

# Mortality of Small Cetaceans and the Crab Bait Fishery in the Magallanes Area of Chile Since 1980

Anne-Catherine Lescauwet and Jorge Gibbons

*Casilla 527, Punta Arenas, Chile*

## ABSTRACT

Since 1974, species of small cetaceans, fur seals, sea lions, sea birds and to some extent sea otters, have been taken deliberately each year for bait in the Chilean artisanal fishery for centolla, southern king crab (*Lithodes santolla*) and centollón, false king crab (*Paralomis granulosa*). We describe the socio-economic context of this fishery and we review official fishery statistics and unpublished data in order to estimate the magnitude of this direct take between 1980 and 1992. We find that the need for bait in the crab fishery has continually decreased from a peak value of 950 tonnes in 1986 to a minimum of 450 tonnes in 1992. In recent years, three new trends are contributing to alleviate mortality pressure on marine mammals in Magallanes: a change in fisheries legislation, an increased diversification of the artisanal fishery and an increasing public awareness of the values of marine wildlife.

**KEYWORDS:** INCIDENTAL CAPTURE; DIRECT CAPTURE; FISHERIES; SOUTH PACIFIC; PINNIPEDS; SEA OTTERS; COMMERSON'S DOLPHIN; BLACK DOLPHIN; DUSKY DOLPHIN; RIGHT WHALE DOLPHIN; BURMEISTER'S PORPOISE; MANAGEMENT.

## INTRODUCTION

As several authors have reported (e.g. Goodall, 1977; Sielfeld *et al.*, 1977a; b; Torres, 1977; Sielfeld and Venegas, 1978; Cárdenas *et al.*, 1987; Goodall and Cameron, 1980; Goodall *et al.*, 1988b; Leatherwood *et al.*, 1988), small cetaceans have been taken deliberately each year since 1974 in the Magellan region of Chile for use as bait in traps set for centolla or southern king crab (*Lithodes santolla*) and centollón or false king crab (*Paralomis granulosa*). However, no thorough examination of the development of the crab fishery, its geographic expansion or the demand for marine mammal bait has been presented previously. In this paper, we discuss the socio-economic background to the fishery, the historical sequence of relevant political and economic events, and attempt to estimate the numbers of cetaceans that would have been required to support the crab fisheries in recent years.

This work is predicated on the assumption that, to conserve populations in the Patagonian and Fuegian channels, one needs to have: (a) better information on the status of the populations affected by activities related to crab fishing, (b) better information on the numbers of cetaceans killed and (c) a basic management plan for presentation to the Chilean government and the fishing communities.

## MATERIALS AND METHODS

We have reviewed the literature on the crab fisheries in southern Chile with respect to the use of bait and the social and economic factors affecting or influencing the fisheries. We especially sought information on cultural elements, ethnic structures and population transitions within the fishing communities of the Magellan region.

Written sources included annual statistics from port authorities, the Servicio Nacional de Pesca (SERNAP), the Instituto de Fomento Pesquero (IFOP), the Servicio Agrícola y Ganadero (SAG), the Corporación Nacional de Fomento a la Producción (CORFO), the Instituto Nacional de Estadísticas (INE) and a published socio-economic profile of a part of the artisanal fishing community (Henríquez, 1990). We also checked every issue of the regional newspaper *La Prensa Austral*, from

1987 to early 1993, for articles related to the taking of wildlife for bait, the over exploitation of crab etc. This newspaper search gave us an indication of what information has been made available to the community and the perceived importance of these issues at the regional level.

We conducted extensive interviews with fishermen (approx. 60), 16 of 25 company managers, scientists, representatives of the Chilean Navy and personnel in the fisheries service. Company managers completed questionnaires designed to elicit their views on the condition of the crab fisheries, suggested solutions to problems and likely obstacles to implementation of regulatory measures. The Secretary of Fisheries kindly cooperated with a 'written interview' regarding new policies.

We used the region's 14 fishing areas (IFOP, publications 1979-1990) to identify fishing grounds with the highest catch effort. Annual catch effort values per area are given as fractions of the total annual catch effort. The seasonal and geographical distribution of catch effort was compared with the available information on distribution of small cetaceans.

In this paper, the term 'catch effort' refers only to the effort directed at the trapping of crabs. It does not encompass the effort involving nets or diving gear. We calculated effort using IFOP methods, with the following assumptions:

- a 40% loss in active fishing days due to poor weather or technical difficulties;
- an average submersion time per trap set (cast) of 72 hours for centolla (one third of the traps are set per cast);
- an average submersion time of 48 hours for centollón (one half of the traps are set per cast).

The monthly catch effort per vessel was thus calculated by multiplying the number of traps on board by the number of fishing days per month and then dividing by either 2 (centollón) or 3 (centolla).

Partial monthly and yearly information on crab catch effort was available for 1979-1986 from SERNAP and IFOP. Catch effort for 1987-1989 was calculated from daily

fishing activity as recorded by harbour personnel, who noted the arrival and departure of vessels and the areas from which crabs were harvested (fishing Regions I-XIV, see Fig. 3). Files kept by the port authorities provided each vessel's length. By knowing the average number of traps carried by different length classes of vessels, we were able to estimate the total number of traps deployed from a particular port.

Our estimates of catch effort for centolla and centollón, combined, during 1990-1992 are based on the total estimated number of traps available in the region and the number of effective fishing days. The total catch effort, multiplied by a 'bait unit', gives an indication of the total amount of bait used (both wildlife and legal). Since in reality bait units may vary in size by as much as 1.5kg, the use of a single value is arbitrary. We chose 0.5kg, the minimum amount of bait needed for a single trap, to generate conservative estimates of total bait requirements.

We identified potential legal sources of bait in the region (e.g. slaughterhouse waste, waste from the industrial fishery) and reviewed official information to verify that this bait was being used for crabbing.

Finally, in our discussion we consider available data for 1993 and 1994 in our assessment of conclusions drawn from the main period of our work (i.e. up to 1992).

## RESULTS

### Government policy and national fisheries

Growth in fisheries has made fishing the second most important category in the Chilean economy, contributing 12% of the total value of national exports in 1990. In 1989, Chile exported a total catch of 6.6 million tonnes of fish, shellfish, crustaceans and algae worth US\$930 million. Developments in the Chilean fishery industry occurred under a regime of free access to fisheries and major reductions in all forms of regulation and control. It had an extremely destructive impact on natural resources, with the exhaustion of mollusc banks and the overfishing of important pelagic fish and shellfish populations. Ten of the main fisheries, together contributing 85% of the total export value, showed signs of overexploitation (Couve, 1991).

