

Breeding distribution and abundance of seabirds on islands off north-central Chile

Distribución reproductiva y abundancia de aves marinas en islas del norte y centro de Chile

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ABSTRACT

Between 1999 and 2003 we collected information on the breeding distribution and abundance of 12 seabird species occurring on nine islands off the coasts of north and central Chile (27°-33° S). The Peruvian booby *Sula variegata* was the most abundant seabird with a breeding population of ca. 18,000 pairs concentrated in two islands, followed by the Humboldt penguin *Spheniscus humboldti* with ca. 9,000 pairs, the largest colony being at Chañaral Island with ca. 7,000 pairs. Kelp gulls *Larus dominicanus* bred at all the surveyed sites in colonies of variable size, ranging from 40 to 2,000 pairs. Peruvian diving-petrels *Pelecanoides garnotii* and Peruvian pelicans *Pelecanus occidentalis* bred at restricted sites, but generally in large colonies. Magellanic penguins *Spheniscus magellanicus*, wedge-rumped storm-petrels *Oceanodroma tethys*, Neotropical cormorants *Hypoleucos brasiliensis*, guanay cormorants *Leucocarbo bougainvillii*, red-legged cormorants *Stictocarbo gaimardi*, band-tailed gulls *Larus belcheri* and Inca terns *Larosterna inca* nested at few sites forming small colonies (from a few to 150 pairs). Two new breeding sites are reported for the Peruvian diving-petrel and nesting of the wedge-rumped storm-petrel is confirmed on the Chilean coast for the first time. Despite protective status, most of the islands showed human disturbance, derived mainly from guano harvesting, egg and tourism. On at least five of these islands we were able to confirm introduced mammals including rats, rabbits and cats. These factors are likely to be detrimental to seabirds and thus demand detailed assessment. Further comprehensive ornithological surveys in other areas are needed so as to improve the scarce knowledge that we currently have on the seabird populations along the Chilean coast.

Key words: seabirds, breeding colony, abundance, conservation, Humboldt Current, Chile.

RESUMEN

Entre 1999 y 2003 obtuvimos información sobre la distribución reproductiva y abundancia de 12 especies de aves marinas en nueve islas frente a las costas del norte y centro de Chile (27-33° S). El piquero *Sula variegata* fue la especie más abundante con una población reproductiva de 18.000 parejas, concentrada principalmente en dos islas. La segunda especie más abundante fue el pingüino de Humboldt *Spheniscus humboldti* con ca. 9.000 parejas, siendo isla Chañaral la colonia más grande con ca. 7.000 parejas. La gaviota dominicana *Larus dominicanus* nidificó en todas las islas formando colonias que variaron desde 40 a 2.000 parejas. Yuncos *Pelecanoides garnotii* y pelícanos *Pelecanus occidentalis* nidificaron en pocos lugares, pero formando grandes colonias. El pingüino de Magallanes *Spheniscus magellanicus*, la golondrina de mar peruana *Oceanodroma tethys*, el yeco *Hypoleucos brasiliensis*, el guanay *Leucocarbo bougainvillii*, el lile *Stictocarbo gaimardi*, la gaviota peruana *Larus belcheri* y el gaviotín monja *Larosterna inca* nidificaron en colonias pequeñas (1 a 150 parejas) y en pocos lugares. Se encontraron dos nuevos sitios de nidificación de yunco y se confirma por primera vez la reproducción de la golondrina de mar peruana en la costa chilena. A pesar de ser áreas protegidas, algunas de las islas presentaron perturbación humana debido a extracción de guano, colecta de huevos y turismo y en al menos cinco de ellas observamos mamíferos introducidos como ratas, conejos y gatos. Es probable que estos factores sean altamente negativos para las aves marinas y requieren por lo tanto una evaluación detallada. Prospecciones ornitológicas más intensas en otras áreas serían muy útiles para mejorar el escaso conocimiento que se tiene actualmente de las poblaciones de aves marinas a lo largo de la costa chilena.

Palabras clave: aves marinas, colonia reproductiva, abundancia, conservación, corriente de Humboldt, Chile.

INTRODUCTION

Seabirds are key components of the pelagic marine ecosystem and appropriate monitoring of their populations can provide, in addition to their obvious important contribution to their conservation per se, useful information on several aspects of the marine environment, including the distribution of their fish prey (which may be the basis of commercially important fisheries), pollution and the onset of oceanographic anomalies (Monaghan 1996, Furness & Camphuysen 1997).

