returning late afternoon to dusk. Sexually distinct daily activity patterns prevent nests being unattended, reducing the risk of nests being dismantled or egg/chick loss through depredation by conspecifics (Bernstein & Maxson 1984), or exposure to opportunistic predators such as gulls (Gummer *et al*. 2024). In addition, sexual segregation in foraging areas/depths, and/or diet, diminishes competition between genders, e.g., Antarctic shag (*Leucocarbo bransfieldensis*) (Casaux & Bertolin 2018); recent studies suggest New Zealand king shags reflect this, but with individual preferences overriding the sex-stereotyped behaviour (Bell 2022).

Sexually dimorphic plumage markings also enabled clarification of New Zealand king shag parental roles during egg and early nestling phases. At Duffers Reef, movements of both sexes during courtship prior to egg-laying in April were followed: females departed after it was light (typically 0800–0900h) and returned around the middle of the day; pairs loafed together for a period (e.g., an hour) then males departed for afternoon, returning late afternoon to dusk. This period in the middle of the day is when nest material collection typically occurs (Bernstein & Maxson 1984; Schuckard 1994). In this study, some birds did come and go a little more frequently through some days. Sometimes, a female would disappear again in the afternoon and be back by dusk, and sometimes the male would also fit in a second excursion at the end of the day.

At White Rocks, in March prior to egg-laying,

Figure 2. Dorsal patches showing on previous season's 2018-juvenile New Zealand king shag (5 May 2019).

it was noted that males tended to stand at the nest in the morning, whereas females sat on the nest in the afternoon. In fact, this reflected a general observation (albeit limited) that showed breeding males spending overall less time sitting at the nest outside the incubation and brooding phases than females, e.g., before egg laying but also following breeding failure.

During incubation, generally only males occupied nests at daybreak while females were out foraging, returning late morning to mid-afternoon after which generally only females were on nests, males returning from sea late afternoon to nightfall. These extended foraging hours have also been documented by Schuckard (1994). Good night-viewing at Duffers Reef showed incubation swap-overs in the early hours, usually between 0200–0400h, with all males ready on the nest by daybreak for the first day-time shift. In summary, each sex made a single daily foraging excursion during the incubation phase.

There were two nests with good observations on feeding patterns of pairs with one or two newly hatched nestlings. Males made an extra excursion away from the nest later in the day as soon as the first young had hatched. One male was seen feeding his chick while standing by the nest, while his mate brooded. Once all chicks had hatched, both parents made two excursions to sea each day. Typically, females with young would leave ahead of other females with eggs, returning by mid-morning, and males rearing chicks would leave late morning returning early afternoon ahead of incubating males. Then females departed early afternoon, returning mid-afternoon, and finally, males were gone by late afternoon, returning before dark. In summary, one then both parents would increase foraging trips to two each per day (daylight hours only) once all nestlings had hatched. Increasing foraging trip number while reducing trip duration as nest energy requirements increase occurs in other shags (Casaux & Berrera-Oro 2006).

Data collection on movements of parents feeding older chicks was not feasible as dorsal markings could not be seen once adults were no longer sitting at nests. There are other features worth future investigation for sex differences. Alar markings were variable on birds and limited observations suggest they are potentially related to dorsal patch size. While not a focus of this study but notable for the species, caruncles were at least as large on females as on males, and sometimes larger (Fig. 1).

ACKNOWLEDGEMENTS

This project was funded by the Marine Species Team, Biodiversity Group, DOC and supervised by Graeme Taylor and Karen Middlemiss. Dan Palmer (DOC) and Mike Bell (Wildlife Management International/Toroa Consulting) set up the cameras and downloaded the data.

LITERATURE CITED

Bell, M. 2019. King shag research project: Year One update report. Unpubl. Wildlife Management International Technical Report to the Marine Farming Association and Seafood Innovations Limited.

Bell, M. 2020. New Zealand King Shag research project: Year Two update report. Unpubl. Toroa Consulting Technical Report to the Marine Farming Association and Seafood Innovations Limited.

Bell, M. (*ed.*). 2022. Kawau pāteketeke/King Shag (*Leucocarbo carunculatus*) Research 2018–2022. Final report on the Marine Farming Association and Seafood Innovations Limited King Shag research project. Unpubl. Toroa Consulting Technical Report to the Marine Farming Association and Seafood Innovations Limited.

Bernstein, N.P.; Maxson, S.J. 1984. Sexually distinct daily activity patterns of blue-eyed shags in Antarctica. *The Condor 86*: 151–156.

Casaux, R.; Barrera-Oro, E. 2006. Review—Shags in Antarctica: their feeding behaviour and ecological role in the marine food web. *Antarctic Science 18:* 3–14.

Casaux, R.; Bertolin, M.L. 2018. Foraging patterns of the Antarctic Shag *Phalacrocorax bransfieldensis* at Harmony Point, Antarctica. *Marine Ornithology 46(2)*: 169–175.

Checklist Committee (OSNZ). 2022. Checklist of the Birds of New Zealand (5th edition). *Ornithological Society of New Zealand Occasional Publication No. 1*. Wellington: Ornithological Society of New Zealand.

