

Humboldt Penguin Census on Isla Chañaral, Chile: Recent Increase or Past Underestimate of Penguin Numbers?

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Abstract.—While Isla Chañaral (29°02'S) in Chile has long been recognized as one of the most important breeding islands for the Humboldt Penguin, the reported numbers of birds there never exceeded 3,500 breeding individuals in the last two decades. However, in 2002, a one-day survey found considerably more penguins present on Isla Chañaral, which exceed the world population estimate for the species (3,300-12,000 birds). Between 9 and 14 February 2003 we conducted a census of the Humboldt Penguin on Isla Chañaral. Two different survey methods were combined to assess the number of penguins. Terrestrial or surface counts were used to survey penguins on open plains or beaches. Small area surveys of randomly established quadrats were conducted to assess the density of penguins in nests and the total number of nest sites. Results from small area surveys were extrapolated using surface size ratios of counting quadrats vs. entire nesting sectors. We determined that approximately 22,000 adult Humboldt Penguins, 3,600 chicks and 117 juveniles were present on the island during the survey. The results were much higher than any previously published estimate. Natural processes alone cannot account for an increase, and penguin numbers on Isla Chañaral previously have been underestimated. The results correspond well with recent publications that suggest that Humboldt Penguin numbers in Chile have been underestimated in the past due to inappropriate or inconsistent census methods. There are concerns about the current protection status of the island in light of its fragility and importance as the premier breeding location of the Humboldt Penguin along its entire distributional range. *Received 12 January 2004, accepted 3 May 2004.*

Key words.—Humboldt Penguins, *Spheniscus humboldti*, census, population size, population estimate, penguin numbers, Isla Chañaral, conservation status, Humboldt Penguin National Reserve, Chile.

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The Humboldt Penguin (*Spheniscus humboldti*) is endemic to the west coast of South America, and its breeding distribution ranges from cool temperate latitudes of southern Chile (Isla Puñihuil, 42°73S), along the dry and arid coastal regions of the Atacama Desert in northern Chile and southern Peru to subtropical Isla Foca (5°12S) in north Peru. With the onset of commercial guano harvesting in Peru in the mid-1800s, numbers of Humboldt Penguins decreased dramatically (Coker 1920; Murphy 1936; Duffy 1994). Growing efforts of coastal fisheries in the second half of the 20th Century further contributed to a general deterioration of Humboldt Penguins' food resources throughout their breeding range (Duffy 1983; Hays 1984; Simeone *et al.* 1999). During the last two decades, severe El Niños may have exacted a further toll on the populations in Peru and Chile (e.g., Hays 1986; Araya and Todd 1987; Paredes *et al.* 2003).

Currently, the total world population is believed to be between 3,300 and 12,000

birds that are all confined to a few off-shore islands and inaccessible sea caves in Peru and Chile (BirdLife International 2000). Isla Chañaral (29°02S), located off the southern coast of the 3rd Region in Chile (Fig. 1) is one of three islands forming the Humboldt Penguin National Reserve. Considered as Chile's most important Humboldt Penguin breeding site, the island's penguin numbers have reportedly never exceeded 3,500 birds in the last 20 years (Araya and Todd 1987; Vilina 1993; Ellis *et al.* 1998). Yet a one-day survey conducted in February 2002 estimated a total of more than 16,000 penguins on the island (Diaz and Rozas 2003). Considering previous estimates of penguin numbers, this figure was surprising. Although the census design—using chains of observers counting along parallel transects crossing through the nesting areas—seemed inappropriate to ensure accurate results, the discrepancy between Diaz and Rozas (2003) and previously published figures warranted verification. The need for

clarification of Isla Chañaral's importance for the Humboldt Penguin was furthermore driven by increasing and largely unregulated tourism activities that led to governmental considerations of a reduction of the reserve's protection status for commercial reasons (Vilina *et al.* 1995; Simeone *et al.* 2003).

