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Chronic oil pollution harms Magellanic penguins in the Southwest Atlantic

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Abstract

Petroleum pollution is a problem for seabirds along the Southwest Atlantic coast. Twenty-five groups from Salvador, Brazil (12°58′S) to San Antonio Oeste, Argentina (40°43′S) survey or rehabilitate sick or oiled seabirds. Four groups, one each in Brazil and Uruguay, and two in Argentina, kept counts of birds found alive and in need of rehabilitation. An average of 63.7% of the seabirds found were Magellanic penguins (*Spheniscus magellanicus*), with 3869 reported since 1987. Mainly adult penguins were found in Argentina (1605 of 2102 penguins of known age class) and Uruguay (158 of 197). Juveniles were most common in Brazil (234 of 325). Oil fouling was the most frequent cause of injury or sickness. The number of oiled penguins reported in their wintering range has greatly increased since the early 1990s and is strongly correlated with petroleum exports from Argentina. Our results show that chronic petroleum pollution is a problem for wildlife from Southern Brazil through Northern Argentina, and regulations and enforcement are failing to protect living resources.

Keywords: Magellanic penguin; *Spheniscus magellanicus*; Argentina; Uruguay; Brazil; Chronic petroleum pollution

1. Introduction

Petroleum is one of the most common toxic substances released into the marine environment with chronic petroleum pollution (small but frequent oil discharges) accounting for most petroleum pollution in the ocean (USNRC, 2003). However, because accidental discharges of oil receive considerable media attention, the public perceives those oil spills as extremely damaging to natural systems (Hunt, 1987; Boersma et al., 1995; Parrish and Boersma, 1995), but remains largely unaware of chronic petroleum pollution.

Seabirds are one of the most vulnerable groups of marine animals affected by oil pollution (Clark, 1984; Dunnet,

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1987; Piatt et al., 1990). Penguins are particularly vulnerable to oil spills because they swim low in the water, do not fly, and likely are less able to detect and avoid petroleum than other seabirds. When the *Apollo Sea* sank in 1994 off Cape Town, South Africa, spilling about 2,000 tons of petroleum, 10,000 African penguins (*Spheniscus demersus*) were oiled (IBRRC, 2005). Similarly when the *Treasure* sank in 2000 near Cape Town, South Africa, spilling 1300 tons of bunker oil, 20,000 African penguins were affected, and another 19,500 were prevented from becoming oiled because they were moved 800 km from the spill site (Nel and Whittington, 2003; IBRRC, 2005). Impacts of oil spills on seabirds often are better documented than exposures to chronic discharge (from ships, at terminals, or from oily ballast water). However, in the case of Argentina there are long-term records documenting chronic oil pollution and its effects on penguins along the Chubut coast (Gandini et al., 1994).

Oiling of penguins is likely a common problem wherever tankers and penguins mix. Residues and oily sludge from ship's bunker tanks killed or harmed about 350 Little penguins (*Eudyptula minor*) yearly at Phillip Island, Australia (Revill and Healy, 1999). One of the best documentations of how vulnerable penguins are to petroleum discharge is the chronic pollution problem along the coast of Argentina. For decades chronic oil pollution killed Magellanic penguins in Argentina (Jehl, 1974, 1975; Korschenewski, 1975; Jenkins, 1978; Perkins, 1983; Boersma, 1987; Knaus, 1990; Gandini et al., 1994) and more recently has been documented as a problem in Brazil (Petry and Fonseca, 2002; Petry et al., 2004). Gandini et al. (1994) estimated over 40,000 Magellanic penguins (*Spheniscus magellanicus*) were killed each year by chronic oil pollution along the coast of Chubut Province, Argentina, from 1982 to 1991. In 1994 tanker lanes were moved 100 km farther offshore and few penguins are now found dead with petroleum along the Chubut coast (Boersma, unpublished data).

