

PRESENCE OF THE LEOPARD SEAL, *Hydrurga leptonyx* (DE BLAINVILLE, 1820), ON THE COAST OF CHILE: AN EXAMPLE OF THE ANTARCTICA - SOUTH AMERICA CONNECTION IN THE MARINE ENVIRONMENT

Anelio Aguayo-Lobo^{1,*}, Jorge Acevedo R.², José Luis Brito³, Paola Acuña G.², Manuela Bassoi⁴, Eduardo R. Secchi⁴ & Luciano Dalla Rosa⁴

¹ Instituto Antártico Chileno (INACH), Depto. Científico. Plaza Muñoz Gamero 1055, Punta Arenas, Chile.

² Fundación Centro de Estudios del Cuaternario (CEQUA), Sección Ecología de Ecosistemas Marinos. PO Box 737. Avda. Bulnes 01890, Punta Arenas, Chile.

³ Museo Municipal de Ciencias Naturales y Arqueología de San Antonio. Salvador Sanfuentes 2365, Barrancas, San Antonio, Chile

⁴ Universidade Federal do Rio Grande (FURG), Instituto de Oceanografia, Lab. Tartarugas e Mamíferos Marinhos, CP 470. Rio Grande, RS, Brazil, CEP: 96201-900.

E-mails: aaguayo@inach.cl, jorge.acevedo@cequa.cl, jbrito@sanantonio.cl, paola.acuna@cequa.cl, manu.bassoi@gmail.com, edu.secchi@furg.br, lucianodr2000@yahoo.com.br

ABSTRACT

Sightings of 115 leopard seals, *Hydrurga leptonyx*, have been recorded along the Chilean coasts from 1927 to 2010. Mostly immature seals occurred in northern and central Chile (18°20'S-39°59'S), especially in winter, while immature and adult individuals of both sexes and in good condition were commonly sighted year-round in glacial areas of southern Chile, especially Tierra del Fuego (south of 53°43'S), suggesting that this Antarctic species can be considered as a regular member of the marine fauna of Chile, with occasionally hauling out on the northern coastline as seasonal vagrants. Keeping in mind data limitation, we discuss some ways of northern dispersion and the year-round presence of animals in the Southern region of South America. These include, respectively: the close proximity of the Fuegian channels with the Antarctic Peninsula facilitated by the northward extension of the Antarctic pack ice during winter and/or through the influence of the Malvinas current; and the suitable habitat of the Fuegian channels, with similar characteristics to the Antarctic environment and locally abundant food resources.

Keywords: Leopard seal; Chile; South America; Southern Ocean.

RESUMO

PRESENÇA DA FOCA-LEOPARDO, *Hydrurga leptonyx* (DE BLAINVILLE, 1820), NA COSTA DO CHILE: UM EXEMPLO DA CONEXÃO ENTRE ANTÁRTICA E AMÉRICA DO SUL NO AMBIENTE MARINHO. Entre 1927 e 2010, 115 focas-leopardo, *Hydrurga leptonyx*, foram avistadas ao longo da costa Chilena. Na região centro-norte (18°20'S-39°59'S), especialmente no inverno, a maioria dos registros esteve representada por indivíduos imaturos. Indivíduos imaturos e adultos de ambos os sexos ocorreram ao longo do ano, em boas condições físicas, em áreas glaciais da região sul do Chile, especialmente na Terra do Fogo (ao sul de 53°43'S). Nesta revisão, há evidências robustas para sugerir que a espécie é uma visitante regular da fauna Antártica em território austral chileno, ocorrendo eventualmente como vadios sazonais na costa norte do país. Apesar das limitações inerentes aos dados, discutem-se sobre a dispersão da espécie em direção ao norte e subsequente presença de indivíduos na porção austral da América do Sul. Estas incluem respectivamente: a proximidade entre os canais Foguinos e a Península Antártica, favorecida pela expansão da capa de gelo em direção ao norte durante o inverno e/ou pela influência da corrente das Malvinas; o habitat adequado nas canais Foguinos, com características similares àquelas do ambiente Antártico, somado à presença de recursos alimentares localmente abundantes.

Palavras-chave: Foca-leopardo; Chile; América do Sul; Oceano Austral.

RESUMEN

PRESENCIA DE LA FOCA LEOPARDO, *Hydrurga leptonyx* (DE BLAINVILLE, 1820) EN LA COSTA DE CHILE: UN EJEMLO DE CONEXIÓN DE AMBIENTE MARINO ENTRE ANTÁRTICA Y AMÉRICA DEL SUR. Entre 1927 y 2010, 115 focas leopardos, *Hydrurga leptonyx*, han sido registradas a lo largo de la costa chilena. En la región centro-norte (18°20'S-39°59'S), especialmente en invierno, la mayoría de los registros corresponden a individuos inmaduros; mientras que ejemplares maduros e inmaduros de ambos sexos y en buenas condiciones físicas son avistados durante todo el año, en áreas de glaciares del sur de Chile, especialmente en Tierra del Fuego (sur de los 53°43'S), sugiriendo que esta especie antártica puede ser considerado como un miembro regular de la fauna marina de Chile, con presencia ocasional en las costas norteñas, como vagabundo estacional. Teniendo en cuenta la limitación de los datos, discutimos algunas vías de dispersión hacia el norte y la presencia durante todo el año de los animales en la región austral de América del Sur. Estas incluyen, respectivamente: la cercana proximidad de los canales fueguinos con la Península Antártica, facilitado por la extensión hacia el norte del hielo marino antártico durante el invierno y/o a través de la influencia de la corriente de las Malvinas; y el hábitat apropiado de los canales fueguinos, con características similares al ambiente Antártico y abundante recursos alimenticios locales.

Palabras claves: Foca leopardo; Chile; América del Sur; Océano austral.

INTRODUCTION

The leopard seal has a circumpolar distribution inhabiting pack-ice and waters south of the Polar Front. Given their preference for living on the ice, the species is referred to as a pagophilic seal (Ray 1970, King 1983) or a proper Antarctic seal (Aguayo-Lobo & Torres 1971). In Antarctica, it is the largest of the pagophilic seals, which also include the Crabeater seal, *Lobodon carcinophaga* (Hombron & Jacquinot 1842), Weddell seal, *Leptonychotes weddellii* (Lesson, 1826) and the Ross seal, *Ommatophoca rossi* Gray, 1844. In addition, leopard seal is the most voracious of the pagophilic seals, taking a diverse range of prey, including krill, fishes, cephalopods, sea birds (mainly penguins) and young seals (Hamilton 1939, Gwynn 1953, Brown 1957, Penney & Lowry 1967, Hall-Aspland & Rogers 2004, Casaux *et al.* 2009).

The leopard seal population is mainly distributed on the outer fringes of the circumpolar pack-ice to 78°S and it largely remains within these fringes as the pack-ice retreats during spring and summer (Gilbert & Erickson 1977, Bester *et al.* 1995, Bester *et al.* 2002, Rogers *et al.* 2005, Rice 1998). However, some individuals disperse northwards and have been sighted on the continents abutting the Southern Ocean (example (ex.) Barrett-Hamilton 1901, Scheffer 1958, Best 1971, Horning & Fenwick 1978, King 1983, Rounsevell 1988, Slater 1991, Rounsevell & Pemberton 1994, Mawson & Coughran 1999, Reeves

et al. 2002) and the Subantarctic islands. Leopard seals aggregations have been documented year-round at Heard (Gwynn 1953) and South Georgia (Hamilton 1939, Laws 1957) Islands, and seasonally at Macquarie (Gwynn 1953, Rounsevell & Eberhard 1980), Bird (Walker *et al.* 1998), Falkland (Hamilton 1939, Bonner & Laws 1964), South Orkneys (Hamilton 1939, Erickson *et al.* 1970), South Shetland (Laws 1957, 1973, Aguayo-Lobo & Torres 1967, Erickson *et al.* 1970, Aguayo-Lobo 1970, Hiruki *et al.* 1999), Kerguelen (Paulin 1952, Bester & Roux 1986, Borsa 1990), Marion (Bester *et al.* 2006) and Amsterdam (Dearborn 1952) Islands. Although most leopard seals remain associated with sea ice or glacial ice, the northernmost record is from the Cook Island (Berry 1960).