The aims of this study were: a) to estimate the number of Humboldt Penguins on Isla Chañaral following methods recommended for terrestrial census by Luna-Jorquera *et al.* (2000) to maintain consistent census methods with recently conducted surveys; b) to compare our data with previously published estimates; and c) to discuss our findings in relation to the island's current protection and conservation status.

STUDY SITE AND SPECIES

Isla Chañaral is located 6 km off the Chilean coast, some 100 km north of La Serena (Fig. 1). Together with Isla Choros and Isla Damas, the island forms the Hum-

boldt Penguin National Reserve, which is administered by the Chilean Forestry Corporation (Coperación Nacional Forestal—CONAF). Isla Chañaral, lying approximately 30 km north of the other two islands, is somewhat isolated from the increasing tourist activities that primarily occur around Isla Choros and Isla Damas. With an area of 655 ha, Isla Chañaral is the biggest of the reserve's islands.

Humboldt Penguins congregate in their colony and start mating in mid-March (Zavalaga and Paredes 1997; Simeone *et al.* 2002). On Isla Chañaral, open nests are rare and the majority are established in dug-out nest bowls under cacti and other vegetation that provide protection from the sun. Breeding takes place between March and December with two distinct peaks in April/May and November/December (Simeone *et al.* 2002; pers. obs.). The penguins lay two egg clutches, chicks hatch after ca. 41 days and both are usually reared and fledge after 10-12 weeks (Zavalaga and Paredes 1997). Humboldt penguins moult once a year, between January and March (Zavalaga and Paredes 1997; Simeone *et al.* 2002). During the three week period it takes to complete the feather change, the birds are confined to land (Duffy 1991; Zavalaga and Paredes 1997). The species is considered sedentary, non-migrating (Croxall and Davis 1999; Davis and Renner 2003) and it is likely that most birds moulting on Isla Chañaral represent resident individuals (but see Culik *et al.* 2000). With the exception of Isla Choros (estimated 720 breeding birds),