### Unmanageability of the crab fisheries

Chilean commercial fisheries for centolla and centollón are centred in the Magellan Region (49°S-56°S). This region supplies 97% of the national production of centolla and 100% of that of centollón. In 1976, accelerated and sustained growth began in this industry with increases in the sizes of the fleets, the processing companies, the geographical areas, annual landings and exports (Table 1, Figs 1 and 2).

Annual landings before 1976 fluctuated between 200 and 450 tonnes.

By 1986, crabbing had become unmanageable, as shown by the high percentage of illicit captures; Hernandez and Diaz (1986) estimated that 30-40% of the total landings were taken illegally (either undersized crabs, crabs obtained from closed areas or those obtained using illegal methods). Some company owners suggested that this may have reached up to 70% in later years.

Six factors are seen as contributing to the unmanageability of the Chilean crab fisheries.

#### (1) Free access

Little or nothing was required of entrants to the fisheries, resulting in an increase from nine processing plants in 1974 to 27 in 1988.

#### (2) State support

The Chilean government, through CORFO, provided extremely favourable terms for the acquisition of fishing boats and equipment. From 1976 to 1989, 90 beneficiaries in the artisanal sector received, in total, approximately US\$600,000 of credit, while four enterprises in the industrial sector received a total of US\$2,500,000 of credit from 1982 to 1986 (B. Bonifetti, CORFO, pers. comm.). The artisanal fleet grew from approximately 60 before 1970, to nearly 600 boats by 1988.

#### (3) Growth in export demand

Extremely favourable external market conditions arose in recent years for Chilean crab. In 1990, their export value reached approximately US\$2,800 per tonne; 30 times greater than the average value for all other fishing products. This was partially due to the high prices of Alaskan king crab (*Paralithodes camtschatica*) which

Table 1  
Characteristics of growth in crab fishery, Magallanes, 1974-1992. Key: (A) Centolla; (B) Centollón.

Year	Total catch			No. of companies	No. of fishing vessels		No. of transport vessels
		(A)	(B)		(A)	(B)	
1974	511			9			
1976		1,028					
1979	3,220	2,268	952	13	150	63	8
1980	1,810	1,381	429	14	105	26	8
1981	1,590	1,280	310	16	133	46	6
1982	1,782	1,473	309	14	138	18	8
1983	3,586	2,755	831	24	177	90	8
1984	3,597	2,746	851		220	123	8
1985	2,902	2,636	266		229	39	21
1986	3,586	2,593	993		282	130	45
1987	3,961	2,188	1,773	27	296		55
1988	4,491	2,161	2,330	27			
1989	4,250	2,297	1,953	27			
1990	3,699	1,834	1,865	25			
1991	5,127	1,738	3,389				
1992	2,494	1,173	1,321	21			
						550 total	
						550 total	

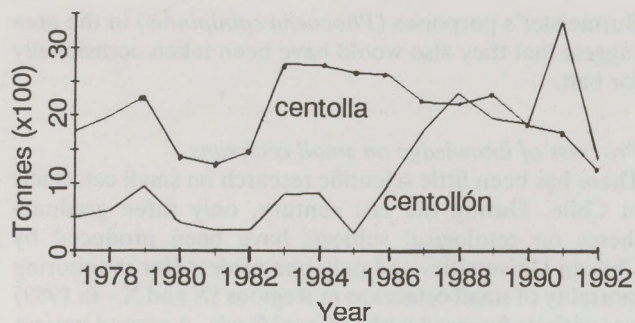


Fig. 1. Annual landings, centolla-centollón.

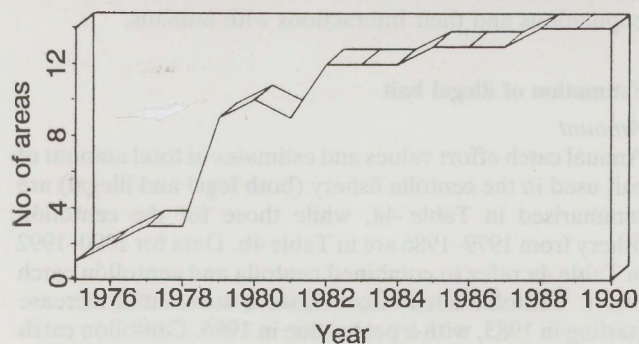


Fig. 2. Geographical expansion of centolla and centollón fishery.

encouraged the USA to import lower-priced crab products from the ex-USSR, Argentina and Chile. The Alaskan fishing grounds were closed from 1982 to 1988. This led to an increase in the number of processing plants in the Magallanes and seriously disrupted the balance between the artisanal fishing sector and the processing capacity of the industry.

#### (4) Lack of regulation

The free market economic policy focused on maximising short-term profits and neglected the government's responsibility for protecting the nation's marine resources. This is evident from the contrast between the major development of the fisheries and the simultaneous decline in SERNAP's work force. In 1973, the SERNAP regional office in Magallanes had 13 inspectors. This declined to between eight (in 1985) and ten (in 1992). The necessary infrastructure (proper vehicles, vessels, radio and office equipment) was not in place to support the staff of inspectors and the legal sanctions were too weak to deter illegal crabbing.

In 1987, only two of the 27 companies were supplied by their own vessels. The remainder of the regional fleet work as individuals, under highly competitive conditions. Crab is bought alive at low prices in the remote fishing areas by company boats that also bring in expensive supplies and gasoline or exchange them for fresh products, often at unfair rates. The increased competition for fresh crab together with poor working conditions has led to criminal activity among fishermen including stealing and sabotage.

#### (5) Geography

Until the mid-1970s, the centolla fishery was limited to nine companies operating only on the west coast of Isla Grande de Tierra del Fuego, around Isla Dawson, in Seno Otway and along the south coast of Peninsula Brunswick (52°S-

54°S). Since 1976, the crab fishing grounds have expanded to cover approximately 25,000km of labyrinthian interior channels that are difficult, if not impossible to police. In 1981, the Porvenir area was closed to crab fishing in response to a study that revealed overfishing in this area (Campodonico, 1979). Seno Otway and Seno Año Nuevo were closed for the same reasons, but many fishermen admitted that they had fished in closed areas at one time or another. In 1990, about 20 boats were discovered fishing in Seno Año Nuevo, using camouflage against aerial surveillance (A. Roman, Director SERNAP-Magallanes, *La Prensa Austral*).