In South America, some vagrant leopard seals have been reported in the Atlantic coast of Brazil (Ximénez *et al.* 1987, Pinedo 1990, Rosas *et al.* 1992, Ferreira *et al.* 1995, Velozo 2007), Uruguay (Vaz-Ferreira 1984, Naya & Achaval 2006) and Argentina (Bastida & Rodríguez 2003, Rodríguez *et al.* 2003, Goodall *et al.* 2005, Barquez *et al.* 2006, Bastida *et al.* 2007, Diario del Fin del Mundo 2007). For the Pacific coast, at least 19 vagrant individuals have been documented along the Chilean coast since 1927, between 30°10'S and 56°S (Plüschow 1927, Oliver-Schneider 1946, Yañez 1948, Housse 1953, Markham 1971, Scheffer 1978, Sielfeld 1978, Torres *et al.* 1979, Torres *et al.* 2000), including Juan Fernández Archipelago (Torres

& Aguayo 1971, Torres 1987). However, after 2000, leopard seal sightings increased markedly, mostly in the southern channels of Tierra del Fuego. Therefore, the aim of this paper was to review and present new information on the presence of leopard seals along the Chilean coast and discuss their year-round occurrence as an example of the connections between Antarctica and South America marine environments.

MATERIAL AND METHODS

Data presented in this note were obtained primarily from two long-term monitoring programs: the one initiated in 1991 by the Wildlife Rescue and Rehabilitation Centre of the Museo Municipal de Ciencias Naturales y Arqueología de San Antonio (MUCINASA), in the central zone of Chile and the marine mammal program initiated in 2002, by researchers of Fundación Centro de Estudios del Cuaternario (CEQUA) and Instituto Antártico Chileno (INACH), in the austral zone of Chilean coast, particularly around the Magellan Strait and Tierra del Fuego.

Another data source consisted of published and unpublished records made by local scientists along the Chilean coast. Information on the presence of “seals” provided by lay people, fishermen, newsletters among others were also considered after careful examination of the information reliability and available pictures. For those geographical positions whose longitude was unknown, it was estimated by obtaining the longitude of the coastline at the known latitude.

Due to the differences in the geography of the coastline and the ocean currents along the coast of Chile, the study area was divided into three zones: i) the Central-Northern zone ranges between 18°20'S and 39°59'S and is characterized by a regular and smooth coastline influenced by the cold coastal Humboldt Current; ii) the Oceanic Islands encompass Desventuradas Islands, Juan Fernández Archipelago and the Eastern Island, all of which are influenced by a warm water current; and iii) the Southern zone ranges between 40°00'S and 56°00'S and is characterized by a very complex and intermittent shoreline with thousands of islands and islets, as well as hundreds of channels that form fjords, bays and sounds, all of which are influenced by glaciers and the cold Cape Horn Current (Figure 1).

The sex of at least 36 specimens were identified

in the field from genital examination, and another five animals via molecular sexing of skin samples collected at Parry fjord by boat, using a lightweight biopsy dart fired from a modified veterinary rifle, Paxarm (Krützen *et al.* 2002). The sex was identified by amplification of sex-specific markers following the protocol of Gilson *et al.* (1998).

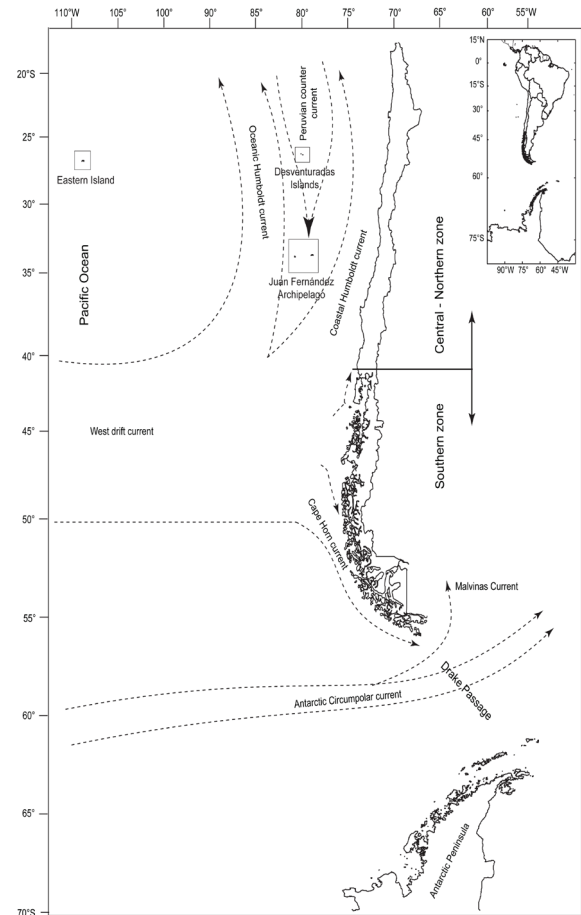


Figure 1. Study area divided into three zones: Central-Northern, Southern and Oceanic Islands (boxes). Main ocean currents are drawn schematically.

RESULTS

A total of 67 sightings with 115 individuals of leopard seals are reported along the Chilean coast from 1927 to 2010 (Table 1, Fig. 2). Of these, 96 individuals (83.4% of the recorded animals) were registered after 2000. The northernmost sightings occurred at Eastern Island (29°09'S) and, for continental Chile, at “La Bandera” beach, Punta Choros (29°13'S). The southernmost sighting occurred to the southwest of Beagle channel (55°06'S). The more old record of leopard seal is given in the film of Gunther Plüschow in 1927 at Almirantazgo Sound (possibly Parry fjord) where shown at least one leopard seal resting on ice floes.

Table 1. Sightings of leopard seals along the Chilean coast. A = adult, J = juvenile, M = male, F = female. (est.) estimated.

n	Date	Latitude (S)	Longitude (W)	N°	Age	Sex	Locality	Region	Remarks	Source
01	1927	¿?	¿?	1	--	--	Almirantazgo Sound	XII	Resting on ice floe	G. Plitschow (1927)
02	1944	36°45	73°10 (est.)	1	--	--	San Vicente	VIII	Occasional presence	Oliver-Schneider (1946)
03	1944-47	55°00	68°50 (est.)	1	--	--	Beagle channel	XII	Occasional presence	Yañez (1948)
04	1947	36°42	73°05 (est.)	1	--	--	Talcahuano	VIII	Occasional presence	Housse (1953)
05	1967	33°37	78°49	1	J	--	Robinson Crusoe Isand	V	Skins remains	Torres & Aguayo-Lobo (1971)
06	Feb/1971	54°37	69°20	4	A	F (1)	Juan Fernández Archipelago Parry fjord, Almirantazgo Sound	XII	Report only 4 individuals and an adult female was killed	Markham (1971)
07	Feb/1978	54°38	69°20 (est.)	1	--	--	Parry fjord, Almirantazgo Sound	XII	--	Sielfeld (1978)
08	Feb/1978	--	--	1	--	--	Almirante Montt Gulf	XII	Skull in museum	Sielfeld (1978)
09	09/Agu/1978	30°10	71°26	1	--	--	Guañaquero beach	IV	--	Scheffer (1978)
10	Feb/1979	46°40	73°52 (est.)	3	--	--	San Rafael lagoon	XI	Resting on ice, good condition	Torres <i>et al.</i> (1979)
11	12/Oct/1994	33°44	71°41 (est.)	1	J	--	El Yali beach	V	Dead. Skull collected. Skull with multiple injured	Zuñiga & Brito (1997)
12	27/Jul/1995	33°37	71°41 (est.)	1	J	F	Santo Domingo beach	V	199 cm of longitude and with multiple injure. Rehabilitated and released	Zuñiga & Brito (1997)
13	Sept/1995	36°38	72°56 (est.)	1	J	--	Lirquen	VIII	--	This paper
14	31/Jul/1996	33°00	71°33 (est.)	1	J	F	Viña del Mar	V	205 cm, sick and dead	This paper
15	22/Jun/2000	33°01	71°33 (est.)	1	J	--	Viña del Mar	V	Near 200 cm of longitude, good condition	MJ Pérez, this paper
16	12/Oct/2000	33°21	71°39 (est.)	1	J	--	Los Tubos beach	V	Near 200 cm of longitude, good condition. Resting on the beach	This paper
17	09/Oct/2001	33°25	71°42 (est.)	1	A	M	El Quisco beach	V	240 cm of longitude, injured	This paper
18	18/Jul/2002	34°25	72°02 (est.)	1	J	F	Pichilemu beach	VI	--	This paper