Gummer, H.; Taylor, G.A.; Palmer, D.; Bell, M. 2024. Breeding biology of New Zealand king shags (*Leucocarbo carunculatus*). *Notornis 71:* 77–92.

Kennedy, M.; Spencer, H.G. 2014. Classification of the cormorants of the world. *Molecular Phylogenetics and Evolution 79*: 249–257.

Marchant, S.; Higgins, P.J. (*eds*). 1990. *Handbook of Australian, New Zealand birds and Antarctic Birds.* Vol. 1. Ratites to ducks. Part B. Melbourne, Oxford University Press.

Miskelly, C.M.; Cooper, J.H. 2020. Macquarie Island shags (*Leucocarbo purpurascens*) at the Auckland Islands – an addition to the New Zealand list. *Notornis 67*: 419–426.

Nelson, J. B. 2005. *Pelicans, cormorants, and their relatives. The Pelecaniformes*. Oxford University Press, Oxford, UK.

Rasmussen, P.C. 1994. Geographic variation in morphology and allozymes of South American imperial shags. *The Auk 111*(1): 143–161.

Rawlence, N.J.; Till, C.E.; Easton, L.J.; Spencer, H.G.; Schuckard, R.; Melville, D.S.; Scofield, R.P.; Tennyson, A.J.D.; Rayner, M.J.; Waters, J.M.; Kennedy, M. 2017. Speciation, range contraction and extinction in the endemic New Zealand king shag complex. *Molecular Phylogenetics and Evolution 115*: 197–209.

Robertson, H.A.; Baird, K.A.; Elliott, G.P.; Hitchmough, R.A.; McArthur, N.J.; Makan, T.; Miskelly, C.M.; O'Donnell, C.J.; Sagar, P.M.; Scofield, R.P.; Taylor, G.A.; Michel, P. 2021. Conservation status of birds in Aotearoa New Zealand 2021. *New Zealand Threat Classification Series 36*. Department of Conservation, Wellington. 43 p.

Schuckard, R. 1994. New Zealand king shag (*Leucocarbo carunculatus*) on Duffers Reef, Marlborough Sounds. *Notornis 41*: 93–108.

Schuckard, R. 2013 [updated 2022]. New Zealand king shag. In Miskelly, C.M. (*ed.*) *New Zealand Birds Online*. www.nzbirdsonline.org.nz

Schuckard, R.; Bell, M.; Frost, P.; Taylor, G.; Greene, T. 2018. A census of nesting pairs of the endemic New Zealand king shag (*Leucocarbo carunculatus*) in 2016 and 2017. *Notornis 65*: 59–66.

Taylor, G.A. 2024 Successful breeding by female-female pairs of flesh-footed shearwaters (*Ardenna carneipes*). *Notornis 71*: 233–236.

Keywords: New Zealand king shag, *Leucocarbo carunculatus*, sexual dimorphism, plumage variation, dorsal patch, parental roles

Notornis, 2024, Vol. 71: 121-124
0029-4470 © The Ornithological Society of New Zealand Inc.

SHORT NOTE

First record of the Eurasian tree sparrow (*Passer montanus*) from Buka, Autonomous Region of Bougainville, Papua New Guinea, and status of the species in Melanesia

JAN-UWE SCHMIDT
Egon-Erwin-Kisch-Str. 26, 01069 Dresden, Germany

The Eurasian tree sparrow (*Passer montanus*) is widespread in its native range in Eurasia and is also found as an introduced species elsewhere, including North America and Australia (Summers-Smith 1995; Barlow *et al.* 2020). It has spread into the insular South Pacific in Micronesia (Clement *et al.* 1993) and in recent years into Melanesia. It is also present on American Samoa (American Samoa Department of Marine & Wildlife Resources, 9 Sep 2022, www.facebook.com/asdmwr; A. Harmon, 2024, ebird.org/checklist/S163378908). Here, I report the first record from Buka, Autonomous Region of Bougainville, Papua New Guinea, and summarise the current status of the species in Melanesia.

I visited Buka and Bougainville Island in November 2022 and January 2024. Buka is the gateway to the region, with daily flights to Port Moresby and Rabaul, and a regular ferry service to the latter. I was aware of the potential presence of Eurasian tree sparrows there and looked for them in 2022 and 2024, but it was not until the last day of my second visit that I saw them. On 25 Jan 2024 I found several tree sparrows near Buka airport. I first saw a flock of eight individuals, and shortly after they had departed, another five sparrows approached from the opposite direction to where the first flock had flown, making a total of 13

Received 18 February 2024; accepted 20 September 2024
*Correspondence: jan-uwe.schmidt@gmx.de

Figure 1. Eurasian tree sparrow on a power pole near Buka Airport, 25 January 2024.

individuals (Fig. 1). The sheer number of individuals suggests the successful establishment of a new local population and even breeding. The birds were found in urban habitat, a mixture of small houses and gardens with scattered trees. They were busy and active, perching only briefly in bushes and on power poles or wires before flying away.

