

## ODONTOCETES OF THE SOUTHERN OCEAN SANCTUARY

Koen Van Waerebeek<sup>1</sup>, Russell Leaper<sup>2</sup>, Alan N. Baker<sup>3</sup>,  
Vassili Papastavrou<sup>4</sup> and Debrah Thiele<sup>5</sup>

<sup>1</sup> Peruvian Centre for Cetacean Research (CEPEC), MUSEO DE LOS DELFINES, Pucusana, Peru.  
Email: cepec.dir@terra.com.pe

<sup>2</sup> Canal House, Banavie, Fort William, PH33 7LY, United Kingdom.

<sup>3</sup> 8 Waters Lane, Kerikeri, Bay of Islands, New Zealand

<sup>4</sup> IFAW, the Old Chapel, Fairview Drive, Bristol BS6 6PW, United Kingdom

<sup>5</sup> Deakin University, Whale Ecology Group – Southern Ocean (WEG-SO), School of Ecology and Environment, Deakin University, PO Box 423, Warrnambool, Victoria 3280, Australia.

### ABSTRACT

Twenty-seven odontocete species are identified as occupying subantarctic and Antarctic habitat covered by the 1994 IWC-established Southern Ocean Sanctuary. Twenty-one species are autochthonous in showing a regular, apparently year-round, presence: *Physeter macrocephalus*, *Kogia breviceps*, *Orcinus orca*, *Globicephala melas edwardii*, *Lagenorhynchus cruciger*, *Lagenorhynchus obscurus*, *Lissodelphis peronii*, *Cephalorhynchus commersonii*, *Cephalorhynchus hectori*, *Tursiops truncatus*, *Delphinus delphis*, *Phocoena dioptrica*, *Hyperoodon planifrons*, *Berardius armuxii*, *Ziphius cavirostris*, *Tasmacetus shepherdi*, *Mesoplodon layardii*, *Mesoplodon traversii*, *Mesoplodon grayi*, *Mesoplodon bowdoini* and *Mesoplodon hectori*. Six species are considered vagrants into the Sanctuary: *Kogia sima*, *Grampus griseus*, *Steno bredanensis*, *Mesoplodon peruvianus*, *Mesoplodon densirostris* and *Mesoplodon mirus*. One ziphiid, *Mesoplodon ginkgodens* was found contiguously. However, the vagrant status of several mesoplodonts is preliminary, and some may be autochthonous. Increasing information on external features of beaked whales allows a higher percentage of odontocetes positively identified to species during sighting surveys. More odontocete species were found, or occurred farther south, in the Southern Ocean Sanctuary, than expected. Overall, much more is known about odontocetes of the Southern Ocean now than in 1994 as a result of the establishment of a number of research programmes. Odontocetes play an important part in the Antarctic polar ecosystem and are subject to different pressures than the baleen whales.

**KEYWORDS:** DISTRIBUTION; MOVEMENTS; ODONTOCETES; ANTARCTIC; SOUTHERN HEMISPHERE; SANCTUARY; SURVEY-VESSEL.

### INTRODUCTION

The odontocetes of the Southern Ocean are relatively poorly known compared to the baleen whales. Commercial whaling in the Southern Ocean during the 20<sup>th</sup> century largely concentrated on baleen whales and the sperm whale *Physeter macrocephalus*. Takes of other odontocete species, particularly *Hyperoodon planifrons*, *Berardius armuxii* ('bottlenose whales') and *Orcinus orca* were relatively much smaller and conducted on a largely opportunistic basis (e.g. Mitchell, 1975a,b; Klinowska, 1991). The ecology of odontocetes within the Southern Ocean ecosystem is very different to the baleen whales whose diets are dominated by krill (*Euphausiidae*). Thus it is likely that odontocetes will respond very differently to physical and biological factors. In particular, the killer whale is unique in terms of its predatory interactions on other cetacean species, particularly minke whales (e.g. Jefferson *et al.*, 1991; Branch and Williams, 2003).

In addition to direct takes, human activities may also impact on odontocetes in different ways to baleen whales in the Southern Ocean. Whereas fishing mortalities for krill are currently relatively low, fishing mortality for some fish species have been high (Constable *et al.*, 2000). Some odontocetes show a very high degree of site affiliation and may spend their entire lives within a very limited geographical area. This has been a consideration in designating Marine Protected Areas specifically for these species e.g. northern bottlenose whales in the Gully, Nova Scotia (Hooker *et al.*, 2002) and several populations of bottlenose dolphins (Evans and Pascual, 2001).

The increase in multi-disciplinary research cruises in the Sanctuary since 1994 has yielded new data on the distribution of odontocete species from visual surveys and observations (e.g. Pierpoint *et al.*, 1997; Gillespie *et al.*, 1997; Rendell *et al.*, 1997; Leaper and Scheidat, 1998; Leaper *et al.*, 2000; Thiele, 2002; Thiele and Gill, 1999; Thiele *et al.* 1997, 2000, 2001, 2002, 2003, 2004). Many observations of beaked whales in particular had not been previously recorded to species level, and the multi-disciplinary data allows examination of some of the factors that may relate to odontocete distribution. In particular, species diversity south of the Antarctic Polar Front is higher than previously thought, as several odontocetes were found to venture significantly further south than suggested by previous data.

Only a handful of earlier papers discuss the distribution of ziphiids and other odontocetes of the Southern Ocean in a broader perspective (Liouville, 1913; Lillie, 1915; Paulian, 1953; Sapin-Jaloustre, 1953; Brownell, 1974; Nishiwaki, 1977; Goodall and Galeazzi, 1985a; Kasamatsu *et al.*, 1988; Baker, 1990; Kasamatsu and Joyce, 1995).

On 26 May 1994 the International Whaling Commission (IWC) at its 47<sup>th</sup> Annual Meeting, in Puerto Vallarta, Mexico, voted by wide majority for the creation of a whale Sanctuary in the Southern Oceans. This provided for a prohibition on commercial whaling, to be reviewed at successive 10 year intervals, the first revision due in 2004. The northern boundary of the Southern Ocean Sanctuary was set at 40°S except for two sections, one (50°W – 130°W) in the eastern South Pacific and western South Atlantic ‘cutting out’ South American waters and another (20°E-130°E) south of the Indian Ocean Sanctuary, where the northern boundaries are set at 60°S and 55°S respectively. The present paper aims to concisely review and update available information for each odontocete species inhabiting the Sanctuary as a background document to facilitate the 2004 Southern Ocean Sanctuary review discussions.

## MATERIAL AND METHODS

We summarized published and unpublished information on the occurrence of odontocete species within the Southern Ocean Sanctuary. Species were grouped into two categories: 21 autochthonous species (regular, probably year-round, presence) and six ‘vagrants’ (with three or less confirmed records<sup>1</sup>). A single species was found in waters contiguous to the Sanctuary boundaries. Five items of interest were addressed, each largely limited to data applicable to the study area: 1) Systematics and Populations; 2) Distribution in Southern Ocean Sanctuary; 3) Migration and Seasonality; 4) Natural History and 5) Conservation Status and Exploitation.

Unpublished data from the ‘Southern Ocean Cetacean Ecosystem Program’ (SOCEP) and the IWC’s Southern Ocean GLOBEC/Commission for the Convention on Antarctic Marine Living Resources (IWC/SO GLOBEC/CCAMLR) collaboration Working Group and associated cruises are also presented here. The focus of this work has been baleen whales, but all species are recorded under these programs. All odontocete records collected up to the 2003/04 season and held by these programmes were contributed to this review.

The SOCEP programme has been funded by the Australian Government since 1995/96 in direct response to the declaration of the IWC Southern Ocean Sanctuary. The primary objective of this programme is to conduct visual survey, tissue biopsy, individual photo-identification and passive acoustic studies on cetaceans in the Sanctuary alongside multidisciplinary research aimed at understanding the dynamics and variability in Antarctic marine ecosystems. Visual surveys on these cruises generally use a four-person observer team, with three on watch at any one time. SOCEP surveys are conducted in East Antarctica (60°E - 150°E). Data collected on this program in the 1995/96 season has been published in Gill and Thiele (1997), Thiele and Gill (1999), Nicol *et al.* (2000) and Thiele *et al.* (2000). All odontocete data collected since then (Fig. 2) on the SOCEP monitoring program (Table 2) has been contributed to this review. Survey cruise details are in Table 1.

The IWC commenced collaborative research with CCAMLR in the Southern Ocean during the 1999/2000 austral summer (Reilly *et al.*, 2000; Hedley *et al.*, 2001). In 2001 a multi-year series of collaborative research cruises began with Southern Ocean GLOBEC. The cruises are multidisciplinary and comprise standard mooring cruises, line transect surveys over a constant grid, and process studies at selected locations, all within the Western Antarctic Peninsula study region around Marguerite Bay; and cruises in the Ross and Weddell Seas. The objective of this collaborative research in the Antarctic is to define how spatial and temporal variability in the physical and biological environment influence cetacean species (IWC, 2000). Visual survey, passive acoustic and tissue biopsy work were conducted by IWC observers and collaborating passive acoustics scientists (see Table 2 for cruise details). Odontocete sightings south of 60°S are listed in Tables 4.

<sup>1</sup> Exceptionally, despite a single record within Sanctuary boundaries, *Mesoplodon traversii* is considered autochthonous, because world-wide the species is known from only three records and the relevant specimen originates from deep (ca. 475km) inside the Sanctuary (Chatham Islands).

The traditional term ‘Antarctic Convergence’ is here replaced by the synonymous but currently preferred ‘Antarctic Polar Front’ (Orsi *et al.*, 1995). The ‘Antarctic Circumpolar Current’ (ACC) equals the formerly named ‘West Wind Drift’. South Island and North Island refer to New Zealand (NZ).

**Table 1.** SOCEP (Southern Ocean Cetacean Ecosystem Program) East Antarctica collaborative cruises 1995/96 – 2003/04 and tourist vessel cruises with experienced observer on board.

Vessel/cruise acronym	Cruise dates	Purpose
V7 2003/04 Aurora Australis	17 Feb – 12 March 2003	Casey resupply and ARP pick up
V3 2003/04 Aurora Australis	2 – 16 Dec 2003 and 26 Feb – 6 March 2004	Heard Island transits
V4 2002/03 Aurora Australis	3 Jan – 18 March 2003	Fine scale krill survey
V7 2001/02 Aurora Australis	26 Jan 2002 – 8 March 2003	Amery Ice Shelf sea ice and oceanographic study
V6 2000/01 Aurora Australis	1 Jan 2001 – 8 March 2001	Fine scale krill survey
V6 1999/00 Aurora Australis	18 Feb 2000 – 29 March 2000	Opportunistic survey
V4 1999/00 Aurora Australis	22 Nov 1999 – 21 Jan 2000	APIS survey
V1 1999/00 Aurora Australis	13 July – 7 Sept 1999	Winter polynya study Mertz Polynya
V1 1998/99 Aurora Australis	15 July – 31 July 1998	Winter polynya study Mertz Polynya
V2 1998/99 Aurora Australis	October 1998	Survey and base resupply
V3 1998/99 Aurora Australis	November 1998	Survey and base resupply
V5.1 1998/99 Polar Queen	18 Feb – 19 March 1999	Survey and base resupply
Kapitan Klebnikov 9899	January 1999	Tourist vessel (PC Gill observer)
V1, V2, V5, V6, V7 1997/98 Aurora Australis	Sept – Nov 1997 and 3 April – 22 May 1998	Various Antarctic and sub-Antarctic
Kapitan Klebnikov 9798	January 1998	Tourist vessel (PC Gill observer)
V4 1995/96 Aurora Australis	19 Jan 1996 – 31 March 1996	Large scale multidisciplinary krill and oceanographic survey
V1 1995/96 Aurora Australis	17 July – 2 September 1995	Winter sea ice study

**Table 2.** IWC-SO GLOBEC/CCAMLR cruises 2000/01 – 2003/04

Vessel/cruise acronym	Cruise dates	Purpose
<i>R/V Laurence M. Gould</i> /LMG 0103	18 March – 13 April 2001	Mooring cruise (Initial deployments)
<i>R/V Polarstern</i> /AntXVIII5b	14 April – 7 May 2001	Survey and ice/krill process cruise
<i>RVTB Nathaniel B. Palmer</i> /NBP 0103	24 April – 5 June 2001	Survey cruise
<i>RVTB Nathaniel B. Palmer</i> /NBP 0104	24 July – 31 Aug 2001	Survey cruise
<i>R/V Laurence M. Gould</i> /LMG 0201A	6 Feb – 3 March 2002	Mooring cruise Retrieve and deploy
<i>R/V Laurence M. Gould</i> /LMG 0203	7 April – 21 May 2002	Process cruise
<i>RVTB Nathaniel B. Palmer</i> /NBP 0202	9 April – 21 May 2002	Survey cruise
<i>RVTB Nathaniel B. Palmer</i> /NBP 0204	31 July – 18 Sept 2002	Survey cruise
<i>R/V Laurence M. Gould</i> /LMG 0302	12 Feb – 17 March 2003	Final mooring cruise (Retrieval)
<i>RVTB Nathaniel B. Palmer</i>	23 Feb – 10 April 2004	Ross Sea ANSLOPE oceanography
<i>R/V Polarstern</i> /AntXXI	27 March – 7 May 2004	Weddell Sea SO GLOBEC

## ODONTOCETES AUTOCHTHONOUS TO THE SANCTUARY

### Sperm whale *Physeter macrocephalus* Linnaeus 1758

#### *Systematics and populations*

No subspecies are described, geographical morphological variation is minimal and mt-DNA is remarkably homogeneous (Machin, 1974; Dufault *et al.*, 1999; Whitehead, 2002). Since 1973, sperm whales of the Southern Hemisphere have been divided in nine stocks or 'divisions'. The boundaries of some of these divisions were called into question but no conclusive assessments were made (Donovan, 1991). However, it is highly unlikely that these management stocks would reflect any biological population structure.

#### *Distribution in Southern Ocean Sanctuary*

The distribution of sperm whales in the Southern Ocean is better documented than for other odontocetes. Of the great whales, sperm whales were second only to fin whales in terms of the numbers of individuals (over 400,000) taken by 20<sup>th</sup> century whaling operations (Clapham and Baker, 2002) in the Southern Hemisphere. Sperm whales are also relatively easy to detect and identify when at the surface and so there is considerable data on distribution from sightings surveys, although abundance estimates are still complicated by the long dive times of the species. More recently, passive acoustic techniques have proven effective for sperm whale surveys in the Southern Ocean (Gillespie, 1997; Leaper *et al.*, 2000). Globally, sperm whale are known as a deep water species and similar distribution patterns in relation to water depth and bottom topography are seen in the Antarctic (Kasamatsu *et al.*, 2000). Kasamatsu and Joyce (1995) review data from sightings surveys conducted between 1976/77 and 1987/88. They reported highest encounter rates in the Indian Ocean sector with highest densities in the area bounded by 62°-66°S, 90°-120°E and south of 66°S, 150°-180°E. These results are consistent with more recent data from acoustic surveys. Gillespie (1997) reported densities some 2-3 times greater for the area 62°-66°S, 80°-125°E compared to the densities reported by Leaper *et al.* (2000) for the Scotia Sea.

Tynan (1998) used catch data to show the influence of the Southern Boundary of the Antarctic Circumpolar Current on sperm whale distribution. The circumpolar distribution of sperm whales appears to follow the Southern Boundary with sperm whales concentrating at higher latitudes in the Indian Ocean than the South Atlantic and tracking the increasing southern penetration of the Southern Boundary between 20°E and 60°E. She noted that regions in which sperm whales occurred in greatest numbers in the 1950s lie along or to the north of the Southern Boundary and suggested that sperm whales migrate southward as far as the poleward extent of Upper Circumpolar Deep Water. Thiele *et al.* (2000) supports these findings with data from a large scale survey (80°-150°E). There, concentrations of sperm whales were found along the Kerguelen Plateau; near frontal zones and eddies associated with the Southern Boundary, and further south where warm water intrusions occurred over deep water and complex bathymetry. Data collected on East Antarctic SOCEP surveys (1995/96 – 2003/04; Table 1) also show sperm whale sightings concentrated at 60°E - 117°E, most sightings were made in January and the furthest south record is 66°32.28'S, 64°29.76'E (D. Thiele, unpublished data). Only one sperm whale sighting was made during SO GLOBEC surveys.

Kasamatsu and Joyce (1995) reported high densities of sperm whales south of 66°S between 150°-180°E with sightings as far south as 74°S in the Ross Sea. Thus concentrations of sperm whales do occur to the south of the Southern Boundary.

