INCIDENTAL MORTALITY OF HUMBOLDT PENGUINS *SPHENISCUS HUMBOLDTI* IN GILL NETS, CENTRAL CHILE

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SUMMARY

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Mortality of Humboldt Penguins *Spheniscus humboldti* drowned in gill nets is documented for the Valparaíso Region, central Chile, based on sampling and reports from local fishermen. Between 1991 and 1996 at least 605 Humboldt Penguins died in gill nets set for 'corvina' *Cilus gilberti*, an average of 120 birds per year. Lesser numbers of other seabirds, including Magellanic Penguins *S. magellanicus*, Red-legged Cormorants *Phalacrocorax gaimardi* and Guanay Cormorants *P. bougainvillii* were killed. Drownings occur mainly during winter (June to August), reducing the population prior to the spring breeding season. Drowning kills adults from the two major colonies of Humboldt Penguins in central Chile, Cachagua and Pájaro Niño. Entanglement of Humboldt Penguins in fishing nets has been reported for other sites in Chile and Perú, suggesting similar mortality along most of the species' range.

RESUMEN

Se documenta mortalidad de pingüinos de Humboldt *Spheniscus humboldti* por enmallamiento casual en redes de pesca en la Región de Valparaíso, Chile central. La información fue obtenida a través del muestreo de playas y comunicaciones de pescadores locales. Entre 1991 y 1996 al menos 605 pingüinos de Humboldt han muerto ahogados en redes de pesca destinadas a la pesquería de la corvina *Cilus gilberti*, promediando 120 aves por año. Otras aves marinas como pingüino de Magallanes *S. magellanicus,* Lile *Phalacrocorax gaimardi* y Guanay *P. bougainvillii* han sido afectadas también, pero en una escala menor. Los ahogamientos ocurren principalmente en los meses de invierno (junio a agosto), afectando así la capacidad reproductiva del peak de primavera. Se estima que estos enmallamietos afectan a pingüinos de las dos colonias principales de la región, Cachagua y Pájaro Niño. Mortalidad en esta especie debida a enmallamiento ha sido descrita también para otros sitios en Chile y Perú, sugiriendo un efecto similar a lo largo de gran parte de su rango de distribución.

INTRODUCTION

Fishing activities by humans can affect seabirds directly, e.g. drowning in nets, drowning while taking longline baits and use of birds as bait or food, or indirectly, e.g. through effects on prey species such as competition between humans and birds for food. This may result in changes in seabird reproductive performance and population sizes (Duffy & Schneider 1994). Longline fisheries are a threat to surface-feeders such as Procellariiformes (Brothers 1991) through the swallowing of baited hooks, or entanglement with hooks and lines (Ashford *et al.* 1995). Fishing nets, on the other hand, seem to constitute more of a threat to diving birds such as penguins and cormorants.

In the Humboldt Current area in the south-eastern Pacific Ocean, commercial fishing seems not to affect seabird populations through starvation or drowning in nets, but apparently led to reduced nesting success because of a decrease in prey availability (Duffy 1983a). Nevertheless, interactions with artisanal fisheries along the shores of Chile and Perú have been cited for a long time as a probable cause of decrease of numbers of Humboldt Penguins *Spheniscus humboldti*, mainly through entanglement in gill nets (Murphy 1936, Araya 1983, Duffy *et al.* 1984, Zavalaga & Paredes 1997).

Off the central Chilean coast in the Valparaíso Region, there is intense fishing activity, using mainly long-lines and, to a lesser extent, gill nets targeting 'corvina' *Cilus gilberti.* We discuss the effects of the use of this latter fishing gear on the local populations of Humboldt Penguins.

STUDY AREA AND METHODS

The study area comprised a 14-km long section of the shoreline of the Valparaíso Region between Punta de Piedra (32º53'S, 71º31'W) and Las Salinas beach (33º00'S, 71º34'W) (Fig. 1). In this area the main target species of the artisanal fisheries is the hake 'merluza' *Merluccius gayi*, which contributed between 42–81% of the overall catch during the period