This is the first record of the Eurasian tree sparrow from the North Solomons region of Papua New Guinea. The species is currently spreading into the insular South-West Pacific. It was recorded on Biak Island, Indonesia, in May 1989 (Holmes 1989), followed by records from Indonesian New Guinea in Amamapare in 1997 (Holmes & Gregory 1997) or 1998 (van Balen *et al.* 2011) and Sorong 2004 (Hornbuckle & Merrill 2004). By 2008 it had reached Port Moresby (J. Raven, 2008, ebird.org/checklist/S56079996), Mount Hagen (M. Edgecombe, 2008, ebird.org/checklist/S122037367; P. Gregory, 2008, ebird.org/checklist/S136004759), Manokwari (R. Chase, 2008, ebird.org/checklist/S7224535), Jayapura (e.g. R. Chase, 2008, ebird.org/checklist/S7237129) and Wamena (e.g. A. Whitlock, 2008, ebird.org/checklist/S47942931). The Eurasian tree sparrow is now present in many towns in both mainland Papua New Guinea and the Indonesian part of the island, including some very remote places with no road access, but is largely absent from rural areas (www.ebird.org).

In the Bismarck Archipelago, it was first recorded on New Britain around Kimbe and Hoskins in July 2000 (S. Conklin, 2000, ebird.org/checklist/S55449198, ebird.org/checklist/S55463366) and again in April and June 2007 (Gregory 2009). It is now also present in and around Rabaul, New Britain, since at least March 2019 (G. Wood, 2019, ebird.org/checklist/S53273498), on Lihir Island since at least October 2019 (A. Babych, 2019, ebird.org/australia/checklist/S61060114), and on New Ireland. On the latter, records began in July 2022 in and around Kavieng (K. Markham, 2022, ebird.org/checklist/S115931638), but the species has since been recorded from other locations on the island. Recent records have also come from Manus, Lavongai, Mussau and even remote Tench Island (R. Bayldon, 2024, ebird.org/checklist/S175233490, ebird.org/checklist/S175122249, ebird.org/checklist/S175010352; J.C. Mittermeier & E. Cottee-Jones, 2024, ebird.org/checklist/S194603576).

In the Solomon Islands, Eurasian tree sparrows were first noticed at Henderson Airport on Guadalcanal Island, where an individual was observed in September 2004 (Dutson 2010 *in* Tarburton 2024). The species is now well established on the central north coast of the island (Butcher *et al.* 2020). Recent records have also come from Buala, Isabel Island, in 2018 (S. Brady, J.M. McCullough & X. Mapel, 2018, ebird.org/checklist/S48935153; L. DeCicco, 2018, ebird.org/checklist/S47582913), from Auki (Malaita) (Dutson 2011; P. Gregory, 2023, ebird.org/checklist/S149910835), and from Tulagi in 2019 (Butcher *et al.* 2020).

In Vanuatu, it has been well established around Luganville on Santo Island since at least 2021 (R. Macalister, 2021, ebird.org/checklist/S84313767).

It has not yet been recorded from New Caledonia, where the house sparrow (*Passer domesticus*) is widespread (Dutson 2011).

These introductions were almost certainly accidental, although intentional translocations cannot be ruled out. However, it is not an attractive species for the cage bird trade (although it is part of it in Indonesia (e.g. Chng *et al.* 2018)) and is usually considered an agricultural pest, making deliberate transport and release unlikely. Although several authors have suggested that the species usually arrived by ship (e.g. Holmes & Gregory 1997; Beehler & Pratt 2016; Butcher *et al.* 2020), there is some evidence that this may not have been the only mode of transport. Air transport was the only way to reach highland towns such as Wamena and other remote places in the interior of New Guinea (notably Doufu, Pagamba and Pogapa in Western New Guinea; see www.ebird.org). In Port Moresby, the first record was made at Jackson's Airport, and on Guadalcanal the first sighting was made at Henderson Airport. On recently colonised Manus Island, a small breeding population was found at the airport (J.C. Mittermeier & E. Cottee-Jones, 2024, ebird.org/checklist/S194603576). Small birds have been found in the cabin of international and domestic passenger flights (e.g. media reports of a small bird (allegedly a sparrow) in the cockpit of a flight from Bahrain to Kochi on 15 July 2022; a house sparrow in the cabin of a Korean Airlines flight in Seoul on 7 Oct 2009; a hummingbird/sparrow in the cockpit of Delta flight DL1943 from Detroit to Atlanta on 30 Dec 2017). Nevertheless, it seems unlikely that pairs or small groups of sparrows have been transported in the cabin of a passenger flight. However, it is conceivable that they may have been transported within the freight compartment, particularly on civil or military cargo flights, although I am not aware of any formal reports of this.

While ship-assisted dispersal may have played the major role, I would postulate that air transport is responsible for at least part of the spread as previously suggested, e.g. by Temme (1985). In addition, local movements may have contributed, following transport routes up rivers and along roads, particularly those with human agriculture and settlement (e.g. along the coastal highway on New Ireland). Tree sparrows are also capable of crossing open water on their own (Summers-Smith 1995), although they rarely do so and, to my knowledge, this behaviour has not been documented in the tropics.