The continental Chilean coast extends over 4,200 km from the subtropical waters at 18° S to the cold temperate seas at 56° S, a territory within which over 50 seabird species breed on numerous islands and coastal localities (Schlatter 1984). Most of this coastline is influenced by the northward flowing Humboldt current, coastal upwelling processes and the periodic occurrence of El Niño events (Camus 2001), all factors that strongly influence the composition and abundance of the seabird assemblage and contribute to its uniqueness, including a large number of endemic species (Murphy 1936, Schlatter & Simeone 1999). The Humboldt Upwelling Ecosystem is one of the most productive marine systems, and one that once supported the largest fishery on earth (Idyll 1973). This, in turn, was the base for an immense number of seabirds and a major industry based on avian guano (Vogt 1942, Jordán & Fuentes 1966, Duffy 1994).

Despite the considerable range of seabird habitat and large number of seabird species along the Chilean coast (109 according to Schlatter & Simeone 1999), little is known of their reproductive distribution and abundance. The first comprehensive revisions of the status of seabirds in Chile (Schlatter 1984, 1987) described their conservation problems, distribution and population trends along the continental coast and at oceanic islands. Recently, Schlatter & Simeone (1999) provided information on definitions and criteria, conservation problems and areas of endemism. Although based on detailed bibliographical compilations and personal communications from ornithologists, these studies included little original and updated information on the abundance of breeding birds, specific location and composition of colonies. Except for few recent studies (e.g., Simeone & Schlatter 1998, Guicking et al. 1999, Vilina & Gazitúa 1999, Simeone & Bernal 2000), data on reproductive abundance and location of seabird colonies in Chile are scarce and found mostly dispersed in the literature or accessible only through personal communications of ornithologists.

In this paper we summarize the information available on the current population status of seabirds that breed on nine islands along the coasts of north-central Chile, and give a qualitative overview of the threats to these populations.

MATERIAL AND METHODS

Study area

Within the frame of our investigations on seabirds between 1999 and 2003, we surveyed a total of nine islands along ca. 700 km of coastline in north-central Chile (Fig. 1, Table 1). These islands are located near centers of coastal upwellings that determine high primary productivity (Johnson et al. 1980, Fonseca & Fariás 1987, Rutllant & Montecino 2002), which, in turn, are the basis for a relatively substantial pelagic fishery that supports appreciable vertebrate populations in the area, particularly seabirds (Acuña et al. 1989).

Methods

The islands were reached with the R/V Stella Maris II from the Universidad Católica del Norte (Coquimbo) or by renting boats from the local fishermen. Surveys were made during the incubation and chick stages, mainly between November and February. The islands were visited as follows: Grande (21 February 2000, 20 February and 10 April 2002, 7 and 21 February 2003), Chañaral (3 to 24 February 2002, 9 to 19 July 2002, 16 to 28 December 2002, 9 to 14 February 2003), Damas (2 and 21 December 2001, 31 January 2002), Choros (20 November to 2 December, 15 to 21 December 2001, 22 to 31 January 2002, 26 February to 1 March 2003), Pájaros 2 (18 January 2000, 6 March and 11 April 2001), Pájaros 1 (23 November to 3 December, 11 to 20 December 2001, 22-23 January 2003), and Pájaro Niño (26 December 1999, 27 December 2001). Data for Concón Island was available only for the breeding season 1995-1996 (29 October and 10 December 1995, 14 February 1996). For Cachagua Island, recent data were obtained from the seabird census program that CONAF V Region of Chile has conducted since 1990.

We assessed breeding populations through direct counts of "apparently occupied nests", defined as substantial or well constructed nests capable of holding eggs and occupied by at least one bird on or within touching distance of the nest (Bibby et al. 2000). For species nesting on the surface in dense aggregations (e.g., boobies, pelicans) or on cliffs

