BREAKING THE DESERT RULE: BREEDING OF GREY GULLS *LEUCOPHAEUS MODESTUS* IN COASTAL SOUTH-CENTRAL CHILE

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Received 26 November 2025, accepted 08 April 2026

ABSTRACT

Thomson, R. F., Vukasovic, M. A., Rodríguez-Ochoa, A., & Estades, C. F. (2026). Breaking the desert rule: Breeding of Grey Gulls *Leucophaeus modestus* in coastal south-central Chile. *Marine Ornithology*, *54*(2), 327–329. http://doi.org/10.5038/2074-1235.54.2.1727

The Grey Gull *Leucophaeus modestus* breeds in the hyper-arid Atacama Desert, but herein we document nesting attempts at Reloca Lagoon (35°41′S, 072°35′W), Chile, > 1,300 km south of its previously reported reproductive range. During 19 years of monitoring (2006–2025), two independent coastal breeding events occurred: one nest in 2007 and five nests in 2024, the latter producing at least two chicks (one of which survived ≥ 3 weeks). No young fledged. Breeding failure was likely influenced by multiple interacting factors, including ecological conditions, behavioural constraints, and environmental differences between desert and coastal habitats.

Key words: coastal breeding, extralimital breeding, reproductive failure, range limits, Chile

INTRODUCTION

The Grey Gull *Leucophaeus modestus* is the only larid that breeds exclusively in the hyper-arid core of the Atacama Desert, commuting nocturnally between inland colonies and coastal foraging areas associated with the Humboldt Current (Aguilar-Pulido et al., 2021). This strategy has selected for extreme physiological specialisations, including low egg water-vapour conductance, nocturnal commuting flights, and limited chick mobility (Guerra et al., 1988a). Embryo mortality occurs when temperatures drop below 17–18 °C, and chicks achieve homeothermy only 6–7 d post-hatching (Aguilar et al., 1998). These traits permit reproduction in one of the hottest and driest deserts on Earth but impose severe constraints in non-desert environments, particularly cooler, more humid coastal habitats.

All known breeding colonies (> 30) are confined to nitrate flats and salt basins of northern Chile, which experience permanently arid conditions (Aguilar-Pulido et al., 2021; Simeone et al., 2022). Rare attempts at coastal breeding within the core range have been reported, including failed events in Peru and northern Chile (Aguilar et al., 2016; Zavalaga et al., 2008). These events indicate that coastal breeding may occur under certain conditions but is generally unsuccessful. No breeding south of 24°S has yet been reported.

Here we document the first confirmed Grey Gull nesting attempts at Reloca Lagoon (35°41′S, 072°35′W), Maule Region, central-southern Chile, ~1,300 km south of the known reproductive range. Using 19 years (2006–2025) of coastal bird monitoring efforts, we describe two independent coastal breeding events by Grey Gulls. Both events failed, but we evaluate them in the context of the species' extreme physiological adaptations to desert breeding.

METHODS

Study Area

Reloca coastal lagoon (35°41′S, 072°35′W), Chanco commune, Maule Region, central-southern Chile, is a coastal, estuarine wetland of 15–40 ha (0.15–0.40 km^2) formed by the intermittent closure of a sandbar. The adjacent dune system (100–300 m wide) supports breeding shorebirds and larids. Vegetation is sparse and dominated by *Ambrosia chamissonis*, with seasonal variation due to dune dynamics driven by storm events.

Long-Term Monitoring

Since July 2006, the site has been surveyed 8–12 times per year, with a minimum of three visits between November–February, by the same observer (MAV), using a spotting scope (20–60× magnification) from fixed observation points. Total counts of waterbirds and evidence of breeding were recorded. Nest searches were conducted primarily for beach-nesting species (e.g., American Oystercatcher *Haematopus palliatus*), during which Grey Gull nests were detected. In 2024/25, weekly visits were conducted as part of an American Oystercatcher breeding study.

Breeding and Population Records

Breeding attempts were confirmed by direct observation of nests with eggs or chicks. Incubating adults were observed at nests, confirming species identity. The annual maximum Grey Gull count during the July–June hydrological year was used as an index of local abundance.

Egg measurements (length and width, in mm) were obtained using a vernier caliper from a subset of nests during the 2024 breeding event.

Ethics Statement

Fieldwork complied with Chilean legislation and the ethical guidelines of the Ethics committee of the Campus Sur – Universidad de Chile. All observations were conducted from a distance, and no birds, eggs, or chicks were handled; therefore, no animal care committee approval was required.

RESULTS

Two independent coastal breeding attempts were confirmed on the dune system west of Reloca Lagoon. First, on 12 December 2007, one active nest containing two eggs was documented; the nest was destroyed by storm-surge overwash by 08 January 2008. Second, during November 2024–February 2025, nine active nests were recorded by 18 December 2024. At least two chicks hatched, one of which survived for ≥ 3 weeks but disappeared before fledging.