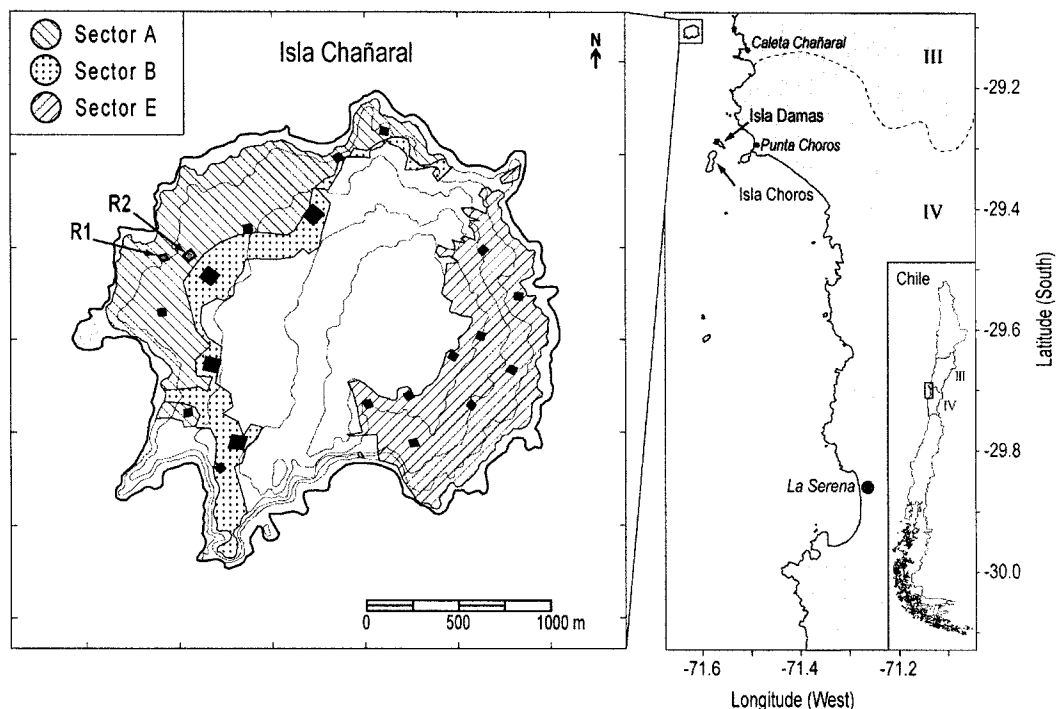


Figure 1. Overview of the coastline of northern central Chile and Isla Chañaral. The two administrative regions Coquimbo (3rd region) and Atacama (4th region) are shaded gray and labeled with Romanic numbers. The three islands belonging to the Humboldt Penguin National Reserve are marked by labeled arrows. Isla Chañaral's features are indicated as 25-m contour lines. Nesting sectors are shown as hatched or dotted areas. Black rectangles mark position and size of counting quadrats used for small area surveys conducted in February 2003. Grey rectangles labeled R1 and R2 give location and size of the reference quadrats surveyed in December 2002.

Isla Damas (ca. 20 breeding birds) and Isla Pajaros (29°35'S, ca. 1,200 breeding birds), there are no other major breeding locations within 500 km of the island from where birds might migrate before undergoing moult (Simeone *et al.* 2003).

METHODS

Estimates of penguin numbers presented in this paper were derived by combining two different census methods. Terrestrial surface counts were used to determine the number Humboldt Penguins on open plains. Additional small-area surveys ("quadrat counts", see Bibby *et al.* 2000) were conducted to assess the amount of adult penguins roosting/moulting under cover (e.g., in nests) that were missed during terrestrial counts, and to assess the total number of nest sites. Gross estimates of number of active nests derived from reference counts performed during peak of chick rearing in December 2002.

Terrestrial Surface Counts

Terrestrial counts were conducted 10-14 February 2003. During that time, most penguins had started to moult but some active nests, containing mainly post-guard chicks were still present. Between late morning to the early evening hours, moulting Humboldt Penguins tended to congregate on elevated inland positions (e.g., rocks, hills) or on beaches (Luna-Jorquera *et al.* 2000; Simeone *et al.* 2002). Therefore, all census work was made between 11.00 h and 18.00 h. Teams of two observers counted penguins from elevated positions outside the nesting areas using binoculars and hand counters. As it was impossible to survey entire plateaux at one time, these were divided into smaller areas defined by landmarks (e.g., rocks, vegetation). Results of these area counts and surveys of all beaches were later totalled to obtain an overall estimate for the two main plateaux and all beaches. The island's eastern plateau was counted with minimum disturbance, as this area was readily observable from the island's higher central plateau (Fig. 1). For the wider western plateau, observers counted from elevated hills or rocks outside the nesting sectors to minimize disturbance of the roosting birds. Some seaward sites were concealed from view by hills or located in narrow gorges and could not be surveyed. However, terrestrial counts covered at least 95% of the island's plains. To count moulting penguins on beaches, the observers followed the sea cliffs to avoid disturbance of inland roosting birds. A previous study on the island found that during the moulting period there is no significant net movement of penguins between beaches and inland areas (T. Ponce, unpubl. data). Therefore, it was deemed best to count plateaux and corresponding beaches on separate days, as access to beaches often involved some disturbance of penguins roosting inland. For every area and beach, numbers of adults, juveniles (one-year old birds distinguished from adults by the lack of a chest band), and chicks were counted twice by each of the two observers. This means that four values were recorded for every area each for adults, juveniles and chicks. The mean of these four values was used to estimate the number of penguins. The minimum and maximum values of the four counts were taken as the range for each counting area. These values from area and beach counts were then totalled to provide estimates and corresponding ranges for western plateau, eastern plateau and all beaches respectively.