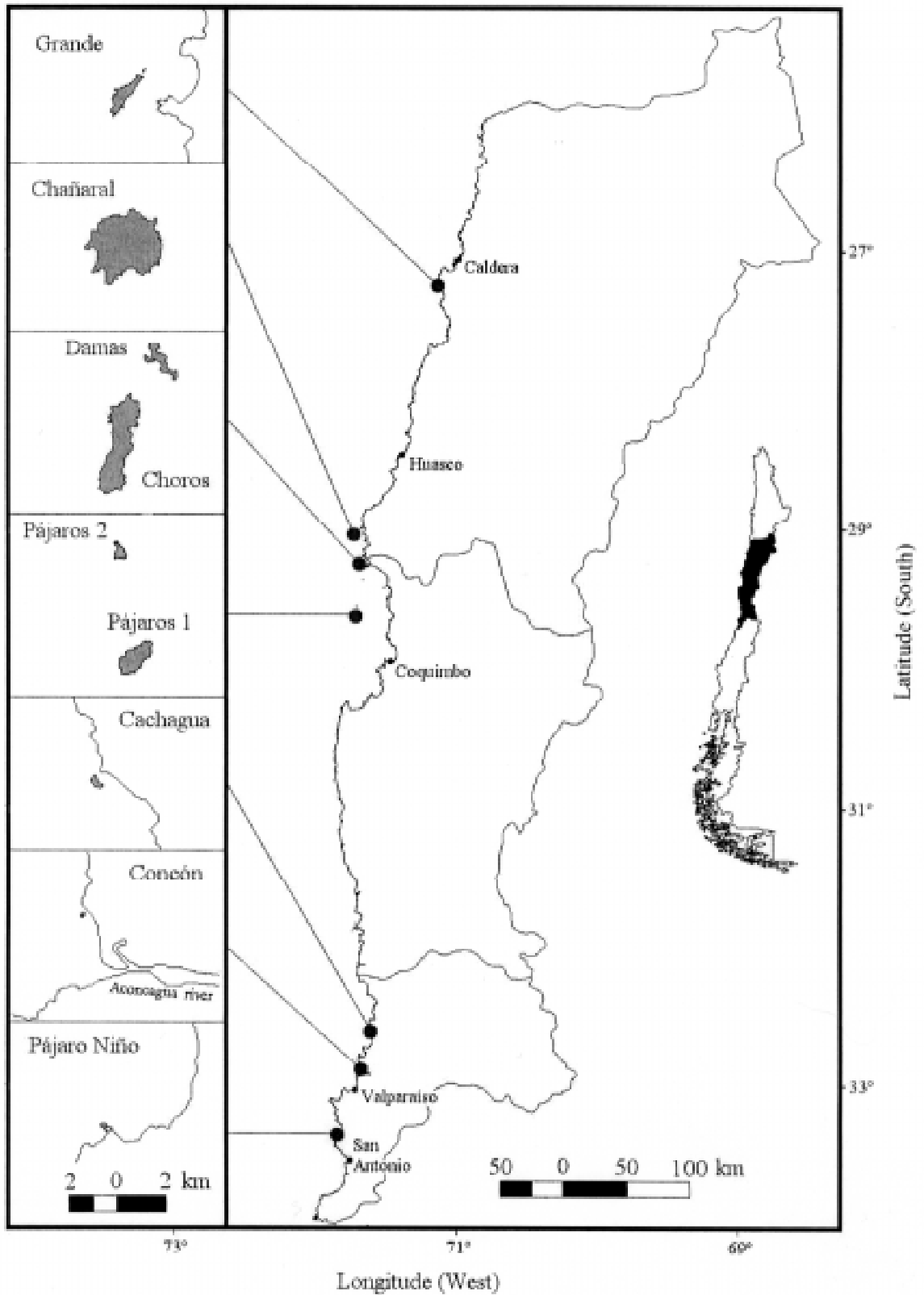


Fig. 1: Location of the surveyed islands in north-central Chile.

Ubicación de las islas prospectadas en el norte y centro de Chile.

TABLE 1

Characteristics of the surveyed islands in north-central Chile

Características de las islas prospectadas en el norte y centro de Chile

Island	Geographic position	Surface area (ha)	Distance to mainland (km)	Protection status
Grande	27°14'S, 70°58'W	54	0.9	None
Chañaral	29°01'S, 71°34'W	572	6.3	National Reserve
Damas	29°13'S, 71°31'W	56	5.2	National Reserve
Choros	29°15'S, 71°32'W	322	6.0	National Reserve
Pájaros 2	29°32'S, 71°33'W	53	21.4	None
Pájaros 1	29°35'S, 71°33'W	124	20.6	None
Cachagua	32°35'S, 71°27'W	4.5	0.1	Natural Monument
Concón	32°53'S, 71°31'W	1.3	0.9	None
Pájaro Niño	33°21'S, 71°41'W	3	0.2*	Nature Sanctuary

*This island is currently joined to the mainland (see Simeone & Bernal 2000)

(e.g. cormorants) we counted nests from vantage points using binoculars and a spotting scope. For species nesting in burrows or crevices (e.g., diving-petrels, penguins, Inca terns) or on the surface but dispersed (gulls) we surveyed the colony checking the nests individually. For species breeding in large aggregations (e.g., boobies, pelicans) we assessed breeding numbers by estimating a "block" of birds and used it as a model to measure the remainder of the colony (Bibby et al. 2000). In the case of Chañaral Island, and due to its large surface area (see Table 1), the breeding activity of Humboldt penguins was assessed counting apparently occupied nest sites in defined plots and extrapolating these to other areas of the island where nesting penguins occurred. A detailed description of this method is in preparation (T Mattern personal communication).