On Buka Island, the sparrows have also been seen near the airport terminal. They may have arrived on one of the relief flights for those affected by the eruption of Mount Bagana in July 2023, or they may have made their way from the nearby Buka docks after being transported by ship.

Following the extinction of the previously established common myna (*Acridotheres tristis*) in Arawa (Hadden 2004), it is currently the only non-native species in the North Solomons. As with other introduced species, attention should be paid to potential impacts on native birds. As the Eurasian tree sparrow is closely associated with human settlements, the risk of displacing native species is not particularly high. However, potential competition for food in grasslands close to towns and villages cannot be ruled out. The Buka population of the buff-bellied mannikin (*Lonchura melaena bukaensis*), formerly found in the grasslands around Buka Airport, has not been recorded for more than 30 years and is thought to be possibly extinct (Hadden 2004; Dutson 2011). If a small population is still present, any further threat would be of concern. There is currently no evidence of a threat to native species by tree sparrows in Melanesia, but the further spread of this invasive species should be closely monitored, with particular attention paid to interactions with other species such as the various endemic mannikin species (genus *Lonchura*).

The Eurasian tree sparrow is becoming increasingly established in Melanesia, particularly in and around human settlements. However, breeding records are sparse and although breeding can be assumed when the species is well established, some attention should be paid to providing evidence. There is also a lack of observations on how the species has moved to new islands or new locations, which should be given more attention, e.g. by interviewing local people.

As the species continues to expand its range, ornithologists are encouraged to look for it in places where it has not yet been recorded. Munda, Gizo, or Choiseul in the Solomon Islands, and Nouméa, New Caledonia, could be the next stepping stones in the species' ongoing expansion into Melanesia.

LITERATURE CITED

Barlow, J.C.; Leckie, S.N.; Pyle, P.; Patten M.A. 2020. Eurasian tree sparrow (*Passer montanus*), version 1.0. *In:* Billerman, S. M. *(ed.) Birds of the World.* Ithaca, NY, USA, Cornell Lab of Ornithology. https://doi.org/10.2173/bow.eutspa.01.

Beehler, B.M.; Pratt, T.K. 2016. *Birds of New Guinea – distribution, taxonomy, and systematics.* Princeton and Oxford, Princeton University Press.

Butcher, S.C.; Crossland, A.C.; Crutchley, P.; Mugan, N.D.; Simeon, K. 2020. Eurasian tree sparrow (*Passer montanus*) recently established on Guadalcanal, Solomon Islands. *Notornis 67*: 485–487.

Chng, S.C.L.; Krishnasamy, K.; Eaton, J.A. 2018. In the market for extinction: the cage bird trade in Bali. *Forktail 34*: 35–41.

Clement, P.; Harris, A.; Davis, J. 1993. *Finches and sparrow – an identification guide.* London, Helm.

Dutson, G. 2011. *Birds of Melanesia – The Bismarcks, Solomons, Vanuatu and New Caledonia.* London, Helm.

Gregory, P. 2008. *Rondon Ridge Lodge, Western Highlands, Papua New Guinea, eBird checklist.* https://ebird.org/checklist/S136004759.

Gregory, P. 2009. Eurasian tree sparrows (*Passer montanus*) in PNG. *Muruk 9*: 98–99.

Hadden, D. 2004. *Birds and bird lore of Bougainville and the North Solomons.* Alderley, QLD, Dove.

Holmes, D.A. 1989. The tree sparrow reaches New Guinea. *Kukila 4*: 151.

Holmes, D.A.; Gregory, P. 1997. Records of house sparrows in Irian Jaya. *Kukila 9*: 181–182.

Hornbuckle, J.; Merrill, I. 2004. *Eastern Indonesia: Sulawesi, Halmahera, west Irian Jaya, Ambon and Tanimbar, August-September 2004.* http://burung-nusantara.org/wp-content/uploads/2012/07/Indonesia_2004_Hornbuckle-et-al.pdf

Summers-Smith, D. 1995. *The tree sparrow.* Guisborough, Summers-Smith.

Tarburton, M.K. 2024. *Bird checklists for 672 Melanesian Islands: Guadalcanal Island bird checklist, Solomon Islands.* http://birdsofmelanesia.net/solomons8.html/guadalcanal.pdf

Temme, M. 1985. First records of wood sandpiper, ruff and Eurasian tree sparrow from the Marshall Islands. *Atoll Research Bulletin 292*: 23–27.

van Balen, S.; Noske, R.; Supriatna, A.A. 2011. Around the archipelago. *Kukila 15*: 126–143.

Keywords: Eurasian tree sparrow, Melanesia, Buka Island

Notornis, 2024, Vol. 71: 125-127
0029-4470 © The Ornithological Society of New Zealand Inc.