#### (6) Cultural factors

Crab fishing is extremely demanding in terms of physical effort, harsh climate (low temperatures, high precipitation, strong winds), exposure to dangerous circumstances and isolation. Most artisanal fishermen have come to the Magallanes from rural areas on Isla Chiloë (42°S-43°S). They generally come from low income backgrounds with limited employment alternatives other than in agriculture or fishing and have little or no formal education (Henriquez, 1990); crab fishing is by far the most lucrative option. For example, the average monthly wage of a shepherd is US\$ 100, whereas crab fishermen could earn as much as US\$ 1,000 per month in the 1980s.

During 1983-1984, a special effort was made by local authorities in Punta Arenas, with support from the Organisation of American States, to improve fishing techniques in the artisanal sector. Although courses (including training in the use of fishing gear, such as longlines, not represented in the Chiloë fishing culture) were offered free of charge, only 43 persons attended. Longlines are an important tool for obtaining fish as bait in the crabbing areas.

The few attempts to form labour unions or other labour organisations have failed, apparently because crab fishing is so profitable and individualistic (Mr J. Gonzalez - President of the Union of Artisanal Fishermen - Punta Arenas, pers. comm.).

#### Summary

In summary, the crab fisheries of Chile can be characterised by: (a) a lack of formal responsibility by the industry with respect to the working conditions and methods of the fishermen; (b) strong competition for raw material, which has stimulated illegal capture; (c) over-capitalisation of the fleet; and (d) a failure of governmental authorities to intervene and prevent resource depletion. The fisheries have become unmanageable in spite of a high degree of awareness among politicians, managers, scientists, fishermen and the general public. This awareness is evident from the abundant information in the media, numerous technical reports by IFOP, seminars and workshops organised by regional authorities and, finally, the number of regulations applied to the fisheries.

Between 1983 and 1986, the previously established 5-month closed season (February-June) was abolished. Later, to protect the centolla during its reproductive season, crabbing was suspended from December to February (1987-1991). A special decree in 1991 established a 7-month closed season (December-June) to protect the species from further overexploitation, but the closed season was shortened to five months in 1992 in view of the socio-economic crisis facing the artisanal sector. The December-January closed season for centollón remains unchanged.

### Status of small cetaceans in southern Chile

#### Legal status

Under Decree No. 223, 1979, of the Ministerio de Economía, Fomento y Construcción, traps are the only type of fishing gear that can be used legally to catch crabs. These traps need bait. In 1977, after Torres (1977) had made the authorities aware of the fact that large numbers of small cetaceans were being taken for crab bait in the Magellan region, the Ministerio de Agricultura published Decree No. 381, prohibiting the catch, transport, commercialisation, possession or processing of small cetaceans. Special permits for scientific or cultural purposes have been issued on four occasions – three relating to the export of Commerson's dolphins (*Cephalorhynchus commersonii*) and one allowing the capture of Chilean dolphins (*Cephalorhynchus eutropia*) (SERNAP, Resolution No. 364, 1988).

#### Actual situation

In spite of the 1977 decree, many publications have referred to continued catches of small cetaceans along the southern Chilean coasts, specifically to support crab bait (Torres, 1977; Sielfeld *et al.*, 1978; Torres *et al.*, 1979; Goodall and Cameron, 1980; Sielfeld, 1983; Goodall and Jordan, 1986; Goodall *et al.*, 1988b; Crespo *et al.*, 1994; and others). Published estimates of the numbers of individuals or meat tonnages of small cetaceans and other marine wildlife are summarised in Table 2; these estimates range from 50 dolphins per week in 1976 (Torres, 1977) to 400 tonnes of marine and other wildlife (including cetaceans) during 1987 (Cárdenas *et al.*, 1987). The species of wildlife known to have been taken for crab bait are listed in Table 3. As to small cetaceans, Peale's dolphins (*Lagenorhynchus australis*), Chilean dolphins and Commerson's dolphins were most affected, while the presence of dusky dolphins (*Lagenorhynchus obscurus*), Southern right whale dolphins (*Lissodelphis peronii*) and

Table 2  
Estimates of illegal captures of small cetaceans.

Year(s)	Estimate	Source
1976 (6 months)	50 specimens/week	Torres, 1977
1978	2,400 specimens/year	Torres, 1979
1979	4,120 specimens/year	Torres <i>et al.</i> , 1979
1980-1983	240 tonnes/year	Sielfeld, 1983
[mainly Commerson's and Peale's dolphins, sea lions and sea birds]		
1987	400 tonnes/year	Cárdenas <i>et al.</i> , 1987
	[species mentioned by Sielfeld (1983)]	

Table 3  
Species of wildlife affected by crab bait fishery.

Most affected species	Species affected to lesser extent
<i>Otaria flavescens</i>	<i>Phocoena spinipinnis</i>
<i>Arctocephalus australis</i>	<i>Lagenorhynchus obscurus</i>
<i>Lagenorhynchus australis</i>	<i>Lissodelphis peronii</i>
<i>Cephalorhynchus commersonii</i>	<i>Phalacrocorax magellanicus</i>
<i>Cephalorhynchus eutropia</i>	<i>Phalacrocorax albiventris</i>
	<i>Phalacrocorax atriceps</i>
	<i>Eudyptes crestatus</i>
	<i>Larus dominicanus</i>
	<i>Larus skoresbii</i>
	<i>Lama guanicoe</i>
	<i>Lutra felina</i>
	<i>Lutra provocax</i>

Burmeister's porpoises (*Phocoena spinipinnis*) in the area suggest that they also would have been taken occasionally for bait.

#### Progress of knowledge on small cetaceans

There has been little scientific research on small cetaceans in Chile. During the last century, only three graduate theses on cetological subjects have been produced by Chilean Universities and only one project (for monitoring mortality of small cetaceans in Regions IX and X – in 1989) was entirely financed with national funds. A second project was partially supported by the Chilean Ministry of Agriculture (Clarke *et al.*, 1978).

In consequence, little is known about the general biology, distribution, trophic relations or reproductive habits of small cetaceans in Chile, or on the status of populations and their interactions with humans.

#### Estimation of illegal bait

##### Amount

Annual catch effort values and estimates of total amount of bait used in the centolla fishery (both legal and illegal) are summarised in Table 4a, while those for the centollón fishery from 1979–1986 are in Table 4b. Data for 1990–1992 in Table 4a refer to combined centolla and centollón catch effort. Centolla catch effort shows a substantial increase starting in 1983, with a peak value in 1986. Centollón catch effort values remain generally low but variable until 1986. Although no data on centollón catch effort after 1986 are included, the substantial increases in total annual landings (Table 1(B) of SERNAP annual statistics) indicate that the

Table 4a  
Annual catch effort values for centolla fishery with estimated amounts of bait used (tonnes).