The geographic positions of the islands were obtained with a GPS. Information on island surface and distance to the mainland (Table 1) were derived from aerial photographs and maps. Although not generally accepted (particularly for Pelecaniformes), we followed the nomenclature and systematic contained in Schreiber & Burger (2002), considering this to be the most updated and uniform source. We recommend the reader to consult Araya et al. (2000) for Chilean and alternative scientific names.

RESULTS

Breeding seabirds

We confirmed and assessed the breeding status of 12 seabird species at nine islands, including two penguins, one diving-petrel, one storm-petrel, one booby, one pelican, three cormorants, two gulls

and one tern. The breeding abundances of seabirds at all the surveyed islands are shown in Table 2.

The Humboldt penguin *Spheniscus humboldti*

This species was found nesting at all the surveyed islands with a total breeding population estimated in ca. 9,000 pairs. Colonies varied greatly in size, from a few pairs counted at Concón Island to ca. 7,000 occupied nests at Chañaral Island during December 2002. In a subsequent visit to this island in February 2003, ca. 20,000 birds, most of them moulting, were counted at the numerous rookeries and beaches. Smaller colonies (600 pairs) were found at Pájaros 1 and Cachagua.

The Magellanic penguin *Spheniscus magellanicus*

Breeding Magellanic penguins were only observed in the southernmost part of the surveyed area; Pájaro Niño Island, where few pairs nested. Two birds (presumably a pair) were observed in November 2001 at Pájaros 1 within a Humboldt penguin nesting area, but we were unable to confirm breeding.

The Peruvian diving-petrel *Pelecanoides garnotii*

Diving-petrels were found breeding at three islands, two of which contained relatively small colonies. The largest colony, at Choros Island, contained a total of 2,672 nests distributed in 47 nesting areas ("yunqueras") ranging from 6 to 725 nests. A close inspection of 14 of these indicated a mean of 58 % apparently occupied nests, which extrapolated to the rest of the "yunqueras", suggests a total of 1,550 nests with breeding activity.

The wedge-rumped storm petrel *Oceanodroma tethys*

During February 2000 two abandoned eggs and one wing from a storm-petrel (Hydrobatidae) were collected on Grande Island. On February 2002, a storm-petrel chick was found in a nest (rock crevice) and near it there were 8 storm-petrel wings corresponding to at least 6 individuals. The comparison of the coloration pattern and measurements of these wings with the drawings of Murphy (1936) suggested two possible species: wedge-rumped storm-petrel *Oceanodroma tethys* or Elliot's storm-petrel *Oceanites gracilis*. During February 2003 eight nests (all rock crevices) were closely inspected: three contained adult birds (at least one was incubating) and five contained abandoned eggs or egg shells. Three adults were captured for close inspection and were subsequently returned to their nests. All three birds were identified as wedge-rumped storm-petrel. Measurements (of adults and eggs) as well as photographs were taken (M. Bernal).

The Peruvian pelican *Pelecanus occidentalis*

Nesting of pelicans was restricted to only two islands in the southernmost part of the surveyed area, with the largest colony on Cachagua. Colony sizes varied between 400 and 3,000 pairs.

The Peruvian booby *Sula variegata*

The Peruvian booby was the most abundant species in the surveyed area with a reproductive population of over 18,000 pairs, with the largest colony located at Pájaros 2. Our presence at this island was very disturbing for the birds, so we did short visits and estimated numbers using "blocks" (see methods). Smaller colonies were found on Grande, Choros and Pájaros 1.

The Neotropical cormorant *Hypoleucos brasiliensis*

Neotropical cormorants were observed breeding at five sites in colonies ranging from 50 to 100 pairs. Birds made nests in dry trees (Cachagua, Pájaro Niño) or cliffs (Chañaral, Choros, Pájaros 1).

The guanay cormorant *Leucocarbo bougainvillii*

Breeding of the guanay cormorant was restricted to two colonies: Concón and Pájaros 2. In the latter, cormorants bred intermingled with boobies.