SHORT NOTE

Observations of southern New Zealand dotterel | pukunui (*Charadrius obscurus obscurus*) foraging on tātaraheke | sand coprosma (*Coprosma acerosa*) at Mason Bay

BRUCE MCKINLAY*
Department of Conservation, 265 Princes Street, Dunedin 9016, New Zealand

DANIEL COCKER
Department of Conservation, 15 Main Road, Rakiura 9846, New Zealand

ROSE COLLEN
62 Bain St, Invercargill, 9812, New Zealand

SHONA SANGSTER
108B Elgin Terrace, Oban, Stewart Island 9818, New Zealand

The diet of the plovers (subfamily Charadriinae) is reported as consisting mainly of marine and intertidal invertebrates (Burton 1972; Marchant & Higgins 1993; Wiersma 1996), however many plovers feed on terrestrial and freshwater invertebrates and not all plovers are coastal. The diet of the New Zealand dotterel *(Charadrius obscurus*) consists of a wide range of marine and terrestrial molluscs, insects, amphipods, crabs and fish (Marchant & Higgins 1993). Relatively little is known of the diet of the southern subspecies (*C. o. obscurus*), but it includes crabs and small flounders (Barlow 1993), and spiders and earthworms (Marchant & Higgins 1993). For much of the year, most adult birds also feed on tidal flats, taking a similar range of invertebrates. Chicks, however, must feed in the rocky areas and wet herbfields on mountain tops until they fledge.

The pukunui (the Te Reo name for *Charadrius o. obscurus*) nests in the subalpine wet herbfields and cushionfields above about 300 m on the uplands of Rakiura / Stewart Island (Heather & Robertson 2015; Marchant & Higgins 1993). The subspecies assembles in post breeding flocks on Rakiura at Paterson Inlet and Port Pegasus, and at Awarua Bay near Invercargill. At high tide the birds find roosts nearby, except in the case of Paterson Inlet where the birds travel some 10 km to the sand dune and 'stonefield' areas of Mason Bay (Dowding & Murphy 1993). At Mason Bay, pukunui roost in loose aggregations across a matrix of sand, pebbles, and cobbles with isolated vegetation. We record here observations of several pukunui at the Mason Bay roost site eating the fruit of sand coprosma

---

Received 15 February 2024; accepted 29 August 2024
*Correspondence: bmckinlay@doc.govt.nz

(tātaraheke, *Coprosma acerosa)*.

All observations were conducted through x10 magnification binoculars or x20 spotting scopes during daylight high tide hours. Photographic images were captured using a Canon Powershot SX 70. These observations were conducted as part of the post-breeding flock counts and mark-recapture observations of colour-banded pukunui as part of the Department of Conservation management programme of pukunui.

On 14 Feb 2022 and again between 28 Feb and 4 Mar 2022, observations of the activity of pukunui were made at Mason Bay, on the west coast of Rakiura (Stewart Island: 46°55′ S, 167° 46′ E.). This area is known as the "stonefields" and has been described as a community of discontinuous vegetation on sand, stony ground and rock. In these areas bare ground is typically more than 50% and can often be up to 100% (Wilson 1987).

At around 14:47 (NZDT) on 3 Mar 2022, a pukunui was observed alongside a prostrate shrub of the tātaraheke or sand coprosma. The bird was repeatedly pushing into the bush and successfully grabbing and swallowing blue-coloured drupes from the tips of the branchlets. It was actively looking around the bush to find suitable drupes and would reach up as well as into the bush to peck for them. The activity was not that of snapping for a flying insect. Nor was the behaviour that of pecking to capture an invertebrate on a branch. It was clearly observable that the bird was plucking drupes from branchlets and swallowing them. In February 2024 similar activity was observed and the bird was clearly seen with a drupe in its bill (Fig 1).

Fig 1: Pukunui, southern New Zealand dotterel holding *Coprosma acerosa* drupe, Mason Bay stonefields, April 2024.

Approximately three birds out of a flock at that time of 55 birds during our time at Mason Bay undertook similar behaviour. Repeatedly, pukunui were observed near or on *C. acerosa* and were actively seen to peck and swallow drupes. Noose mats were deployed to catch pukunui, and these were baited with mealworm (*Tenebrio molitor*) larvae. Occasionally *C. acerosa* drupes were placed beside the noose mats. Pukunui would investigate the drupes on the noose mats and some birds were observed swallowing them.

Globally, the diet of most shorebirds, including plovers, consists largely of invertebrates, but many species do sometimes consume other items, including plant material (Byrkjedal 1980; Pearce-Higgins & Yalden 2004). Many shorebird species appear to be opportunistic feeders, and their diet can differ depending on habitat type and prey availability (e.g. Knopf 1998). The other members of the genus *Charadrius* that breed in New Zealand are northern New Zealand dotterel (*C. o. aquilonius*), banded dotterel (*C. bicinctus*) and the Auckland Island banded dotterel *(C. b. exilis).*

Other members of the genus *Charadrius* are recorded in New Zealand as vagrants, and so assessing the details of diet is problematic and lacks New Zealand context. Red-capped plover (*C. ruficapillus*) is reported as consuming "some vegetation" including seeds (Marchant & Higgins 1993). 'Seeds' are recorded in the diet of oriental dotterel (*C. veredus*, Wiersma & Kirwan 2023).