Small-area Surveys

To assess the total numbers of nests and number of adult penguins at nests, results from small area surveys were extrapolated to the total area of nesting sectors using the GIS software ArcView 3.3 (ESRI, Redlands, CA, USA). Three different sectors were defined on the island after preliminary visual surveys: the "densely populated" sector A (ca. 300 nests/ha) on the western plateau, the "sparsely populated" sector B (ca. 50 nests/ha) in the inner reaches of the western plateau and the "evenly populated" sector E (ca. 200 nests/ha) consisting of the entire eastern plateau (Fig. 1). The boundaries of the sectors were either natural (e.g., cliff edges, bluffs) or subjectively defined according to estimated nest density. The boundaries were mapped by recording geographic positions at approximately 50m intervals using a GPS receiver (eTrex® summit, Garmin International, Inc., Olathe, KS, USA). The maximal horizontal deviation of GPS positions was <6 m. On the western plateau, the transition between the densely (A) and sparsely (B) populated sectors was closely connected to the type of vegetation. While sector A featured large areas of dense shrub and cacti that penguins preferably used for nesting, sector B consisted only of patchy cactus aggregations that offered little shelter for nesting and thinned out towards the interior of the island. To determine surface areas of nesting sectors recorded GPS boundary data (i.e., subjectively defined boundaries) and vector data of the 25-m contour line for all sectors as well as the 125-m contour line for sector E only (i.e., natural boundaries) were combined. Contour lines were taken from a digital vector map of Isla Chañaral (R. Villablanca, unpubl. data based on Yañez and Rojas 1996).

Several quadrats were set up in every nesting sector. We used wooden poles (length = 1.5 m) to mark the corners of each quadrat. Shape and surface area of the quadrats varied slightly as setting of poles was determined by GPS co-ordinates. Quadrats were established at 300-m intervals (determined via GPS, error: <6 m) along randomly chosen zigzag lines. In addition to the two reference quadrats that were set up in December 2002, ten and nine quadrats were established on the western plateau and the eastern plateau, respectively (Fig. 1). Side lengths of quadrats were 40 m for the "densely populated" sector A, 80 m for the "sparsely populated" sector B, and 50 m for the "evenly populated" sector E. Quadrat sizes represented a compromise between the need for a good view of each quadrat (i.e., no or few obstacles inside the quadrat), the necessity to keep observer impact at a minimum (i.e., disturbance during nest counts), and to minimize the effect of patchy nest distribution (i.e., the smaller the quadrat, the greater the possibility that nest densities would be over- or under-estimated).

Initial quadrat counts were conducted between 18 and 28 December 2002 during the peak of the breeding period. High penguin numbers in most parts of the island made it difficult to move without causing disturbance in nesting areas. Therefore, only two survey areas (R1 and R2, see Fig. 1) were established and examined to get a reference number of active nests during this period. Main quadrat counts were carried out on three days during the moulting period in February 2003.

Quadrat counts were conducted by two-observer teams. Firstly, penguins standing in the open inside the quadrat were counted by both observers from a concealed location until a single figure was determined on

consultation (initial count). Secondly, one observer entered the quadrat, searched it thoroughly and recorded number of nests and number of individuals found in nests. Nests were defined as active nests (containing chicks), moulting nests (containing moulting adults or piles of feathers), sleep nests (containing pre- or post-moulting adults), and empty nests (with signs of previous usage, e.g., scat marks, few feathers). Burrows or nests that did not show any of these features were excluded from the count. At the same time, the second observer scanned the quadrat with binoculars and recorded the number of any penguins that fled out of the quadrat because of the presence of the searcher. Before analyzing quadrat counts, we compared the number of penguins determined from the initial count and the number of penguins fleeing the quadrat counted by the watcher during the search process. If fewer penguins left the quadrat than were counted initially, the remainder were considered as hiding in nests and were, therefore, subtracted from the numbers of adults in nests recorded by the searcher. Accordingly, if more penguins fled the quadrat than were counted initially, the excess number was considered as "fleeing from nest" and was added to the final figure of adults in nests.