Year	No. of effective traps	Estimates bait used (tonnes)
1979	1,443,782	722
1980	649,487	325
1981	734,155	367
1982	974,864	487
1983	1,537,259	769
1984	1,445,568	723
1985	1,850,787	925
1986	1,900,000	950
1987	1,875,600	938
1988	1,860,000	930
1989	1,700,000	850
1990	1,600,000	800
1991*	1,800,000	900
1992*	900,000	450

\* Data include both centolla and centollón catch effort values.

Table 4b  
Annual catch effort values for centollón fishery with estimated amount of bait used, 1979-1986.

Year	No. of effective traps	Estimated bait used (tonnes)
1979	100,627	50
1980	44,225	22
1981	50,995	25
1982	48,814	24
1983	200,378	100
1984	272,646	136
1985	66,115	33
1986	282,272	141

Table 5a

Distribution of annual catch effort for centolla (1979-1990\*), for the different fishing Regions (I to XII); catch effort per area is expressed as a fraction of the total annual catch effort.

Year	Region														Undetermined	Total
	I	I-A	II	III	IV	IV-A	V	VI	VII	VIII	IX	X	XI	XII		
1979	0.11	-	0.14	0.01	0.22	-	0.17	0.14	0.16	0.03	-	-	-	-	0.03	1.0
1980	0.03	-	0.15	0.00	0.22	0.00	0.02	0.18	-	0.06	-	0.31	-	-	0.00	1.0
1981	0.04	-	0.04	0.00	0.19	0.05	0.20	0.09	0.20	0.07	-	0.11	-	-	0.00	1.0
1982	0.00	-	0.05	0.05	0.08	0.05	0.28	0.02	0.09	0.05	-	0.10	0.22	-	0.00	1.0
1983	0.02	-	0.30	0.01	0.03	0.01	-	-	0.29	0.33	-	-	-	-	0.00	1.0
1984	0.04	-	0.52	0.00	0.02	0.00	0.04	0.01	0.31	0.05	0.00	0.00	-	-	0.00	1.0
1985	0.00	0.07	0.08	0.08	0.09	0.04	0.17	0.10	0.10	0.02	0.00	0.16	0.08	0.00	0.00	1.0
1986	0.01	0.05	0.06	0.08	0.16	0.04	0.16	0.06	0.09	0.05	-	0.17	0.07	-	0.00	1.0
1987	0.01	0.01	0.01	0.23	0.14	0.03	0.06	0.07	0.09	0.06	-	0.18	0.07	0.03	0.00	1.0
1988	0.00	0.01	0.02	0.17	0.18	0.01	0.07	0.00	0.19	0.02	-	0.31	-	-	0.02	1.0
1989	0.01	0.01	0.00	0.14	0.13	0.00	0.22	0.00	0.10	0.03	0.02	0.16	0.10	0.07	0.00	1.0
1990*	0.03	0.02	0.01	0.07	0.15	0.00	0.19	0.00	0.07	0.12	0.04	0.16	0.01	0.13	0.00	1.0
Total (%)	2	1	12	7	13	2	13	6	13	7	0	14	4	2		100%

\* Based on data from January to June 1990.

catch effort for this species has increased appreciably since 1986. Our estimates of catch effort are similar to those made independently by Hernandez *et al.* (1986) for the period 1979-1984.

#### Evaluation of sources

The catch effort values published by IFOP are supplied by the companies, based on declarations by the fishermen. Harbour records generally confirm information on activity as given by the companies, but independent fishermen's reports on the number of traps used are likely to be underestimates.

In Table 4a we used only harbour activity records and independent methods to estimate the number of traps carried from 1987-1992. Thus these estimates should be little affected by biases in the fishermen's reporting. They are, however, biased by the fact that part of the crab catch has been made with illegal gear (e.g. nets) or by illegal means (e.g. diving). This bias is difficult to quantify, but IFOP publications generally correct estimates of bait requirements by subtracting 20% to account for it. There was noticeable increase in the last few years in the number of boats too small to carry a significant number of traps (IFOP, 1988). This trend is interpreted to indicate that netting and diving for crabs has increased. Crab nets are known to cause a significant amount of incidental small cetacean mortality due to entanglement (Goodall and Cameron, 1980).

The amount of bait used by fishermen within crab extraction areas is difficult to determine. The fishermen usually keep their camp sites stocked with about 15% of the total bait needed (Sielfeld, 1983).

#### Geographical distribution

##### CENTOLLA

For official management purposes, the centolla and centollón fishing grounds have been divided into 14 different fishing Regions (see map, Fig. 3). The distribution of catch effort for centolla from 1979-1990 is given in Table 5a. Fluctuations between seasons are due to the incorporation of new areas as well as the abandonment of others. Before 1976, the crab fishery was limited to the

vicinity of Punta Arenas. From 1979-1989, the main activity was localised in the areas south of the Magellan Strait. Regions V and VII had very low catch effort during 1980-1981, but the crab fishery expanded to Region X during that season. In 1981-1982, Regions V and VII became important crabbing areas again, with no major changes in fishing activity near their northern limits. A further northwards expansion in Region XII occurred in 1987.

After 50 years of intense activity, the Porvenir area (Region I) was closed for four years beginning in 1983. Along with locations in Regions II, IV and VI, this area has been exploited almost continuously for centolla. Accumulative catch effort is highest in Regions II, IV, V, VI and X.

##### CENTOLLÓN

Region IX, where Commerson's dolphins are commonly observed (Goodall, 1994) has been the primary fishing area for centollón throughout the entire period (1979-1986). Regions II, VII and VIII were used less intensively during this period (Table 5b).

Table 5b  
Distribution of catch effort for centollón, 1979-1986.