Continuation of Table I.

n	Date	Latitude (S)	Longitude (W)	N°	Age	Sex	Locality	Region	Remarks	Source
19	25/Jul/2002	34°10	71°48 (est.)	1	J	F	Topocalma	V	Catch and tagged with rototag 3011-3021	This paper
20	27/Jul/2002	33°21	71°38 (est.)	1	J	F	Algarrobo beach	V	Same individual tagged	This paper
21	04/Agu/2002	27°07	109°26	1	J	M	Eastern Island	V	2.05 m of longitude. Multiple injury. Rehabilitated and release.	Alejandro Bugueño, Diario El Mercurio (2002)
22	12/Oct/2002	33°21	71°39 (est.)	1	J	F	Los Tubos beach	V	200 cm, good condition?	This paper
23	17/Jan/2003	54°40	69°28	3	A	M (1) - F (2)	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition. Two skin biopsy	This paper
24	Agu/2003	54°18	70°40	1	A	--	Keat Sound, D'Agostini Sound	XII	Resting on ice, good condition	M. Mansilla, this paper
25	Agu/2003	54°30	70°25	1	J	--	D'Agostini Sound	XII	Resting on ice, good condition	M. Mansilla, this paper
26	28/Nov/2003	54°41	69°29	4	A	F (2)	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	This paper
27	28/Nov/2003	54°40	69°26	1	J	--	SW Parry fjord, Almirantazgo Sound	XII	Near 180 cm of longitude (visually estimated), resting on ice, good condition	This paper
28	07/Feb/2004	54°36	69°22	1	J	F	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition. Skin biopsy	This paper
29	07/Feb/2004	54°36	69°20	1	J	--	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	This paper
30	07/Feb/2004	54°40	69°26	2	J	F (1)	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	This paper
31	07/Feb/2004	54°39	69°25	1	J	--	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	This paper
32	05/Nov/2004	54°40	69°28	4	A	--	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	This paper
33	05/Nov/2004	54°41	69°21	1	A	F	SE Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition. Skin biopsy	This paper
34	19/Jan/2005	54°40	69°22	4	A	F (1)	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	J Plana, this paper
				3	J	--				

Continuation of Table I.

n	Date	Latitude (S)	Longitude (W)	N°	Age	Sex	Locality	Region	Remarks	Source
35	Mar/2005	53°50	72°29	2	--	--	Helado Sound, Bárbara channel	XII	Resting on ice, good condition	H Cárdenas & F Ayarza, this paper
36	19/Apr/2005	54°40	69°21	5	A	M (3)	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	This paper
37	19/Apr/2005	54°40	69°27	1	J	M	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	This paper
38	31/Oct/2005	54°40	69°26	2	J	M	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	This paper
39	31/Oct/2005	54°42	69°20	1	A	M	SE Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	This paper
40	Nov/2005	53°43	72°35	1	--	--	Ballenas Sound, SW Santa Inés Is.	XII	Resting on ice, good condition	H Cárdenas & F Ayarza, this paper
41	27/Jan/2006	54°52	69°45	1	A	M	Pía Sound, Beagle channel	XII	Resting on ice, good condition	A Ojeda, this paper
42	16/Feb/2006	54°46	67°29	1	A	F	Navarino Island, Beagle channel	XII	Swimming and resting on beach	J. Plana, this paper
43	13/Mar/2006	54°35	69°20	1	J	F	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	J Plana, this paper
44	Sep/2006	53°43	72°34	2	--	--	Ballenas Sound, SW Santa Inés Island	XII	Resting on ice, good condition	H Cárdenas & F Ayarza, this paper
45	16/Dec/2006	54°40	69°26	1	A	--	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	This paper
46	16/Dec/2006	54°42	69°20	1	A	--	SE Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	This paper
47	Jan/2007	53°43	72°35	2	--	--	Ballenas Sound, SW Santa Inés Island	XII	Resting on ice, good condition	H Cárdenas & F Ayarza, this paper
48	09/Jul/2007	33°06	71°40	1	J	--	Verde lagoon	V	--	P Guerrero, this paper
49	03/Agu/2007	32°35	71°28	1	J	M	Cachagua	V	Poor condition, emaciated. Rehabilitated and released	R Vargas, this paper

Continuation of Table I.

n	Date	Latitude (S)	Longitude (W)	N°	Age	Sex	Locality	Region	Remarks	Source
50	06/Sep/2007	29°57	71°19	1	J	M	Coquimbo	IV	Poor condition, dead	SERNAPESCA, this paper
51	12/Sep/2007	54°39	69°26	2	A	F	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	This paper
52	27/Nov/2007	54°39	69°24	2	A	F	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	This paper
53	06/Dec/2007	36°45	73°08	1	J	F	Lenga inlet, Corral Bay	VIII	Moulting	Diario Crónica (2007)
54	Apr/2008	54°39	69°27	4	J-A	--	SW Parry fjord, Almirantazgo Sound	XII	Resting on ice, good condition	H Cárdenas & F Ayarza, this paper
55	May/2008	36°45	73°08	1	J	--	Lenga inlet, Corral Bay	VIII	--	This paper
56	Agu/2008	54°29	71°04	2	J	--	Chico Sound, Magdalena channel	XII	Resting on ice, good condition	H Cárdenas & F Ayarza, this paper
57	16/Agu/2008	39°55	73°24	1	J	F	San Juan river, Corral Bay	IX	--	H Riquelme, this paper
58	04/Nov/2008	39°42	73°21	1	J	--	Calbuco beach	IX	Resting	C Sepúlveda, this paper
59	Dec/2008	54°46	69°37	3	J	--	Pia Sound, Beagle channel	XII	Resting on ice, good condition	H Cárdenas & F Ayarza, this paper
60	Dec/2008	55°06	69°55	2	J	--	SW branch of Beagle channel	XII	Resting on ice, good condition	H Cárdenas & F Ayarza, this paper
61	Mar/2009	54°27	69°37	2	J+A	--	Ainsworth Bay, Almirantazgo Sound	XII	Resting on ice, good condition	H Cárdenas & F Ayarza, this paper
62	Agu/2009	33°21	71°39 (est.)	1	J	--	Algarrobo beach	V	Poor condition, emaciated	A Ruiz, this paper
63	12/Agu/2009	33°43	71°40 (est.)	1	J	M?	Santo Domingo beach	V	Apparently in good condition	This paper

Continuation of Table I.

n	Date	Latitude (S)	Longitude (W)	N°	Age	Sex	Locality	Region	Remarks	Source
64	28/Nov/2009	54°33	70°08	4	A	M(1)-F(1)	Hyatt Sound, D'Agostini Sound	XII	Resting on ice, good condition	This paper
65	30/Nov/2009	29°13	71°08 (est.)	1	J	--	La Bandera beach	IV	--	This paper
66	01/Jan/2010	54°33	70°08	1	A	--	Hyatt Sound, D'Agostini Sound	XII	Resting on ice, good condition	H Cárdenas & F Ayarza, this paper
67	05/Agu/2010	33°19	71°39 (est.)	1	J	M	Mirasol beach, Algarrobo	V	210 cm of longitude. Multiple injured on the body. Head with hematomas and effusion in the right eye.	This paper