Total numbers of penguins in nests were assessed by, firstly, calculating the bird density in each quadrat by dividing the number of penguins found by the quadrat's surface area (determined in ArcView 3.3). Secondly, data was square-root transformed to eliminate non-homogeneous variances and to fit a normal distribution and, thereafter, density means as well as 95% confidence intervals for all three nesting sectors were calculated. Finally, mean densities and confidence intervals were back-transformed and used to calculate total values for each sector. The same procedure was used to determine total nest numbers in each sector. To estimate numbers of active nests, results from the two reference quadrats obtained in December 2002 were generalized. The number of active nests was found to be highest at this stage of the breeding season on Isla Choros (Ursula Ellenberg, unpubl. data) and we assumed that same applied to Isla Chañaral. Therefore, the ratio of active vs. total numbers of nests was used and the resulting percentile of active nests in both reference quadrats was applied to the total numbers of nests determined in February 2003 for all nesting sectors.

RESULTS

The sum of means of terrestrial counts for the February census totalled 16,081 adult

penguins (Table 1). Only a small portion of birds counted in the open were chicks ($N = 314$) and juveniles ($N = 117$). While sightings of juveniles were mainly confined to the beach areas, most of the chicks were observed on the plateaux of the island.

From small area surveys ("quadrat counts") we determined that more than 5,900 adult Humboldt Penguins were present in covered nests or burrows and, thus, were likely to be missed during surface counts (Table 2). These birds were roosting, moulting or still attending their offspring. The estimate of chicks in nests was substantially higher (3,308 individuals) than that determined during surface counts (Table 2).

Summing the penguin numbers from terrestrial and quadrat counts, a total of 22,021 adult Humboldt Penguins (73% outside vs. 27% in nests), and a total of 3,622 chicks (9% outside vs. 91% in nests) was estimated. There was an estimated total of 65,853 nest sites (i.e., active nests, nests used for moulting or roosting and empty nests with signs of previous usage) on the island (Table 2). When the two reference quadrats (R1 & R2, Fig. 1) were surveyed during the peak of the breeding season in December 2002, a total of 197 nest sites were found, 14% (27 nests) of which were active. Applying this proportion to the total number of nest sites leads to an approximate estimate of 9,000 nests that might have been active in December (Table 2).

DISCUSSION

There is a consensus among penguin conservationists that accurate estimates of the population size of Humboldt Penguins

Table 1. Numbers of Humboldt Penguins determined during terrestrial counts of eastern plateau, western plateau and beaches on Isla Chañaral conducted between 10 and 14 February 2003. Ranges represent sums of minimum and maximum values of every two-observer count (4 values; see text for details).

	Adults		Chicks		Juveniles	
	Mean	Range	Mean	Range	Mean	Range
Eastern plateau	2,929	2,733-3,155	113	78-149	0	0
Western plateau	6,470	6,174-6,798	157	132-180	3	—
Beaches	6,682	6,362-6,994	45	40-51	114	102-127
Total	16,081	15,269-16,947	314	250-380	117	105-130

Table 2. Surface size of the three nesting sectors and corresponding counting quadrats; estimated numbers of nest sites, adults and chicks found in nests during small area surveys ("quadrat counts") on Isla Chañaral between 9 and 14 February 2003. Confidence intervals are given in parentheses. Numbers of active nests represent 14 percentile (determined in December 2002 for two reference areas, see Methods for details) of estimated number of nest sites.