The distribution of female sperm whales is generally limited to the tropics and warm temperate waters at latitudes less than about 40°. Within the Southern Ocean Sanctuary it is likely that sperm whales are predominantly male and that females are limited to northern waters approaching the 40°S boundary. Gaskin (1973) found that the proportion of females decreased southwards, abruptly at about latitude 44° S in the Tasman Sea and at about 46° - 47° S to the east of New Zealand. The only report of a female south of the Antarctic Polar Front was a single whale caught off South Georgia (Matthews, 1938). Sperm whales at Kaikoura, New Zealand (42°30'S) were dominated by males with only occasional encounters with nursery groups (Childerhouse *et al.*, 1995). Gaskin (1973) found that, like the female population, male sperm whale density also decreases southwards – the density between 50° and 60° S appeared to be less than 25% of that between 30° and 50° S. Gaskin related the distributional and seasonal changes to optimal conditions (upper level sea temperatures) for squid schooling. Mass strandings of sperm whales on the west coast of Tasmania (41°S-43°S) in 1998 were predominantly female also indicating the presence of female groups south of 40°S (Evans *et al.*, 2002). Although data from sightings surveys generally indicate school sizes of one (Kasamatsu and Joyce, 1995), data from acoustic surveys show that sperm whales frequently form aggregations of several individuals within an area of a few square kilometres (Gillespie, 1997; Leaper *et al.*, 2000).

#### *Natural History*

Comprehensive reviews include reproduction (Best *et al.*, 1984), feeding (Kawakami, 1980) and social organization (Best, 1979), *inter alia*.

*Migration and seasonality*

Assessing the winter distribution of all whales in the Southern Ocean is hampered by the lack of survey effort, however it is generally believed that sperm whales move to lower latitudes in winter. Kasamatsu and Joyce (1995) found that overall sperm whale numbers in Antarctic waters increased during November and December to a peak in early January. Analysis of squid beaks from stomachs of male sperm whales caught off Durban showed that Antarctic species were present between May and September suggesting that males were moving north over these months (Clarke, 1980). Sperm whales are certainly present in the northern waters of the Sanctuary during winter months. Ashford *et al.* (1996) report the presence of sperm whales off South Georgia in April/May 53° 30'S and Thiele and Gill (1999) reported sperm whales at 44°S 146°E in July. Sperm whales are also present at Kaikoura, New Zealand (42°30'S) throughout the winter.

*Conservation Status and Exploitation*

Sperm whales were exploited much later in the Antarctic than at lower latitudes, and prior to 1933 annual takes were less than one hundred animals. However, catches rose quickly due to the success of the deep-sea pelagic fleets and by 1939 annual catches were around 2,500. After a reduction in the early 1940s due to the war, whaling increased again in the 1950s with average annual takes around 6,000 sperm whales up until zero catch limits were introduced in the Southern Hemisphere from the 1981/82 season. Kasamatsu and Joyce (1995) give an estimate of 28,100 (CV 0.18) sperm whales south of the Polar Front in January based on IDCR sightings data between 1976/77-87/88. Branch and Butterworth (2001) give estimates of 5,400 (CV 0.38), 10,000 (CV 0.15) and 8,300 (CV 0.16) for the first, second and third IDCR-SOWER sightings surveys respectively. These latter estimates are not corrected for  $g(0)$ . Based on these estimates, Whitehead (2002) suggested around 12,000 whales south of 60°S applying a correction for  $g(0)$ . This estimate, while approximate, does appear consistent with both visual and acoustic survey data. Assuming the area for the Southern Ocean south of 60°S to be  $1.8548 \times 10^6 \text{ km}^2$  (Whitehead, 2002), the range of estimates of sperm whale abundance (5,400-10,000 whales) calculated by Branch and Butterworth (2001) would correspond to densities of between (0.29 – 0.54 sperm whales per 1000km<sup>2</sup>). In his global estimates of population size, Whitehead applied a  $g(0)$  correction to give an average density for south of 60°S of 0.65 sperm whales per 1000km<sup>2</sup>. These estimates compare well with density estimates from acoustic surveys. Gillespie (1997) estimated densities of between 0.5-0.73 sperm whales per 1000km<sup>2</sup> for the sector 80°E – 126°E which is believed to be a relatively high density area and Leaper *et al.* (2000) estimated 0.13 sperm whales per 1000km<sup>2</sup> for the Scotia Sea, which is believed to be a relatively low density area, based on the results of circumpolar surveys (Kasamatsu and Joyce, 1995).

Status designations: IUCN Red List 'Vulnerable'; CITES Appendix I.

**Pygmy sperm whale *Kogia breviceps* (de Blainville, 1838)***Systematics and Populations*

No subspecies are described. However recent genetic research suggests significant population structure may exist (Plön *et al.*, 2003). A global analysis of geographic cranial variation is recommended.

*Distribution in Southern Ocean Sanctuary*

Cosmopolitan but not in polar waters. In the Sanctuary, it is known only from stranded specimens from South Australia and Tasmania (Baker, 1983; Bannister *et al.*, 1996), and from New Zealand where 212 strandings have occurred between 42° and 38° S (Baker and van Helden, 1990).

*Migration and Seasonality*

No information available for Sanctuary waters.

*Natural History*

More oceanic than dwarf sperm whale. For reviews, see e.g. Caldwell and Caldwell (1989) and McAlpine (2002).

*Conservation Status and Exploitation*

No population estimates exist and no specific data for study area; however incidental mortality in fishing gear and ingestion of plastic debris may be a problem (Reeves *et al.*, 2003). Status designations: IUCN Red List 'Least Concern'; CITES Appendix II.

**Killer whale *Orcinus orca* (Linnaeus, 1758)***Systematics and Populations*

The taxonomy of *Orcinus* is currently under revision, and at least two, perhaps three species will ultimately have to be recognized. Pitman and Ensor (2003) discussed three morphologically distinct types of killer whales in Antarctica that do not appear to mingle in schools or hybridise, although geographic ranges overlap.

*Distribution in Southern Ocean Sanctuary*

Killer whales are known to occur throughout Antarctic waters with highest numbers observed during January and close to the northern edge of the pack ice (Brownell, 1974; Budylenko, 1981; Mikhalev *et al.*, 1981; Kasamatsu and Joyce, 1995; Kasamatsu *et al.*, 2000). Hundreds were seen as south as 78°S 170°E, 'at the farthest point of open water to the South' (Wilson, 1907). A major consideration in describing the distribution of killer whales in the Southern Ocean is the finding that there are three different forms with different distribution patterns and ecological traits (Pitman and Ensor, 2003). These authors suggest three forms type A, B, C all of which occur in Antarctic waters during the summer.

SO GLOBEC data indicate presence of killer whales in fjords of western Antarctic Peninsula. The species was seen south to 69°S in all seasons. SOCEP surveys found killer whales mostly in 110°E -160°E, often in ice. Distribution seems to be concentrated near (but not confined to) shelf and shelf slope areas.

#### *Migration and Seasonality*

Winter observations were first documented by Thiele and Gill (1999). Pitman and Ensor (2003) suggest that killer whale type A migrates to low latitudes during the winter and possibly that type B also migrates. Type B and C killer whales, but not type A, have been found within the pack ice in winter.

#### *Natural History*

Type A killer whales are believed to prey primarily on minke whales, type B primarily on seals and type C primarily on Antarctic toothfish (Pitman and Ensor, 2003). Southern ocean killer whale diet and biology is also reviewed in Mikhalev *et al.* (1981), Jefferson *et al.* (1991) and Branch and Williams (2003).

#### *Conservation Status and Exploitation*

Killer whales were not a primary target species for the pelagic whaling fleets in the Southern Ocean. However, Chrisp (1958) reported whaling fleets shooting killer whales because of perceived competition for large whales. Orca catches by the former Soviet Union were usually less than 10 per annum between 1947-66 but were over reported in several years. Thus, in that period the total reported catch by the Slava was 331 whereas the real catch was 57 (CREP, 1995). The catching of killer whales by Soviet whaling ships increased dramatically in 1979/80. The USSR reported a total of 906 killer whales (447 males and 459 females) taken between 18 January 1980 and 21 March 1980 (USSR, 1981) compared to a total take of 738 between 1953/54 and 1978/79 (Mikhalev *et al.*, 1981). The whales were taken from 140°E westwards to 60°E. The take of killer whales was discussed by the IWC Scientific Committee (IWC, 1981a), which recalled its recommendation the previous year that the USSR be urged by the Commission to take no more than 24 killer whales from Antarctica in 1979/80. The Committee noted that the Commission did not follow this recommendation. Following discussion regarding evidence for a complicated stock structure and agreement that, 'there is insufficient evidence on which to base geographical stock boundaries', the Committee recommended that 'catch limits for Antarctic killer whale stocks be zero' (IWC, 1981b).

The Commission considered the Scientific Committee recommendation first in its Technical Committee which agreed to recommend an addition of a new sentence to what was then Schedule Paragraph 9(d) (now paragraph 10(d)). Paragraph 10(d) is the moratorium on factory ship whaling for species other than minke whales. No party has filed an objection to this paragraph so that it is binding on all parties. The text proposed by the Technical Committee was adopted by the Commission by consensus and is as follows 'This moratorium applies to sperm whales, killer whales and baleen whales except minke whales.' Catches of killer whales by the Soviet Union ceased after 1980.

Kasamatsu and Joyce (1995) give an estimate of 80,400 (CV 0.15) killer whales south of the Polar Front in January based on IDCR sightings data between 1976/77-87/88. Branch and Butterworth (2001) give estimates of 91,000 (CV 0.34), 27,000 (CV 0.26) and 25,000 (CV 0.23) for the first, second and third IDCR-SOWER sightings surveys respectively. These estimates have a number of caveats mentioned in the discussion.

Occasional interactions between killer whales and longline fisheries for Patagonian toothfish (Ashford *et al.*, 1996) could lead to incidental mortality, although no examples are documented. Visser (1999) reported ship strikes on *Orca*, including one individual within the Sanctuary area (42° S)

Status designations: IUCN Red List 'Lower Risk (conservation dependent)'. CITES Appendix II.

#### **Southern long-finned pilot whale *Globicephala melas edwardii* (A. Smith, 1834)**

##### *Systematics and Populations*

Davies (1960) accorded subspecific status to Southern Hemisphere long-finned pilot whales *G. edwardii* (A. Smith, 1834) and till date this has not been challenged. No populations are discerned, probably for lack of research. A hemisphere-wide study is long overdue. Features which reliably distinguish *G. melas* from *G. macrorhynchus* often cannot be ascertained in non-closing mode surveys, and pilot whales sighted in southern seas seem to be often assigned by default to *G. melas edwardii* based on mere latitudinal considerations. An explicit indication of

identification criteria is recommended as to allow an *a posteriori* re-evaluation of datasets, considering the southern distribution boundary for *G. macrorhynchus* is imprecisely known and could be revised.

#### *Distribution in Southern Ocean Sanctuary*

Goodall and Galeazzi (1987b) indicated *G. m. edwardii* was found circumpolar throughout the Southern Hemispheric oceans in cold currents (e.g. Humboldt, Falkland and Benguela Currents), north of the Antarctic Polar Front. It is not uncommon in the Scotia Sea and several summer sightings exist off South Georgia, Elephant Island, South Shetlands, and South Orkneys (Brownell, 1974; Hanson and Erickson, 1985; Goodall and Macnie, 1998). However, none were sighted during SO GLOBEC off western Antarctic Peninsula over the two years, any season. In SOCEP surveys, pilot whales were seen near ice as far south as 63°16.8'S and sightings concentrated from 90°E–110°E and 130°E–150°E and generally off the shelf and at the base of the steep shelf (Fig. 2).

Strandings have occurred in Tasmania (Scott, 1942; Davies, 1960; Guiler, 1978; Bannister *et al.*, 1986), New Zealand including North and South Islands and the Auckland Islands (Baker, 1977, 1999); South Orkneys and South Georgia (Goodall and Macnie, 1998), the latter is the southernmost specimen record in the Atlantic sector. In the Indian Ocean, a carcass was retrieved from Heard Island (Guiler *et al.*, 1987), just north of the Sanctuary. Nishiwaki (1977) depicted the circumpolar southern distribution boundary consistently south of the Polar Front at about 56°S, with two southern dips to ca. 65°S (north of the Ross Sea and off the Antarctic Peninsula). Kasamatsu *et al.* (1988) in six cruises registered 26 schools (1,578 animals) south of 58°S. All but one sighting (200 animals in Area IV) were made away from the ice-edge.

Peaks in encounter rates, longitudinally, were found at 90–100°E (E. Indian Ocean), 170–160°W (South Pacific) and smaller peaks at 120–130°E, 110–120°W and 40–50°W (Kasamatsu and Joyce, 1995). An apparent distribution gap is reported at 54–58°S in the South Atlantic-Indian Ocean sector, but no such gap was seen in the South Pacific sector (Kasamatsu and Joyce, 1995). The latter reported a southernmost sighting at 64°S.

Brownell (1974) reported sightings near Scott Island (67°S, 179°W) and in the central Pacific sector at 68°S, 120°W. Southernmost well-documented summer records stand at 67°41'S, 05°44'W (SST, –1.0°C) in the Atlantic (Kasamatsu *et al.*, 1988) and a group of six spotted in the NE Ross Sea at 66°33'S, 140°40'E. These lend increasing credibility to a sighting at 69°53'S, in 1909 reported by Liouville (1913). Summer sightings south of the Polar Front below 60°S are nothing unusual, even with calves (Goodall and Macnie, 1998; Ensor *et al.*, 1999), and long-finned pilot whales form part of the normal cetacean fauna of Antarctic seas.

#### *Seasonality and Migration*

Highest encounter rates were in the second half of January (Kasamatsu and Joyce, 1995). No clear seasonality was identified, but neither discounted (small sample size). Pilot whales were seen in Antarctic waters only in mid- and late summer (December and March) and Kasamatsu and Joyce (1995) reported no sightings south of 50°S in winter months, although survey effort is minimal then. The southernmost winter sighting (18 June; 25 animals) is at 55°27'S, 68°44'W, in Drake Passage (Goodall and Macnie, 1998).

#### *Natural History*

Feeds on cephalopods (Clarke and Goodall, 1994). Observed in close association with minke whales, hourglass and dusky dolphins (Goodall and Galeazzi, 1987; Goodall and Macnie, 1998). Some well-studied mass strandings yielded ample biological data (in Tasmania, Scott, 1942; in Magallanes, Venegas and Sielfeld, 1980; in Patagonia, Crespo *et al.*, 1985).

#### *Status and Exploitation*

Exploitation in the Southern Hemisphere has been sporadic and very low (Mitchell, 1975a,b). No direct exploitation is known to occur at present in Southern Ocean Sanctuary waters. Long-finned pilot whale is considered relatively scarce in Antarctic waters (Sapin-Jaloustre, 1953; Hanson and Erickson, 1985), and sometimes the species is not recorded over a full summer survey (SO GLOBEC data; Thiele *et al.*, 2000). However, large schools make them the 'third most numerous whale' sighted in Antarctic waters (Hanson and Erickson, 1985). Kasamatsu and Joyce (1995) give an estimate of 200,000 (CV 0.35) long-finned pilot whales south of the Polar Front in January based on IDCR sightings data between 1976/77–87/88, but note several caveats to this estimate in discussion.

Status designations: IUCN Red List 'Not Evaluated'. CITES Appendix II.

### **Hourglass dolphin *Lagenorhynchus cruciger* Quoy and Gaimard, 1824**

#### *Systematics and Populations*

A full synonymy and taxonomic history is given in Goodall *et al.* (1997a). Other southern *Lagenorhynchus* species were synonymized with (date-prioritized) *L. cruciger* (e.g. Liouville, 1913; Bierman and Slijper, 1947) until Fraser (1966) specified the name covers the hourglass dolphin only. Nominal species assignments for pre-1966 sightings are therefore unreliable unless verifiable morphological evidence is available. *L. cruciger* is most often attributed

(Goodall *et al.*, 1997a; Rice, 1998) to Quoy and Gaimard (1824), supported by an unmistakable description, and a rough sketch, but no specimen. True (1889) and Robineau (1990) argued that D'Orbigny and Gervais (1847) is the valid species description because the type specimen was collected at '57°-76°S' SE of Cape Horn. No subspecies or population structure have been suggested.

#### *Distribution in Southern Ocean Sanctuary*

Pelagic, deep water, circumpolar on both sides of the Antarctic Polar Front and northward in cool currents associated with the Antarctic Circumpolar Current; from about 45°S to fairly near the pack ice. The southernmost sighting at 67°38'S in the South Pacific sector (Goodall *et al.*, 1997a; Goodall, 2002). D'Orbigny and Gervais (1847) stated that they found *Delphinus cruciger* from 57°S-76°S, the cited southern latitude being most probably a misprint.