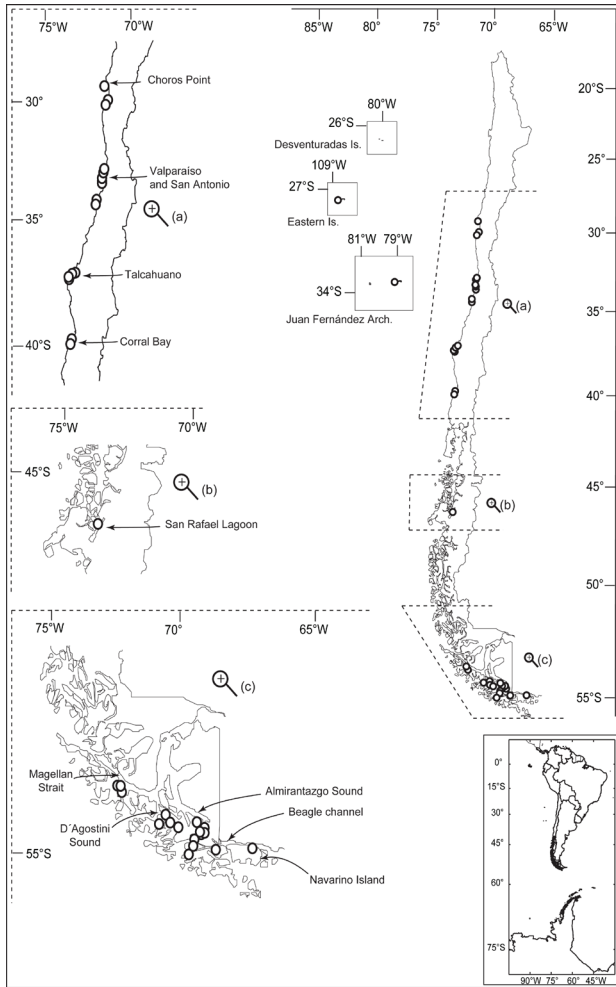


Figure 2. Sighting locations of leopard seals, *Hydrurga leptonyx*, along the Chilean coast, including detailed views of the main sighting areas.

The records of leopard seals in the Central-Northern zone were distributed from 29°13'S (Punta Choros) to 39°55'S (San Juan river), with at least 25 sightings of solitary individuals (Figures 2 and 3). Two of these records correspond to the same individual (sightings N° 19 and 20, Table 1) that was tagged with Rototag numbers 3011 and 3021 in Punta Topocalma (34°10'S) and re-sighted two days later at Algarrobo beach (33°21'S). Only 11 individuals were sexed in this zone, involving six females and five males. Most of the records (52%) occurred between 33-34°S, and 19.2% occurred between 36-37°S. All individuals were juveniles, except for one adult male observed at "Quisco" beach (33°25'S). Sightings were more frequent during winter and spring seasons (n = 23 sightings), particularly in July and August (n = 12 sightings). Regarding body condition, at least five leopard seals were reported to be in poor condition and/or with multiple injuries, and two animals died later (sightings N°14 and 50). One individual (sighting N°11) was found dead on the beach with multiple injuries to the skull. Another two injured individuals (sightings N°12 and 49) were positively treated by the Wildlife Rescue and Rehabilitation Centre of MUCINASA and then released on the beach; one of them remained around the release location for about one month.



Figure 3. Solitary leopard seals seen at Punta Choros (a), Santo Domingo beach (b), Lengua inlet (c) and Corral Bay (d).

Only two individuals have been reported in the Oceanic Islands zone. The first record corresponds to a skin remains of a juvenile individual from Robinson Crusóe Island (Torres & Aguayo 1971). However, Torres (1987) based a survey of local fishermen reported that the presence of “Tigrillo” (name given by island people to leopard seals) was not new, and that they are hunted by the fisherman as they

were considered very dangerous at sea. The second individual was a juvenile male of 205 cm body length reported in Vaihu, Eastern Island, on 4 August 2002 (Figure 4). This leopard seal was in poor condition and with multiple injuries to the body, including a deep cut in the tongue, presumably caused by a hook. The specimen was rehabilitated and released on the beach in late August.



Figure 4. Juvenile leopard seal photographed at Eastern Island on 4 August 2002.

In the Southern zone, 40 sightings involving 87 individuals in good conditions have been recorded from the San Rafael Lagoon ($46^{\circ}40'S$) to the Beagle channel ($55^{\circ}06'S$), with a high occurrence ($n = 37$) south of Ballena Sound ($53^{\circ}43'S$). The only record at San Rafael Lagoon, in February 1979, was noted as “several”. In this zone to south of Ballena Sound, the records were concentrated in four localities:

Almirantazgo Sound (23 sightings - 56 individuals at Parry fjord and 1 sight. - 2 indiv. in Ainsworth Bay); D’Agostini Sound (4 sight. - 9 indiv.); Beagle channel (5 sight. - 8 indiv.); and around the SW coast of Santa Inés Island (Ballena and Helado Sound; 4 sight. - 7 indiv.) (Figure 5). All individuals were recorded resting on ice floes at glacial areas, except for one individual seen at Navarino Island (sighting N°42).



Figure 5. Leopard seals seen at Parry fjord, Almirantazgo Sound (a, b), D’Agostini Sound (c) and Pia Sound, Beagle channel (d).

The number of animals per sighting in each location ranged from 1 to 9. Group size was larger at the Parry fjord (mean = 6 individuals per sighting, range: 1-9), followed by D'Agostini sound (mean = 2.2, range: 1-4). The Beagle channel and the southwest coast of Santa Inés Island presented 1.6 and 1.7 individuals per sighting (range: 1-3), respectively.

Juvenile and adult leopard seals of both sexes were seen seasonally (mainly during summer) on the southwest coast of Santa Ines Island and the Beagle channel; during summer, winter and spring in the D'Agostini sound, and year-round in the Parry fjord. In addition, both adult males and females were present mainly in spring and summer at the Parry fjord, and at least three adult males and two females were observed in autumn and late winter, respectively. More animals were expected to have been seen during an expedition conducted in mid-winter to Parry fjord, however we were unable to explore the entire fjord due to bad weather and the heavy pack-ice. It is interesting to note that a small leopard seal (visually estimated at 180-cm long, N°27) was observed resting on ice floe in late November at Parry fjord.

DISCUSSION

The movements of leopard seals are difficult to study because of their solitary nature (Borsa 1990). However, a number of leopard seals are thought to displace north from the pack-ice to the sub-Antarctic Islands (ex. Gwynn 1953, Rounsevell & Eberhard 1980; Bester & Roux 1986) or venture even farther north, especially during long-term irruptions of non-breeding leopard seals. Occasional sightings have been reported in Australia (Barrett-Hamilton 1901, Jones 1925, Berry 1960, Ingham 1960, Csordas 1963, Marlow 1967, Rounsevell & Pemberton 1994), New Zealand (Horning & Fenwick 1978), South America (ex. Scheffer 1978, Markam 1971, Ximénez *et al.* 1987, Vaz-Ferreira 1984, Torres *et al.* 2000, Bastida & Rodríguez 2003, Bastida *et al.* 2007) and South Africa (Roberts 1951, Courtney-Latimer 1961, Best 1971). In addition, the leopard seals seen to the north of the Antarctic Polar Front tend to be immature animals (Siniff & Stone 1985, Bester *et al.* 2006), and the proportion of immature seals hauling out increases with decreasing latitude (Rounsevell & Pemberton 1994). Nevertheless, small numbers of all

ages are observed throughout the year at Kerguelen (Bester & Roux 1986, Borsa 1990) and Heard (Gwynn 1953, Brown 1957) Islands, and seasonally on other locations such as Macquarie (Rounsevell & Eberhard 1980) and Bird (Walker *et al.* 1998, Jessopp *et al.* 2004) Islands.

Presence of leopard seals in Chile has been reported mainly to south of 40°S (see Table 1). To our knowledge the oldest record of leopard seal at Chile is given in the film of Gunther Plüschow in 1927. In this film shown at least one leopard seal resting on the ice floes when sailing Almirantazgo Sound onboard the vessel "Feuerland". Although the exact location is unknown, is possible that this animal was resting at Parry fjord. Meanwhile the first multiple sightings was also documented in February of 1971 at Parry fjord, regarding simultaneously four individuals (Markham 1971). This author noted that the thermal characteristics of the fjord were very similar to the Antarctic habitat (water and air temperature and presence of ice and pack-ice), providing a favorable summer habitat for the leopard seal. Later, Sielfeld (1978) reported the presence of another leopard seal in the same locality during February 1978, and based on artisanal fishermen anecdotes, suggested that leopard seals occurred year-round in the Patagonian channels. He also suggested that these individuals derived from a potential sub-Antarctic population or from partial migration of immature animals that delayed their migration to the Antarctic.