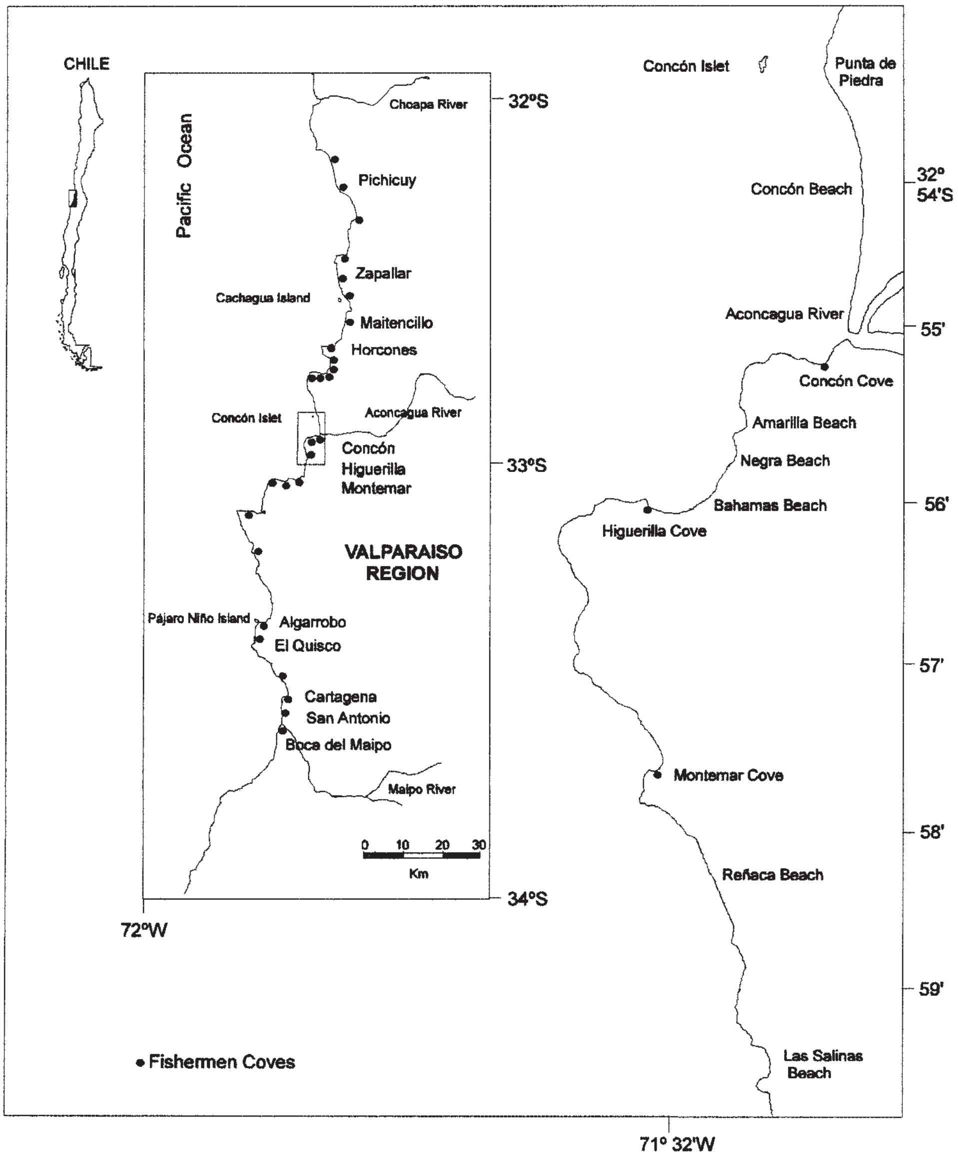

Fig. 1. *Study area in Valparaíso Region, central Chile.*

TABLE 1

Mortality of penguins in the study area caused by entanglement in gill nets between August 1991 and December 1996

	Humboldt Penguin (adults)	Magellanic Penguin (adults)	*Spheniscus* spp. (juveniles)	*Spheniscus* spp. (adults and juveniles)*	Totals
August 1991	38	56	29	–	**123**
June 1992	–	–	–	156	**156**
August 1994	138	2	60	–	**200**
July 1995	15	–	4	–	**19**
March 1996	2	–	3	–	**5**
July 1996	–	–	–	29	**29**
September 1996	7	–	–	–	**7**
October 1996	20	–	4	–	**24**
December 1996	–	–	–	100	**100**
Total	**220**	**58**	**100**	**285**	**663**

*Information from fishermen.

1991–1996. Merluza is mainly caught with longlines. A smaller fishery, but one of economic importance, is that for the corvina. This species is fished within one or two miles of the shore, using gill nets of mesh size 20 cm. The mouth of the Aconcagua River, which attracts many fish species in its nutrient-rich waters to spawn, makes this area of especial interest for artisanal fishermen and attracts aggregations of feeding penguins.