Northern NZ dotterel diet has been reported on in more detail but is still summarized as "No detailed studies" (Marchant & Higgins 1993). For northern NZ dotterel, aquatic and terrestrial invertebrates, live or recently dead, with small fish taken occasionally on tidal estuaries, and small crabs are an important part of the diet; on dry sandy beaches, sandhoppers (*Talorchestia* spp.) are a common prey item (Dowding *et al.* 2006). We are aware of one other record of NZ dotterel eating plant material. At Taramaire, Firth of Thames, in 1985 and again in 1997, observations were made of northern NZ dotterel feeding on the young tips of glasswort (*Sarcocornia australis*; Chudleigh 1998).

Banded dotterels (*C. b. bicinctus*) have long been known to include plant material in their diet, including berries of *Coprosma petriei* and *Muehlenbeckia axillaris;* (Hughey 1997; Pierce 1980; Stead 1932). There is a single record of an Auckland Island banded dotterel (*C. b. exilis*) specimen reported as containing "many small seeds", but most birds appear to eat invertebrates (Pierce 1980). There is also one record of a small amount of grass ingested by a wrybill (*Anarhynchus frontalis*) (Burton 1972), but it is not clear whether this was eaten deliberately. The shore plover (*Thinornis novaeseelandiae*) has apparently not yet been recorded eating vegetation (Marchant & Higgins 1993).

Our observations of pukunui eating fruit add to the list of plovers that will occasionally include plant material in their diet.

ACKNOWLEDGEMENTS

We thank Emma MacDonald for her observations. This note benefitted from review by John Dowding, Richard Ewans, and David Melville.

LITERATURE CITED

Barlow, M. 1993. New Zealand dotterel: South Island historical notes and Southland coastal records. *Notornis 40*: 15–25.

Burton, P. 1972. Some anatomical notes on the wrybill. *Notornis 19*: 26–32.

Byrkjedal, I. 1980. Summer food of the golden plover *Pluvialis apricaria* at Hardangervidda, southern Norway. *Ecography 3*: 40–49.

Chudleigh, B. 1998. New Zealand dotterel (*Charadrius obscurus*) eating plant material. *Notornis* 45: 155–156.

Dowding, J.E.; Lovegrove, T.G.; Ritchie, J., Kast, S. N.; Puckett, M. 2006. Mortality of northern New Zealand dotterels (*Charadrius obscurus aquilonius*) following an aerial poisoning operation. *Notornis 53*: 235–239.

Dowding, J.E.; Murphy, E.C. 1993. Decline of the Stewart Island population of the New Zealand dotterel. *Notornis 40*: 1–13.

Heather, B.; Robertson, H.A. 2015. *The field guide to the birds of New Zealand*. Auckland, Penguin Random House.

Hughey, K.F.D. 1997. The diet of the wrybill (*Anarhynchus frontalis*) and the banded dotterel (*Charadius bicinctus*) on two braided rivers in Canterbury, New Zealand. *Notornis 44*: 185–193.

Knopf, F.L. 1998. Foods of mountain plovers wintering in California. *Condor 100*: 382–384.

Marchant, S.; Higgins, P.J. 1993. *Handbook of Australian, New Zealand & Antarctic birds.* Volume 2, Raptors to Lapwings. Melbourne; Oxford University Press.

Pearce-Higgins, J.W., Yalden, D.W. 2004. Habitat selection, diet, arthropod availability and growth of a moorland wader: the ecology of European golden plover *Pluvialis apricaria* chicks. *Ibis 146*: 335–346.

Pierce, R. 1980. Habitats and feeding of the Auckland Island banded dotterel (C*haradrius bicinctus exilis* Falla 1978) in autumn. *Notornis 27*: 309–324.

Stead, E. 1932. *The life histories of New Zealand birds*. London: The Search Publishing Co. Ltd.

Wiersma, P. 1996. Red-breasted plover in: del Hoyo, J., Elliott, A. & Sargatal, J. (*eds*) *Handbook of the birds of the world.* Vol. 3. Hoatzin to Auks. Lynx Edicions, Barcelona.

Wiersma, P.; Kirwan, G.M. 2023. Oriental plover (*Anarhynchus veredus*). *In*: Birds of the world (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, & E. de Juana, *eds*). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.oriplo1.01.1

Wilson H.D. 1987. *Vegetation of Stewart Island, New Zealand*. Supplement to the *New Zealand Journal of Botany*. Department of Scientific and Industrial Research, Wellington, N.Z. 131 pp.

Keywords: New Zealand dotterel, *Charadrius obscurus,* diet, foods, *Coprosma acerosa*

OFFICERS 2024

Please refer to the Birds New Zealand website (www.birdsnz.org.nz/contact/) for up-to-date contact details and email addresses.