TABLE 2
Breeding abundance (number of pairs) of seabirds on islands off north-central Chile

Abundancia reproductiva (número de parejas) de aves marinas en islas del centro-norte de Chile

Species	Grande ^c	Chañaral	Damas	Choros	Pájaros 2	Pájaros 1	Cachagua	Concón	Pájaro Niño
Humboldt penguin <i>Spheniscus humboldti</i>	150 ^c	7,000 ^d	10 ^c	360 ^c	#	600 ^c	600 ^c	10*, 5 ^a	250 ^a 5 ^c
Magellanic penguin <i>Spheniscus magellanicus</i>	100 ^c				50 ^b				
Peruvian diving-petrel <i>Pelecanoides garnotii</i>	3 ^d			1, 550 ^d					
Wedge-rumped storm-petrel <i>Oceanodroma tethys</i>									
Peruvian pelican <i>Pelecanus occidentalis</i>	90 ^d	# ^b 100 ^b		170 ^c , 60 ^d 100 ^c , 50 ^d	15,000 ^a 4 ^a , 12 ^b	3,000 ^c , 410 ^d 50 ^c	3,000 ^b , 400 ^c 50 ^c	150* 10*, 5 ^a	1,000 ^c 55 ^c
Peruvian booby <i>Sula variegata</i>		# ^b 500 ^b	100 ^c	20 ^c 1 ^c	100 ^b	2,000 ^c	50 ^c	40*, 50 ^a 10*	450 ^a
Neotropic cormorant <i>Hypoleucos brasiliensis</i>									
Guanay cormorant <i>Leucocarbo bougainvillii</i>	11 ^d	# ^b							
Red-legged cormorant <i>Stictocarbo gaimardi</i>	# ^d								
Band-tailed gull <i>Larus belcheri</i>	# ^d								
Kel gull <i>Larus dominicanus</i>									
Inca tern <i>Larosterna inca</i>									

Breeding season when count or estimate was made: * 1995-1996, ^a 1999-2000, ^b 2000-2001, ^c 2001-2002, ^d 2002-2003
(#) Nesting confirmed, but not quantified

The red-legged cormorant *Stictocarbo gaimardi*

Only reduced number of cliff-nesting red-legged cormorants were found at four islands, with colony sizes ranging from 5 to 20 pairs.

The band-tailed gull *Larus belcheri*

Two fledglings were seen in February 2003 at Grande Island and a single incubating pair was observed at Choros Island in January 2002.

The kelp gull *Larus dominicanus*

Like penguins, kelp gulls were found nesting at all the surveyed islands, breeding in colonies of between 40 and 2,000 pairs. The largest colony was at Pájaros 1.

The Inca tern *Larosterna inca*

We were able to locate only one site within the surveyed area where Inca terns breed: the small Concón Island. Up to 10 pairs breeding in rock crevices were counted there.

Threats to seabirds

Choros and Damas, both protected and managed by the Chilean Forestry Service (Corporación Nacional Forestal, CONAF) (see Table 1) are facing increased numbers of tourists, particularly those interested in observing Humboldt penguins. Although only circumnavigation is allowed at Choros, landing and camping is possible at Damas. During spring and summer we regularly observed unauthorized fisherman camps at these islands, where they collected seafood and kelp gull eggs. At Choros, fishermen hunted European rabbits *Oryctolagus cuniculus*, usually by chasing them, an activity that was observed to cause great alert and panicking among penguins. Fishermen also regularly visited Pájaros 1, where they collected kelp gull and booby eggs, which resulted in massive nest desertion in the latter with nest contents being taken by gulls. Unregulated visits (mainly fishermen) were also observed at Chañaral, Concón and Cachagua. Guano harvesting was confirmed at four islands: Grande, Pájaros 2, Pájaros 1 and Concón. According to fishermen, rabbits are regularly hunted with traps and also with guns (three cartridges were found) at Chañaral. Fishermen

confirmed that Humboldt penguins are sometimes hunted at Pájaros 1 for consumption or for use as bait in the crab fishery. Rats *Rattus rattus* were observed at Pájaros 1, Cachagua and Pájaro Niño. At the former, large numbers occur and were observed to predate on Humboldt penguin eggs and chicks. Large numbers of rabbits were present at Chañaral and Choros, but were reduced at Pájaro Niño. Cats were regularly observed at the latter.