Magellanic penguins migrate between Argentina and Brazil in the Atlantic Ocean on routes that can overlap with heavy maritime traffic and petroleum development (Stokes et al., 1998; Pütz et al., 2000). Our goal was to assess the location, nature and magnitude of the chronic oil pollution problem for Magellanic penguins along the Southwest Atlantic coast in their wintering range, where little information is available. If chronic oil pollution is a serious problem, we expected there would be a number of rehabilitation groups dedicated to washing seabirds. Further, we predicted that more groups would be located in areas where the problem was chronic. Here, we document the location and number of rehabilitation groups for seabirds along the Southwest Atlantic coastline from northern Brazil to central Argentina to use them as an index of the extent and nature of chronic oil pollution. We report the number of penguins collected alive by four rehabilitation groups along the coast of northern Argentina to Southern Brazil.

2. Methods

We searched for organizations that counted oiled seabirds and/or rehabilitated them from Fortaleza, Brazil (3°46′S, 38°33′W) to San Antonio Oeste (40°47′S, 64°47′W), Argentina, covering approximately 8200 km of coastline (Fig. 1). We contacted nongovernmental organizations (NGOs), governmental agencies, research institutions, museums, rehabilitation centers, aquariums and zoos, and compiled a directory of these organizations. We concentrated on penguins instead of all seabirds because penguins can survive for several weeks and often come ashore after being oiled, so are more likely to be found alive after oiling than most seabird species.

Four groups kept data on how many live penguins they found oiled or in need of care, and their age classes (juveniles or adults). We present these data by geographic area and year: two are centers located in Argentina (Fundación Mar del Plata Aquarium and Fundación Mundo Marino), one response group—the International Fund for Animal Welfare emergency relief—provided data on two oil spills in Uruguay, and a fourth is a center in Brazil (CRAM). We also examined patterns of petroleum production and shipping in the Southwest Atlantic Ocean, using data compiled from government and industry web sites.

3. Results

Twenty five groups from Salvador, Brazil (12°58′S, 38°29′W) to San Antonio Oeste, Argentina (40°43′S, 64°55′W) survey or rehabilitate sick or oiled seabirds along 6800 km of coastline (Table 1, Fig. 1). Nineteen solely rehabilitate birds, three only survey beaches and four groups do both (Table 1). The oldest group started in Mar del Plata, Argentina, in 1980. All groups reported finding penguins with petroleum and said penguins were most common on the coast in winter (June to September). By far the most seabirds rehabilitated were Magellanic Penguins (63.7% from 1995 to 2005). The northernmost record of penguins in need of care was near the city of Maceió, Brazil (9°40′S, 35°44′W).

Live penguins with petroleum were more common in northern Argentina and less common at low latitudes. Mar del Plata Aquarium had the highest average of live oiled penguins each year (106, S.E. = 24.6, $n = 1167$, 11 years). The total number of oiled penguins decreased from Argentina to Brazil with the lowest numbers found at the lower latitudes (Fig. 2).

Not surprisingly, rehabilitation groups are not evenly spaced along the coast: Rio de Janeiro to Santos (22°54′S, 43°14′W to 23°56′S, 46°22′W) had seven organizations, and Uruguay to Mar del Plata (38° 00′S, 57°32′W to 34°53′S, 56°11′W) had eleven, with only five centers between those regions and two to the north (Fig. 2).

Rehabilitation centers were generally clustered near ports, oil terminals and offshore platforms, the most likely point sources of marine oil pollution. However, many