The presence of leopard seal since 1927 and the increase of number sightings from 1971 in southern localities of Chile with similar habitat to the Antarctic environment, and the presence of both males and females of all ages and in good condition from summer to spring, especially at Parry fjord and D'Agostini Sound, suggest that leopard seals remain year-round in the Fuegian channels. In fact, satellite telemetry data revealed relatively restricted movements, particularly during winter, of adult leopard seals in Pridz Bay, Eastern Antarctic (Rogers *et al.* 2005). Other satellite telemetry data from Queen Maud Land, Eastern Antarctica, shown that two adult leopard seals take on quite extensive northward winter migration but always stayed close to the edge of the pack ice with only occasional haul outs (Nordøy & Blix 2009). Both satellite telemetry data suggest that the movements although slightly

offshore did not reflect the usual northward winter migration described for the juvenile leopard seal. It is also possible that the numbers of leopard seals seen in the different southern fjord of Chile in different years represent only a portion of those present, due to illegal sealing made by fishermen as leopard seals are considered very dangerous to them. Moreover, the sightings of adult males and females in spring and summer in both Parry fjord and D'Agostini Sound coincide with the reproductive season of this species in the Antarctic pack-ice (Hamilton 1939, Gilbert & Erickson 1977, Kooyman 1981, Rogers *et al.* 2005), and considering that the length between birth and the first six months of this species is about 1.2 to 1.9 m (Valette 1906, Matthews 1929, Hamilton 1939), the small individual seen in late November (sighting N°27) could possibly have been a pup born at Parry fjord, Almirantazgo Sound. However, additional data are required to assess if the leopard seals are breeding in the fjords of South America.

Under the above scenario, the presence of leopard seals in the Northern-Central zone is quite different. Except for one adult male recorded in winter and spring and absent from late spring to late autumn, all sightings consisted of immature individuals. This northward movement, possibly from the Southern zone, concurs with the breeding season of the species and the consequent increase of aggressive behaviour by older individuals, which produces a greater degree of spatial separation among individuals (Müller-Schwarze & Müller-Schwarze 1975), particularly on juveniles (Rounsevell & Eberhard 1980). It will reinforce the fact that occurrences, mainly juveniles, to the northernmost areas of Chile could probably also be influenced by social behaviour events. Moreover, in the Central-north zone of Chile, leopard seals were usually not re-sighted the following day, and multiple sightings within the same year never occurred at the same beach. This indicates either the presence of solitary individuals, or that individuals tend to haul out sporadically at various locations. Nonetheless, it is possible that not all leopard seals in the area haul out despite the presence of land, and the numbers recorded may represent only a portion of those present.

Our review suggests that the leopard seal is a regular member of the marine fauna in the Southern zone, with occasionally hauling out along the Central-

Northern zone as seasonal vagrants. Otherwise, the number sightings of leopard seals increased four times from 2000 to 2010 ($n = 52$) with respect to 1927-1999 ($n = 14$), although it is not clear, however, if this increase could be related to the rise of observation efforts, human expansion, population growth, or if it might reflect environmental modification due to climate change. Although there is no evidence of a long-term increase in average annual air temperatures around Magellan Strait (Santana *et al.* 2009), the reduced winter sea ice extent due to the increasing air temperatures of the Antarctic Peninsula region (Vaughan *et al.* 2003) could potentially cause a dispersion to the north of individuals, particularly young's, in search of suitable habitat.

One of the questions to be resolved refers to the rationale for the northward dispersion of some individuals. Traditionally, the movement of leopard seals from the Southern Ocean northward of the Antarctic Polar Front has been attributed to the northward extension of the pack ice during winter (Gwynn 1953, Bonner & Laws 1964, Rounsevell & Eberhard 1980, Bester & Roux 1986, Hempel 1990, Testa *et al.* 1991, Bester *et al.* 1995, Jessopp *et al.* 2004). The seals would then return back towards the Antarctic continent during austral spring (Brown 1957, Erickson *et al.* 1971, Siniff & Stone 1985). Intra-specific aggression (mainly towards immatures) or food shortages have also been suggested to explain the seal migration to the north (Øritsland 1977, Rounsevell 1988, Rogers & Bryden 1997). Although our data are limited and it is not possible to rule out that these rationale can drive the northward dispersion, especially considering the close proximity of the Fuegian channels area with the Antarctic continent (508 nm) in relation to another continents, the Malvinas current could also be a potential via for the northbound movements from Antarctica to South America. This current is a narrow branch of the Antarctic Circumpolar Current that flows northward along the South Atlantic coast of South America (Legeckis & Gordon 1982, Garzoli 1993, Matano *et al.* 1993, Vivier & Provost 1999) transporting relatively fresh and cold waters (mean sea surface temperature = 6°C) over the continental slope (Brandini *et al.* 2000). In addition, the Malvinas current is characterised by high levels of biological productivity from coastal upwelling along the

southeastern portion of Patagonia (Csirke 1987, Lutz & Carreto 1991, Sabatini *et al.* 2004). Assuming the leopard seals take advantage of this current, once they reach the tip of South America they can potentially move to the inlets in search of suitable “Antarctic” environments (ex. glacial areas), which are absent on the Atlantic Patagonian coast.

The year-round presence of leopard seals in the Fuegian channels suggests that they might benefit from locally abundant food resources such as penguins, South American fur seals, seabirds, fishes, cephalopods and euphausiids. In fact, the diet of the leopard seal in Antarctica is reported to consist of diverse prey items that include all kinds of prey from small krill to other species of seals (Penney & Lowry 1967, Hunt 1973, Müller-Schwarze & Müller-Schwarze 1975, Gilbert & Erikson 1977, Øritsland 1977, Siniff & Stone 1985, Bester & Roux 1986, Green & Williams 1986, Lowry *et al.* 1988, Borsa 1990, Kooyman 1981, Rogers & Bryden 1995, Hiruki *et al.* 1999, Vera *et al.* 2004). Despite the species’ diverse diet, there is also evidence for spatial and temporal variation in the relative proportions of the various prey items (Laws 1984). For some leopard seal populations, penguins are considered a temporary resource (Penney & Lowry 1967), but for others, penguins are a greater component of the diet (Hall-Aspland & Rogers 2004). The stomach of an adult female killed at Parry fjord exhibited remains of fish and Magellan penguin (*Spheniscus magellanicus*) (Markham 1971). However, we have opportunistically seen brown scats without the presence of feathers or fur on ice floes, suggesting possibly a diet comprised of fish. The scats of a leopard seal sighted at Santo Domingo beach in July of 1995 revealed fish and seabirds as prey items (JLB pers. obs.).

Although the observations presented here suggest a year-round presence of leopard seals in the Southern area of South America, further research such as satellite telemetry studies, together with additional sampling for genetic analysis are urged to verify movements behaviour and residency of young and adult leopard seals between the southern fjords of South America and Antarctica and/or Sub-Antarctic Islands.

ACKNOWLEDGMENTS: We are indebted to Mr. Francisco Ayarza O. and the crew on board the M/V CHONOS, particularly the skippers Mr.

Hugo Cárdenas and Mr. Manuel Mancilla, for all the cooperative work. We also thank the directors of INACH, CEQUA and MUCINASA for their support to our respective marine mammal projects. The Brazilian authors also thank to their respective directors for support this cooperative work. Finally, we are grateful to our colleagues and friends for their observations of leopard seals along the Chilean coast, the skipper Roger Wallis of yacht “Australis” for provide the film of Gunter Plüschow during the field work in December 2010 at Almirantazgo Sound, and the anonymous referee’s for improve this manuscript.