DISCUSSION

Seabirds are known to breed (or have bred) at other islands within the study area (e.g. Cima Cuadrada, Chungungo, Tilgo, Gaviotas, Huevos), but these were not surveyed. Some seabird species, on the other hand, have been reported to nest in the area (e.g., South American tern *Sterna hirundinacea*, red-billed tropicbird *Phaeton aethereus*) but we did not record them during our visits. In the following section we discuss our data only in the context of the known breeding distribution of each species along the Chilean coast and, when relevant, also along its entire known breeding range.

Breeding seabirds

The Humboldt penguin breeds almost exclusively on islands over 4,500 km along the Pacific coast from Punta Aguja (5° S) in Perú to the Puñihuil Islands (41° S) in Chile (Ellis et al. 1998). Although the Chilean population has been regularly censused by B. Araya and colleagues from 1980 to the present (most data is summarized in Ellis et al. 1998), this information refers primarily to roosting and moulting birds (i.e. outside their nests) and it is thus inadequate for comparison with our data and the establishment of population trends. Comparison of our data with that of Simeone & Bernal (2000) for Pájaro Niño and that of Meza et al. (1998) for Cachagua, suggests that the breeding populations at these two colonies have remained relatively stable over the last eight years, fluctuating between 280-330 and 500-1,000 pairs, respectively. To the best of our knowledge, the estimated breeding population of Humboldt penguins at Chañaral Island (7,000 pairs) is the largest ever recorded for this colony and any other along its entire distributional range (see Ellis et al. 1998). The observation of ca. 20,000 birds moulting in February 2003 supports this (T. Mattern & U. Ellenberg personal observations). Chañaral concentrates at present

ca. 80 % of the breeding population within the study area. Fluctuations in numbers, however, should be carefully interpreted since breeding abundance and timing in this species are highly sensitive to marine productivity and environmental factors like El Niño events and rainfall (e.g., Simeone et al. 2002).

Breeding of few pairs of Magellanic penguins was confirmed only for Pájaro Niño Island, coinciding with the observations of Simeone & Bernal (2000). Other nesting sites in north-central Chile have included Cachagua (Philippi 1937, Housse 1945) and probably Chañaral (Araya 1983). The literature mentioned above indicates that breeding of Magellanic penguins in the region is reduced and sporadic and likely represents the northern limit of this species. The main breeding areas in Chile are concentrated between Chiloé at 41°S (Simeone & Schlatter 1998) and the Magellan Region at 56°S (with ca. 1 million birds, Venegas 1994). Magdalena Island (52°S) is one of the largest colonies with ca. 40,000 pairs (Venegas 1999).

Until now, only two colonies of Peruvian diving-petrels were known from the Chilean coast: Pan de Azúcar (26°S) and Choros (Carboneras 1992a). Our finding of colonies on Grande and Pájaros 2 adds new nesting places for this species. The colony on Choros supported 300 nests in the late 1980s (Birdlife International 2000), a figure that contrasts with our counts of 1,550. Whether this represents an increase or reflects differences in sample effort is unknown. A large colony existed on Chañaral formerly (Millie 1939), but it is believed that introduced foxes *Pseudalopex* spp. were responsible for its extinction (Araya & Duffy 1987). Despite an intensive survey of this island and the presence of large numbers of birds foraging in adjacent waters (ca. 600 individuals), no nests were found. Main nesting sites of this species are restricted mainly to San Gallán and La Vieja islands, in the Peruvian coast, which have a combined population of 12,000 to 13,000 breeding pairs (Jahncke & Goya 1998).

Breeding grounds of storm-petrels (Hydrobatidae) occurring along the south eastern Pacific coast are poorly known and it has been suggested that some species may breed even in the inland desert (but see Marín 2002). Virtually nothing is known of overall population numbers, trends or threats of these birds (Schlatter 1984, Carboneras 1992b, Birdlife International 2000). The Elliot's storm petrel is the only hydrobatid known to breed in Chile, on Chungungo islet at 29°S (Schlatter & Marín 1983, Hertel & Torres-Mura 2003), which is also the only breeding place confirmed for this species along its whole range (Carboneras 1992b). Our finding confirms that

another member of this family breeds in Chile at Grande Island: the wedge-rumped storm-petrel. Breeding areas for this species were known for the Galápagos Archipelago (*Oceanodroma tethys tethys*) and for San Gallán and Pescadores islands (*O. t. kelsalli*) off the Peruvian coast (Murphy 1936, Carboneras 1992b). In Chile, its southernmost limit was given only until Antofagasta at 23°S (Araya et al. 2000). We consider this discovery highly relevant as it expands the distribution range of the species, confirms a new nesting site in the Chilean coast and provides information on this least-known bird family. The cryptic nature of the nesting sites used by this species (crevices) poses a problem for adequate assessment and it is possible that its presence on other islands has been overseen.