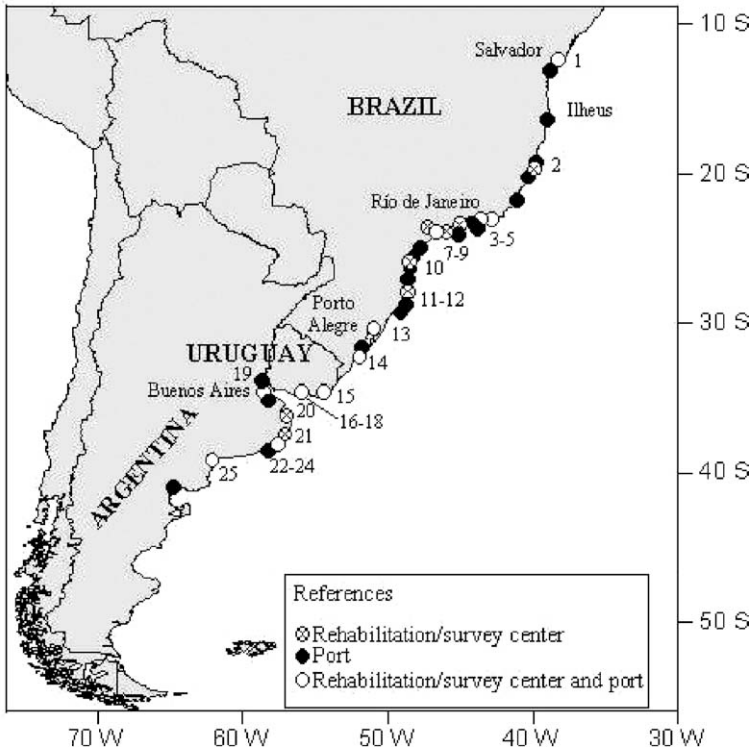

Fig. 1. Map of the Atlantic coast of South America showing the location of rehabilitation/survey organizations, and ports/oil terminals. Numbers correspond to organizations listed in Table 1.

ports, terminals and platforms had no rehabilitation center nearby. In Brazil, from Maceió to Uruguay there are 21 ports, 43 oil terminals and 14 rehabilitation centers (Fig. 1). The offshore Campos Basin, north of Rio de Janeiro, is the most prolific production area in Brazil, with 17 offshore platforms pumping petroleum during 2003 (Agencia Nacional do Petroleo do Brasil, 2005). Uruguay has a port at Montevideo, an oil terminal at Punta del Este and four rehabilitation centers. Argentina has 17 ports (8 in our study area in northern Argentina), five main oil terminals (OLADE/SIEE, 2000) and seven rehabilitation centers (Fig. 1).

The number of oiled penguins found along the coast varied among years but there was a dramatic increase beginning in the mid 1990s coincident with exponential growth of oil exportations in Argentina (Fig. 3) (Secretaría de Energía de la Nación Argentina, 2005; OLADE/SIEE, 2000). The number of oiled penguins (log transformed) was strongly correlated with oil exports in Argentina from 1987 to 2002 ($r^2 = 0.81$, $n = 16$, $p < 0.001$).

Petroleum pollution was the most common reason penguins were rehabilitated. Of penguins that were treated significantly more were treated for petroleum (77%) than for any other cause ($\chi^2 = 1101$, $n = 3869$, $p < 0.001$). Of the penguins captured the age was known for 91% ($n = 3517$). Adults (64%) were significantly more likely to be rehabilitated (all causes) than juveniles ($\chi^2 = 317$, $n = 3517$, $p < 0.001$). Adults with petroleum were significantly more common than juveniles (G-test = 393.01, $n = 2624$, $p < 0.001$). The geographic distributions of adults and juveniles were not similar. Juveniles were significantly more likely to be found in Brazil (74.6%) and adults in Uruguay (100%) and Argentina (65.2 and 78.7% for Mundo Marino and Mar del Plata Aquarium, respectively) ($\chi^2 = 531$, $n = 3517$, $p < 0.001$).

4. Discussion

Penguins are brought to rehabilitation centers along the Southwest Atlantic coast every year during their non-breeding season and the majority of them are oiled. Petroleum pollution along this coast is not a new problem as rehabilitation groups have existed for more than 20 years. Clearly, chronic pollution is not new and is a long-term problem from northern Argentina to Southern Brazil. Existing laws and enforcement have failed to solve the pollution problem in the Southwest Atlantic. The number of rehabilitation centers and the frequency of oiled penguins off the coast of Mar del Plata suggest this is one of the main locations of chronic petroleum pollution in the Southwest Atlantic. The petroleum-covered penguins appear to reflect their winter distribution with juveniles found farther north and adults concentrating around Mar del Plata (Boersma et al., 1990; Stokes et al., 1998). The number of penguins encountering oil decreased to the north, likely reflecting the drop in abundance of penguins at low latitudes.