Year	Region						Total
	I	II	IV-A	VII	VIII	IX	
1979	-	-	-	6,500	-	94,127	100,627
1980	1,056	-	-	-	-	43,169	44,225
1981	-	12,219	-	-	17,151	21,625	50,995
1982	-	1,678	-	27,064	-	20,072	48,814
1983	-	-	-	80,483	31,610	88,285	200,378
1984	-	-	-	87,766	23,313	161,567	272,646
1985	-	-	-	-	27,361	38,754	66,115
1986	-	57,090	-	-	27,037	188,145	272,272
Total	1,056 (1%)	70,987 (6%)	-	201,813 (19%)	126,472 (12%)	655,744 (62%)	1,056,072

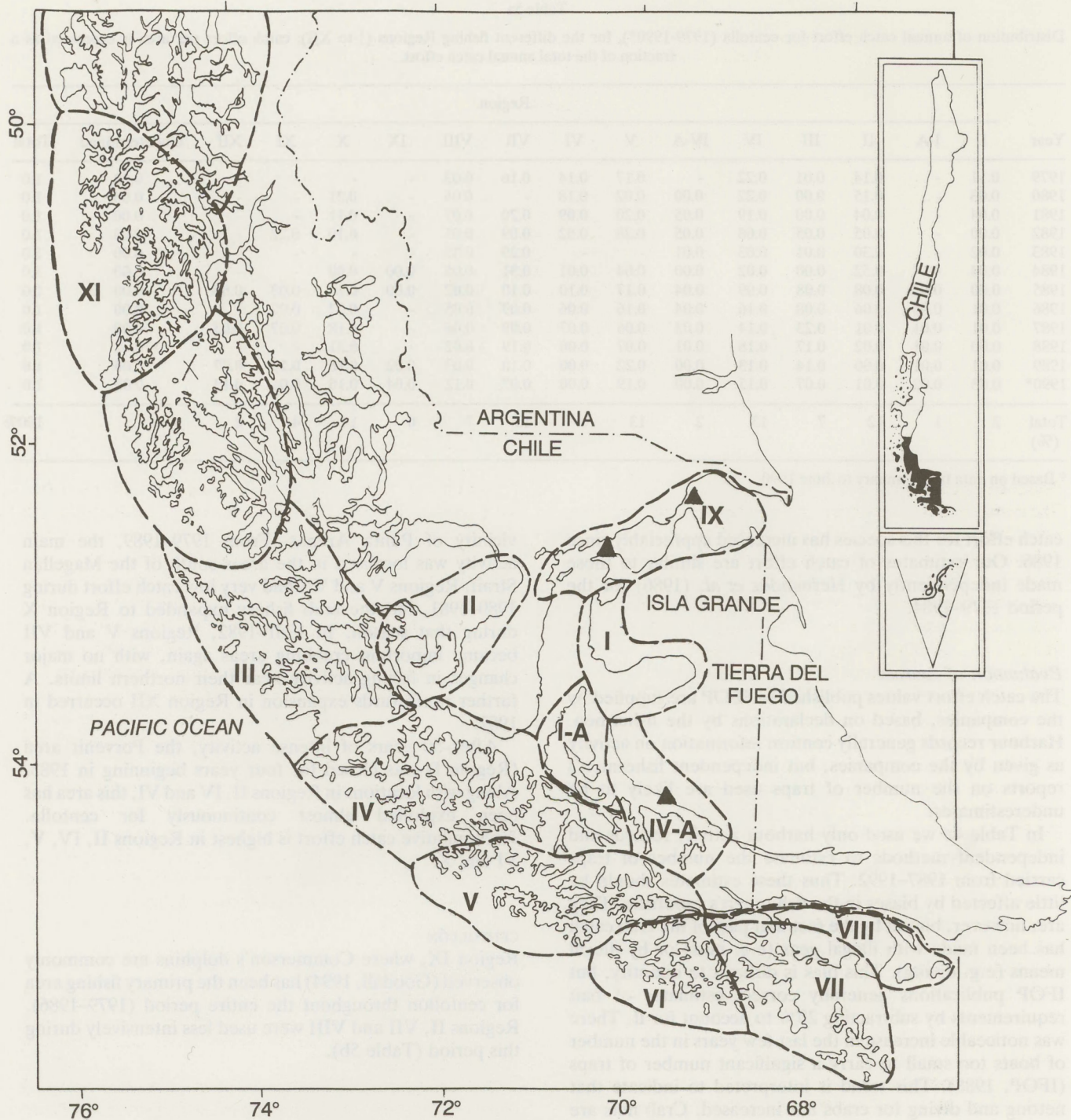


Fig. 3. Geographical location of fishing areas – centolla and centollon (XII Region – from IFOP).

#### *Evaluation of sources*

Information on capture sites has become less and less reliable with the growth in illegal crabbing activity, especially since certain areas have been closed. The fishermen are the exclusive sources of data on capture sites. We can therefore assume that there is a negative bias in the amount of catch effort assigned to closed areas and a corresponding positive bias in the amount assigned to areas still open to fishing.

#### *Monthly variations*

Table 6 shows monthly catch effort for centolla, 1979–1990. Catch effort for the centolla fishery was low during

the first months of the calendar year and gradually increased towards the peak winter months. Data from IFOP show it was highest for the centollón fishery during the first half of the calendar year, with peak values from April to July.

#### *Evaluation of sources*

The monthly fishing activity (recorded as departure and arrival of boats in the harbour) information can be regarded as reliable, at least during the open season. During the closed season illegal fishing continues, although probably at relatively low levels.

Table 6

Seasonal variations in catch effort for the centolla fishery 1980-1990. Catch effort per month is expressed as a fraction of total annual catch effort. Key: CS = closed season.

Year	Month												Total
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	
1980	0.25	CS	CS	CS	CS	CS	0.04	0.06	0.07	0.15	0.18	0.23	0.98
1981	-	CS	CS	CS	CS	CS	-	-	-	-	-	-	-
1982	-	CS	CS	CS	CS	CS	-	0.11	0.13	0.20	0.25	0.30	0.99
1983	0.01	0.01	0.04	0.12	0.17	0.20	0.16	0.12	0.07	0.03	0.02	0.02	0.97
1984	-	0.05	0.12	0.16	0.21	0.18	0.13	0.07	0.04	0.02	0.01	0.01	1.00
1985	0.08	0.08	0.06	0.05	0.05	0.07	0.08	0.09	0.10	0.12	0.11	0.11	1.00
1986	0.06	0.05	0.06	0.05	0.06	0.07	0.08	0.09	0.11	0.12	0.12	0.10	0.97
1987	CS	0.03	0.06	0.06	0.07	0.09	0.11	0.12	0.12	0.16	0.17	CS	0.99
1988	CS	0.04	0.08	0.06	0.09	0.11	0.13	0.12	0.14	0.08	0.09	CS	0.95
1989	CS	0.04	0.08	0.09	0.09	0.09	0.11	0.12	0.11	0.12	0.13	CS	0.97
1990*	CS	0.14	0.22	0.25	0.20	0.18	-	-	-	-	-	CS	0.99

\*Based on data January to June.