The main breeding areas of Peruvian pelicans have been historically located along the Peruvian coast (Jordán & Fuentes 1966, Crawford & Jahncke 1999) and reports for Chile were known only for northern localities (e.g., Gigoux 1930, Guerra & Cikutovic 1985), with exception of an outlying colony off Mocha Island (Murphy 1936, Housse 1945) which still persists (R. Schlatter personal communication). Within the surveyed area, Cachagua and Pájaro Niño are the only sites where we confirmed pelican nesting, which had regularly occurred since the early 1990s, except during El Niño years (Meza et al. 1998, Simeone & Bernal 2000). These colonies have been comparatively well monitored over recent years, with Pájaro Niño regularly supporting between 1,000 and 2,700 pairs (Simeone & Bernal 2000) and Cachagua between 1,700 to 4,000 pairs (Meza et al. 1998). A small colony (ca. 60 pairs) was observed at Concón Island in December 1983 (M. Bernal unpublished results), but breeding no longer occurs there.

Within the study area, the largest colony of Peruvian booby was found at the Pájaros islands (particularly the smallest), which have been known since the 1970s (Nelson 1978) although until this study no reliable estimates were available. Other colonies in Chile are known for islets off Horcón and coastal cliffs at Maitencillo, both near Valparaíso at 30°S (Philippi 1937, Housse 1945), Santa María Island at 37°S (Housse 1936) and islets off Mocha (R. Schlatter personal communication). The main breeding sites of this species are found on islands off the Peruvian coast (Nelson 1978, Crawford & Jahncke 1999).

We found only small colonies of Neotropical cormorants, a species which breeds all along the Chilean coast in a wide variety of habitats (Housse 1945, Johnson 1965, Araya et al. 2000) and which is one of the most abundant and widespread sea-

bird in South America (Orta 1992). In Chile, a large colony (ca. 7,000 pairs) exists at Quiriquina Island at 36° S (Kalmbach et al. 2001).

Guanay cormorants were found nesting at only two islands and in small numbers. Vilina et al. (1995) sighted fledglings at Choros Island, but we were unable to ascertain breeding at this site. Historical records of nesting sites in Chile include Pupuya (Johnson 1965), Santa María (Housse 1936) and Mocha islands (Murphy 1936, Housse 1945) and it is uncertain if these colonies still remain. At Concón Island nesting has been observed previously in December 1983 (60 pairs), February 1992 (200 pairs) and February 1995 (five pairs) (M. Bernal unpublished data). This information suggests irregular and reduced breeding along the surveyed area, which probably also reflects the reproductive status of the species along the Chilean coast. As with pelicans and boobies, the main breeding sites of Guanay cormorants are along the Peruvian coast (Jordán & Fuentes 1966, Crawford & Jahncke 1999).

None of the surveyed islands supported large numbers of nesting red-legged cormorants. A recent and complete survey along the Chilean coast (E. Frere personal communication) confirms that this species nests scattered, and in low numbers, along the coast of north-central Chile, but that larger colonies occur in the south: Punta Ronca (39° S) and Doña Sebastiana Island (41° S) with 964 and 703 pairs, respectively. This study estimated the Chilean population at ca. 5,000 pairs.

Little is known about the breeding status of the band-tailed gull in Chile, a species whose center of abundance is located on the shores and inshore guano islands of Perú (Burger & Gochfeld 1996). In Chile, nesting has been reported for the coast near Iquique at 20° S (Johnson 1965) and our observations at Grande and Choros islands, although numerically negligible, constitute the southernmost record of breeding in this species (Burger & Gochfeld 1996). Its similarity with the kelp gull, nevertheless, makes identification difficult and it is thus likely that nesting of this gull may have been overlooked in other parts of the country.

Kelp gulls were found nesting at all the surveyed islands with the largest colony occurring on Pájaros 1 (2,000 pairs). The colony at Pájaro Niño has remained stable between 1995 and 1998 with 400-500 pairs per season (Simeone & Bernal 2000), figures that are close to ours (450 pairs). This seabird breeds all along the Chilean coast both on the mainland and at islands in a great variety of habitats (Housse 1945, Johnson 1965).