There are 25 rehabilitation centers from Salvador to San Antonio Oeste along the 6800 km of coastline suggesting

Table 1
Directory of organizations that rehabilitate oiled birds and/or survey beaches from Fortaleza, Brazil, to San Antonio Oeste, Argentina

#	Organization	Location	Activities			
		Country, city, province	Rehabilitation	Beach survey	S	W
1	Projeto Mamíferos Aquáticos (MAMA) y Zoológico de Salvador	Brazil, Salvador, Bahía	•		12°58′	38°29′
2	Centro Universitário Vila Velha	Brazil, Espírito Santo, ES	•		20°19′	40°21′
3	GEMM-Lagos/ENSP/FIOCRUZ	Brazil, Río de Janeiro, RJ		•	22°27′	42°43′
4	Fundação RioZoo	Brazil, Río de Janeiro, RJ	•		22°27′	42°43′
5	Zoológico de Niterói	Brazil, Río de Janeiro, RJ	•		22°54′	43°06′
6	Aquário de Ubatuba	Brazil, Ubatuba, SP	•		23°44′	45°04′
7	Aquamundo	Brazil, Guarujá, SP	•		23°55′	46°13′
8	Aquário Municipal de Santos	Brazil, Santos, SP	•		23°56′	46°20′
9	IBAMA Iguape	Brazil, Iguape, SP	•	•	24°41′	47°28′
10	Centro de Estudos do Mar, Universidade Federal do Paraná	Brazil, Pontal do Sul, PR	•	•	25°34′	48°21′
11	Centro de Tratamento e Recuperação de Animais Silvestres (CETRAS)	Brazil, Florianópolis, Santa Catarina	•		27°35′	48°34′
12	Reabilitacao de Animais Marinhos (REAMAR)	Brazil, Arroio do Silva, SC	•		29°09′	49°34′
13	Centro de Estudos Costeiros, Limnológicos e Marinhos (CECLIMAR), Universidade Federal do Rio Grande do Sul	Brazil, Tramandai, RS	•		29°56′	50°7.5′
14	Centro de Recuperação de Animais Marinhos (CRAM), Museu Oceanográfico Prof. Eliézer de C. Rios, Fundação Universidade Federal do Rio Grande	Brazil, Rio Grande, RS	•		32°03′	52°08′
15	SOS—Rescate de Fauna Marina	Uruguay, Pta. Colorada, Piriápolis	•		34°48′	55°17′
16	Protección de Fauna Marina (PROFAUMA)	Uruguay, Montevideo	•		34°53′	53°11′
17	Rescate Eco Marítimo	Uruguay, Montevideo	•		34°53′	53°11′
18	CID/Karumbe	Uruguay, Montevideo		•	34°53′	53°11′
19	Acuario Nacional de Buenos Aires	Argentina, Buenos Aires	•		34°36′	58°29′
20	Fundación Mundo Marino	Argentina, San Clemente del Tuyú, Buenos Aires	•	•	36°22′	56°44′
21	Fundacion Ecologica Pinamar	Argentina, Pinamar, Buenos Aires		•	34°38′	58°28′
22	Fundación Fauna Argentina	Argentina, Mar del Plata, Buenos Aires	•		38°0′	57°33′
23	Sr. Martínez/INIDEP	Argentina, Mar del Plata, Buenos Aires	•		38°0′	57°33′
24	Mar del Plata Aquarium	Argentina, Mar del Plata, Buenos Aires	•		38°0′	57°33′
25	Zoológico de Bahía Blanca	Argentina, Bahía Blanca, Buenos Aires	•		38°44′	62°16′