During SO GLOBEC surveys it was seen south to 66°S off western Antarctic Peninsula. In SOCEP, hourglass dolphins were concentrated on the shelf slope and other edges of steep bathymetry (like Kerguelen Plateau) mostly around KP in the west of the study area (75°E – 115°E). Most sightings between 115°E - 150°E were in the vicinity of the shelf and shelf slope (Fig. 2). Encountered south to 64°31.2'S.

The species' global northern range boundary is unclear, but Atico (16°S), southern Peru (Heintzelman, 1981) and 'about 25°S' (Scheffer and Rice, 1963) are not supported. A purported sighting (without description nor photograph) off the Rio de la Plata, Uruguay, at 36°14'S, 52°43'W (Nichols, 1908) is also doubtful. The same applies to a *Lagenorhynchus* sighting off Valparaíso at 33°40'S, 74°55'W (Clarke, 1962)<sup>2</sup>. All of these may have been *L. obscurus*. The northernmost substantiated specimen records, both in the SE Pacific, are a 163cm specimen captured at 49°S, 78°W off Wellington Island, southern Chile (Nichols, 1908), and another at 53°13'S, 106°20'W (N. Miyazaki, in Brownell and Donahue, 1999). A sighting by Murphy (1947) in the Argentine basin at 42°24'S, 42°28'E on 14 November 1912 is uncertain. An alleged specimen from Tasmania (Guiler, 1978) was re-identified as *Lissodelphis peronii* (Van Waerebeek, 1993a).

The species is often reported from around South Georgia (e.g. Matthews, 1977). Gaskin (1968) recorded a sighting from southeast of the Chatham and Antipodes Islands (45° - 50°S) and also (1972) claimed a record from Kaikoura, New Zealand, at 42°20'S, 174°05'E in the winter of 1963. Goodall *et al.* (1997a) listed four specimens from the east coast of New Zealand's South Island, including a skull in the Otago Museum.

Wilson (1907) reported *L. cruciger* from the outer zone of the pack-ice at 55°-60°S and about 135°E (Australian sector) in summer (November-January). Lillie (1915) believed it confined to a comparatively narrow band just north of the pack ice, and observed it from December-April at 55°-65°S and from 157°E to 88°W (n= 9; South Pacific sector). Bierman and Slijper (1947) reported *Lagenorhynchus wilsoni* (synonym) from the SE South Atlantic at 48°59'S, 06°36'E (n=4) and a school at 46°52'S, 08°30'E in the Bouvet sector (Area III), with SST respectively 3.7 and 5.5 °C. Their drawing unmistakably confirms *L. cruciger*.

Two southernmost sightings include one in northern Ross Sea, near Scott Island (66°36'S, 177°51'E) (G. Joyce photo in Leatherwood and Reeves, 1983) and another at 67°38'S, 179°57'E in the South Pacific (Miyazaki and Kato, 1988).

Fraser (1966) examined a specimen taken at 56°20'S, 40°09'E, south of the Prince Edward Islands, and later Stahl (1982) reported two sightings from south of the Crozet Islands in February at 47°44'S (north of the Sanctuary) and 55°04'S. Thiele *et al.* (2000) reported ten of eleven sightings, offshore in the east section of eastern Antarctica (80-150°E) (10 sightings involving 49 animals between 63°-64.3°S). All except one occurred at, or in close proximity to, the southern boundary of the ACC and/or the Antarctic Divergence (AD), or between these features in regions where they were separated. Preference was shown for areas associated with frontal zones and eddies.

Kasamatsu and Joyce (1995) found hourglass dolphins mainly in the northernmost areas of the Antarctic, especially in the Indian Ocean and South Atlantic sectors. They penetrated farthest south (67°S) between 150°E – 150°W in the South Pacific. Not seen in waters south of 66°S in South Atlantic and Indian Ocean sector. Longitudinal gaps appeared at 80-150°W and 0-40°W. The distribution pattern is apparently similar to that of the long-finned pilot whale (Kasamatsu and Joyce, 1995).

Hourglass dolphins rarely strand in the Sanctuary and few specimens exist in collections: South Island of New Zealand, and Livingston Island in the South Shetlands (Fraser and Noble, 1968; Goodall *et al.*, 1997a).

<sup>2</sup> R. Clarke (1962) clarified that Philippi recorded the species he sighted 'in 1896, as *Tursio obscurus* Gray', a synonym of the dusky dolphin *L. obscurus* (see Gray, 1866). Before Fraser (1966), the three southern *Lagenorhynchus* species were considered a single species, referred to as *L. cruciger* (Bierman and Slijper, 1947). R. Clarke (1962) thus logically applied the pre-1966 name '*L. cruciger*' to any southern *Lagenorhynchus* dolphin, including dusky dolphin *L. obscurus*. Clarke (1962) for his entire survey did otherwise not report any dusky dolphins, one of three species most common off Chile (Van Waerebeek, 1992a,b). We conclude that his sighting most likely were dusky dolphins.



### Migration and Seasonality

Seasonality in Antarctic waters is suggested by an increase in encounter rates in February, perhaps corresponding to an increase in SST which peaks in March; either linked to thermoregulatory factors (*cf.* small body size) or prey availability (Kasamatsu and Joyce, 1995). Two groups were recorded in winter (July 1995) in open water (55°01.8'S, 141°00.6'E and 57°14.2'S, 139°51.9'E), with SST of 1.4°C and 1.1°C respectively (Thiele and Gill, 1999).

### Natural History

Only minimal information is available about its natural history. Goodall *et al.* (1997) reviewed information on morphology, internal anatomy, food habits and reproduction. A 183 cm female was near sexual maturity, and males of 175 and 183 cm were sexually mature but not physically mature. Food has included more or less digested small fish (Nichols, 1908), or squid (Ash, 1962; Clarke and Goodall, 1994).

### Exploitation and Conservation Status

Some have been harpooned for food and a few for research purposes, but otherwise no exploitation of hourglass dolphin existed (Ash, 1962; Nichols, 1908; Fraser, 1964, 1966; Brownell and Donahue, 1999). Nichols (1908), who took two, stated 'their flesh tastes somewhat like meat, somewhat like fish, and is a very welcome break in a diet composed chiefly of salted and canned foods'. At least one specimen was incidentally caught in an experimental Japanese drift net fishery for squid around 53°13'S, 106°20'W (N. Miyazaki, *in* Brownell and Donahue, 1999). No other incidental captures are reported.

The January population in Antarctic waters was estimated at 144,300 (CV 0.17) (Kasamatsu, 1993; Kasamatsu and Joyce, 1995). Branch and Butterworth (2001) presented some data on hourglass dolphin abundance also from the IDCR-SOWER surveys, but including the second and third circumpolar, but did not consider these estimates reliable. No conservation problem is identified (Goodall *et al.*, 1997a; Reeves and Leatherwood, 1994; Reeves *et al.*, 2003). Status designations: IUCN Red List 'Least Concern'. CITES Appendix II.

## Dusky dolphin *Lagenorhynchus obscurus* (Gray, 1828)

### Systematics and Populations

Van Waerebeek (1992a, 1993b) documented significant geographic variation in morphology, some considered at subspecific level, but refrained from describing subspecies pending further evidence. Rice (1998) named three subspecies (coinciding with South America, South Africa and New Zealand) without adding further evidence, nor offering diagnoses. Molecular genetic analyses support divergent SE Pacific and Atlantic lineages, but otherwise reveal an intricate phylogenetic pattern (Cassens *et al.*, 2003; *in preparation*) which legitimizes the cautionary approach. Dusky dolphin hybridizes with other delphinids. A probable hybrid with *L. peronii* was photographed off Argentina (Yazdi, 2002)<sup>3</sup> and a skull from Peru suggested hybridism with *Delphinus capensis* (Reyes, 1996).

### Distribution in Southern Ocean Sanctuary

Fraser (1966) first distinguished the three austral *Lagenorhynchus* spp. and corrected the long-held view (Bierman and Slijper, 1947; Davies, 1963) that all *Lagenorhynchus* from southern seas are colour varieties of one species 'dusky dolphin, *Lagenorhynchus cruciger*', which continues to hamper interpretation of pre-1966 records. Van Waerebeek *et al.* (1995) comprehensively reviewed *L. obscurus* global distribution. Occurrence off Tasmania and southern Australia was recently documented based on 13 sightings and a stranded mother/calf pair (Gill *et al.*, 2000). A few sightings (40-43°S) were made south of Gough Island (Tristan da Cunha archipel) in the mid-Atlantic (Van Waerebeek *et al.*, 1995).

Baker (1977) indicated Campbell Island (52° 30'S, 169°10'E) as the then known southernmost range for the New Zealand stock. Nishiwaki (1977) believed that *L. obscurus* 'stays 300 to 500 km to the north of the convergence' and 'does not go farther south than 58°S'. However, two sightings in Drake Passage are from south of the Antarctic Polar Front, one at 57°50'S and another north of the South Shetland Islands, at 60°29'S (Goodall *et al.*, 1997b; Fig.9). Thiele *et al.* (1997) encountered dolphins which closely resembled dusky dolphins and were 'distinctly unlike hourglass dolphins' at 64°28'S, 120°02'E on 1 March 1997. Lillie (1915) also reported dusky dolphins south of 58°S, which was questioned, but in the light of the above, may have been correct. If *L. obscurus* is now confirmed to venture south of the Polar Front, it remains a rare event. During SOCEP surveys, the species was seen to 48°S.

### Migration and Seasonality

Although dusky dolphins can move over great distances, there is no evidence of regular migratory movements. Sightings around New Zealand have been related to SST (Gaskin, 1968).

<sup>3</sup> Black-white colouration pattern, elongated body shape expresses *L. peronii* phenotype; presence in dusky dolphin school, dorsal fin (diminutive and caudad position) and hint of flank patch points to affinity with *L. obscurus*.

*Natural History*

Aspects of the biology of the NZ population are reviewed in Webber (1987), Cipriano (1992), Van Waerebeek (1992a, 1993b) and Würsig *et al.* (1997).

*Exploitation and Conservation Status*

The New Zealand/Australia stock, unlike Peruvian and Atlantic populations, is not subjected to any exploitation. Status designations: IUCN Red List 'Not Evaluated [NZ dusky dolphin]'. CITES Appendix II.

**Southern right whale dolphin *Lissodelphis peronii* (Lacépède 1804)***Systematics and Populations*

No subspecies or populations are recognized. Suggestions of conspecificity with northern right whale dolphin *L. borealis* (Honacki *et al.*, 1982) are not convincing. *L. peronii* is cranially similar (Van Waerebeek, 1993a) and phylogenetically close to *L. obscurus* with which it can hybridize in the wild (Yazdi, 2002).

*Distribution in Southern Ocean Sanctuary*

Southern circumpolar, from about 18°S to 55°S, with a northernmost record from 12°30'S, Peru (e.g. Baker, 1981; Van Waerebeek *et al.*, 1991; Jefferson *et al.*, 1994). In the northern part of the Sanctuary it is fairly common off South Island, NZ, in the Tasman Sea and waters directly south of Australia (Gaskin, 1968, 1972). Brownell (1974) called it a marginal Antarctic species. Kasamatsu *et al.* (1988) reported only three groups (none with calves) south of 58°S: two in Area VI south of the Antarctic Polar Front (60°39'S, 154°14'W and 61°20'S, 163°27'W) and one in Area I (58°09'S, 67°17'W). All sightings were mixed schools. The southernmost known specimen is a skull collected from South Shetland Islands (Goodall and Galeazzi, 1985a).

During SOCEP, four sightings were recorded from 47°S- 49.23°S. One large group of 75 animals, but other groups small (2–10 animals).

*Migration and Seasonality*

There is no evidence of any significant seasonal or migratory movements, however this may be due to a lack of dedicated research.

*Natural History*

SST range: +1.4 °C to 13.8°C (Kasamatsu *et al.*, 1988). The biology of southern right whale dolphin is reviewed by Van Waerebeek *et al.* (1991), Jefferson *et al.* (1994), Newcomer *et al.* (1996) and Lipsky (2002).

*Conservation Status and Exploitation*

Bennett (1840) wrote that 'our crew never lost the opportunity of harpooning them, as we esteemed their flesh a delicacy'. Apart from some by-catches, anthropogenic mortality in the Sanctuary is thought to be minimal. However, mortality in gillnet fisheries off Chile may not be insignificant (Van Waerebeek *et al.*, 1991). Status designations: IUCN Red List 'Data Deficient'. CITES Appendix II.

**Commerson's dolphin *Cephalorhynchus commersonii* (Lacépède 1804)***Systematics and Populations*

Rice (1998) recognized two subspecies without presenting names, diagnoses or types (invalid under the International Code for Zoological Nomenclature). These coincided with the two known populations, one which occurs off South America and penetrates Drake Passage (Southern Ocean Sanctuary waters), and the second from the Kerguelen Archipelago (Paulian, 1953; Robineau, 1984, 1989). Their plausible origin and radiation is discussed by Pichler *et al.* (2001).

*Distribution in Southern Ocean Sanctuary*

Distributed mostly, with highest abundance, in areas outside the Sanctuary, i.e. east coast of southern South America, Peninsula Valdéz south to Tierra del Fuego. Fairly common in the Magellan Straits and Falklands Islands and south of 50°S on the Chilean coast. The northernmost range is unclear but probably is close to 41°26'S (Goodall *et al.*, 1988) in the SW Atlantic. There is only one area of reported occurrence within Sanctuary, i.e. the southern stratum of Drake Passage (Dawson, 2002): southernmost sighting records include two south of the Antarctic Polar Front NW of Livingstone Island, South Shetlands (n=1, 61°59'S, 63°05'W, 27 Feb. 1966; n=12, 61°50'S, 63°17'W, 27 Feb. 1966); a third sighting (n=5) is from 58°10'S, 67°58'W on 28 Feb. 1966; and a fourth (n=2) is reported from 'Drake Passage' on 5 December 1972 (Aguayo and Torres, 1967; Aguayo, 1975). These are the only published sightings from that area and, as Brownell and Praderi (1985) pointedly stated, these sightings are 'extremely puzzling', and were it not for an unmistakable photograph (p.1124, Aguayo, 1975) they might be questioned. Numerous scientific vessels make observations in Drake Passage but have not reported any Commerson's dolphins since. To add to the debate, Ellis (1982) reported to 'have seen a film of 15 or so

Commerson's dolphins pacing a U.S. Coast Guard icebreaker in the Antarctic'. This film should be located and re-examined, but it would seem hard to confuse Commerson's dolphin with *L. peronii* or *P. dioptrica*.

Unsubstantiated reports of *C. commersonii* off South Georgia (Hart, 1935; Matthews, 1931) were questioned by Brownell and Praderi (1985) and Brown (1988), but by then had widely seeped into the literature (e.g. Brownell, 1974; Leatherwood *et al.*, 1983; Fisher and Hureau, 1985; Strange, 1992). However, if Commerson's dolphins make, albeit rare, excursions offshore and south into Drake Passage, there is little compelling logic to exclude the possibility of its occurrence, if rare, in the Scotia Sea off South Georgia. Further research must shed light on this matter.

Immediately north to the Sanctuary, a reproductively isolated, both morphologically and genetically distinct, population resides in waters of the Kerguelen archipelago (48°30'-50°S, 68°30'-70°45'E) (Paulian, 1953; Buffrénil *et al.*, 1989; Goodall, 1994; Pichler *et al.*, 2001; Robineau, 1984, 1989b; Stahl, 1982). Conceivably some individuals from Kerguelen population may penetrate into the Sanctuary's Indian Ocean sector.

#### *Migration and Seasonality*

There is no evidence of any seasonal or migratory movements, but reported rare Drake Passage sightings could point to irregular, wandering movements offshore and south under (indeterminate) favourable oceanographic conditions. Conceivably, a higher population size half a century ago may have led to more frequent 'extralimital' records.

#### *Natural History*

Goodall *et al.* (1988) and Goodall (1994) comprehensively reviewed the biology of the South Atlantic population. *C. commersonii* is typically an inshore species, but sometimes occurs offshore, e.g. near the shelf edge off Kerguelen Islands, SE of the Falkland Islands and near Burdwood Bank, Argentina and Drake Passage (Goodall, 1994). Prey includes squid (Clarke and Goodall, 1994).

#### *Conservation Status and Exploitation*

No abundance estimates are available. Good estimates are lacking also for the level of catches off southern South America (Reeves *et al.*, 2003), and no captures are registered in the Sanctuary. A few specimens were known taken for research purposes at Kerguelen (Paulian, 1953; Angot, 1954). French observers on board Russian trawlers fishing on the Kerguelen plateau did not report any incidental dolphin kills (D. Robineau, *in* Reeves and Leatherwood, 1994). Reeves and Leatherwood (1994) reviewed information on exploitation of South American population; at least 18 were taken for captive display in Tierra del Fuego (Goodall *et al.*, 1988).

Status designations: IUCN Red List 'Not evaluated'. CITES Appendix II.