	Sector A	Sector B	Sector E	Total
Area				
Entire breeding sector (ha)	117.68	57.88	127.51	303.08
No. of counting quadrats	7	5	9	21
Total area of quadrats (ha)	1.10	3.66	1.92	6.68
Nest sites (active & empty)				
Mean density (nest sites ha ⁻¹)	292	51	224	—
Estimated no. of nest sites	34,343 (21,727-49,833)	2,977 (1,787-4,469)	28,533 (22,912-34,770)	65,853 (46,426-89,072)
Estimated no. of active nests	4,705	408	3,909	9,022
Adults in nests				
Mean density (adults ha ⁻¹)	26	10	18	—
Estimated in nests	3,117 (1,963-4,536)	568 (163-1,218)	2,247 (674-4,737)	5,931 (2,801-10,491)
Chicks in nests				
Mean density (chicks ha ⁻¹)	26	3	1	—
Estimated in nests	3,044 (1,746-4,700)	171 (27-440)	93 (19-556)	3,308 (1,792-5,695)

can only be obtained through standardized methodology (Araya *et al.* 2000). One suggested approach is to have repeated censuses during the moulting period (Crawford and Boonstra 1994; Ellis *et al.* 1998; Luna-Jorquera *et al.* 2000). At this time, the majority of the penguins (i.e., breeders and non-breeders) are confined to land until their feather change is completed. Numbers obtained from a single census are likely to represent an underestimate as penguins that have either finished or have not yet started their annual moult are at sea. Two or more consecutive censuses at three week intervals during the entire period over which moulting occurs may help to minimize this bias (see Araya *et al.* 2000; Luna-Jorquera *et al.* 2000; Paredes *et al.* 2003). On Isla Chañaral, the need to avoid disturbance of the penguins, permitted only a single moult census in February 2003 and it can be expected that a portion of the island's Humboldt Penguins was at sea and thus missed. Luna-Jorquera *et al.* (2000) conducted combined at-sea and terrestrial counts of Humboldt Penguins and found that up to 25% of the total number of penguin may be at sea during a single terrestrial census. On Isla Chañaral, this would account for approximately 7,300

birds. Thus, Isla Chañaral may in fact hold more than 29,000 adult penguins, if migration is ruled out as factor influencing number of moulting penguins present. The total estimate of 22,000 birds determined from the land surveys can, therefore, be regarded a conservative figure.

The number of juveniles was low. Only 0.7% of the penguins observed during terrestrial counts were juveniles; all but three individuals were encountered on the beaches. However, in Chile, juvenile Humboldt Penguins generally moult to their adult plumage a month earlier than adults (Simeone *et al.* 2002). By the time moulting adults reach their peak numbers, most juveniles have either left the colonies already or are no longer distinguishable from adults (Simeone *et al.* 2002). As a consequence, the number of juveniles determined cannot be considered as representative.

The number of chicks certainly also represents an underestimation of the total number for that year. In February, the breeding period was well advanced, and it is reasonable to assume that at this time most chicks had left. In the east of the island, most of the chicks were encountered in the open, while in the west, the majority were still in nests

(see Tables 1 and 2). This could indicate a slight breeding asynchrony between the areas, with chicks fledging and, thus, leaving their nests earlier in the east. During the peak of breeding in December 2002, there must have been considerably more active nests. Although we can only present a gross estimate of active nests that derived from a survey of a small fraction of one breeding area, there might have been approximately 9,000 active nests on the island. The majority (>86%) of the estimated 65,853 nest sites did not serve for breeding purposes, but were either used by roosting (or later moulting) penguins or represented breeding/roosting sites from previous years.