Little has been reported on the nesting sites of Inca terns in Chile and its main breeding areas are

on the Peruvian coast among inshore guano islands (Gochfeld & Burger 1996). We were able to ascertain nesting only at the small Concón Island, where Johnson (1965) reported a few breeding individuals already in 1960. To the best of our knowledge this represents the species southernmost breeding site. Other breeding sites in Chile have been reported for Iquique and Antofagasta (Housse 1945, Johnson 1965). As with storm-petrels, the cryptic nest sites of this bird (e.g., cracks and crevices among rocks) may cause nests to be overlooked and it is possible that breeding may occur at other islands.

Threats to seabirds

Most of the conservation problems faced by seabirds in Chile and recommendations heading to improvement of conservation remain valid and we do not believe it necessary to revise them in detail here (see Schlatter 1984, 1987, Schlatter & Simeone 1999).

Despite protection, a common problem at most of the surveyed islands was the intrusion of people. The effects of the human activity on the breeding and distribution of seabirds along the Chilean coast has not been adequately addressed and must remain a matter of speculation. Cases at other seabird colonies elsewhere suggest, however, that such activities are generally detrimental (e.g., Vermeer & Rankin 1984, Duffy 1994, Carney & Sydeman 1999) and thus demand urgent research. Seabirds, and particularly penguins, are becoming an important attraction for the ecotourism industry in Chile and are thus vulnerable to mismanagement (e.g., Simeone & Schlatter 1998). It is noteworthy, for example, that at Damas breeding success and abundance of Humboldt penguins is considerably lower than at the nearby Choros (Luna-Jorquera et al. 2000, Ellenberg & Luna-Jorquera 2002¹). At present, and despite its protective status, a tourist project plans the construction of a hotel on the vicinity of the "Reserva Nacional Pingüino de Humboldt" (see Table 1). In this area, the local community of fishermen greatly profit from wildlife, and together with the Regional Fishery Council (Consejo Zonal de Pesca, regions Three and Four), are conducting a project to define sustainable exploitation areas and a wildlife-oriented tourism (L. Núñez per-

¹ ELLENBERG U & G LUNA-JORQUERA (2002) Efecto de la perturbación humana sobre la nidificación de pingüinos de Humboldt. Duodécimo Congreso de Ciencias del Mar, Valdivia, Chile: 95.

sonal communication). Ecotourism at seabird colonies is a potential threat that needs to be carefully planned and managers must clearly define areas of wildlife and human usage. Guano harvesters and fishermen, on the other hand, may also have considerable impact on nesting seabirds (Duffy 1994, Carney & Sydeman 1999) as they enter the colonies, disturb birds, collect their eggs, hunt rabbits and remove guano (which is sold as fertilizer). Guano is a high-quality breeding substrate for several burrow-nesters including the Humboldt penguins (e.g., Paredes & Zavalaga 2001).

Introduced mammals may have detrimental effects on island-nesting seabirds (see summaries in Moors & Atkinson 1984, Burger & Gochfeld 1994) as seabirds have evolved without them and thus lack effective anti-predator mechanisms (Lack 1968). The presence of rats, rabbits and cats on islands along the Chilean coast is largely known (Schlatter 1984), but their potential effects (e.g., predation, habitat degradation) on seabird populations have not been assessed. Recently, Simeone & Bernal (2000) reported predation by cats and dogs on seabirds nesting at Pájaro Niño Island, but this seems to be sporadic. A matter of concern is also the predation that native animals are exerting on Peruvian diving-petrels. Meichßner (2001) determined that 61 % of a total of 624 pellets of burrowing owl *Athene cunicularia* contained feathers of diving-petrels breeding at Choros. Villegas (2002), also at this island, determined that marine otters *Lontra felina* hunt these birds by digging out their burrows (see also Mattern et al. in press). Given the conservation status of this small petrel (IUCN Endangered, Birdlife International 2000), this situations needs assessing.

In this paper we have attempted to provide updated information on the breeding abundance of some seabird species on islands along ca. 700 km of coastline from the nearly 4,200 km of the whole country. Our discovery of new nesting sites of diving- and storm-petrels, for instance, suggests that other secretive seabirds may be also nesting along the Chilean coast but have been largely overlooked due to the lack of adequate searching. This has likely resulted in an incomplete picture of the composition and abundance of the seabird assemblage. This local contribution needs thus to be supplemented with further comprehensive ornithological surveys in other areas so as to improve the picture of the Chilean seabird populations.

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