### **Hector's dolphin *Cephalorhynchus hectori* (P.J. Van Beneden, 1881)<sup>4</sup>**

#### *Systematics and Populations*

A full synonymy and taxonomic history is given in Baker (1978). Since then, genetic analyses of the mtDNA of Hector's dolphins have identified four regional populations in this endemic New Zealand species (Pichler, 2002). This discovery was followed by an analysis of the morphological variation between those populations, which showed consistent differences between the North Island and South Island populations. Using both genetics and morphology, Baker *et al.* (2002) described the North Island population (north of 40° S) as a new subspecies, *C. hectori maui*, and relegated the three South Island populations (south of 40°S; 'East coast', 'West coast' and 'South coast') to the subspecies *C. hectori hectori*.

#### *Distribution in Southern Ocean Sanctuary*

*C. hectori hectori* occurs around most of the South Island of New Zealand except for the southern fiords, and therefore falls within the Sanctuary. Maui's dolphin is entirely outside the Sanctuary.

#### *Migration and Seasonality*

There are no indications of any significant seasonal or migratory movements, but satellite tagging is currently being trialed to track its movements.

#### *Natural History*

Hector's dolphin is exclusively neritic and is most often seen within 0.5 nm from shore (Dawson and Slooten, 1988), but ranges to at least 18 nm offshore (ANB, personal observations). Several authors discussed natural history aspects (e.g. Mörzner Bruyns and Baker, 1973; Baker, 1978; Dawson and Slooten, 1988; Slooten and Lad, 1991;

<sup>4</sup> *non* 'P.J. van Bénédén' (erroneous spelling) *in* Hershkovitz (1966), Rice (1998), and others. Pieter-Jan Van Beneden, Flemish professor (19<sup>th</sup> century) at the Katholieke Universiteit van Leuven, Flanders, Belgium.

Slooten and Dawson, 1994, Bräger, 1999). The dolphins have a restricted home range of approximately 33 nm (Bräger, 1999), and there are three genetically distinct populations on the eastern, southern and western coasts of the South Island (Pichler, 2002).

#### *Conservation Status and Exploitation*

Occasionally taken in trawl fishing operations (Mitchell, 1975a; Baker, 1978), gillnets (van Bree, 1972; Mörzer Bruyns and Baker, 1973; Dawson, 1991, 2002; Slooten and Lad, 1991) or killed by boat collisions (Stone and Yoshinaga, 2000). The North Island Maui's dolphin *C. hectori maui* and the South Island Hector's dolphin *C. hectori hectori* require separate management (Baker *et al.*, 2002).

Total abundance for this species is low at 7,300 dolphins. Incidental takes in inshore gillnets are the biggest threat to its survival (Dawson, 1991, 2002; Slooten and Lad, 1991). Status designations: IUCN Red List 'Endangered' (*C. hectori*). The northern Maui's dolphin may number fewer than 100 individuals and is listed as 'Critically Endangered'. CITES Appendix II.

### **Common bottlenose dolphin *Tursiops truncatus* (Montagu, 1821)**

#### *Systematics and Populations*

At least two species of bottlenose dolphin occur in the Southern Hemisphere, but only *T. truncatus* is known from the northern parts of the Sanctuary. Indo-Pacific bottlenose dolphin *T. aduncus* (Ehrenberg, 1833) does not occur beyond warm temperate habitats. Inshore and offshore *T. truncatus* 'ecotypes' constitute unnamed ESUs, distinct at least at subspecies level.

#### *Distribution in Southern Ocean Sanctuary*

Common bottlenose dolphins are cosmopolitan but are absent from polar waters (Marcuzzi and Pilleri, 1971). Within Sanctuary the species occurs around Tasmania and New Zealand (Baker, 1983; Bannister *et al.*, 1996) where it is common in the Bay of Islands, Hauraki Gulf, and Marlborough Sounds (Baker, 1972) and in Fiordland (Haase and Schneider, 2001). De Boer *et al.* (1999) reported a single group of six bottlenose dolphins near Hobart (depth 36m; 20°C) but otherwise no oceanic sightings known.

Contiguous to the Sanctuary, specimen records exist from the Falkland Islands (Strange, 1992) and Bahía San Sebastian, southern Patagonia (Goodall, 1978; Goodall and Galeazzi, 1985a; R.N.P. Goodall, Email to KVVW, 29 September 2003). The southern distribution boundaries for the common bottlenose dolphin are unknown (55°S is cited by Bannister *et al.*, 1996; ca. 48°S is mapped by Wells and Scott, 2002, and 45° 30'S, stated by Haase and Schneider, 2001), but *T. truncatus* is not reported from sighting surveys in subantarctic and Antarctic waters (Brownell, 1974; Miyazaki and Kato, 1988; Kasamatsu and Joyce, 1995; authors, pers. observations). Limits to the species range appear SST- related, either directly, or indirectly through distribution of prey.

#### *Migration and Seasonality*

No evidence of seasonal movements is available in the Sanctuary, however *T. truncatus* can be seasonally migratory in temperate waters, such as at the northern limit of its range in the NW Atlantic (Bannister *et al.*, 1996; Wells and Scott, 2002), and it is likely the same may be true for its austral range.

#### *Natural History*

In New Zealand, demographics of Fiordland bottlenose dolphins have been studied by Haase and Schneider (2001). Calving takes place there between December and February, and the average calving interval was three years. A survival rate of 80% in the first year was comparable to bottlenose dolphin data from the tropics. Data from Australia are reviewed by Bannister *et al.* (1996).

#### *Conservation Status and Exploitation*

No population estimates for the Southern Ocean and no documented examples of exploitation are available. A rare 'mass stranding'<sup>5</sup> of 21 animals was documented from Delaware Bay (41° 08'S, 173°28'E), South Island, NZ, in March 1982 (Robson, 1984), all of which were rescued. Status designations: IUCN Red List 'Data Deficient'. CITES Appendix II.

### **Short-beaked common dolphin *Delphinus delphis* Linnaeus, 1758**

#### *Systematics and Populations*

Two forms exist in South Australia (contiguous to the Southern Ocean Sanctuary) but 'it is not known whether these represent the short- or long-beaked types' (Bannister *et al.*, 1986).

<sup>5</sup> Likely a tidal trapping (A.N. Baker, personal assessment).

*Distribution in Southern Ocean Sanctuary*

Common dolphins frequent coastal waters all around New Zealand (Baker, 1972) although it is unclear how far south they occur. Short-beaked form recorded from at least Tasmania. Not recorded from territories in the Antarctic or Heard and Macquarie Islands (Bannister *et al.*, 1996).

*Migration and Seasonality*

Not known to be migratory off Australia and New Zealand.

*Natural History*

The biology of Southern Hemisphere *D. delphis* has not yet been documented.

*Conservation Status and Exploitation*

Status designations: IUCN Red List 'Data Deficient'. CITES Appendix II.

**Spectacled porpoise *Phocoena dioptrica* Lahille, 1912***Systematics and Populations*

Barnes (1985) assigned spectacled porpoise to a new genus: *Australophocoena dioptrica*. However, its close relationship with other *Phocoena* species, recognized by Lahille (1912), was confirmed again by mt-DNA cytochrome b analysis (Rosel *et al.*, 1995). No subspecies or distinct populations are defined, however Perrin *et al.* (2000) showed that the relative rostrum length of an Auckland Island specimen was shorter than the range for other regions. Further sampling should resolve suggested geographical variation.

*Southern Ocean Distribution*

Although it has a southern circumpolar distribution (Baker, 1977; Goodall and Schiavini, 1995a), spectacled porpoise appears most common in the southwestern South Atlantic off Tierra del Fuego, outside the Sanctuary (Goodall and Cameron, 1979). Within the Sanctuary, stranded specimens are reported from South Georgia (Fraser, 1968; Strange, 1992; Burton, 1997), Bruny Island, Tasmania (K. Evans *in* Brownell and Clapham, 1999), Macquarie Island (Fordyce *et al.*, 1984), NZ South Island (Baker, 1999) and Auckland Islands (Baker, 1977). It has been seen near Antipodes Islands (Kasamatsu and Joyce, 1990) and Auckland Islands (M. Cawthorn *in* Goodall and Schiavini, 1995). In the Indian Ocean, it was recorded at Heard and Kerguelen Islands (Southern Ocean Sanctuary contiguous areas). Apparent concentration of records near subantarctic islands is possibly due to observer bias (Bannister *et al.*, 1996). The most boreal record is from southern Brazil at 32°S.

*Migration and seasonal movements*

No seasonal movements are confirmed, but sightings made far offshore between 54°S -59°S (IWC, 1991) suggest that there may be some movement across the open ocean, however not necessarily seasonal.

*Natural History*

Habits are both coastal and offshore. Recent reviews are by Goodall and Schiavini (1995), Bannister *et al.* (1996) and Brownell and Clapham (1999). In the western South Atlantic spectacled porpoise seems to breed in spring. Group size in all confirmed sightings have ranged 1-3 animals (Goodall and Schiavini, 1995; Ensor *et al.*, 2001). Kasamatsu *et al.*, (1990) indicated that spectacled porpoise does not form large schools, however this conclusion seems premature considering the small number of sightings. Burmeister's porpoise *Phocoena spinipinnis*, till recently, was also thought to form solely small groups, until a school of ca.150 individuals was sighted off Peru (Van Waerebeek *et al.*, 2002). The stomach of one specimen contained some anchovy and small crustaceans (Goodall and Schiavini, 1995); squid was also mentioned (Bannister *et al.*, 1996).

*Conservation Status and Exploitation*

Hamilton (1952) indicated that 'the species had been taken off South Georgia'. A live-stranded animal in South Georgia was eaten; moreover according whaling captains these porpoises were sometimes shot with rifles for food (Fraser, 1968; Brownell and Clapham, 1999). It used to be hunted by fishermen of Uruguay and southern Chile (Praderi, 1971; Goodall and Schiavini, 1995). Possible entanglement in driftnets and other nets, set, lost or discarded in international waters at higher latitudes (Bannister *et al.*, 1996), and in bottom and midwater trawls (Reeves *et al.* 2002). Population abundance is unknown, but considered 'rare' (Goodall and Schiavini, 1995). Status designations: IUCN Red List 'Data Deficient'. CITES Appendix II.

**Beaked whales *Ziphiidae***

During SOCEP and SO GLOBEC surveys beaked whales were not identified to species. SOCEP found them mostly on shelf slope and near ice. During SO GLOBEC, three mesoplodont sightings were recorded across Drake Passage, and unidentified beaked whales were seen in Gerlache Strait and in the fjords of western Antarctic Peninsula (Figure 1).

**Southern bottlenose whale *Hyperoodon planifrons* Flower, 1882***Systematics and Populations*

No subspecies are named and information on population composition is lacking (Mitchell, 1975a; Mead, 1989a), however mt-DNA control region sequences of two specimens from New Zealand differed 4.12%, considerably higher than the normal interspecific variation of 2% found in other beaked whales (Dalebout *et al.*, 1998). A taxonomic study with global perspective is necessary.

*Distribution in Southern Ocean Sanctuary*

Extensive circumpolar distribution, from the Antarctic continent north to ca. 28°40'S (G.J.B. Ross, *pers. comm.* to ANB, October 2001). In the Sanctuary, strandings are known from the South Island of New Zealand (Baker, 1999), and at 54°19'S on South Georgia (G.J.B. Ross, *pers. comm.* to ANB, October 2001).

*Migration and Seasonality*

Sightings off Durban, South Africa, show strong seasonality with peaks in February and October, the February peak possibly suggesting a general movement northward out of the Antarctic in late summer (Findlay *et al.*, 1992; Sekiguchi *et al.*, 1993).

*Natural History*

Morphology of the southern bottlenose whale is known from only very few specimens and intraspecific variation has not been assessed (e.g. Fraser, 1945; Hale, 1983; Liouville, 1913; Tomilin and Latyshev, 1967). Diet includes a number of Antarctic and subantarctic squid species (Baker, 1983; Hale, 1931; Sekiguchi, 1993; Slip *et al.*, 1995; Zemskii and Budylenko, 1970). The dentine of two *H. planifrons* were found difficult to interpret in terms of ageing (Mitchell *et al.*, 1981).

*Conservation Status and Exploitation*

Southern bottlenose whale 'is sometimes encountered by whalers and killed' (Mitchell, 1975b). At South Georgia, one bottlenose whale was landed in 1912-13; at South Shetlands seven were landed in 1911-13, two in 1923-24 and three in 1925-27 (Harmer, 1928; Risting, 1922). Mead (1989a) published a 1923 photograph of an adult specimen on a flensing platform, reportedly at a South Georgia whaling station. In contrast, Harmer (1928) did not report any South Georgia catches for 1923, but for the South Shetland Islands. Fraser (1945) studied a male caught near South Georgia on an unidentified year. More recently, a few specimens were taken by Soviet whalers for research purposes (Tomilin and Latyshev, 1967; Zemskii and Budylenko, 1970). Kasamatsu *et al.* (1988) reported 42 specimens taken in Antarctic waters from 1970-1982.

Before 1990, population estimates and even relative abundance data of *H. planifrons* were lacking (Mead, 1989a). Sekiguchi *et al.* (1993) indicated it as the second most frequently encountered cetacean in high latitudes of the Southern Ocean. Also, southern bottlenose whales are by far the most abundant ziphiid there, i.e. they account for more than 90% of ziphiid sightings (Kasamatsu *et al.*, 1988). More recently, Kasamatsu and Joyce (1995) suggested there to be about 600,000 beaked whales in the Antarctic during summer months, of which the majority were thought to be southern bottlenose whales, based on IDCR sightings data between 1976/77-87/88, with a correction for g(0). However, the majority of the data for this estimate comes from the first circumpolar survey when only 5% of beaked whales were identified to species level (Branch and Butterworth, 2001). Branch and Butterworth (2001) give estimates of 72,000 (CV 0.13) and 54,000 (CV 0.12) southern bottlenose whales for the second and third IDCR-SOWER circumpolar surveys respectively. These estimates were not corrected for g(0) and have a number of caveats mentioned in the discussion.

Status designations: IUCN Red List 'Lower Risk (conservation dependent)' and CITES Appendix II.

**Arnoux's beaked whale *Berardius arnuxii* Duvernoy, 1851***Systematics and Populations*

Duvernoy (1851) described the species from a 975cm male stranded in Akaroa, New Zealand, the skull of which is curated at the Muséum national d'Histoire naturelle, Paris (Robineau, 1989a). No subspecies, populations or stocks are known.

*Distribution in Southern Ocean Sanctuary*

Arnoux's beaked whale has a wide circumpolar distribution, from the Antarctic pack-ice north to approximately 34°S (Reeves *et al.*, 2003). Specimens are reported from New Zealand, Tasmania, South Georgia, South Shetland Islands and sightings from the Tasman Sea (Fraser, 1937; Bannister *et al.*, 1996; Baker, 1999; Jefferson *et al.*, 1993; Balcomb, 1989). Sightings have occurred predominantly in subantarctic regions, many along the Antarctic Peninsula and in the Weddell Sea (Taylor, 1957; Stonehouse, 1972; McCann, 1975; Lichter, 1986; Hobson and Martin, 1996). Multiple sightings are reported along Victoria Land coast, western Ross Sea, as far south as the

McMurdo Sound ice edge (Ponganis *et al.*, 1995), and off Kemp Land, east Antarctic coast, at 66°56'S, 61°54'E (Rogers and Brown, 1999).

#### *Migration and Seasonality*

*B. armuxii* occurs both north and south of the Antarctic Polar Front, but there is no information available on seasonal shifts or migration. It is recorded among sea ice, even in winter when trapped (Taylor, 1957).

#### *Natural History*

The few facts known are reviewed by Balcomb (1989), Klinowka (1991) and Mead (2002). The usual dive duration is 15-25min, but *B. armuxii* can stay submerged for an hour, which complicates sightings-based surveys. Ageing from dentine readings is difficult to interpret (Mitchell *et al.*, 1981).

#### *Conservation Status and Exploitation*

No abundance estimates exist, however it is notably rare compared to the sympatric southern bottlenose whale. Rarely taken in the Antarctic (Mitchell, 1975a). A specimen of *B. armuxii* was caught outside Deception Island, South Shetlands (Fraser, 1937), another ice-trapped individual was probably killed by gun (Taylor, 1957). Status designations: IUCN Red List 'Lower Risk (conservation dependent)'. Since 1979, Arnoux's beaked whale was CITES Appendix II, but was transferred to Appendix I in 1986 (Klinowska, 1991).

### **Cuvier's beaked whale *Ziphius cavirostris* G. Cuvier, 1823**

#### *Systematics and Populations*

No analysis has been made of population structure and world-wide morphological variation as well as molecular genetics studies are long overdue. Although Rice (1998) dismissed it outright, the population status of an alleged Indo-Pacific subspecies *Z. cavirostris indicus* Van Beneden, 1863 needs verification by comparative genetic and morphological studies. Representative cranial samples are mostly available.