It is questionable that Isla Chañaral's high penguin numbers are a recent development. Table 3 gives a summary of estimates of penguin numbers on Isla Chañaral for the last 20 years. The two main estimates of penguin numbers are in Araya and Todd (1987) and Araya and Bernal (in Ellis *et al.* 1998). Although numbers presented in both are presumably derived from the same data collected by Araya, discrepancies in reported numbers are striking. According to these sources, numbers of Humboldt Penguins on Isla Chañaral generally did not exceed 2,500 breeding individuals during the 1980s and 1990s (the figure for 1985 in Ellis *et al.* appears to be a transcription error). Overall, penguin numbers were low during the 1982/83 El Niño event which was reflected in there being fewer than 300 individuals

present on the island in 1984. In the following years, numbers increased slowly until a peak was reached in 1995/1996 (Table 3). Although regular surveys were conducted since 1987 (Braulio Araya, pers. comm.), no data have been published or are available for review for the periods between 1991-93 and 1997-2001. Vilina (1993) reports that there were 3,500 breeding penguins present on the island in 1993. Trends of penguin numbers after the 1997/1998 El Niño are a matter of speculation. However, in Peru, that event led to a marked decline in penguin numbers (Paredes *et al.* 2003). In this light, the apparent increase in penguin numbers between 1996 and 2002 (3,500 vs. 16,262 individuals, Table 3) is surprising.

Natural processes might have contributed to changes in penguin numbers on Isla Chañaral in the past. In recent years, surveys in Peru indicated a southward shift of Humboldt Penguins, where penguin numbers in the country's north decreased, while at the same time numbers in the south increased. Paredes *et al.* (2003) suggested that movements might explain this. Although Humboldt Penguins are considered to be sedentary birds that do not tend to migrate (Croxall and Davis 1999), there is evidence that this species defers breeding and travels considerable distances to compensate for El Niño induced food shortages (Culik and Luna-Jorquera 1997; Culik *et al.* 2000; Davis and Renner 2003). It is generally assumed that Humboldt Penguins making such move-

Table 3. Estimates of Humboldt Penguins numbers on Isla Chañaral from published literature. Asterisks mark figures referred to as "breeding individuals" (*). Rhombus (◊) marks figure that seemingly derived from transcription error. Figure given for this study represents sum of number of adult penguins in the open determined from terrestrial surface counts and number of adult penguins in nests estimated from small-area-surveys. Note: seasons 1982/1983 and 1997/1998 were greatly affected by El Niño phenomena.

Author(s)	1980-82	1981/82	1984	1985	1986	1988-89	1990	1993	1995-96	2002	2003
Araya & Todd (1987)†	—	1,750	218	600	1,000	—	—	—	—	—	—
Vilina 1993††	—	—	—	—	—	—	—	3,500	—	—	—
Cheney 1998	—	—	—	—	—	—	—	—	2,500	—	—
Ellis <i>et al.</i> 1998	750*	—	146*	6,000*◊	1,000*	788*	1,500*	—	2,500*	—	—
Braulio Araya (pers. comm.)	—	—	—	—	—	—	—	—	—	5,000	—
Diaz & Rozas (pers. comm.)†††	—	—	—	—	—	—	—	—	—	16,262	—
This study	—	—	—	—	—	—	—	—	—	—	22,021

†Cited from Araya and Todd (1988), a reprint of their 1987 paper.

††Cited from Simeone (1996).

†††Absolute figure cited from Diaz and Rozas (2002).

ments return to their original colonies to breed in the year following an El Niño, rather than settling in new breeding areas (Araya and Todd 1987; Simeone *et al.* 2002). Especially the absence of other major breeding locations within a 500 km radius of Isla Chañaral, reduces the likelihood of movements as possible reason for changes in penguin numbers.

Instead, it is more likely that inconsistent survey methods employed during the last 20 years resulted in estimates that led to a general underrating of Isla Chañaral's penguin numbers. Depending on the stage of breeding, penguin surveys will result in varying figures (see Araya *et al.* 2000; Luna-Jorquera *et al.* 2000; Paredes *et al.* 2003). Any survey conducted during breeding is likely to record only the breeding portion of a population and, thus, will underestimate its true size. This is especially true during El Niño years when Humboldt Penguins are known to defer breeding and spend more time at sea (Culik *et al.* 2000).