President:	NATALIE FORSDICK
Vice-President:	IAN ARMITAGE
Secretary:	JOHANNES CHAMBON
Treasurer:	PAUL GARNER-RICHARDS
Council Members:	COLIN MISKELLY ELEANOR GUNBY KEITH WOODLEY IAN ARMITAGE MARK AYRE MARTINE DARROU BRUCE MCKINLAY (ex officio)

EXECUTIVE OFFICER	INGRID HUTZLER

EDITORS

NOTORNIS	JAMES SAVAGE
NOTORNIS (Associate)	COLIN MISKELLY
Birds New Zealand:	MICHAEL SZABO
Book Reviews:	MICHAEL SZABO

CONVENORS & ORGANISERS

Beach Patrol:	IAN ARMITAGE
Moult Records:	VACANT
Nest Records:	ROGER SHARP
Records Appraisal Committee:	COLIN MISKELLY
Scientific Committee:	GRAEME TAYLOR
Banding Liaison Officer:	VACANT
Checklist Convenor:	COLIN MISKELLY
Membership Secretary:	KURIEN (KOSHY) YOHANNAN
Wader Counts:	ANDREW CROSSLAND ADRIAN RIEGEN
Web Support Officer:	ROGER SHARP

LIBRARIANS

Books & Journals:	VACANT
Publications purchasing:	PAUL CUMING

REGIONAL REPRESENTATIVES 2024

Please refer to the Birds New Zealand website (www.birdsnz.org.nz/contact/) for up-to-date contact details and email addresses.

Far North:	VACANT
Northland:	Su SINCLAIR Ph: 027 419 5647 *birds.northland@birdsnz.org.nz*
Auckland:	Ian McLEAN Ph: 021 535 121 *birds.auckland@birdsnz.org.nz*
South Auckland:	Sue FROSTICK Ph: 09 267 2495 *birds.sth.auckland@birdsnz.org.nz*
Waikato:	Jeanette BROOKER Ph: 021 203 2982 *birds.waikato@birdsnz.org.nz*
Bay of Plenty / Volcanic Plateau:	Paul CUMING Ph: 07 571 5125 *birds.bop.volcanic@birdsnz.org.nz*
Gisborne / Wairoa:	Geoff FOREMAN Ph. 06 868 8826 *birds.gisb.wairoa@birdsnz.org.nz*
Taranaki:	Peter FRYER Ph. 027 271 4150 birds.taranaki@birdsnz.org.nz
Manawatu:	Kirsten OLSEN Ph: 027 354 6010 *birds.manawatu@birdsnz.org.nz*
Whanganui:	VACANT *birds.whanganui@birdsnz.org.nz*
Hawke's Bay:	Bernie KELLY Ph: 06 870 0837 *birds.hawkesbay@birdsnz.org.nz*
Wairarapa:	Oliver DRUCE Ph: 06 304 9854 or 027 334 5705 *birds.wairarapa@birdsnz.org.nz*
Wellington:	Annemieke HAMILTON Ph: 021 114 8823 *birds.wellington@birdsnz.org.nz*
Nelson:	Mark AYRE Ph: 027 240 4045 *birds.nelson@birdsnz.org.nz*
Marlborough:	Patrick CROWE Ph: 027 258 3101 *birds.marlborough@birdsnz.org.nz*
Canterbury / West Coast:	Anita SPENCER Ph: 0204 124 8185 *birds.canterbury@birdsnz.org.nz*
Otago:	Dawn PALMER Ph: 027 442 7348 *birds.otago@birdsnz.org.nz*
Southland:	Peter MCCLELLAND Ph: 027 312 0141 *birds.southland@birdsnz.org.nz*

Abbreviated Instructions to Authors

Please consult the full instructions at *http://osnz.org.nz*

Submission of manuscripts: Manuscripts may be submitted by e-mail to the Managing Editor, Dr James Savage editor.notornis@birdsnz.org.nz. The submission should be in MS Word format. To facilitate the review process, a single document should be submitted, with Tables and Figures (preferable .jpg format) included in the document, but following the main text and references. Large embedded files should be compressed sufficiently so that the final document size is no larger than 10MB, yet image quality is retained. Should the manuscript be accepted, the Editor will request separately submitted files for images in the relevant format and in suitable resolution. Consult a recent issue for general formatting procedures. A brief covering letter must accompany the submission, confirming that the paper or material in it has not been published previously and is not under consideration with another publication. If the manuscript contains information provided to the author as a personal communication, confirmation that the author has permission to publish this information is required. Authors are strongly advised to have their manuscript read, and critically reviewed, by friends or colleagues. Although this is not a formal requirement of the journal, it may influence the treatment of the manuscript. Complying with any administrative requirement of the author's workplace or supporting agency is a matter between those parties; such matters are not checked by the editors and OSNZ accepts no responsibility in case of any dispute.

Ethics: Papers reporting experimental work on animals should include a reference to the code of practice adopted and relevant animal ethics approval. While the review process may highlight certain issues in this regard it is the responsibility of the author/s to ensure that the relevant procedures are followed and acknowledged when, 1) working on and handling animals, and 2) accessing land where permission is required.

Editorial process: All manuscripts are acknowledged upon receipt. The Managing Editor will make an initial assessment of the manuscript to confirm its subject, content, scope, and quality are appropriate for the journal. The Managing Editor will approach potential referees to review the paper; two reviewers for an original paper, and one reviewer for a short note. The Managing Editor will decide on acceptance for publication following receipt of the reviewers' reports.