Nests consisted of simple scrapes in sandy substrate without lining material. Distances between nests ranged from 10 to 20 m, and all nests were located within an area of approximately 150 × 50 m.

The first evidence of breeding during the second event was recorded on 13 November 2024, when three nests, each containing a single egg, were found. By 17 December 2024, a total of nine nests had been recorded, with clutch sizes ranging from one to two eggs (mean = 1.33 eggs per nest).

Egg measurements were obtained from 12 eggs. Egg length ranged from 54.6 to 60.6 mm, and width ranged from 38.4 to 43.9 mm. Eggs were whitish to pale pink, with irregular brown spotting.

Both attempts failed to produce fledged young. Grey Gulls have been recorded annually at the site since 2006, with maximum counts per austral summer ranging from 130 individuals (2024) to 2,316 individuals (2008).



Fig. 1. Downy chick of Grey Gull *Leucophaeus modestus* (~3–4 weeks old) photographed on Reloca beach, Maule Region, central-southern Chile (35°41′S, 072°35′W) on 31 January 2025. This was the longest-surviving offspring recorded during the southernmost breeding attempts of this obligate desert-nesting species. Photo credit: Alejandro Rodríguez-Ochoa

DISCUSSION

The Reloca nesting attempts constitute the southernmost breeding attempts by Grey Gulls and represent sporadic extralimital breeding rather than a confirmed range expansion. Both events failed, consistent with the generally low success of coastal breeding attempts by this gull species reported elsewhere (Aguilar et al., 2016; Simeone et al., 2022; Zavalaga et al., 2008).

Breeding at Reloca occurred during austral summer (January–February), consistent with the timing at northern colonies (Aguilar-Pulido et al., 2021; Simeone et al., 2022). Nest structure was also similar, consisting of simple scrapes, although stones commonly associated with desert nests were absent at Reloca. Egg size fell within the ranges described by Aguilar-Pulido et al. (2021), and clutch sizes (one to two eggs, mean = 1.33) matched the most common clutch sizes reported for the species. This suggests that, despite the shift to a coastal environment, basic species-specific reproductive traits, such as egg morphology and clutch size, remained consistent.

The timing of breeding was also consistent with that reported for northern populations, with nesting initiated in November and continuing through December. This further supports the idea that reproductive phenology is not altered in coastal environments.

Taken together, these observations indicate that breeding failure at Reloca is unlikely to be associated with intrinsic reproductive limitations and, instead, supports the hypothesis that external ecological factors are responsible. Although previous studies have emphasized physiological constraints associated with the species' desert breeding ecology, our observations suggest that breeding failure at Reloca was likely driven by ecological conditions, behavioural constraints, and environmental differences such as humidity. Temperatures at Reloca are not necessarily lower than those in the Atacama Desert, but coastal humidity is substantially higher and may influence egg and chick survival. Further data are required to evaluate this supposition.

The disappearance of chicks before fledging may reflect predation, energetic limitations, or other environmental pressures. Although detection failure cannot be completely ruled out, it is unlikely given the intensive nest-search effort conducted at the site.

Human disturbance may also play an important role. Despite its relative remoteness, the site is frequently used by recreational fishers and tourists, with off-road vehicles, and horseback riders crossing nesting areas. Additionally, potential predators recorded in the area include Andean fox *Lycalopex culpaeus*, lesser grison *Galictis cuja*, Chimango caracara *Milvago chimango*, Kelp Gull *Larus dominicanus*, and domestic dogs *Canis lupus familiaris*, all of which may negatively affect breeding success.

Food availability does not appear to be a limiting factor. Preliminary evidence suggests that the Grey Gull diet in the area is dominated by Pacific Sand Crab *Emerita analoga* (Rivera & Thomson, 2026), indicating that prey resources are available.

In conclusion, although the Grey Gull remains strongly associated with desert breeding conditions, sporadic coastal breeding

attempts can occur but are unlikely to result in successful reproduction under current conditions.

ACKNOWLEDGEMENTS

We thank the many observers who contributed to the Reloca monitoring programme and Arauco forestry and pulp company for funding the long-term survey program. We thank also the reviewers for their comments, which helped improve this paper.

FUNDING

Long-term monitoring at Reloca Lagoon was funded by Arauco forestry and pulp company.

AUTHOR CONTRIBUTIONS

Conceptualization: RFT, CFE. Formal analysis: RFT. Funding acquisition: CFE. Investigation: MAV, ARO. Methodology: RFT, MAV, ARO. Project administration: RFT. Writing—original draft: RFT. Writing—review & editing: all authors.

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