With one exception (Vilina 1993 cf. Simeone 1996), all accounts for penguin numbers between 1980 and 2001 originate from the census data of B. Araya (Araya and Todd 1987; Araya and Bernal in Ellis *et al.* 1998; Cheney 1998), which leads to the assumption that surveys followed a consistent methodology. None of these sources reveal specific details about timing and methods employed. Consequently, it is difficult to place the findings of our and other studies in the context of these figures. However, there is some evidence that in the past the numbers of Humboldt Penguins on Isla Chañaral have been considerably underestimated. For example, Araya and Todd (1987) state that in November 1985 "there were at least 600 Humboldt Penguins in Isla Chañaral". Yet Duffy (1987) reports that during a visit to Isla Chañaral in November 1985 he encountered "several thousand Humboldt Penguins". This figure was confirmed by Rory Wilson, who was present at the same time ("5000 or more penguins", R. Wilson, pers. comm.). For 2002, B. Araya (pers. comm.) gives a figure of 5,000 penguins present during the moult in February/March. In contrast to this, a terrestrial count of moulting penguins

conducted on 14 February 2002 suggests that more than 16,000 birds were present on the island (Diaz and Rozas 2003). This survey involved chains of up to seven observers traversing the island (Hernan Diaz, pers. comm.), which might have induced counting errors. Humboldt Penguins are recognized as a timid species and react to human presence at distances of more than 150m (U. Ellenberg, unpubl. data). Considering this, a census consisting of observer chains must be regarded as a too intrusive approach (i.e., causing penguins to flee or hide) and is likely to yield underestimates. Nevertheless, our data support Diaz and Rozas' findings.

Conservation Concerns

Isla Chañaral can be considered to be the most important breeding location for the Humboldt Penguin. Yet the island's protection status and lack of appropriate management of the entire Humboldt Penguin National Reserve give reason for concerns. Recently, the Chilean government discussed the exclusion of parts of the reserve to allow the construction of a tourist complex (Simeone *et al.* 2003) which demonstrates the reserve's vulnerability towards economically driven exploitation in the wake of rapidly increasing ecotourism activities in the area. Furthermore, the absence of any administrative bodies in the vicinity of Isla Chañaral renders the island vulnerable to unmanaged intrusion. While access to the reserve's other islands is monitored and regulated to some extent by CONAF through the reserve headquarters in Punta Choros (see Fig. 1), access to Isla Chañaral (from Caleta Chañaral) is largely unregulated although landing is officially not permitted. This is mainly due to the fact that the Humboldt Penguin National Reserve extends across region borders of Chile's Coquimbo region (4th region—Isla Choros and Isla Damas) and Atacama region (3rd region—Isla Chañaral) and, thus, falls under the jurisdiction of different regional CONAF bodies. The biggest issue, however, is that CONAF has neither the financial means nor sufficient trained staff necessary for adequate management of the reserve (Vilina 1995; pers. obs.)

While further research is needed to monitor penguin numbers on Isla Chañaral, any unregulated and prolonged human presence on the island will undoubtedly have negative impacts. During the course of this study it became clear that it is impossible to move on the island without causing major disturbance inside nesting areas, which can result in nest failure (U. Ellenberg, unpubl. data). Therefore, efforts to ensure adequate management of the national reserve and regulation of visits should be of great benefit for the future of Isla Chañaral's Humboldt Penguins.

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Erratum

In the paper, Conservation implications of the large colony of Double-crested Cormorants on East Sand Island, Columbia River estuary, Oregon, U.S.A., by Cynthia D. Anderson, Daniel D. Roby, and Ken Collis, *Waterbirds* 27: 155-160, an error appears in the last paragraph of the Discussion (p. 159, line 18). The correct text should read: Despite dramatic increases in the size of the East Sand Island cormorant colony in the last 13 years, the available evidence indicates that the numbers of *P. a. albociliatus* are slowly increasing relative to the interior population (*P. a. auritus*) (M. Naughton, pers. comm.).