#### *Distribution in Southern Ocean Sanctuary*

According to Heyning (1989), Cuvier's beaked whale is probably found in all oceans and major seas except in the polar regions. However, Kasamatsu *et al.* (1988) reported two observations of Cuvier's beaked whale south of the Antarctic Polar Front, one each in Area VI and Area I. Goodall and Galeazzi (1985) also indicated 'sightings south of 60°S' and Ensor *et al.* (1999) reported three summer sightings at an approximate location (read from published chart) 63.7°S, 90°E ; 63.3°S, 119.6°E and 64.6°S, 128.5°E (mean group size =2). In February 2004 a close range encounter with a small group of Cuvier's beaked whales occurred in Drake Passage, en route to Livingston Island (AMLR 2004 Weekly Report 7, unpublished data). Balcomb (1989) cites 'from the Antarctic continent and ice edge (78°S) north to about 34°S'. Austral specimen records are from the Falkland Islands (at 693cm the largest known specimen; Heyning, 1989), southeast of the Auckland Islands at 52° 08'S (Baker, 1977), and the New Zealand mainland near Cook Strait (41° 24'S) (Baker, 1990), and Tasmania (Guiler, 1978).

#### *Migration and Seasonality*

No migratory movements have been determined.

#### *Natural History*

Reviewed by Heyning (1989, 2003) and Klinowska (1991). Most prey items are open ocean, mesopelagic, or deep-water benthic organisms, concurring with the idea that *Z. cavirostris* is an offshore, deep-diving species. There is some evidence that Cuvier's beaked whales might avoid vessels by diving, thus g(0) may be less than 1.

#### *Conservation Status and Exploitation*

No abundance estimates are available for any region. Cuvier's beaked whale has not been subjected to any fishery in the Southern Hemisphere (Mitchell, 1975a,b; Klinowska, 1991). Some incidental mortality may occur in high-seas gillnet fisheries. Otherwise, the species appears to be exceptionally vulnerable to acoustic trauma (Reeves *et al.*, 2003). Except for the latter there are no known habitat problems (Klinowska, 1991). Status designations: IUCN Red List 'Data Deficient'. CITES Appendix II.

### **Shepherd's beaked whale *Tasmacetus shepherdi* Oliver, 1937**

#### *Systematics and Populations*

Also called Tasman beaked whale. Almost exclusively known from about 30 strandings in New Zealand, southern Australia and Argentina. No subspecies nor stocks are discerned, the latter mainly due to a scarcity of specimens.

#### *Distribution in Southern Ocean Sanctuary*

Probably circumglobal in temperate waters of Southern Hemisphere (Rice, 1998), associated with cooler waters from 33°S to 53°50'S (Klinowska, 1991; R.N.P. Goodall, *pers. comm.* to ANB, October 2000). Whether it

penetrates Antarctic waters is as yet unknown. Most strandings are from South Island, Stewart and Chatham Islands, in the New Zealand region (Rice, 1998). Putative sightings of live individuals in western South Atlantic (53°45'S, 42°30'W) and off Christchurch on the east coast of South Island (Watkins, 1976).

#### *Migration and Seasonality*

Six of the strandings have occurred in the southern summer (November-March) and one in the winter (August). However this is too small a sample on which to base conclusions on seasonal distribution (Mead, 1989c).

#### *Natural History*

Reviewed by Mead (1989c). Shepherd's beaked whale seems to be ichthyophagous.

#### *Conservation Status and Exploitation*

Shepherd's beaked whale is not taken in any fisheries (Mitchell, 1975a,b; Northridge, 1984). If this is mainly an oceanic species feeding in deep water in the Southern Ocean, it would be unlikely to suffer any major interactions or habitat problems (Northridge, 1984; Klinowska, 1991), however the species conservation status is unknown (Reeves *et al.*, 2003). Status designations: IUCN Red List 'Data Deficient'. CITES Appendix II.

### **Strap-toothed beaked whale *Mesoplodon layardii* (Gray, 1865)**

#### *Systematics and populations*

Also known as Layard's beaked whale. No subspecies, populations or stocks are described. A real danger exists for confusion with the spade-toothed whale, *M. traversii*, during ship-based surveys because its external characteristics and behaviour are fully unknown. However, *M. traversii* is thought to be a large, tusked mesoplodont in which the teeth, from a distance, may not be distinguishable from the protruding teeth of *M. layardii*. The striking colouration pattern of the latter could be the only reliable characteristic to distinguish both species, that is if *M. traversii* looks significantly different.

#### *Distribution in Southern Ocean Sanctuary*

Distributed throughout the southern oceans in cold temperate waters. Contiguous and within the Sanctuary, strandings are reported for southern Australia, Tasmania and the southern part of New Zealand (Dixon, 1980; Mead, 1989b; Rice, 1998) and in the past few years several sightings were registered in Antarctic waters. Southernmost specimens include a rostrum found on Macquarie Island at 54°30'S (re-identified by Baker and van Helden, 1999) and a broken calvaria from Heard Island (53°S, 73°30'E) just north of the Sanctuary (Guiler *et al.*, 1987). Most known strandings of *M. layardii* are between 33°S and 53°S (G.J.B. Ross, *pers.comm.* to ANB, October 2001).

#### *Migration and Seasonality*

Migratory movements cannot be evaluated due to limited number of confirmed sightings.

#### *Natural History*

Information for strap-toothed beaked whale, the largest known mesoplodont, is reviewed by Mead (1989b). Mitchell *et al.* (1981) examined the dentine of one *M. layardii* and found it massive and difficult to interpret.

#### *Conservation Status and Exploitation*

No catches of *M. layardii* have ever been reported. The species conservation status is unknown. Status designations: IUCN Red List 'Data Deficient'. CITES Appendix II.

### **Spade-toothed beaked whale *Mesoplodon traversii* (Gray, 1874)**

#### *Systematics and Populations*

No subspecies, populations or stocks are known for *M. traversii*. The holotype, a mandible with teeth, from the Chatham Islands was incorrectly assigned to *M. layardii* for over 125 years. The species was re-discovered from the mandible with large male teeth housed in the Museum of New Zealand, and subsequent mt-DNA correlation with a calvaria stranded on Robinson Crusoe Island, Chile, and described as Bahamonde's beaked whale *Mesoplodon bahamondi* Reyes, Van Waerebeek, Yañez and Cárdenas, 1995. Finally, *M. bahamondi* was recognized as a junior synonym of *M. traversii* (van Helden *et al.*, 2002). It is possible that sightings of this species may have been mistaken for *M. layardii*.

#### *Distribution in Southern Ocean Sanctuary*

*M. traversii* is the least-known of all living species of cetaceans; its external features are not documented and evidently it has never been recognized from sightings. Only three specimens are known, one each from Robinson Crusoe Island, Juan Fernández Islands (33°37'S, 78°53'W), from Pitt Island, Chatham Islands, NZ (44°17'S, 176°15'W) and from White Island, NZ (35°31'S, 177°11'E) (van Helden *et al.*, 2002). The Pitt Island specimen is



the only record within the Sanctuary. It is unknown whether *M. traversii* occurs in Antarctic waters, but there is no reason to think why this medium-to-large sized (Reyes *et al.*, 1995) austral mesoplodont would not.

#### *Migration and Seasonality*

Migratory movements cannot be evaluated for lack of data. All specimens stranded in unknown season.

#### *Natural History*

No information is available.

#### *Conservation Status and Exploitation*

No catches have ever been reported and status is unknown. Status designations: IUCN Red List 'Not Evaluated'. CITES Appendix II.

### **Gray's beaked whale *Mesoplodon grayi* von Haast, 1876**

#### *Systematics and Populations*

No information is available on geographic variation and subspecific division. A North Sea stranding is still the only confirmed record from the Northern Hemisphere. Considered extralimital, it has been found to be genetically identical to specimens of *M. grayi* from New Zealand (M. Dalebout *pers. comm.* to ANB, 2001).

#### *Distribution in Southern Ocean Sanctuary*

The long-held view on the occurrence of Gray's beaked whale is that it covers a circumglobal distribution in temperate or cold temperate waters of the southern hemisphere between 30° and 45° (e.g. Marcuzzi and Pilleri, 1971; Ross, 1979; Rice, 1998; Pitman, 2002). Documented specimen and sighting localities is reviewed by Mead (1989b). Most strandings occur between 35°S and 45°S (G.J.B. Ross, *pers. comm.* to ANB, October 2001).

In New Zealand, it is known from both North and South Islands, where it is the second commonest single strander after *Kogia breviceps*, with ca.180 recorded specimens (New Zealand Whale Stranding Database, Museum of NZ, Wellington, courtesy A.L. van Helden). These strandings and the absence of regular inshore sightings at sea, indicate an offshore population close to New Zealand's east coast. It is the only beaked whale known to have mass-stranded: 25 came ashore on the Chatham Islands in 1873 (von Haast, 1877). Recorded from Tasmania (Nicol, 1986; Bannister *et al.*, 1996), and one specimen (A748, Tasmanian Museum), misidentified as *M. bowdoini*, was re-assigned to *M. grayi* (Baker, 2001).

While Pitman (2002) summarizes *M. grayi* distribution as 'circumglobal in temperate waters of the southern hemisphere', in the same paper an excellent photo taken by Richard A. Rowlett is printed 'taken in Antarctic waters'. Ohsumi *et al.* (1994) indicate a sighting of Gray's beaked whale in the Antarctic based on the IDCR/SOWER survey programme since 1987/88, at about 62°30'S, 150°E (approximate from map) in the Australian Antarctic basin. De Boer *et al.* (1999) sighted two Gray's beaked whales near the Balleny Islands, also off Ross Sea Ice edge (ca. 67°S; 7-20 January 1999) in 950m of water at 2°C. *M. grayi* also occurs in the Scotia Sea, south of the Polar Front (e.g. Table 3). We conclude that the (sub)Antarctic is part of the normal distribution area for *M. grayi*, much like it is for *M. layardii* (e.g. Pitman, 2002). This should become clearer still in the future when an increasing percentage of the hitherto lumped ziphiid sightings are identified to species.

Goodall and Galeazzi (1985) first referred to some 53 stranding observations or specimens of *M. grayi* recorded from the tips of the southern continents, the southernmost being Tierra del Fuego at ca. 54°S. Mead (1989b), repeated by Ohsumi *et al.* (1994), discusses a particular specimen in the Museum of New Zealand (NMNZ612) which he says was collected from an unknown locality in the Antarctic; Mead adds 'it is difficult to attach much importance to this record because *M. grayi* has been known to stray before' (referring to The Netherlands record). However, the origin of this specimen should be of interest. Anton van Helden, Collection manager (marine mammals) at The Museum of New Zealand (*in litt.* to KVVW, 8 April 2003) disputes Mead's (1989b) conclusion and believes the specimen is from the Chatham Islands<sup>6</sup>.

<sup>6</sup> *M. grayi* specimen NMNZ612 was donated to the Colonial Museum (now Museum of New Zealand, Wellington) by Lady Kinsey of Christchurch. The next specimen in the register, a mandible of *T. shepherdii*, listed as coming from the Chatham Islands, is from the same donor. The previous record is a southern right whale earbone that is listed as 'Antarctic?'. A ditto mark is below this associated with the *M. grayi* specimen, however this has been crossed out (probably a product of the transfer of information from the old register). Anton van Helden concludes that, in his opinion 'the most likely origin of the *M. grayi* specimen is the Chatham Islands'.

**Table 3.** New sightings of (like-) Gray's beaked whale in the Scotia Sea by two of the authors (KVV and RL), observed from the RRV *James Clark Ross*.

<i>Identification</i>	<i>Date</i>	<i>Location</i>	<i>Group size</i>	<i>Depth SST (°C)</i>	<i>Comments</i>
<i>M. grayi</i>	4 Feb. 2003	61.394166° S 31.194° W	6 (5-7)	3,956m 1.16 °C	Long, white rostra sticking out above water surface; no teeth seen.
like – <i>M. grayi</i>	8 Feb 2003	56.85648° S 31.59967° W	4 (4-5)	3,608m 2.64 °C	In 1 individual: long rostrum seen before whitish head surfaces; body grey-brown, no scars seen on 3.5-5m body

*Natural History*

Reviewed by Mead (1989b). Mitchell *et al.* (1981) examined the dentine of one *M. grayi* and found it massive and difficult to interpret. The occurrence of early foetuses in May, near-term foetuses in September, and mother with calves in January-February indicates summer breeding in the New Zealand region (ANB, unpublished data).

*Migration and Seasonality*

Migratory movements cannot be evaluated due to lack of data. But strandings between 30°S and 50°S occur most frequently from December through March, suggesting an inshore movement in summer (ANB, unpublished data).

*Conservation Status and Exploitation*

No abundance estimates. No catches have ever been reported in the Southern Ocean. Status designations: IUCN Red List 'Data Deficient'. CITES Appendix II.

**Andrews' beaked whale *Mesoplodon bowdoini* Andrews, 1908***Systematics and Populations*

No information is available on subspecies, populations or stocks. At one time considered conspecific with *M. stejnegeri* and *M. carlhubbsi* from the North Pacific (Orr, 1953; IWC, 1989; Mead, 1989b), *M. bowdoini* is now firmly regarded as a fully distinct species (Baker, 2001; Dalebout *et al.*, 1998).

*Distribution in Southern Ocean Sanctuary*

No confirmed at-sea sightings, and only 35 specimens are known, all from strandings. In New Zealand, stranded specimens are documented from South Island, Stewart, Chatham and Campbell Islands (Andrews, 1908; Mead, 1989b; Baker, 2001). A rostrum was retrieved also from Macquarie Island (Baker, 2001), at 54°30'S the southern-most authenticated record. Globally, the northern-most record is from Bird Island, Western Australia, at 32°12'S. Within and beyond the Sanctuary, this species is circumpolar, having been recorded also from southern Australia, Tristan da Cunha, and the Falkland Islands (Baker, 2001). A presumed specimen from Tasmania (Guiler, 1967) was re-identified as *M. grayi* (Baker, 2001).

*Migration and Seasonality*

None known, however potential migratory movements cannot be evaluated due to a lack of reliable sightings data.

*Natural History*

Extremely little is known. Diet most likely includes small squid and fishes. In the New Zealand region, calving period is indicated as summer/autumn, and calves measure around 2.2m at birth (Klinowska, 1991; Baker, 2001).

*Conservation Status and Exploitation*

No captures have been recorded and there exists no abundance estimate, hence the conservation status of Andrews' beaked whale is unknown. Status designations: IUCN Red List 'Data Deficient' and CITES Appendix II.

**Hector's beaked whale *Mesoplodon hectori* (Gray, 1871)***Systematics and Populations*

The systematic status of *M. hectori* was reviewed by Mead and Baker (1987), and Dalebout *et al.* (2002). To date, no information is available on populations or stocks. Four specimens from California, initially assigned to *M. hectori* were found to represent a new species, *M. perrini* (Dalebout *et al.*, 1998, 2002). Analysis of mtDNA shows no subspecies in samples from New Zealand and Australia (M. Dalebout, *pers. comm.* to ANB, 2001).

*Distribution in Southern Ocean Sanctuary*

No confirmed at-sea sightings are known. Only 38 specimens, all stranded, have been positively identified, and all are from the Southern Hemisphere. Fifteen of these originate from within the Sanctuary circumpolar, and the remainder were recorded slightly north of the Sanctuary, to *ca* 34°S. The largest sample (n=16) is from New Zealand, where 13 of those were within the Sanctuary, followed by Argentina, Tasmania, South Africa and Chile (Goodall, 1978; Mead and Baker, 1987). Four specimens have stranded on the Falkland Islands (R.N.P. Goodall, *pers. comm.* to ANB, October 2000).

The southernmost specimen record is from Navarino Island, Tierra del Fuego at 55°S (R.N.P. Goodall, *pers. comm.* to ANB, April 2003). Rice (1998) refers to it as circumpolar in temperate waters of the Southern Hemisphere. However no compelling reasons exist to conclude that *M. hectori* does not occur in (sub)antarctic waters, and it may easily go unnoticed among unidentified sightings of small beaked whales.

*Migration and Seasonality*

The seasonal nature of stranding records (Dec. through April, in NZ) suggests an inshore movement in summer.

*Natural History*

Reviewed by Mead and Baker (1987) and Mead (1989b). Mother with calf recorded at Stanley (40°48'S), Tasmania, in early April, and northern Argentina and New Zealand in January, suggest a summer calving season.

*Conservation Status and Exploitation*

No direct captures have been documented and the conservation status of Hector's beaked whale is indeterminate. Until 1979, *M. hectori* was known from sexually and physically immature specimens. This was partly responsible for the species being placed in a new genus, *Paiekea*, by Oliver (1922), and regarded as juveniles of *Berardius armuxii* by McCann (1962). However, work by Fraser (1950), Moore (1960), Ross (1970), Mead and Baker (1987) and Dalebout *et al.* (2002), demonstrated that *M. hectori* is a distinct species. Status designations: IUCN Red List 'Data Deficient'. CITES Appendix II.