Information on drowning of seabirds was obtained by observing fishing activities and from discussions with local fishermen. Occasionally, residents reported beach-cast dead birds. Each time a mortality was observed or reported, the entire study shoreline was surveyed by vehicle. Stops were made at each beach and dead birds were counted. When drowned birds were not washed ashore only estimates from fishermen were considered. Unfortunately, this latter information is less detailed, e.g. it is not known whether penguins were adults or juveniles, Humboldt or Magellanic *S. magellanicus* Penguins. Only recently-dead birds, identifiable by colour of soft parts and colour and condition of iris were considered in this study. Many of the dead birds showed characteristic signs of net entanglement such as abrasions on feet, flippers and base of the bill.

RESULTS

Annual trends in drowning

During each of the years 1991, 1992, 1994 and 1996, single events leading to mortality of 100 or more penguins were recorded (Table 1). During 1995 no large mortalities where detected but smaller numbers of drownings were observed. Data on mortality due to drowning in fishing nets are not available for 1993.

Drowning events

On 31 August 1991, residents at Bahamas and Concón beaches (Fig. 1) reported large numbers of dead penguins ashore. A visit to the area confirmed the presence of 123 birds that had drowned in gill nets.

On 4 June 1992, fishermen reported a mortality of 156 penguins in the vicinity of Concón Islet (Fig. 1). Details of species involved and maturity of individuals are not known.

Between 28 and 31 August 1994, a large mortality of penguins and other seabirds was observed on the shoreline between Bahamas and Concón beaches. Subsequently local fishermen confirmed the drowning of seabirds. On 3 September, this shoreline was checked and 200 dead penguins were counted. Six dead Guanay Cormorants *Phalacrocorax bougainvillii* and one Red-legged Cormorant *P. gaimardi* were also counted. It was also reported that on Amarilla beach an undetermined number of carcasses were burned and buried by beach attendants for hygienic purposes. On 31 August, two dead Humboldt Penguins obtained from a fishing boat were examined at the Instituto de Oceanología, Universidad de Valparaíso. The gonads of both birds, a male and a female, were in the active state, their stomachs contained fish (sardine *Clupea bentincki* and anchovy *Engraulis ringens*), abundant subdermal fat was present and the lungs and air sacs contained water. Mortality was estimated to have occurred within the preceding 24 hours.

On 29 July 1995, fishermen reported a further stranding event. An inspection along the Bahamas, Negra, Amarilla and Concón Beaches (Fig. 1) yielded a count of 19 dead penguins. A field necropsy of an adult male at Concón beach revealed inactive testes, a stomach containing fish and water in the air sacs and lungs. Date of death was estimated as no more than two days previously. Five dead Guanay Cormorants were also discovered.

On 13 March 1996, more dead birds were reported from Concón Beach by residents. Totals of five penguins, 16 Guanay Cormorants and one Red-legged Cormorant were counted during a visit to the site. As in 1994, an indefinite number of carcasses had been removed from the beach some days before. During 3, 14 and 15 July 1996, local fishermen reported the entanglement of 29 penguins in fishing nets near Concón Islet. During 27 and 29 September 1996, fishermen reported seven adult Humboldt Penguins drowned in gill nets in the vicinity of Concón Islet. On 15 October 1996, 24 dead penguins were washed ashore at Reñaca Beach (Fig. 1). Two birds were analysed, an adult female and a juvenile. The adult had abrasions at the base of the bill and on the feet. Its gonads were in recession, but the incubation patch was present. Its stomach contained sardines. The juvenile also had abrasions at the base of the bill and on the feet. Its stomach contained sardines and cephalopods. Between 6–7 December 1996, fishermen reported that about 100 penguins became entangled in gill nets. None of these birds reached the beaches, because they were put inside sacks to sink. There are no details on sex or species of the birds.

In the Valparaíso region the ratio of Magellanic to Humboldt Penguins is about 1:150 (unpubl. data). Therefore, it has been assumed that most of the unidentified drowned penguins were Humboldt Penguins. The situation in 1991 when 56 Magellanic Penguins were reported from fishing nets (Table 1) is considered highly unusual. Given this assumption, a total of 605 Humboldt Penguins drowned during the period 1991–1996 (1993 excepted) in the study area due to interactions with artisanal fisheries, an average of at least 120 Humboldt Penguins per year.