### Presence of cetaceans

The most common small cetaceans in the Magellan regions are Commerson's and Peale's dolphins. Commerson's dolphins are found principally in the eastern Strait of Magellan (Region IX), especially from the Segunda Angostura eastwards (Goodall, 1994). Aerial surveys in this area in January-February 1984 indicated the presence of 3,211 ( $\pm 1,680$ ) dolphins (Leatherwood *et al.*, 1988). A more extensive aerial survey carried out in May 1987 gave a population estimate of only 313 (*sic*) individuals (Venegas and Atalah, 1988). The difference may be due to (a) a real decrease in population; (b) seasonal migrations of the dolphins from the area; or (c) differences in survey methods or observer abilities. Commerson's dolphins in the Kerguelen Islands migrate offshore in winter (Robineau, 1985; De Buffr n l *et al.*, 1989) and winter offshore movements have been suggested for those of the Magellan region (Goodall *et al.*, 1988a; Goodall, 1994). It thus seems more likely that there are fewer dolphins in the area during the most intensive fishing periods. Peale's dolphins are found throughout the year and their distribution covers all interior waters including the most intensive crabbing areas, they may be the species most affected by crab fishing. From 1984, the areas south of the Magellan Strait (Regions V, VI and VIII) where dusky dolphins are most frequently observed, have become important crabbing areas. An apparently resident group of Chilean dolphins is observed throughout the year in Seno Skyring, a non-crabbing area.

### Interviews and public information

#### Crab industry interviews

Most of the heads of companies who were interviewed accused the fishermen of ignorance and irresponsible behaviour. They considered the fishermen to be responsible for problems related to the use of wildlife as crab bait. However, they assumed their share of responsibility for the regional overfishing of crab and admitted to participating in illegal practices. For example, one administrator admitted that several thousand pinnipeds had been killed by his company in the last few years for bait and aphrodisiacs; genitals of sea lions (*Otaria flavescens*) and fur seals (*Arctocephalus australis*) were exported illegally to Asian markets while their carcasses served as crab bait.

All of the managers interviewed agreed that their bait supplies did not cover the necessities of the fishermen, but in the case of the companies which did not own their own vessels, the managers assumed no responsibility for the actions of independent fishermen. Fishermen generally accepted their responsibility for killing wildlife but claimed that no economically viable alternatives exist. Many fishermen believe that red meat is by far the best bait.

Many fishermen claimed that the introduction of harpoons by fishermen from the region of Valdivia (Region IX - 40°S) in the 1970s triggered an increase in the use of wildlife, cetaceans in particular. The use of harpoons was well documented in the 1970s (Sielfeld *et al.*, 1977a; b; Goodall and Cameron, 1980). Fishermen argued that the men from Chilo , the majority of the crab fishermen, did not know how to use longlines or harpoons and that this accounted for the deficit of bait supplies. However, in November 1992, a metal-working shop in Punta Arenas was manufacturing harpoons to catch dolphins.

#### Alternative sources of bait

Company heads and fishermen agreed that an improvement in the transport to the fishing areas of cheap, legal bait, such as demersal fishery waste could provide part of the solution.

The availability of 'legal bait' in the region is deduced from annual fisheries and meat production statistics. Since most artisanal fish products are sold whole, only waste from industrial fish processing is taken into account; this has increased since 1987 (INE, 1988-1989; SERNAP, Annual Statistics Reports). The availability and applicability of different types of bait were studied by Diaz (1988). The most common species available were frozen hake (*Macruronus magellanicus*), jurel (*Trachurus murphy*), salted sardines (*Clupea bentincki*) and anchoveta (*Engraulis ringens*). His results suggest that although sardines and anchoveta are perhaps the best crab bait, they would cost more than demersal fishery waste.

#### Cetacean mortality

Both fishermen and industry representatives insisted that the mortality of marine mammals was highest from 1980-1986 and that it had decreased to a minimum since the arrival of the industrial fishing fleet in the region (1988), which produces significant quantities of waste annually.

Nevertheless, according to eye-witness accounts, the take of small cetaceans for bait continued, for example, in Otway Sound (April 1991) and Beagle Channel (February 1991). Photographic evidence of the use of wildlife was published in the local newspaper (19 March 1991). According to Cardenas *et al.* (1986a; b) companies provided up to 30% of the needed bait in 1985/1986. Fishermen claimed that most dolphins were taken during 1983–1986, although the majority of the estimated 2,000 tonnes of bait (mostly illegal) consisted of sea lions. Our estimate of the total amount of bait used in 1986 (950 tonnes) would require a maximum of 6,300 sea lions (average weight 150kg) or 13,750 dolphins (average weight 70kg) in the event that these species had been the exclusive source of illegal bait. We assume that in the actual crab bait fishery (1992), the take of small cetaceans did not exceed 10% of the total demand for bait (45 tonnes), or an equivalent of 600 dolphins per year.

### DISCUSSION

Our results indicate that small cetacean mortality in the artisanal sector has declined substantially since 1990, as a consequence of the three factors outlined below.

#### (1) *A decrease in the demand for bait due to reduced fishing effort*

The estimated 450 tonnes of bait used in 1992 is about half the annual estimate for the period between 1985 and 1989. This decrease in fishing effort may have been a result of the depletion of crab stocks, or for economic or technical (regulatory) reasons. In any event the decrease might facilitate the recovery of regional wildlife populations.

#### (2) *A decrease in the proportion of illegal bait*

Between 1983 and 1988, much of the bait was provided by wildlife. By 1992, the regional production of waste (in both slaughter houses and the industrial fishery) was sufficient to cover the estimated amount of bait needed. In addition, there are indications that the fishery for legal bait in the fishing grounds has increased substantially.

#### (3) *A decrease in the proportion of small cetaceans in the illegal bait*

In the last few years, the most affected species of wildlife in terms of bait have been sea lions and penguins, both easy targets when in breeding colonies on land. Dolphins appear to have become less abundant in the fishing areas, which may also be a factor in their decline in relative importance as bait.

#### The present situation

A number of questions arise concerning the ecological consequences of the historic crab fisheries. In this section we use available data for 1993–4 (i.e. after the main period reviewed in this paper) to describe new trends observed in the artisanal fishery.