**ODONTOCETES VAGRANT INTO THE SANCTUARY****Dwarf sperm whale *Kogia sima* (Owen, 1866)***Systematics and Populations*

No subspecies have been described, however recent genetic research suggests significant population structure (Plön *et al.*, 2003). Further work should include a global analysis of geographic variation in crania, considering that sufficient material is available.

*Distribution in Southern Ocean Sanctuary*

Cosmopolitan except polar waters. In the Sanctuary, it is known only from stranded specimens in Tasmania (Guiler, 1978; Bannister *et al.*, 1996). One of us (DT) collected a female with full-term foetus at Cloudy Bay, Bruny island, Tasmania. In contiguous waters, strandings are known from South Australia (Bannister *et al.*, 1996) and three records from northern New Zealand (Baker and van Helden, 1990; ANB, unpublished data).

*Migration and Seasonality*

No data for Sanctuary waters.

*Natural History*

Reviewed by Caldwell and Caldwell (1989) and McAlpine (2002). More coastal than pygmy sperm whale.

*Conservation Status and Exploitation*

No population estimates exist and no specific data for study area; however incidental mortality in fishing gear and ingestion of plastic debris may be a problem (Reeves *et al.*, 2003). Status designations: IUCN Red List 'Least Concern'; CITES Appendix II.

**Lesser beaked whale *Mesoplodon peruvianus* Reyes, Mead and Van Waerebeek, 1991***Systematics and Populations*

Also named Peruvian beaked whale and pygmy beaked whale. No subspecies or populations are identified, however, *M. peruvianus* from the eastern and western Pacific may belong to different biological stocks. Sightings of '*Mesoplodon* sp. A' in the offshore eastern Pacific, tentatively assigned to *M. peruvianus* (Pitman and Lynn, 2001), remain to be confirmed as such.

*Distribution in Southern Ocean Sanctuary*

Lesser beaked whales have been found in temperate waters of the eastern Pacific (Chile, Peru, Mexico, California). One stranding at Kaikoura (42°31'S, 173°30'E), South Island, NZ (Baker and van Helden, 1999) currently stands as the southernmost record for the species, and adds it among Sanctuary species. Pitman and Lynn (2001) called the latter 'almost certainly an extralimital record' but this conclusion seems premature, and is probably incorrect. The southern range of *M. peruvianus* remains entirely unclear and it could extend much further south into the Southern Ocean Sanctuary.

#### Migration and Seasonality

No information is available. Most freshly taken specimens in Peru were landed during summer months (K. Van Waerebeek and J.C. Reyes, unpublished data). This could be related to inshore movements connected to a number of parameters, including favourite prey availability or calving. It probably has little or nothing to do with sea surface temperatures, which in the cold Peru Current system show only the weakest of correlations with seasons.

#### Natural History

The Kaikoura specimen was physically mature at 372cm (Baker and van Helden, 1999).

#### Conservation Status and Exploitation

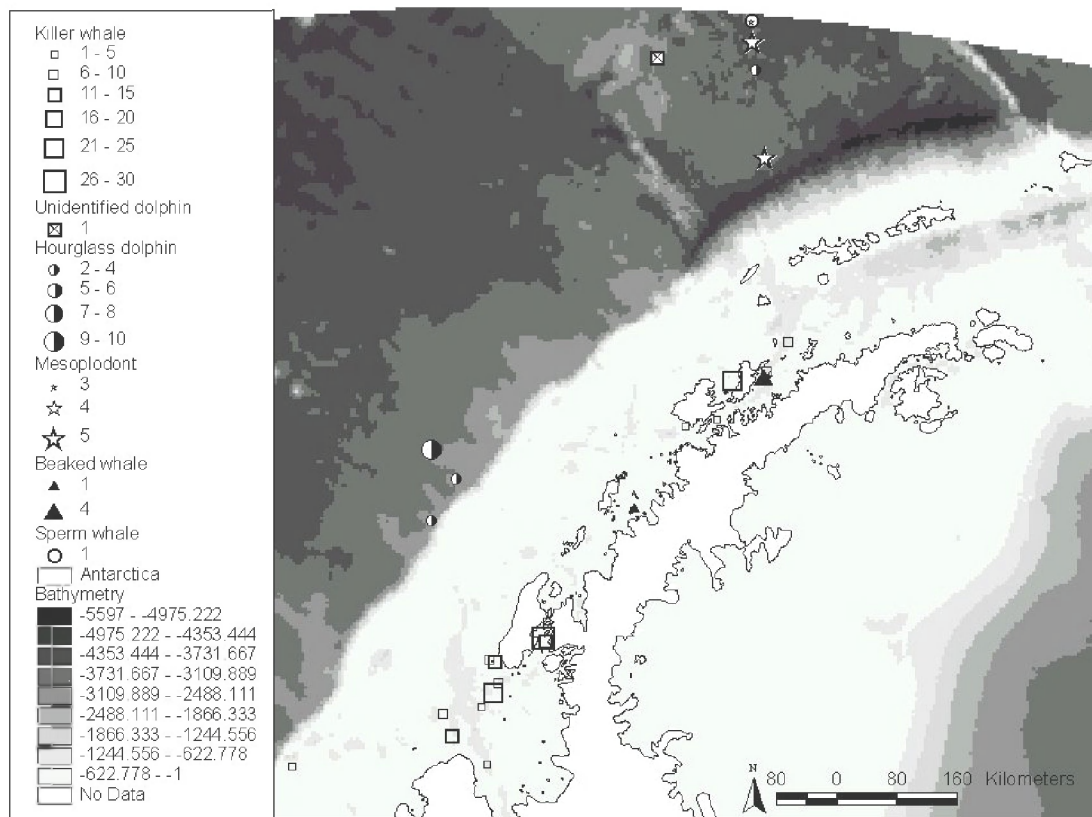
Off Peru, lesser beaked whales are incidentally taken with some regularity (Reyes *et al.*, 1999; K. Van Waerebeek and J.C. Reyes, unpublished data). The skull of a single specimen from northern Chile showed two bullet lesions (Van Waerebeek *et al.*, 1999). No other information on its status, including no abundance estimates are available. Status designations: IUCN Red List 'Data Deficient'. CITES Appendix II.

#### Dense-beaked whale *Mesoplodon densirostris* (de Blainville, 1817)<sup>7</sup>

##### Systematics and Populations

Also referred to as Blainville's beaked whale. No subspecies or populations are described, but given its global distribution (see Pastene *et al.*, 1990), studies of geographic variation are needed.

Fig. 1. Odontocete sightings during IWC-SO GLOBEC/CCAMLR surveys off western Antarctic Peninsula (see Table 2).



<sup>7</sup> de Blainville, Henri Marie (1777-1850), French physician. *Non* 'Blainville' (Hershkovitz, 1966; *et alii*).

*Distribution in Southern Ocean Sanctuary*

At the southern end of its circumglobal distribution in low and mid-latitudes, contiguous to the Sanctuary, Dense-beaked whale is known from strandings in South Africa, North Island, NZ (90 Mile Beach, Northland and Tangoio, Hawke Bay, at 39°19'S, 176°57'E), just north of the Sanctuary boundary (Baker and van Helden, 1999), and southern Chile at 41°28'S, 73°00'W (Guiler, 1966; Pastene *et al.*, 1990; Bannister *et al.*, 1996). The only record firmly within Sanctuary boundaries is a specimen from Tasmania, at 40°50'S (Guiler, 1966; Bannister *et al.*, 1996). A mesoplodont rostrum from Macquarie Island was thought to be a vagrant far beyond the supposed normal range' (Bannister *et al.*, 1996), however this specimen was re-identified as a large male *M. layardii* (Baker and van Helden, 1999).

*Migration and Seasonality*

No evidence of migratory movements is available. Dense-beaked whale's normal tropical and warm temperate distribution suggests that it probably penetrates northern Sanctuary strata (circa 40°S) mainly in summer months. The most poleward global record is off Nova Scotia at 45°N (Pastene *et al.*, 1990), and similar range extensions may be possible in austral waters.

*Natural History*

*M. densirostris* is essentially a warm-water species. Group size is small and typically ranges from 3-7 animals (Mead, 1989b; Klinowska, 1991). Individual cranial variation was studied by Besharse (1971).

*Conservation Status and Exploitation*

No abundance estimates are available. One adult male killed by fishermen near Puerto Montt, southern Chile, was rendered for its oil (Pastene *et al.*, 1990). Status designations: IUCN Red List 'Data Deficient'. CITES Appendix II.

**True's beaked whale *Mesoplodon mirus* True, 1913***Systematics and Populations*

No subspecies or populations are described, but divergent southern and northern hemisphere populations may exist considering a lack of records in equatorial waters.

*Distribution in Southern Ocean Sanctuary*

In the Southern Hemisphere, just a few strandings are known from areas contiguous to the Southern Ocean Sanctuary, including South Africa, western and southern Australia, and Tasmania (Bannister *et al.*, 1996).

One of us (DT) collected a young, freshly dead *Mesoplodon* sp. on 13 October 1993 which had stranded at Clifton Beach, Tasmania. The specimen was provisionally assigned to *M. mirus* (G. Ross, pers.comm. to D. Thiele), however available field data and the skull need a thorough re-evaluation. Until that happens, the senior author considers the specimen *Mesoplodon* sp.

*Migration and Seasonality*

No evidence of migratory movements exists. Chances are that distribution extends into (sub)antarctic latitudes.

**Risso's dolphin *Grampus griseus* (G. Cuvier, 1812)***Distribution in Southern Ocean Sanctuary*

Risso's dolphin *Grampus griseus* normal distribution include warm and temperate seas. Off Australia south to 39°S (Victoria) (Bannister *et al.*, 1996). The species has been recorded from within the Sanctuary in New Zealand waters by Baker (1974), who reported two strandings on the northern coast of Cook Strait at 41°17'S, 174°54'E. An adult Risso's dolphin, the famous 'Pelorus Jack' accompanied ships across Admiralty Bay, Marlborough, New Zealand (40°58'S, 173°51'E) between 1880 and 1912 (Baker, 1974). Off southern South America, Risso's dolphin has been encountered south of 50°S, so it may penetrate considerably farther into the Tasman Sea than the Cook Strait record suggests.

**Rough-toothed dolphin *Steno bredanensis* (Lesson, 1828)***Distribution in Southern Ocean Sanctuary*

A warm-water species, the rough-toothed dolphin is known from the Southern Ocean Sanctuary only at 41°30'S, 174° 03'E, Cloudy Bay, east coast of the South Island, New Zealand, where two specimens stranded together in June 1990 (ANB, unpublished data).

*Migration and Seasonality*

With a confirmed winter record at 41°30'S, hypothetical future summer records could reach even farther south.

**ODONTOCETE OCCURRING CONTIGUOUS TO THE SANCTUARY**

### Ginkgo-toothed beaked whale *Mesoplodon ginkgodens* Nishiwaki and Kamiya, 1958

#### *Distribution in Southern Ocean Sanctuary*

The ginkgo-toothed beaked whale is known from three stranding events on the New South Wales coast, Australia, at ca.37°S (Bannister *et al.*, 1996), and one on the west coast of the North Island of New Zealand at 39°S (A. L. van Helden, *pers. comm.* to ANB, 2003). Thus, *M. ginkgodens* inhabits the Tasman Sea.

A skull initially assigned to this species, collected at White Island, New Zealand (37°31'S, 177°11'E) (Baker and van Helden, 1999) was re-identified as *M. bahamondi* Reyes *et al.* 1991, a junior synonym of *M. traversii* (van Helden *et al.*, 2002).

## DISCUSSION

Prior to the declaration of the Southern Ocean Sanctuary, research programmes focused on estimating abundance of commercially exploited whale species. However, since 1994, the establishment of much broader research programmes has resulted in a much greater knowledge of the distribution of several odontocete species in the Southern Ocean. Nonetheless, many remain poorly known.

### Beaked whales

Despite hundreds of biologists navigating in Antarctic waters for two centuries, until recently, the only two ziphiids recognized from the Antarctic Ocean have been the southern bottlenose whale and Arnoux's beaked whale (e.g. Brownell, 1974; Nishiwaki, 1977; Miyazaki and Kato, 1988; Kasamatsu and Joyce, 1995; Ponganis *et al.* 1995), easily identified due to size and highly visible bulbous head. Other beaked whales may be as abundant, but less conspicuous. As recently as Nishiwaki (1977), *M. layardii*, *M. grayi* and *M. hectori* were considered of a temperate-cold, but not a cold-water, distribution, much less occurring south of the Antarctic Polar Front. Goodall and Galeazzi (1985) first suggested that 'a species of *Mesoplodon*' may reach the South Shetland Islands, without specifying taxon.

Until recently, most research cruises (e.g. Nishiwaki *et al.*, 1999) pooled mesoplodonts under ziphiid whales, as little attempts were made to discriminate between species, mainly because of the difficulty in identifying beaked whale species at sea with limited diagnostic external characters. Also, the few stranding records south of 45°S may reflect the paucity of land surfaces and any associated human populations. Most subantarctic islands are uninhabited and only visited during dedicated expeditions for purposes other than searching for stranded cetaceans. Despite these limitations, evidence is emerging which suggests that mesoplodonts are widely distributed throughout sub(antarctic) seas. This paper shows that *M. layardii*, *M. grayi* and unidentified mesoplodonts (Tables 3, 4) are not uncommon, especially considering their lengthy and deep diving and inconspicuous surface behaviour which makes them difficult to detect. Positive data are still too scarce to establish the southern distribution range for several other mesoplodonts, including two smaller species *M. hectori* and *M. peruvianus*, and four larger species *M. bowdoini*, *M. traversii*, *M. mirus* and *M. ginkgodens*, but any of these could occur in the (sub)antarctic. Mesoplodonts continue to surface in unexpected areas. For instance, (boreal) polar distribution was recently revealed for Sowerby's beaked whale *Mesoplodon bidens* (Carlström *et al.*, 1997; Lien and Barry, 1990).

Mesoplodonts previously identified as like-strap-toothed beaked whales (and perhaps even some 'positive' sightings) may conceivably cover also some spade-toothed beaked whales *M. traversii* (Gray, 1874), considering that external features of the latter are unknown. The large teeth of adult male *M. traversii* are similar enough to have been confused with the tusk-size teeth of *M. layardii* for over a century (see van Helden *et al.*, 2002). Future morphological data hopefully will pin-point discriminating features.

While some authors denied a distribution of Cuvier's beaked whale in polar regions (Moore, 1963; Heyning, 1989; Rice, 1998), Kasamatsu *et al.* (1988) reported two observations south of the Antarctic Polar Front, and in 2004 a small group was sighted in the Drake Passage.

If many earlier surveys in (sub)antarctic waters did not reveal *Mesoplodon* spp., it is most readily explained by a bias in research effort focused on large whales<sup>8</sup> (e.g. Murase *et al.*, 2001) and a lack of confidence in beaked whale identification leading to lumping species as ziphiids (e.g. Miyazaki and Kato, 1988; Ohsumi *et al.*, 1994; Kasamatsu and Joyce, 1995). However, the southern boundary of summer distribution might also have shifted south. Increasingly experienced observers and the use of high-magnification binoculars will continue adding positive sightings and shed light on the issue.

### Status

The abundance and status of all odontocete populations in the Southern Ocean Sanctuary are poorly known. Branch and Butterworth (2001) calculated estimates for sperm whale, killer whale, and southern bottlenose whale from the IDCR/SOWER surveys, but noted important caveats surrounding all of these estimates. For deep-diving

<sup>8</sup> Closing on ziphiids is rarely attempted during surveys.

species such as sperm whale and southern bottlenose whale, the assumption of  $g(0)=1$  is not realistic and will result in a negative bias. For hourglass dolphins in particular, estimates are also complicated by responsive movement because this species is known for approaching vessels in order to bowride. SOCEP data suggest long-finned pilot whales and killer whales often approach vessels with active, bottom-mounted pingers (D.Thiele, unpublished data).

Kasamatsu and Joyce (1995) had previously calculated abundance estimates for sperm whales, killer whales, long-finned pilot whales, hourglass dolphins, and all beaked whales combined from the IDCR surveys between 1976/77 and 1987/88. This included data from what is often referred to as the first (1978/79-1983/84), and part of the second circumpolar survey. An estimate of  $g(0)$  was made for each species based on a model of diving behaviour and this was used to correct the abundance estimates. For several of the species including sperm whale, long-finned pilot whale and hourglass dolphin the area south of 60°S covered by the IDCR/SOWER surveys has only limited overlap with their known latitudinal range in the Southern Ocean. The different latitudinal and longitudinal coverage of the circumpolar surveys has complicated comparisons between them and Branch and Butterworth (2001) did not find reliable evidence of any trends in odontocete numbers.