DISCUSSION

Penguins of the genus *Spheniscus* are especially vulnerable to gill nets because of their foraging method (see Wilson & Wilson 1990, Wilson 1995). In the study area, Humboldt Penguins feed predominantly on pelagic schooling fish, such as anchovy and the sardines *Sardinops sagax* (Wilson *et al.* 1989) and *Clupea bentincki* (pers. obs.). These fish species remain in the area near the shore throughout most of the year (Montecinos & Balbontín 1993). On the other hand, corvinas approach the shore to feed on the sand crab *Emerita analoga.* Fishermen set their gill nets near the shore. When penguins are pursuing anchovies and sardines towards the nets, they are probably unable to see the nets because of the transparent material with which they are made. The birds become entangled and subsequently drown. Other seabird species, such as the Peruvian Booby *Sula variegata*, Guanay Cormorant, Red-legged Cormorant, and Peruvian Pelican *Pelecanus thagus*, feed with Humboldt Penguins (Duffy 1983b), and could also be affected by entanglement in nets.

The surveyed area is near Concón Islet (32º53'S, 71°31'W), which supports only about 10 pairs of Humboldt Penguins. However, about 250 Humboldt Penguins regularly attend this locality (MB pers. obs.). Because of the small number of penguins breeding at Concón Islet, it is probable that the drownings documented in this paper include birds from other colonies. In the Valparaíso Region, the two major breeding sites for Humboldt Penguins are Cachagua Island (32º35'S, 71º28'W) and Pájaros Niño Peninsula (formerly an island) (33º21'S, 71º40'W), which respectively are located 35 km to the north and 60 km to the south of Concón Islet. These two colonies support about 4000 adult Humboldt Penguins.

Mortalities occur mainly during winter months, from June to August when most of the penguins are not breeding. In these months, Humboldt Penguins form large aggregations. Humboldt Penguins banded at Pájaros Niño Island moved as far as 170 km (R. Wallace pers. comm.). Winter drowning will reduce numbers of birds breeding in the following spring (September–October). In autumn, reproductive success is decreased by rains which often flood and collapse nests, as has been observed at Pájaro Niño and Cachagua Islands (unpubl. data) and at northern colonies such as Chañaral Island (Vilina 1993).

The figures presented in this paper are underestimates, considering that many carcasses are removed from beaches and that numbers of birds never reach the shore. Further, the survey reports on only a minor portion of mortality of penguins off Chile caused by artisanal fisheries. Fishing effort varies along the coast of the Valparaíso Region (Table 2). There are at least four areas of intensive corvina fishing:

I. Pichicuy Cove,
II. from Zapallar to Horcones Cove,
III. from Concón to Montemar Cove and
IV. from Algarrobo to Boca del Maipo Cove.

All these are areas where penguins risk entanglement, especially area IV which supported 65% of the Valparaíso fishery for corvina during 1991–1996. Probably the recorded penguin mortality should be increased by a factor of two or three. As most of the shoreline of Peru and Chile is subject to fishing activities, the adverse impact of artisanal fishing could affect the Humboldt Penguins throughout most of the species' range.

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TABLE 2

The main coves where the artisanal fishery for Corvina operates in the Valparaíso region indicating catches (tonnes) for 1991–1996

Area	Cove	1991	1992	1993	1994	1995	1996	Totals
I	Pichicuy	7.0	3.0	3.0	0.7	1.3	2.3	**17.3**
II	Zapallar	2.0	1.0	0.0	14	0.1	0.6	**5.1**
II	Maitencillo	16.0	3.0	0.0	4.3	2.3	6.0	**32.3**
II	Horcones	1.0	4.0	1.0	11.6	0.5	0.3	**18.4**
III	Concón	0.0	0.0	0.0	6.0	0.0	0.0	**6.0**
III	Higuerillas	30.0	20.0	5.0	4.4	4.8	20.6	**84.8**
III	Montemar	nd	nd	nd	3.0	11.9	21.8	**36.7**
IV	Algarrobo	6.0	3.0	2.0	1.5	8.8	10.7	**32.0**
IV	El Quisco	2.0	4.0	1.0	0.9	2.7	5.8	**16.4**
IV	Cartagena	5.0	14.0	0.0	0.2	0.3	0.0	**19.5**
IV	San Antonio	30.0	41.0	29.0	80.2	1.2	0.5	**181.9**
IV	Boca del Maipo	197.0	85.0	63.0	95.1	46.0	42.0	**528.1**
	Other coves	15.0	25.0	39.0	33.2	50.6	67.5	**230.3**
	Totals	**311.0**	**203.0**	**143.0**	**244.0**	**131.0**	**179.0**	**1211.0**

*Data from Servicio Nacional de Pesca (SERNAP-CHILE).
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