#### (1) *Diversification*

The artisanal fishery in Region XII is slowly recovering after a period of major changes due to certain events that forced restructuring in this sector. As a consequence of the overexploitation of centolla and the establishment of a seven month closed season, artisanal fishermen turned their attention towards other resources.

Although the annual catch of crustaceans continues to be significant (2,487 tonnes in 1992; 2,200 tonnes in 1993), the actual landings have dropped by almost half compared to 1988. This can be better shown by considering the percentage of crustaceans as part of the total artisanal production. Between 1985 and 1989 crustaceans represented 30% of the total artisanal production. Since then the percentage has declined as follows: 1990, 25%; 1992, 20%; 1993, 10%. By contrast, in 1989, sea urchins accounted for only 0.5% of the total artisanal catch (80 tonnes). By 1993, they comprised 50% of the total artisanal catch, most of which was exported to Japan. Early in 1994, a daily average of 3 tonnes of sea urchins was being exported to Japan.

Other traditional resources in the region include clams, mussels, squid and octopus. The exploitation of molluscs initially seemed to offer an interesting alternative, but since 1990, persistent red-tide events lasting up to a year in a large part of the region have meant that they became too toxic for human consumption. In 1992, a red tide lasting for a year or more (Dr Luis Vergara, Director of the Servicio Nacional de Salud, *La Prensa Austral*) affected 100% of the interior waters. Nevertheless, molluscs provided 33% (6,500 tonnes) of the total artisanal catch in 1993 (c.f. 60% in 1989).

Many artisanal fishermen in the region invested in demersal fishery equipment, encouraged by the high catches of the newly arrived industrial fleet. However, for a number of reasons this proved unsuccessful, including a lack of knowledge on the biology and migration patterns of these species, insufficient technical knowledge, an inability to compete economically with the industrial fleet and the fact that artisanal vessels are restricted to interior waters. An estimated 80% of these fishermen returned to the exploitation of traditional resources as illustrated by the percentage contribution of demersal fishing to total artisanal fishery production: 1990, 20%; 1992, 2%; 1993, 5%.

In summary, although with limited diversification the relative importance of crustaceans in artisanal fishery landings has diminished significantly, in terms of absolute production, the catch continues to be important. The Magallanes artisanal fishery continues to be unpredictable and susceptible to sudden changes in the external market.

#### (2) *Legislation*

Modifications in fishery legislation in 1991 introduced the concept of 'Full Exploitation Regime' with a partial restriction of access through the auction of established fishing quotas. As noted earlier, a special decree was introduced extending the closed season for centolla from 5 to 7 months per year, but this was revoked in 1991 when the red tides prevented the mollusc fishery acting as an alternative source of income during the closed season. The new legislation has enhanced the reorganisation of the crab fishery by restricting the number of operating companies and increasing the requirement for infrastructure as a condition of permits. The fact that artisanal fishermen must subscribe to a regional register and reside in the region of their fishing activity should facilitate control and management in the region. Modifications also refer to the creation of Regional and Zonal Fisheries Councils with consultative and regulatory power, respectively, and the participation of the artisanal sector. Finally, a rigorous application of more severe sanctions should increase the efficiency of control.



### (3) Organisation

The artisanal sector is beginning to move towards labour organisation through unions and cooperatives, although participation is still limited (approx. 30% of the 1,600–1,700 fishermen). This should facilitate co-operation with regard to control, technical assistance, social and medical care, education etc. The creation of a training centre in 1992 (FUNCAP, Fundación para la Capacitación del Pescador Artesanal) that provides free specialisation courses to artisanal fishermen and the requirement that they subscribe to the local register should result in some improvement in social conditions.

### (4) Education

The knowledge of and interest in marine mammals in Chile is increasing, as indicated by the number of workshops and conferences and by the growing number of researchers in the field. There is also more concern for conservation by the community channelled through regional and national non-governmental organisations. The strong increase in (eco)tourism in the region may increase awareness of the economic value of marine mammals. Tourism has been the fastest growing sector in Magellanes' local economy for the last three years and in 1993, ecotourism accounted for about 25% of the total regional tourism revenue (total of US\$70 million, 160,000 visitors; Servicio Nacional de Turismo, Sernatur, 1994).

Although marine expeditions are now offered, despite the great potential (e.g. see the WDCS report on whale watching in Latin America and the Caribbean, 1994) none as yet is based on dolphin or whale watching activities.

### (5) External pressure

On 13 May 1992, a US based NGO formally petitioned the US government to ban imports of crab and crab products from Chile, under the 1972 Marine Mammal Protection Act. This provides for the Secretary of the Treasury to ban the import of commercial fish and fish products caught with methods that kill marine mammals in excess of US standards. The petition was supported by at least nine major US based environmental and wildlife conservation NGOs and by Fisheries Associations.

In response, the Chilean government through its regional office SERNAP, produced a leaflet on aspects of the biology of some of the species of marine mammals in regional waters and called for a study of the bait problem in Region XII.

A multi-disciplinary commission was established to study the availability of legal bait and mechanisms for its distribution in the fishing areas. The commission determined that a stock of 40 tonnes of bait (mostly originating from industrial fishery waste) should be kept frozen in case no fresh legal bait is available. However, no agreed mechanisms have been established concerning the legal enforcement of the use of this bait or the cost of permanently maintaining such a stock. Ultimately, the decision to buy and be supplied with legal bait depends upon the fishermen themselves.

## RECOMMENDATIONS

(1) To reduce to a minimum the use of illegal bait, an independent consultant should be engaged to: (a) assess the current availability of legal bait in the region; (b) make cost-benefit comparisons; (c) plan for the development of an infrastructure to distribute bait to the fishing areas; and (d) provide a legal framework to make the use of legal bait obligatory.

- (2) Public awareness regarding cetaceans should be increased by: (a) establishing a follow-up to the 1992 programme of education for children on marine mammals and their environment, supported by the IUCN Cetacean Specialist Group; (b) evaluating the potential of dolphin and whale watching in the region and ensuring that the promotion of projects to develop this activity includes suitable regulations and guidelines; (c) the promotion of marine protected areas in Chile, including the incorporation of sites of special interest for marine mammals.
- (3) Studies of the populations of small cetaceans should be supported; these should focus on obtaining data that can be used to assess fishery impacts on populations (e.g. abundance, distribution and stock identity; populations dynamics, trophic relations).