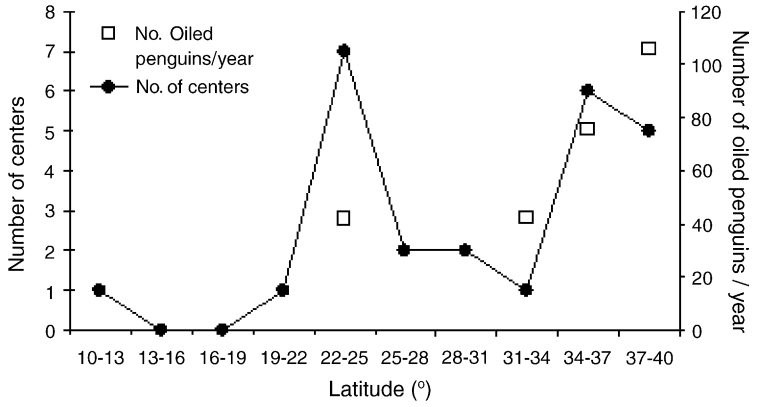

Fig. 2. Number of oiled penguins counted per year and number of rehabilitation centers along the Atlantic coast of South America. *X*-axis corresponds to geographic coordinates.

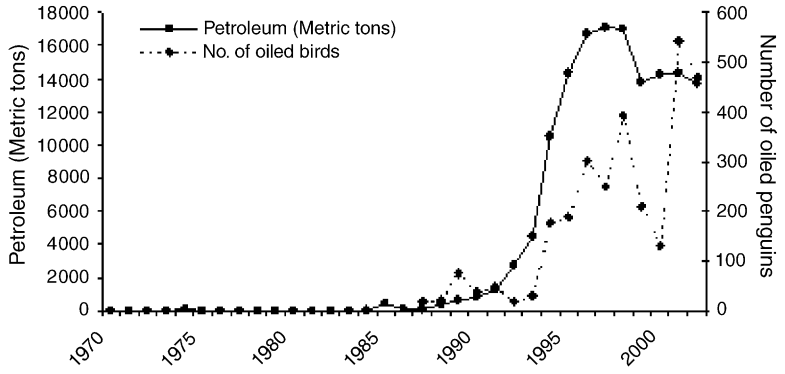

Fig. 3. Number of oiled penguins registered by the four rehabilitation groups and Argentina's oil exportation from 1971 to 2002.

oil pollution is a large-scale problem along the Southwestern Atlantic coast. As expected, the number of oiled penguins is positively correlated with Argentina's oil exportation that grew rapidly starting in the early 1990s.

Oil extraction and loading take place at specific locations but oiled penguins are found all along this coast. Why are penguins found oiled where there are no petroleum activities? Penguins are hardy birds that can survive without eating for three to four weeks during courtship, incubation and molt (Yorio and Boersma, 1994; Hood et al., 1998). Moreover, Magellanic penguins can swim 100 km a day (Stokes and Boersma, 1999). Even during the breeding season they travel 100s of km on their foraging trips (Boersma and Parrish, 1998; Stokes and Boersma, 1999). Thus, we estimate that petroleum-covered penguins could travel up to 1500 km before their fat reserves forced them to retreat to land to remain warm. Penguins, therefore, are likely poor indicators of the exact location of chronic oil pollution.

Northern Argentina had more oiled penguins than Uruguay or Brazil. The large proportion of adults found in Argentina suggests chronic oil pollution here may be reducing the population. In long-lived seabirds such as penguins, that mature late and lay small clutches, even small decreases in adult survival can cause populations to decline (e.g., Sæther and Bakke, 2000). In addition, even small amounts of petroleum reduce reproductive success in penguins (Fowler et al., 1995). Petroleum pollution is likely contributing to the long-term decline at the largest Magellanic penguin colony at Punta Tombo, Argentina, where active nests have declined over 20% since 1987 (Boersma, 1997). Moreover, more adults are found oiled than juveniles suggesting that adults may be more affected by chronic pollution than juveniles. The large number of adult penguins affected by chronic oil pollution in their wintering range suggests that this problem will have to be ameliorated before populations of Magellanic penguins rebound at their breeding colonies. We conclude that governments have failed to adequately protect penguins from petroleum pollution in the Southwest Atlantic. We need to enforce the national and international regulations that prohibit oil discharge and create incentives to reduce both accidental and intentional oil spills.

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