Deep-water squid, thought to be regurgitated at the surface by sperm whales form part of the diet of several species of albatross. Clarke *et al.* (1981) concluded from an examination of wandering albatross *Diomedea exulans* diet that twenty-two of the species found in albatross regurgitations have also been identified from sperm whale stomachs: only three species were not found in sperm whale stomachs. It would be hard to imagine how else an albatross could catch such squid. Clarke and Prince (1981) found less overlap with sperm whale diet in grey-headed albatross *Diomedea chrysostoma* and black-browed albatross *Diomedea exulans*, finding one large *Ancistrocheirus* sp. squid beak that was likely regurgitated, but the remainder of species found were thought to be caught at the surface. Thus it is possible that sperm whales play a significant role in the feeding ecology of albatrosses, particularly wandering albatross.

Some studies have attempted to examine the prey consumption by odontocetes in the Southern Ocean (Kasamatsu and Joyce, 1995) and particularly the consumption of cephalopods relative to pinnipeds and seabirds (Santos *et al.*, 2001; Hindell *et al.*, 2003). These comparisons are complicated by the exact area considered and the data used for abundance estimates. Kasamatsu and Joyce (1995) estimated that beaked whales accounted for 67% of odontocete consumption and sperm whales 22%, whereas the range of values estimated by Santos *et al.* (2001) for sperm and beaked whales overlapped but with sperm whales having the higher values. Regardless of the exact data used, it is clear that odontocetes play an important role in the Southern Ocean ecosystem.

When CCAMLR was first negotiated as part of the Antarctic Treaty System the initial objective agreed by the Antarctic Treaty Consultative Parties in 1977 was to ensure that exploitation of krill would not inhibit the recovery of whale and seal populations. However, it is also non-krill dependent predators, such as odontocetes, that may have been affected by recent fisheries, including the collapse of the marbled rockcod (*Notothenia rossii*) in the early 1970s and, some stocks of the Patagonian toothfish (*Dissostichus eleginoides*) within the CCAMLR area (Constable *et al.*, 2000). Squid fisheries also have a high potential to impact on odontocetes, most especially on beaked whales, many of which seem strictly teuthophagous, as well as on sperm whales. Following declines in catches of *Ilex argentinus* in the southwest Atlantic, the ommastrephid squid (*Martialia hyadesi*) is a likely candidate for further exploitation (Rodhouse, 1997). *M. hyadesi* is widely distributed in the sub-Antarctic Scotia Sea and in considering an ecological approach to the potential fisheries management for this species, Rodhouse (1997) included sperm whale, southern bottlenose whale and long-finned pilot whale as significant predators. The southern elephant seal (*Mirounga leonina*) is also a major predator on squid and amongst the pinnipeds probably occupies the closest ecological role to sperm whales and beaked whales in terms of diet and diving behaviour and off-shore foraging patterns. Hindell *et al.* (2003) suggested that southern elephant seals account for between 19–36% of the total Antarctic consumption of cephalopods by sperm whales, beaked whales, seals and seabirds combined. In the Indian Ocean sector, southern elephant seal numbers declined between the 1950s and 1980s. Although food availability has been regarded as an explanation for the decline (e.g. McMahon *et al.*, 2003) an alternative suggestion is that the decline may have been due to predation by killer whales (Branch and Williams, 2003).

There has generally been insufficient data to examine relationships in distribution patterns between odontocetes and other cetaceans in the Southern Ocean. Most of the relationships examined involve killer whales. Results from the IDCR/SOWER surveys indicate a strong correlation between observed densities of killer and minke whales with densities of both species being highest close to the ice edge (Branch and Butterworth, 2001; Branch and Williams, 2003). Leaper *et al.* (2001) noted an association in occurrence between sperm whales and killer whales from line-transect data in the Scotia Sea. Other authors have also reported observations of the two species together (Mikhalev *et al.*, 1981; Nolan *et al.*, 2000). However, analysis of data from circumpolar surveys demonstrated temporal variations in density suggesting ‘different migration patterns by species, especially between sperm whale and killer

whale' (Kasamatsu and Joyce, 1995). This may indicate that correlations between sperm whale and killer whale distribution patterns are limited to localised areas.

From the above, it becomes clear that a significant amount of new information on Odontocete spatial and temporal distribution in the Southern Ocean, and their ecological interactions, has become available over the past decade, but our knowledge remains patchy and much remains to be investigated.

## ACKNOWLEDGEMENTS

Natalie Goodall is thanked for data and literature support, Anton van Helden for providing data from the New Zealand Whale Stranding Database. We also acknowledge information provided as personal communications from Graham Ross to ANB. These data were gathered originally for IWC document SC40/SM23 (Distribution of beaked whales in the Southern Hemisphere), published only as an abstract. Since then, a number of records have been received from R.N.P. Goodall, A.N. Baker, C. Kemper and J.G. Mead and added to the database by Dr. Ross. We thank all originators for the use of this information. Funding for KVV, RL and VP was provided by the International Fund for Animal Welfare. 'Southern Ocean Cetacean Ecosystem Program' (SOCEP) was funded by the Australian Government. Surveys part of IWC-Southern Ocean GLOBEC/CCAMLR were funded by these respective organisations.

## REFERENCES

- Aguayo, L. A. 1975. Progress Report on Small Cetacean Research in Chile. *J. Fish. Res. Board Canada* 32: 1123-1143.
- Aguayo, L. A. and Torres, D. 1967. Observaciones sobre mamíferos marinos durante la Vigésima Comisión Antártica Chilena. *Rev. Biol. Mar.* 13: 1-57.
- Andrews, R. C. 1908. Description of a new species of *Mesoplodon* from Canterbury Province, New Zealand. *Bull. Amer. Mus. Nat. History* 24 (8): 203-215.
- Angot, M. 1954. Observations sur les mammifères marins de l'Archipel de Kerguelen, avec une étude détaillée de l'Elephant de mer *Mirounga leonina* L. *Mammalia* 18: 1-11. [not seen: cited in Brownell and Praderi, 1985].
- Ash, C. 1962. Whaler's Eye. Macmillan Co. N.Y. 245pp.
- Ashford, J.R., Rubilar, P.S. and Martin, A.R. 1996. Interactions between cetaceans and longline fishery operations around South Georgia. *Mar. Mamm. Science* 12(3): 452-457.
- Awbrey, F. T., Thomas, J.A., Evans, W.E. and Leatherwood, S. 1982. Ross Sea killer whale vocalizations: preliminary description and comparison with those of some Northern Hemisphere killer whales. *Rep. int. Whal. Commn.* 32: 667-70.
- Baker, A. N. 1972. New Zealand Whales and Dolphins. *Tuatara* 20(1) 49pp.
- Baker, A.N. 1974. Risso's dolphin in New Zealand waters and the identity of 'Pelorus Jack'. *Rec. Dom. Museum. Wellington* 8(16):2676-276.
- Baker, A. N. 1977. Spectacled porpoise, *Phocoena dioptrica*, new to the Subantarctic Pacific Ocean. *N.Z. J. Mar. Freshw. Res.* 11: 401-406.
- Baker, A. N. 1978. The status of Hector's dolphin, *Cephalorhynchus hectori* (Van Beneden), in New Zealand waters. *Rep. Int. Whal. Commn.* 28: 331- 334.
- Baker, A. N. 1981. The southern right whale dolphin *Lissodelphis peronii* (Lacépède) in Australasian waters. *Nat. Mus. NZ Rec* 2(4): 17-24.
- Baker, A.N. 1983. Whales and Dolphins of New Zealand and Australia: an Identification guide. Wellington, Victoria University Press. 133pp.
- Baker, A.N. 1990. Marine Mammals. pp. 241-262, In G.P. Glasby (Ed). *Antarctic Sector of the Pacific*, Elsevier Press, Oxford
- Baker, A.N. 1999. Whales and Dolphins of New Zealand and Australia: an Identification guide. Wellington, Victoria University Press. 133pp.
- Baker, A.N. 2002. Status, relationships, and distribution of *Mesoplodon bowdoini* Andrews, 1908 (Cetacea: Ziphiidae). *Marine Mammal Science* 17 (3): 473-493.
- Baker, A.N., Smith, A.N.H. and Pichler, F.B. 2002. Geographical variation in Hector's dolphin: recognition of new subspecies of *Cephalorhynchus hectori*. *J. Royal Soc. New Zealand* 32 (4): 713-727.
- Baker, A. N. and van Helden, A. L. 1990. First record of the dwarf sperm whale, *Kogia simus* (Owen), from New Zealand. *National Museum of New Zealand Records* 3 (12): 125-130.
- Baker, A. N. and van Helden, A. L. 1999. New records of beaked whales, Genus *Mesoplodon*, from New Zealand (Cetacea: Ziphiidae). *J. Royal Soc. New Zealand* 29: 235-244.
- Balcomb, K.C. III. 1989. Baird's beaked whale *Berardius bairdii* Stejneger, 1883: Arnoux's beaked whale *Berardius arnuxii* Duvernoy, 1851. pp. 261-288. In: Handbook of marine Mammals. (eds. S.H. Ridgway and R. Harrison). Academic Press.
- Bannister, J.L., Kemper, C.M. and Warneke, R.M. 1996. *The Action Plan for Australian cetaceans*. Australian Nature Conservation Agency. 242 pp.



- Barnes, L.G. 1985. Evolution, taxonomy, and antitropical distributions of the porpoises (Phocoenidae, Mammalia). *Mar. Mamm. Science* 1: 149-165.
- Bennett, F. 1840. *Narrative of a whaling voyage around the globe, from the year 1833 to 1836*. R. Bentley, London. 395pp.
- Besharse, J. C. 1971. Maturity and sexual dimorphism in the skull, mandible, and teeth of the beaked whale, *Mesoplodon densirostris*.
- Best, P.B. 1979. Social organization in sperm whales, *Physeter macrocephalus*. Pp. 227-289. In: (eds. H.E. Winn and B.L. Olla). Behavior of marine animals. Plenum Press, NY.
- Best, P.B., Canham, P.A.S. and McLeod, N. 1984. Patterns of reproduction in sperm whales, *Physeter macrocephalus*. *Rep. int. Whal. Commn.* (special issue 6): 51-79.
- Bierman, W.H. and Slijper, E.J. 1947. Remarks upon the species of the genus *Lagenorhynchus*. I. *Proc. Kon. Ned. Akad. Wet.* 50: 89-100.
- Brager, S. 1999. Association patterns in three populations of Hector's dolphins *Cephalorhynchus hectori*. *Can. J. Zoology* 77: 13-18.
- Branch and Butterworth. 2001. Estimates of abundance south of 60°S for cetacean species sighted frequently on the 1978/79 to 1997/98 IWC/IDCR-SOWER sightings surveys. *Journal of Cetacean Research and Management* 3(3):251-270
- Branch, T.A. and Williams, T. 2003. Legacy of industrial whaling: could killer whales be responsible for declines in Southern Hemisphere sea lions, elephant seals and minke whales? Paper SC/55/IA4 presented to IWC Scientific Committee, Berlin, 2003.
- Brown, S.G. 1988. Records of Commerson's dolphin (*Cephalorhynchus commersonii*) in South American waters and around South Georgia. *Rep. int. Whal. Commn. (Special Issue 9)*: 85-92.
- Brown, S.G. and Gaskin, D.E. 1987. Report on whale observations in the Antarctic 1966/67. *FAO Fish. Circ.* 111.
- Brownell, R.L. jr. 1974. Small odontocetes of the Antarctic. pp. 13-19. In: V.C. Bushnell (ed.) *Antarctic Map Folio Series*. Folio 18. American Geographic Society, New York.
- Brownell, R.L. Jr. and Clapham, P.J. 1999. Spectacled porpoise *Phocoena dioptrica* Lahille, 1912. pp. 379-391. In: *Handbook of Marine Mammals* 6. Academic Press.
- Brownell, R.L. and Donahue, M.A. 1999. Hourglass dolphin, *Lagenorhynchus cruciger* (Quoy and Gaimard, 1824). pp. 121-135 In: *Handbook of Marine Mammals*. Vol. 6. 121-135.
- Brownell, R.L. Jr. and Praderi, R. 1985. Distribution of Commerson's *Cephalorhynchus commersonii* and the rediscovery of the type of *Lagenorhynchus floweri*. *Sci. Rep. Whales Res. Inst.* 36: 153-164.
- Budylenko, G.A. 1981. Distribution and some aspects of the biology of killer whales in the South Atlantic. *Rep. int. Whal. Commn.* 31: 523-5
- Buffr  nil, V.D., Dziedzic, A., and Robineau, D. 1989. R  partition et d  placements des dauphins de Commerson (*Cephalorhynchus commersonii* Lac  p  de 1804) dans un golfe des   les Kerguel  n: donn  es du marquage individuel. *Canadian J. Zool.* 67: 516-521.
- Burton, R. 1997. South Georgia. The Government of South Georgia and the South Shetland Islands. 29pp.
- Caldwell, D.K. and Caldwell, M.C. 1989. Pygmy sperm whale *Kogia breviceps* (de Blainville, 1838): dwarf sperm whale *Kogia simus* Owen, 1866. pp. 235-260. In: S.H. Ridgway and R. Harrison (eds). *Handbook of Marine Mammals*. Vol. 4. Academic Press.
- Carlstr  m, J., Denkinger, J., Feddersen, P. and Oien, N. 1997. Record of a new northern range of Sowerby's beaked whale (*Mesoplodon bidens*). *Polar Biology* 17: 459-461.
- Cassens, I., Van Waerebeek, K., Best, P.B., Crespo, E.A., Reyes, J. and Milinkovitch, M.C. 2003. The phylogeography of dusky dolphins (*Lagenorhynchus obscurus*): a critical examination of network methods and rooting procedures. *Molecular Ecology* 12: 1781-1792.
- Centre for Russian Environmental Policy, 1995. *Soviet Antarctic Whaling Data 1947-1972*. Moscow 336pp.
- Childerhouse, S. J., Dawson, S. M. and Slooten, E. 1995. Abundance and seasonal residence of sperm whales at Kaikoura, New Zealand. *Can. J. Zool.* 73: 723-731.
- Chrisp, J. 1958. South of Cape Horn: a story of Antarctic whaling. R. Hale, London.
- Cipriano, F. 1992. Behavior and occurrence patterns, feeding ecology, and life history of dusky dolphins (*Lagenorhynchus obscurus*) off Kaikoura, New Zealand. Ph.D. dissertation, University of Tucson, Tucson, AZ. 216pp.
- Clapham, P.J. and Baker, C.S. 2002. pp. 1328-1332. Modern whaling. In: W.F. Perrin et al. (eds). *Encyclopedia of Marine Mammals*, Academic Press.
- Clarke, M. R. 1980. Cephalopoda in the diet of Sperm Whale. *Discovery Reports* 37: 1-324.
- Clarke, M. R., Croxall, J. P., and Prince P.A. 1981. Cephalopod remains in regurgitations of the wandering albatross *Diomedea exulans* at South Georgia. *British Antarctic Survey Bulletin*. 54: 9-21.
- Clarke, M.R. and P. A. Prince. 1981. Cephalopod remains in regurgitations of black-browed and grey-headed albatrosses at South Georgia. *British Antarctic Survey Bulletin* 54: 1-7.