## ACKNOWLEDGEMENTS

We greatly appreciate the time given by all the persons mentioned in this paper, who represented many official and non-official organisations and fishermen. R.N.P. Goodall, A.C.M. Schiavini, K. Niedermann, R.R. Reeves, G.P. Donovan and an anonymous reviewer offered helpful suggestions on the manuscript. We thank Sean Whyte (Whale and Dolphin Conservation Society) for supporting our work in Chile from the very beginning.

## REFERENCES

- Campodonico, I. 1979. La veda de la centolla (*Lithodes antarctica*) en la region de Magallanes. *Ans. Inst. Pat. Punta Arenas (Chile)* 10:229–34.
- Cárdenas, J.C., Oporto, J., Stutzin, M. and Gibbons, J. 1986a. Impacto de la pesquería de centolla (*Lithodes antarctica*) sobre las poblaciones de cetáceos y pinípedos en la región de Magallanes, Chile. Resumenes 2a Reuniao de trabalho de Especialistas em mamíferos aquáticos da America do Sul (4–8 de Agosto de 1986). Rio de Janeiro, Brasil. 49pp.
- Cárdenas, J.C., Stutzin, M., Oporto, J. and Cabello, C. 1986b. First steps to cetacean conservation and management in Chile. Final Report of Project WH-445. WWF-US/CODEFF.
- Cárdenas, J.C., Gibbons, J., Oporto, J. and Stutzin, M. 1987. Impacto de las pesquerías de centolla y centollón sobre las poblaciones de mamíferos marinos de Magallanes, Chile. *Amb. y Des.*, Vol. III 1 and 2: 111–119. Abril-Agosto 1987.
- Clarke, R., Aguayo-L. A. and del Campo, S.B. 1978. Whale observation and whale marking off the coast of Chile in 1964. *Sci. Rep. Whales Res. Inst., Tokyo* 30:117–78.
- Couve, A. 1991. Secretary of Fisheries, Chile. *La Caleta Magazine* 7 January 1991.
- Crespo, E.A., Corcuera, J.F. and López Cazorla, A. 1994. Interactions between marine mammals and fisheries in some coastal fishing areas of Argentina. (Published in this volume.)
- De Buffrénil, V., Dziedzic, A. and Robineau, and D. 1989. Distribution and movement of Commerson's dolphin (*Cephalorhynchus commersonii* [Lacépède, 1894]) in the gulf of the Kerguelen Islands: data from individual taggings. *Can. J. Zool.* 67(2):516–21.
- Diaz, P. 1988. Estudio de carnada óptima para la pesca de centolla, XII región, Chile. *Inf. Inst. Fom. Pesqu.* Santiago, Chile.
- Goodall, R.N.P. 1977. Preliminary report on the small cetaceans stranded on the coasts of Tierra del Fuego. *Rep. int. Whal. Commn* 27:505.
- Goodall, R.N.P. 1994. Commerson's dolphin *Cephalorhynchus commersonii* (Lacépède 1804). pp. 241–67. In: S.H. Ridgway and R. Harrison (eds.) *Handbook of Marine Mammals*. Vol. 5. *The First Book of Dolphins*. Academic Press, London and San Diego. 416pp.
- Goodall, R.N.P. and Cameron, I.S. 1980. Exploitation of small cetaceans off southern South America. *Rep. int. Whal. Commn* 30:445–50.
- Goodall, R.N.P. and Jordan, J.D. 1986. Review of fisheries in the Magellan region of Chile. Paper SC/38/SM21 presented to the IWC Scientific Committee, May 1986 (unpublished). 9pp.

Goodall, R.N.P., Galeazzi, A.R., Leatherwood, S., Miller, K.W., Cameron, I.S., Kastelein, R.K. and Sobral, A.P. 1988a. Studies of Commerson's dolphins, *Cephalorhynchus commersonii*, off Tierra del Fuego, 1976-1984, with a review of information on the species in the South Atlantic. *Rep. int. Whal. Commn* (special issue 9):3-70.

Goodall, R.N.P., Galeazzi, A.R. and Lichter, A.A. 1988b. Exploitation of small cetaceans off Argentina 1979-1986. *Rep. int. Whal. Commn* 38:407-10.

Henriquez, J. 1990. Estudio socio-economico, cooperativa de pescadores 'Union Austral de Puerto Natales'. Presentado por Comité organizador de la Cooperativa. Asesoría FIDE XII. Punta Arenas, Chile.

Hernandez, M.B. and Diaz, P. 1986. Analisis de la Pesquería de centolla. Diagnóstico Bio-Pesquero de la centolla XII región, 1985. Inf. Inst. Fom. Pesqu.s/n Santiago-Chile, 43.

Leatherwood, S., Kastelein, R.A. and Hammond, P.S. 1988. Estimate of numbers of Commerson's dolphins in a portion of the northeastern Strait of Magellan, January-February 1984. *Rep. int. Whal. Commn* (special issue 9):93-102.

Robineau, D. 1985. Donnees sur l'ecologie due dauphin de Commerson aux Iles Kerguelen. Colloque sur l'écologie marine des îles subantarctiques et antarctiques. SCAR/SCOR Group of Specialists on Southern Ocean Ecosystems and their Living Resources, Paris, June 1985 (unpublished).

Siefeld, W. 1983. *Mamíferos Marinos De Chile*. Universidad de Chile, Santiago. 199pp.

Siefeld, W. and Venegas, C. 1978. Observaciones de delfinidos en los canales australes de Chile. *An. Inst. Patagonia* 9:145-52.

Siefeld, W., Venegas, C. and Atalah, A. 1977a. Antecedentes acerca de la conservación y manejo de mamíferos marinos y sus ecosistemas, OAS, Puerto madryn, Argentina. (Unpublished manuscript).

Siefeld, W., Venegas, C. and Atalah, A. 1977b. Consideraciones acerca del estado de los mamíferos marinos en Chile. *An. Inst. Patagonia* 8(297-312) [In Spanish].

Siefeld, W., Venegas, C., Atalah, A. and Torres, J. 1978. Prospección de Otariidos en las costas de Magallanes. *Ans. Inst. Pat. Punta Arenas (Chile)* 9:157-69.

Torres, D. 1977. Actual situación de los mamíferos marinos y sus ecosistemas, OAS, Puerto Madryn, Argentina. (Unpublished). 39pp.

Torres, D., Yañez, J. and Cattán, P. 1979. Mamíferos marinos de Chile: antecedentes y situación actual. *Biol. Pesq. (Chile)* 11:49-81.

Venegas, C. and Atalah, A. 1988. Estimación de la población de *Cephalorhynchus commersonii* en el Estrecho de Magallanes. (Unpublished manuscript).