REFERENCES

- AGUAYO-LOBO, A. 1970. Census of Pinnipedia in the South Shetland Islands. Pp. 395-397. *In:* M.W. Holdgate (ed.). Antarctic Ecology. Vol. I. Academic Press, London and New York. 604p.
- AGUAYO-LOBO, A. & TORRES, D. 1967. Observaciones sobre mamíferos marinos durante la Vigésima Comisión Antártica Chilena. Primer censo de Pinnipedia en las islas Shetland del Sur. *Revista de Biología Marina*, 13(1): 1-57.
- AGUAYO-LOBO, A. & TORRES, D. 1971. Identificación a distancia de focas antárticas. *Serie Científica INACH*, 3: 87-101.
- BARRETT-HAMILTON, G.E.M. 1901. Seals. Pp. 9-11. *In:* Rapports Scientifiques. Resultants du Voyage du s/y Belgica, Zoologie en 1897-1898-1899.
- BARQUEZ, R.M.; DÍAZ, M.M. & OJEDA, R.A. 2006. *Mamíferos de Argentina. Sistemática y Distribución*. Sociedad Argentina para el Estudio de los Mamíferos. Tucumán, Argentina. 359p.
- BASTIDA, R. & RODRÍGUEZ, D. 2003. *Mamíferos Marinos de Patagonia y Antártida*. 1ra. Ed. Buenos Aires. Vázquez Maziini Editores. 208p.
- BASTIDA, R.; RODRÍGUEZ, D.; SECCHI, E. & DA SILVA, V. 2007. *Mamíferos Acuáticos de Sudamérica y Antártida*. 1ra. Ed. Buenos Aires. Vázquez Maziini Editores. 366p.
- BERRY, J.A. 1960. The occurrence of a leopard seal in the tropics. *Anim ad Magazine Nature History*, 3: 591.
- BEST, P. 1971. A leopard seal from Hout Bay, South Africa. *Zoologie Africaine*, 6: 176-179.
- BESTER, M.N. & ROUX, J.P. 1986. Summer presence of leopard seals, *Hydrurga leptonyx* at Courbet Peninsula, Iles Kerguelen. *South African Journal Antarctic Research*, 16: 29-32.
- BESTER, M.N.; ERICKSON, A.W. & FERGUSON, J.W.H. 1995. Seasonal change in the distribution and density of seals

- in the pack ice off Princess Martha Coast, Antarctica. *Antarctic Science*, 7(4): 357-364, doi:10.1017/S0954102095000502.
- BESTER, M.N.; FERGUSON, J.W.H. & JONKER, F.C. 2002. Population densities of pack ice seals in the Lazarev Sea, Antarctica. *Antarctic Science*, 14(2): 123-127, doi:10.1017/S0954102002000676.
- BESTER, M.N.; HOFMEYS, G.J.G.; KIRKMAN, S.P.; CHAUKE, L.F.; DE BRUYN, P.J.N.; FERREIRA, S.M.; MAKHADO, A.B.; MASWIME, T.A.M.; MCINTYRE, T.; MUTANDRI, T.W.; MUNYAL, F.M.; PISTORIUS, P.A.; RADZILAMI, P.M.; RAMUNAZI, A.J.; TSHITHABANE, N.H. & WILKINSON, I.S. 2006. The leopard seal at Marion Island, vagrant or seasonal transient?. *South African Journal Antarctic Research*, 36(2): 195-198.
- BONNER, W.N. & LAWS, R.M. 1964. Seal and Sealing. Pp. 163-190. In: R. Priestley, R.J. Adie & G. de Q. Robin (eds.). Antarctic Research. A review of British Scientific Achievement in Antarctica. Butterworths, London.
- BORSA, P. 1990. Seasonal occurrence of the leopard seal, *Hydrurga leptonyx*, in the Kerguelen Islands. *Canadian Journal of Zoology*, 68(2): 405-408, doi:10.1139/z90-059.
- BRANDINI, F.P.; BOLTOVSKOY, D.; PIOLA, A.; KOCMUR, S.; ROTTGERS, R.; ABREU, P.C. & LOPES, R.M. 2000. Multiannual trends in fronts and distribution of nutrients and chlorophyll in the southwestern Atlantic (30-62 ° S). *Deep-Sea Research I*, 47(6): 1015-1033. doi: 10.1016/S0967-0637(99)00075-8.
- BROWN, K.G. 1957. The leopard seal at Heard Island, 1951-54. Austral National Antarctic Research Expedition. *Interior Report*, 16. 34p.
- CASAUX, R.; BARONI, A.; RAMÓN, A.; CARLINI, A.; BERTOLIN, M. & DIPRINZIO, C.Y. 2009. Diet of the leopard seal *Hydrurga leptonyx* at the Danco Coast, Antarctic Peninsula. *Polar Biology*, 32(2): 307-310, doi: 10.1007/s00300-008-0567-0.
- CSIRKE, J. 1987. The Patagonian fishery resources and the offshore fisheries in the South-West Atlantic. FAO Fisheries Technical Paper 286. 75p.
- CSORDAS, S.E. 1963. Leopard seals on Macquarie Island. *Victorian Nature*, 79: 358-362.
- COURTNEY-LATIMER, M. 1961. Two rare seal records for South Africa. *Annals of the Cape Province Museum*, 1: 102.
- DEARBORN, J.H. 1952. An unusual occurrence of the leopard seal at Mac Murdo Sound, Antarctica. *Journal of Mammalogy*, 43: 273-275.
- DIARIO CRÓNICA. 2007. Curiosa foca llegó a Lenga. <http://www.cronica.cl/edicion_cronica/seccion/articulo.php?id=41584&dia=1196910000> (Accessed on 12/06/2007).
- DIARIO DEL FIN DEL MUNDO. 2007. Foca leopardo en la cota de Ushuaia. <<http://www.eldiariodelfindelmundo.com/noticias/leer/12126/foca-leopardo-en-la-costa-de-ushuaia.html>> (Accessed on 08/28/2007).
- DIARIO EL MERCURIO. 2002. Habitante de isla de Pascua adoptan a una foca como mascota. <<http://www.emol.com/noticias/nacional/detalle/detallenoticias.asp?idnoticia=92380>> (Accessed on 08/13/2002).
- ERICKSON, A.W.; R.J.HOFMAN, W.L.T. & OCHLENSCHLAGER, R.J. 1970. Seal survey in the South Shetland and South Orkney Islands. *Antarctic Journal of the United State*, 5(4): 130-131.
- ERICKSON, A.W.; SINIFF, D.B.; CLINE, D.R. & HOFMAN, R.J. 1971. Distributional ecology of Antarctic seals. Pp. 56-76. In: G. Deacon (ed.). Symposium on Antarctic Ice and Water Masses, Tokyo. Scientific Committee on Antarctic Research, Cambridge. 113p.
- FERREIRA, H.D.O.; ZERBINI, A.N. & SICILIANO, S. 1995. Occurrence of crabeater and leopard seals in Southern Brazil. P. 36. In: XI Bienal Conference on the Biology of Marine Mammals, 14-18 December, Orlando – USA.
- GARZOLI, S.L. 1993: Geostrophic velocity and transport variability in the Brazil-Malvinas confluence. *Deep Sea Research I*, 40(7): 1379-1403. doi:10.1016/0967-0637(93)90118-M.
- GILBERT, J.R. & ERICKSON, A.W. 1977. Distribution and abundance of seal in the pack-ice of the Pacific Sector of Southern Ocean. Pp.703-748. In: G.A. Llanos (ed.). Adaptations within Antarctic Ecosystem. Smithsonian Institution, Washington D.C. 1252p.
- GILSON, A.; SYVANEN, M.; LEVINE, K. & BANKS, J. 1998. Deer gender determination by polymerase chain reaction: validation study and application to tissues, bloodstains, and hair forensic samples from California. *California Fish and Game*, 84: 159-169.
- GOODALL, R.N.P.; BOY, C.C.; BENEGAS, L.G. & SCHIAVINI, A.C.M. 2005. Antarctic seals on the coasts of Tierra del Fuego,