Manuscript styles:

Full papers: The main sections of the manuscript should be: 1) Title page containing the title, authors' names, affiliation/s, a suggested short title, and corresponding authors contact e-mail. The title should be as short as possible while still reflecting the content of the paper. 2) Abstract (~150 words) that provides a succinct summary of the main findings of the study, followed by up to seven Keywords. 3) The major parts (Introduction, Materials and Methods, Results, Discussion, Acknowledgments, Literature cited) should follow continuously. Avoid footnotes. *Headings:* There are three levels of headings. First level is **BOLD CAPITALS**; second level is **Bold initial capitals**; third level is *Italic capitals and lower case*. If necessary, a fourth level of *Capitals and small capitals* can be invoked. Text continues on the same line for third and fourth level headings. Use only those levels that are appropriate: main sections are first level headings.

Short notes: These are generally of <2,000 words and report a single item of ornithological interest. The text is without subdivision with results and discussion combined and the only first level headings used are 'Acknowledgements' and 'Literature cited'. Authors' names and affiliation/s are placed at the beginning and keywords at the end of the manuscript.

Book reviews: Publishers of books are invited to contact the Managing Editor in this regard.

Editorial conventions: The most recent edition of the *Checklist of New Zealand birds* should be taken as the prime reference of taxonomy and nomenclature for both scientific and common names of bird species in the New Zealand region (see: *http://nzbirdsonline.org.nz/*). Use a similar authoritative source for other regions. Use of other nomenclature can be adopted where necessary, as in taxonomic papers or where explained or justified in the text. At first mention, both the common and the scientific names (italicised and in brackets) of a species must be given; thereafter one or other may be used, but not both. Subspecific names should be given only if relevant to the content of the paper. Authorities for species names are not required, unless dictated by the subject matter.

Literature cited: Authors are responsible for the accuracy of all references. All citations in the text must be on the list of references; all on the list must be cited. Cite references in the text chronologically and list alphabetically in full at the end of the paper. In the text, names of two authors should be linked by '&'; for three or more, the first author's name should be followed by '*et al.*' Use of transitory reference sources, e.g. web sites, is not encouraged. Journal titles or titles of other periodicals or series must be cited in full.

Tables: Each table should begin on a separate page, numbered in Arabic numerals in the order as referred in the text, and accompanied by a title at the top. Horizontal lines should appear only between the title and the table body, and below the last line of tabulated data. In some instances, clarity may be improved by short horizontal lines over column heads that are logically linked. Do not use vertical lines anywhere in the table.

Figures: Check image quality and legibility by photocopying at the necessary reduction. Lettering should be in sans-serif type (e.g. Helvetica or Arial), not bold, and only initial letters of axis labels capitalised. The preferred symbols are those that are readily available on word processor packages. Photographs must be sharp and of good contrast. Identify necessary details with appropriate labelling. Colour photographs can be printed, but please enquire before submitting. Maps should be simple enough to present the relevant context of the study. Avoid copying poor quality and/or over-detailed images from, for example, Google Earth or institutional reports, etc. Captions should be prefaced by Figure in bold and referenced sequentially in the text by Fig. 1, etc. (not Figure). Provide appropriate legends, or list the meanings of shading or other details in the caption. Captions should contain enough information to explain the figures without reference to the text.

Copyright: The Ornithological Society of New Zealand assumes copyright of the printed script. The author/s, by "signing off" the final version of their manuscript, are assigning copyright to the Society. The assumption of copyright is to protect authors from having their publication subjected to commercial exploitation without their knowledge and agreement and does not confer any financial gain to OSNZ.

Page charges: There are currently no page charges for authors.

Revised and updated March 2024

NOTORNIS

Journal of the Ornithological Society of New Zealand Inc.

Volume 71, Part 3, September 2024

CONTENTS

Papers

Where do some Aotearoa New Zealand seabirds go? Records of *Thalassarche* albatrosses and *Procellaria* petrels in Ecuadorian waters. **Reyes, E.M.R.; Giovanardi, S.; Suarez-Espin, G.; Haase, B.; Rexer-Huber, K.; Parker.G.; Sagar, P.; Fischer, J.H.** **69**

Breeding biology of kawau pāteketeke | New Zealand king shags (*Leucocarbo carunculatus*) **Helen Gummer, H.; Taylor, G.A.; Palmer, D.; Bell, M.** **77**

Amendments to the 5th edition (2022) of the *Checklist of the Birds of New Zealand* **Miskelly, C.M.; Forsdick, N.J.; Palma, R.L.; Rawlence, N.J.; Tennyson, A.J.D.** **93**

Short notes

Sexual dimorphism in plumage, and gender roles in breeding kawau pāteketeke | New Zealand king shags (*Leucocarbo carunculatus*) **Gummer, H.** **115**

First record of the Eurasian Tree Sparrow (*Passer montanus*) from Buka, Autonomous Region of Bougainville, Papua New Guinea, and status of the species in Melanesia **Schmidt, J-W.** **121**

Observations of southern New Zealand dotterel | pukunui (*Charadrius obscurus obscurus*) foraging on tātaraheke | sand coprosma (*Coprosma acerosa*) at Mason Bay. **McKinlay, B.; Cocker, D.; Collen, R.; Sangster, S.** **125**