- Argentina – Review and Update. Pp. 56-57. In: S. Thatje, J.A. Calcagno & W.E. Arntz (eds.). Evolution of Antarctic Fauna. Extended abstracts of the IBMANT/ANDEEP International Symposium and Workshop in 2003. Berichte zur Polar- und Meeresforschung, 507. 200p.
- GREEN, K. & WILLIAMS, R. 1986. Observations on food remains in faeces of elephant, leopard and crabeater seals. *Polar Biology*, 6: 43-45, doi: 10.1007/BF00446239.
- GUNTER, P. 1927. Film *Silberkondor über Feuerland*, documentary, 1929.
- GWYNN, A.M. 1953. The status of the leopard seal at Heard Island and Macquarie Island. 1948-1950. ANARE Research Expedition Interim Report No. 3. Antarctic Division. Department of External Affairs. Melbourne, Australia. 38p.
- HALL-ASPLAND, S.A. & ROGERS, T.L. 2004. Summer diet of leopard seals (*Hydrurga leptonyx*) in Prydz Bay, Eastern Antarctica. *Marine Mammal Science*, 27(12): 729-734, doi: 10.1007/s00300-004-0662-9.
- HAMILTON, J.L. 1939. The leopard seal, *Hydrurga leptonyx* (de Blainville). *Discovery Reports*, 18: 239-264.
- HEMPEL, G. 1990. The Weddell Sea: a high polar ecosystem. Pp. 5-18. In: K. Sherman, L.M. Alexander & B.D. Gold (eds.). Large marine ecosystems: patterns processes and yields. American Association for the Advancement of Science, Washington, D.C. 240p.
- HIRUKI, L.M.; Schwartz, M.K. & Boveng, P. 1999. Hunting and social behaviour of leopard seals (*Hydrurga leptonyx*) at Seal Island, South Shetland Islands, Antarctica. *Journal of Zoology* (London), 249(1): 97-109, doi: 10.1111/j.1469-7998.1999.tb01063.x.
- HORNING, D.S.J. & FENWICK, G.D. 1978. Leopard seals at the Snares islands, New Zealand. *New Zealand Journal of Zoology*, 5: 171-172.
- HOUSSE, R. 1953. *Los Mamíferos de Chile. Su vida y sus costumbres*. Ediciones de la Universidad de Chile. Santiago. 159p.
- HUNT, J.F. 1973. Observations on the seals of Elephant Island, South Shetland Islands, 1970-71. *British Antarctic Survey Bulletin*, 36: 99-104.
- INGHAM, S.E. 1960. The status of seals (Pinnipedia) at Australian Antarctic stations. *Mammalia*, 24: 422-430.
- JESSOPP, M.N.; FORCADA, J.; REID, K.; TRATHAN, P.N. & MURPHY, E.J. 2004. Winter dispersal of leopard seals (*Hydrurga leptonyx*): environmental factors influencing demographics and seasonal abundance. *Journal Zoology* (Lond), 263: 251-258, doi: 10.1017/S0952836904005102
- JONES, F.W. 1925. *The mammals of South Australia. The monodelphia*. Vol. 3. Handbooks of the flora and fauna of South Australia, British Scientific Guild, Adelaide. 458p.
- KING, J.E. 1983. *Seals of the World*. British Museum Natural History. Oxford University Press, Oxford. 240p.
- KOOYMAN, G.L. 1981. Leopard seal, *Hydrurga leptonyx*, de Blainville 1820. Pp. 261-274. In: S.H. Ridway & R.J. Harrison (eds.). Handbook of Marine Mammals. Vol.2. Seals. Academic Press, London and New York. 359p.
- KRÜTZEN, M.; BARRE, L.M.; MÖLLER, L.; HEITHAUS, M.R.; SIMMS, C. & SHERWIN, W. 2002. A biopsy system for small cetaceans: darting success and wound healing in *Tursiops* spp. *Marine Mammal Science*, 18: 863-878.
- LAWS, R.M. 1957. On the growth rates of the leopard seal, *Hydrurga leptonyx* (de Blainville 1820). *Säugetierkundliche Mitteilungen*, 5(2): 49-55.
- LAWS, R.M. 1973. The current status of Seals in the Southern Hemisphere. Pp. 144-161. In: IUCN Publ (ed.). Seals. New Series Supplement Paper No. 39. Morges, Switzerland.
- LAWS, R.M. 1984. Seals. Pp. 621-715. In: R.M. LAWS (ed.). Antarctic ecology. Vol. II. Academic Press, London. 850p.
- LEGECKIS, R. & GORDON, A. 1982: Satellite observations of the Brazil and Falkland Currents - 1975 to 1976 and 1978. *Deep-Sea Research*, 29(3): 375-401. doi: 10.1016/0198-0149(82)90101-7.
- LOWRY, L.F.; TESTA, J.W. & CALVERT, W. 1988. Notes on winter feeding of crabeater and leopard seals near the Antarctic Peninsula. *Polar Biology*, 8: 475-478, doi: 10.1007/BF00264724.
- LUTZ, V.A. & CARRETO, J.I. 1991. A new spectrofluorometric method for the determination of chlorophyll-*a* and degradation products and its application in two frontal areas of the Argentine Sea. *Continental Shelf Research*, 11(5): 433-451. doi:10.1016/0278-4343(91)90052-8.
- MARKHAM, B.J. 1971. Observation on the elephant seal and the leopard seal seals on Brecknock Peninsula (Alberto M. de Agostini National Park). Tierra del Fuego. *Anales Instituto de la Patagonia (Chile)*, 2: 160-163.

- MARLOW, B.J. 1967. Mating behaviour in the leopard seal, *Hydrurga leptonyx* (Mammalia: Phocidae), in captivity. *Australian Journal of Zoology*, 15(1): 1-5, doi:10.1071/ZO9670001.
- MATANO, R.P.; SCHLAX, M.G. & CHELTON, D.B. 1993. Seasonal variability in the southwestern Atlantic. *Journal of Geophysical Research*, 98: 18027-18035. doi:10.1029/93JC01602
- MATTHEWS, L.H. 1929. The Natural History of the Elephant Seal with notes on other seals found at South Georgia. *Discovery Reports*, 1: 233-255.
- MAWSON, P.R. & COUGHRAN, D.K. 1999. Records of sick, injured and dead pinnipeds in Western Australia, 1980–1996. *Journal of the Royal Society of Western Australia*, 82: 121-128.
- MÜLLER-SCHWARZE, D. & MÜLLER-SCHWARZE, C. 1975. Relations between leopard seals and adelic penguins. Pp. 394-404. In: K. Ronald & A.W. Mansfield (eds.). *Biology of the Seal. Rapports et Progress-Verbaux Des Reunion*. Vol. 169. Charlottenlund Slot, Denmark. 557p.
- NAYA, D.E. & ACHAVAL, F. 2006. Nuevos registros de especies pocos comunes de Pinnipedia y primer registro de *Arctocephalus gazella* (Peters, 1875) (Pinnipedia: Otariidae) para el Uruguay. *Boletín de la Sociedad Zoológica del Uruguay (2da Época)*, 15: 23-27.
- NORDØY, E.S. & A.S. BLIX. 2009. Movements and dive behaviour of two leopard seals (*Hydrurga leptonyx*) off Queen Maud Land, Antarctica. *Polar Biology*, 32: 263-270, doi: 10.1007/s00300-008-0527-8
- OLIVER-SCHNEIDER, C. 1946. Catálogo de los mamíferos de Concepción. *Boletín de la Sociedad de Biología, Concepción (Chile)*, 21: 67-83.
- ØRITSLAND, T. 1977. Food consumption of seals in the Antarctic pack ice. Pp. 749-767. In: G.A. Llano (ed.). *Adaptations within Antarctic ecosystems: Proceedings of the 3rd SCAR symposium on Antarctic biology*. Smithsonian Institute, Washington, DC. 1252p.
- PAULIN, P. 1952. Sur la presence aux Iles Kerguelen, *Hydrurga leptonyx* (Bl.) et d' *Arctocephalus gazella* (Pet). Et notes biologiques sur deux phocides. *Mammalia*, 16: 223-227.
- PENNEY, R.L. & LOWRY, G. 1967. Leopard seal predation on Adelie penguin. *Ecology*, 48(5): 878-882, doi:10.2307/1933751.
- PINEDO, M. C. 1990. Ocorrência de Pinípedes na Costa Brasileira. *Garcia de Orta, Sér. Zool.*, 15(2): 37-48.
- RAY, C. 1970. Population Ecology of Antarctic Seals. Pp. 398-414. In: M.W. Holdgate (ed.). *Antarctic Ecology*. Vol. 1. Academic Press, London and New York. 604p.
- REEVES, R.R, STEWART, B.S; CLAPHAM, P.J. & POWELL, J.A. 2002. *Guide to marine mammals of the world*. Chanticleer Press, Inc. 527p.
- RICE, D.W. 1998. *Marine mammals of the world: Systematics and distribution*. Special Publication Number 4, The Society for Marine Mammalogy. Allen Press, USA. 231p.
- ROBERTS, A. 1951. *The mammals of South Africa*. Hafner, New York. 700p.
- RODRÍGUEZ, D., BASTIDA, R., MORÓN, S., RODRÍGUEZ, S. & LUOREIRO, J. 2003. Occurrence of leopard seals in Northern Argentina. *Lajam* 2(1): 51-54.
- ROGERS, T. & BRYDEN, M.M. 1995. Predation of Adelie penguins (*Pygoscelis adeliae*) by leopard seals (*Hydrurga leptonyx*) in Prydz Bay, Antarctica. *Canadian Journal of Zoology*, 73(5): 1001-1004, doi: 10.1139/z95-119.
- ROGERS, T. & BRYDEN, M.M. 1997. Density and haul-out behavior of leopard seals (*Hydrurga leptonyx*) in Prydz Bay, Antarctica. *Marine Mammal Science*, 13(2): 293-302, doi: 10.1111/j.1748-7692.1997.tb00632.x.
- ROGERS, T.L.; HOGG, C.J. & IRVINE, A. 2005. Spatial movement of adult leopard seal (*Hydrurga leptonyx*) in Prydz Bay, Easter Antarctica. *Polar Biology*, 28: 456-463, doi: 10.1007/s00300-004-0703-4.
- ROSAS, F.C.W., CAPISTRANO, L.C., DI BENEDITTO, A.P. & RAMOS, R. 1992. *Hydrurga leptonyx* recovered from the stomach of a tiger shark captured off the Rio de Janeiro coast, Brazil. *Mammalia*, 56: 153-155.
- ROUNSEVELL, D. 1988. Periodic irruptions of itinerant leopard seals within the Australasian sector of the Southern Ocean, 1976–1986. *Paper and Proceeding of the Royal Society of Tasmania*, 122: 189-191.
- ROUNSEVELL, D. & EBERHARD, I. 1980. Leopard Seals, *Hydrurga leptonyx* (Pinnipedia), at Macquarie Island from 1949 to 1979. *Australian Wildlife Research*, 7: 403-415, doi: 10.1071/WR9800403.
- ROUNSEVELL, D. & PEMBERTON, D. 1994. The status and seasonal occurrence of leopard seals, *Hydrurga leptonyx*, in Tasmanian waters. *Australian Mammalogy*, 17: 97-102.

- SABATINI, M.; RETA, R. & MATANO, R. 2004. Circulation and zooplankton biomass distribution over the southern Patagonian shelf during late summer. *Continental Shelf Research*, 24(12): 1359-1373. doi:10.1016/j.csr.2004.03.014.
- SANTANA, A.; BUTOROVIC, N. & OLAVE, C. 2009. Variación de la temperatura en Punta Arenas (Chile) en los últimos 120 años. *Anales Instituto Patagonia (Chile)*, 37(1): 85-96.
- SCHEFFER, V.B. 1958. *Seals, sea lions and walruses. A review of the Pinnipedia*. Stanford University Press, Stanford. 179p.
- SCHEFFER, F. 1978. Presencia de un leopardo marino en la playa de Guanaqueros, 12 agosto, Coquimbo, Chile. *Condor*, 41: 2329.
- SIELFELD, W. 1978. Algunas consideraciones sobre fócidos, (Pinnipedia) asociados a la costa de Chile. *Anales del Instituto de la Patagonia, Punta Arenas. (Chile)*, 9: 153-156.
- SINIFF, D.B. & STONE, S. 1985. The role of the leopard seal in the trophodynamics of the Antarctic marine ecosystem. Pp. 555-560. In: W.R. Siegfried, P.R. Condy & R.M. Laws (eds.). Antarctic nutrient cycles and food webs. Springer-Verlag, New York. 700p.
- SLATER, J. 1991. Leopard seal entanglement in Tasmania, Australia. *Marine Mammal Science*, 7: 323.
- TESTA, J.W.; OEHLERT, G.; AINLEY, D.G.; BENGTSO, J.L.; SINIFF, D.B.; LAWS, R.M. & ROUNSEVELL, D. 1991. Temporal variability in Antarctic marine ecosystems: periodic fluctuations in the phocid seals. *Canadian Journal of Fisheries Aquatic Science*, 48(4): 631-639, doi: 10.1139/f91-081.
- TORRES, D. & AGUAYO-LOBO, A. 1971. Algunas observaciones sobre la fauna del archipiélago de Juan Fernández. *Boletín de la Universidad de Chile*, 2(212): 26-37.
- TORRES, D.; YAÑEZ J. & CATÁN, P. 1979. Mamíferos Marinos de Chile. Antecedentes y Situación Actual. *Biología Pesquera (Chile)*, 11: 49-81.
- TORRES, D. 1987. Antecedentes sobre el lobo fino de Juan Fernández, *Arctocephalus philippii*, y proyecciones para su estudio. Pp. 287-317. In: J.C. Castilla (ed.). Islas Oceánicas Chilenas: Conocimiento Científico y Necesidades de Investigaciones. Ediciones de la Universidad Católica de Chile. 353p.
- TORRES, D.; AGUAYO-LOBO, A. & ACEVEDO, J. 2000. Mamíferos Marinos de Chile. II. Carnívora. *Serie Científica INACH*, 50: 25-103.
- VALETTE, L.H. 1906. Viaje a las islas Orcadas Australes. Anales del Ministerio de Agricultura, Sección de Zootecnia, Bacteriología, Veterinaria y Zoología, Buenos Aires, III(2). 70p.
- VAUGHAN, D.G.; MARSHALL, G.J.; CONNOLLEY, W.M.; PARKINSON, C.; MULVANEY, R.; HODGSON, D.A.; KING, J.C.; PUDSEY, C.J. & TURNER, J. 2003. Recent rapid regional climate warming on the Antarctic Peninsula. *Climatic Change*, 60: 243-274.
- VAZ-FERRIERA, R. 1984. La foca leopardo *Hydrurga leptonyx* (de Blainville, 1820) (Pinnipedia, Phocidae) en el Uruguay. *Boletín de la Sociedad Zoológica del Uruguay (2da Época)*, 2: 18-21.
- VELOZO, R. 2007. Encalhe de mamíferos acuáticos entre a foz dos rios Pardo (BA) e São Francisco (SE). *MSc Dissertation*. Universidade Estadual de Santa Cruz, Brasil. 112p.
- VERA, C.; VARGAS, R. & TORRES, D. 2004. El impacto de la foca leopardo en la población de cachorros de lobo fino antártico en cabo Shirreff, Antártica, temporada 2003-2004. *Boletín del Instituto Antártico Chileno*, 23(1): 19-22.
- VIVIER, F. & PROVOST, C. 1999. Direct velocity measurements in the Malvinas Current. *Journal of Geophysical Research*, 104: 21083-21103. doi:10.1029/1999JC900163.
- WALKER, T.R.; BOYD, I.L.; McCAFFERTY, D.J.; HUIN, N.; TAYLOR, R.I. & REID, K. 1998. Seasonal occurrence and diet of leopard seals (*Hydrurga leptonyx*) at Bird Island, South Georgia. *Antarctic Science*, 10(1): 75-81, doi:10.1017/S0954102098000108.
- XIMÉNEZ, A.; SIMOES-LOPEZ, P.C. & PRADERI, R. 1987. Notas sobre mamíferos marinhos de Santa Catarina e Rio de Grande do Sul (Pinnipedia-Cetacea). Pp. 100-103. In: Anais da 2ª Reunião de Trabalho de especialistas em Mamíferos Aquáticos da América do Sul. Rio de Janeiro, Brasil.
- YAÑEZ, A.P. 1948. Vertebrados Marinos Chilenos. *Revista de Biología Marina*, 1(2). 103-123.
- ZUÑIGA, P. & BRITO, J.L. 1997. Presencia de *Hydrurga leptonyx* en la costa continental de Chile Central. In: VII Congreso Interamericano de Biodiversidad y Zoología de Vertebrados. Universidad de Concepción. Chile. 154p.

Submetido em 14/09/2010

Aceito em 25/01/2011