- Clarke, M. and Goodall, N. 1994. Cephalopods in the diets of three odontocete cetacean species, stranded at Tierra del Fuego, *Globicephala melaena*, *Hyperoodon planifrons* and *Cephalorhynchus commersonii*. *Antarctic Science* 6(2): 149-154.
- Clarke, R. 1962. Whale observation and whale marking off the coast of Chile in 1958 and from Ecuador towards and beyond the Galápagos Islands in 1959. *Norsk Hvalfangst-Tidende* 51 (7): 265-287.
- Constable, A. J., de la Mare, W. K., Agnew, D. J., Everson, I. and Miller, D. 2000. Managing fisheries to conserve the Antarctic marine ecosystem: practical implementation of the Convention of the Conservation of Antarctic Marine Living Resources (CCAMLR). *ICES Journal of Marine Science* 57: 778-791.
- Crespo, E.A., Pagnoni, G. and Pedraza, S.N. 1985. Structure of a long-finned pilot whale school stranded in Patagonia. *Sci. Rep. Whales Res. Inst.* 36: 97-106.
- Dalebout, M.L., Mead, J.G., Baker, C.S., Baker, A.N. and van Helden, A.L. 2002. A new species of beaked whale *Mesoplodon perrini* sp.n. (Cetacea, Ziphiidae) discovered through phylogenetic analysis of mitochondrial DNA sequences. *Mar. Mamm. Science* 18: 577-608.
- Dalebout M.L., van Helden, A., Van Waerebeek, K. and Baker, C.S. 1998. Molecular genetic identification of southern hemisphere beaked whales (Cetacea: Ziphiidae). *Molecular Ecology* 7: 687-94.
- Davies, J.L. 1960. The southern form of the pilot whale. *J. Mammalogy* 41: 29-34.
- Davies, J.L. 1963. The whales and Seals of Tasmania. University of Tasmania.
- Dawson, S.M. and Sooten, E. 1988. Hector's dolphin: distribution and abundance. *Rep. Int. Whal. Commn.* (special issue 9): 315-324.
- Dawson, S.M. 1991. Incidental catch of Hector's dolphins in inshore gillnets. *Mar. Mamm. Science* 7: 118-132.
- Dawson, S.M. 2002. *Cephalorhynchus* dolphins. pp. 200-203. In: W.F. Perrin, B. Würsig, J.G.M. Thewissen (eds.). *Encyclopedia of Marine Mammals*. Academic Press, San Diego.
- De Boer, M.N., Frizell, J. and Sonntag, R.P. 1999. Cetacean observation in the Southern Ocean and Indian Ocean Sanctuaries. SC/51/O12, IWC SC Meeting Grenada, 14pp. (unpublished).
- Dixon, J.M. 1980. A recent stranding of the strap-toothed whale, *Mesoplodon layardi* (Gray) (Ziphiidae) from Victoria, and a review of Australian records of the species. *Vict. Naturalist* 97: 34-41.
- Donovan, G.P. 2004. A review of IWC stock boundaries. Pp. 39-68. (A.R. Hoelzel, editor). Genetic ecology of whales and dolphins. *Rep. Int. Whal. Commn.* (special issue 13).
- D'Orbigny, A. and Gervais, P. 1847. Voyage dans l'Amérique méridionale. IV (2), Mammifères, Paris, Bertrand éditions.
- Dufault, S., Whitehead, H., and Dillon, M. 1999. An examination of the current knowledge on the stock structure of sperm whales (*Physeter macrocephalus*) worldwide. *J. Cetacean Res. and Manag.* 1: 1-10.
- Duvernoy, M. 1851. Mémoire sur les caractères ostéologiques des genres nouveaux ou des espèces nouvelles de cétacés vivants ou fossiles dont les squelettes entiers, ou les têtes seulement sont conservés dans les galeries d'Anatomie comparée du Museum d'Histoire naturelle. *Annals. Sci. nat.*, 3e sér., (Zool.) 15: 5-71.
- Ellis, R. 1982. Dolphins and Porpoises. Alfred A. Knopf, New York. 270pp.
- Ensor, P., Matsuoka, K., Marques, F., Miura, T., Murase, H., Pitman, R., Sakai, K. and Van Waerebeek, K. 2001. 2000-2001 IWC –Southern Ocean Whale and Ecosystem Research (IWC-SOWER) Circumpolar Cruise, Areas V, VI and I. Report to IWC Scientific Committee Meeting, London.
- Ensor, P., Sekiguchi, K., Doherty, J., Kleivane, L., Ljungblad, D., Marques, F., Matsuoka, K., Narita, H. Pitman, R., Sakai, K. 1999. 1998-99 IWC–Southern Ocean Whale and Ecosystem Research (IWC-SOWER) Antarctic Cruise, Areas III and VI. SC/51/CAWS6 report to IWC SC Meeting, Grenada.
- Evans, P.G.H. and Pascual, E.U. 2001. Protected areas for cetaceans. Proceedings of the workshop, Valencia, Spain, 1999. European Cetacean Society Newsletter 38 (Special Issue).
- Folkens, P.A., Reeves, R.R., Stewart, B.S., Clapham, P.J., and Powell, J.A. 2002. Guide to Marine Mammals of the World. Alfred A. Knopf. 527pp.
- Fordyce, R.E., Mattlin, R.H., and Dixon, J.M. 1984. Second record of spectacled porpoise from subantarctic Southwest Pacific. *Sci. Rep. Whales Res. Inst.* 35: 159-64.
- Findley, K.P., Best, P.B., Ross, G.J.B. and Cockcroft, V.C. 1992. The distribution of small odontocete cetaceans off the coast of South Africa and Namibia. *S. Afr. J. Mar. Sci.* 12: 237-270.
- Fisher, W. and Hureau, J.C. (eds.) 1985. FAO Species identification sheets for fishery purposes. Southern Ocean (Fishing Areas 48, 58 and 88) (CCAMLR Convention Area). Vol 2. Commission for the Conservation of Antarctic marine Living Resources, FAO, Rome. 471pp.
- Fraser, F.C. 1937. Part II. Whales and Dolphins. pp. 201-349. In: J.R. Norman and F.C. Fraser. *Giant fishes, whales and dolphins*. Putnam, London.
- Fraser, F.C. 1945. On a specimen of the southern bottlenosed whale, *Hyperoodon planifrons*. *Discovery Reports* 23: 19-36.
- Fraser, F.C. 1950. Notes on a skull of Hector's beaked whale *Mesoplodon hectori* (Gray) from the Falkland Islands. *Proceedings of the Linnean Society of London* (Zoology) 162: 50-52.
- Fraser, F.C. 1964. Whales and whaling, Chapter XI. pp. 191-205. In: Antarctic Research; British Scientific Achievement in Antarctica.

- Fraser, F.C. 1966. Comments on the Delphinoidea. pp. 7-31. In: K.S. Norris (ed.) *Whales, Dolphins and Porpoises*. University of California Press. 789pp.
- Fraser, F.C. 1968. Notes on a specimen of *Phocoena dioptrica* from South Georgia. *Brit. Antarct. Surv. Bull.* 16: 51-56.
- Fraser, F.C. and Noble, B.A. 1968. Skull of *Lagenorhynchus cruciger* from Livingston Island, South Shetland islands. *Brit. Antarct. Survey Bull.* 15: 29-38.
- Gaskin, D.E. 1968. Distribution of Delphinidae (Cetacea) in relation to sea surface temperature off eastern and southern New Zealand. *New Zealand J. Mar. Freshw. Res.* 2: 527-543.
- Gaskin, D.E. 1972. Whales, dolphins and seals, with special reference to the New Zealand Region. Heinemann Educational Books Ltd, Auckland.
- Gaskin, D.E. 1973. Sperm whales in the western south Pacific. *New Zealand Journal of Marine and Freshwater Research* 7 (1& 2): 1-20.
- Gill, P.C., Ross, G.J.B., Dawbin, W.H. and Wapstra, H. 2000. Confirmed sightings of dusky dolphins (*Lagenorhynchus obscurus*) in southern Australian waters. *Mar. Mamm. Science* 16(2): 452-459.
- Gill, P.C. and Thiele, D. 1997. A winter sighting of killer whales (*Orcinus orca*) in Antarctic sea ice. *Polar Biol.* 17: 401-404.
- Gillespie, D. 1997. An acoustic survey for sperm whales in the Southern Ocean Sanctuary conducted from the RSV Aurora Australis. *Rep. int. Whal. Commn.* 47: 897-907.
- Goodall, R.N.P. 1978. Report on the small cetaceans stranded on the coasts of Tierra del Fuego. *Scient. Rep. of the Whales Research Institute* 30: 197-230.
- Goodall, R.N.P. 1994. Commerson's dolphin *Cephalorhynchus commersonii* (Lacépède 1804). pp. 241-267. In: S.H. Ridgway and R. Harrison (eds.) *Handbook of Marine Mammals*. Vol. 5. Academic Press, London.
- Goodall, R.N.P. 1997. Review of sightings of the hourglass dolphin, *Lagenorhynchus cruciger*, in the South American sector of the Antarctic and sub-Antarctic. *Rep. Int. Whal. Commn.* 47: 1001-1013.
- Goodall, R.N.P. 2002. Hourglass dolphin *Lagenorhynchus cruciger*. In: W.F. Perrin, B. Würsig & J.G.M. Thewissen. *Encyclopedia of marine mammals*. Academic Press, San Diego.
- Goodall, R.N.P., Baker, A.N., Best, P.B., Meyer, M. and Miyazaki, N. 1997a. On the biology of the hourglass dolphin, *Lagenorhynchus cruciger* (Quoy and Gaimard, 1824). *Rep. Int. Whal. Commn.* 47: 985-999.
- Goodall, R.N.P. and Cameron, I.S. 1979. *Phocoena dioptrica* una nueva especie para aguas Chilenas. *Rev. Mus. Argent. Cienc. Nat. 'Bernardino Rivadavia'. Inst. Nac. Invest. Cienc. Nat. Zool.* 12: 143-152.
- Goodall, R.N.P., de Haro, J.C., Fraga, F., Iñiguez, M.A. and Norris, K.S. 1997b. Sightings and behaviour of Peale's dolphins, *Lagenorhynchus australis*, with notes on dusky dolphins, *L. obscurus*, off southernmost South America. *Rep. Int. Whal. Commn.* 47: 757-775.
- Goodall, R.N.P. and Galeazzi, A.R. 1985. A review of the food habits of the small cetaceans of the Antarctic and Sub-Antarctic. pp. 566-72. In: W.R. Siegfried, P.R. Condy & R.M. Laws (eds.). *Antarctic Nutrient Cycles and Food Web*.
- Goodall, R.N.P. and Galeazzi, A.R. 1985. Sightings of pilot whales off southern South America. *Rep. Int. Whal. Commn.* 37, Resumé Section., p. 400.
- Goodall, R.N.P., Galeazzi, A.R., Leatherwood, S., Miller, K.W., Cameron, I.S., Kastelein, R.K. and Sobral, A.P. 1988. 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): 3-83.
- Goodall, R.N.P. and Macnie, S.V. 1998. Sightings of pilot whales off South America South of 30°S: a review of data to 1988. *Rep. int. Whal. Commn.* 48: 565-579.
- Goodall, R.N.P. and Schiavini, A.C.M. 1995. On the biology of the spectacled porpoise, *Australophocaena dioptrica*. *Rep. int. Whal. Commn.* (special issue) 16: 411-453.
- Goodall, R.N.P., Schiavini, A.C.M. and Fermani, C. 1994. Net fisheries and net mortality of small cetaceans off Tierra del Fuego, Argentina. *Rep. int. Whal. Commn.* (special issue 15): 295-304.
- Guiler, E. R. 1966. A stranding of *Mesoplodon densirostris* in Tasmania. *J. Mamm.* 47: 327.
- Guiler, E.R. 1967. Strandings of three species of *Mesoplodon* in Tasmania. *J. Mamm.* 48: 650-652.
- Guiler, E.R. 1978. Whale strandings in Tasmania since 1945 with notes on some seal reports. *Papers Proc. Roy. Soc. Tasmania* 112: 189-213.
- Guiler, E.R., Burton, H.R. and Gales, N.J. 1987. On three odontocete skulls from Heard Island. *Sci. Rep. Whales Res. Inst.* 38: 117-124.
- Hale, H.M. 1931. Beaked whales – *Hyperoodon planifrons* and *Mesoplodon layardii* – from South Australia. *S. Austr. Mus. Rec.* 4: 291-311.
- Hamilton, J.E. 1952. Cetacea of the Falkland Islands. *Comunicaciones Zoológicas del Museo de Historia Natural de Montevideo* 66(4): 1-66.
- Hanson, M.B. and Erickson, W.A. 1985. Sightings of toothed whales along the Antarctic coast and in the South Atlantic Ocean. *Antarctic J. US* 20(2): 16-19.
- Harmer, S.F. 1928. The History of Whaling. Proceedings of the Linnean Society of London, Session 140, 1927-28: 51-95.

- Hart, T.J. 1935. On the diatoms of the skin films of whales, and their possible bearing on problems of whale movements. *Discovery Rep.* 10: 247-282. [quoted in Brown, 1988].
- Haase, P.A. and Schneider, K. 2001. Birth demographics of bottlenose dolphins, *Tursiops truncatus*, New Zealand. *New Zealand J. Mar. & Freshwat. res.* 35: 675-680.
- Hedley, S., Reilly, S., Borberg, J., Holland, R., Hewitt, R., Watkins, J., Naganobu, M., Sushin, V. 2001. Modelling whale distribution: a preliminary analysis of data collected on the CCAMLR-IWC krill synoptic survey. IWC/SC/E9, Paper submitted to IWC SC July 2001, London.
- Hershkovitz, P. 1966. *Catalog of Living Whales*. Smithsonian Institution, Washington D.C. 259pp.
- Heyning, J.E. 1989. Cuvier's beaked whale *Ziphius cavirostris* G. Cuvier, 1823. pp. 289-308. In: S.H. Ridgway and R. Harrison (eds.) *Handbook of Marine Mammals*. Vol. 4. Academic Press.
- Heyning, J.E. and Mead, J.G. 1996. Suction feeding in beaked whales: Morphological and observational evidence. *Natural History Museum of Los Angeles County Contributions in Science* 464: 1-12.
- Hindell, M. A., Bradshaw, C. J. A., Sumner, M. D., Michael, K. J. and Burton, H. R. 2003. Dispersal of female southern elephant seals and their prey consumption during the austral summer: relevance to management and oceanographic zones. *Journal of Applied Ecology* 40: 703-715.
- Hobson, R.P. and Martin, A.R. 1996. Behaviour and dive times of Arnoux's beaked whales, *Berardius arnuxii*, at narrow leads in fast ice. *J. Zoology* 74: 388-393.
- Honacki, J.H., Kinman, K.E. and Koeppl. 1982. *Mammal Species of the World: a taxonomic and geographic reference*. Association of Systematics Collections and Allen Press, Lawrence, KS.
- Hooker, S. K., Whitehead, H. and Gowans, S. 2002. Ecosystem consideration in conservation planning: energy demand of foraging bottlenose whales (*Hyperoodon ampullatus*) in marine protected area. *Biological Conservation* 104: 51-58.
- IWC. 1981a. Report of the Scientific Committee, Annex H Report of the Sub Committee on small cetaceans. *Rep. int. Whal. Commn* 31:141-143
- IWC. 1981b. Report of the Scientific Committee. *Rep. int. Whal. Commn* 31: 67-68
- IWC, 1989. Report of the Scientific Committee. *Rep. int. Whal. Commn* 39: 117-129.
- IWC, 1991. Report of the Scientific Committee. *Rep. int. Whal. Commn* 41: 51-219.
- Jefferson, T.A., Leatherwood, S. and Webber, M.A. 1993. *FAO species identification guide. Marine Mammals of the World*. Rome, FAO. 320pp.
- Jefferson T.A., Newcomer, M.W., Leatherwood, S., and Van Waerebeek, K. 1994. Right whale dolphins *Lissodelphis borealis* (Peale, 1848) and *Lissodelphis peronii* (Lacépède, 1804). pp.335-361. In: S.H. Ridgway and R. Harrison (eds.) *Handbook of Marine Mammals*. Volume 5. Delphinidae and Phocoenidae.
- Jefferson, T.A., Stacey, P.F. and Baird, R.W. 1991. A review of killer whale interactions with other marine mammals: predation to co-existence. *Mamm. Rev.* 21: 151-180.
- Jehl, J.R., Evans, W.E., Awbrey, F.T. and Dreischman, W.S. 1981. Distribution and geographic variation in the killer whale, *Orcinus orca*, populations in the Antarctic and adjacent waters. Paper SC/Jn81/KW6.
- Kasamatsu, F., Hembree, D., Joyce, G. G., Tsunoda, L., Rowlett, R. and Nakano, T. 1988. Distribution of cetacean sightings in the Antarctic: results obtained from the IWC/IDCR minke whale assessment cruises, 1978/79 to 1983/84. *Rep. int. Whal. Commn.* 38: 449-485.
- Kasamatsu, F. and Joyce, G. G. 1995. Current status of Odontocetes in the Antarctic. *Antarctic Science* 7(4): 365-79.
- Kasamatsu, F., Matsuoka, K. and Hakamada, T. 2000. Interspecific relationships in density among the whale community in the Antarctic. *Polar Biology* 23: 466-473.
- Kawakami, T. 1980. A review of sperm whale food. *Sci. Rep. Whales Res. Inst.* Tokyo 32: 199-218.
- Klinowska, M. 1991. Dolphins, porpoises and whales of the World. IUCN, Gland, Switzerland and Cambridge. 429pp.
- Leaper, R., Gillespie, D. and Papastavrou, V. 1999. Results of passive acoustic surveys for odontocetes in the Southern Ocean. *J. Cetacean Res. Manag.* 2(3): 187-196.
- Leaper, R. and Scheidat, M. 1998. An acoustic survey for cetaceans in the Southern Ocean Sanctuary conducted from the German Government Research vessel *Polarstern*. *Rep. int. Whal. Commn.* 48: 431-437.
- Leatherwood, S., Reeves, R. and Foster, L. 1983. *The Sierra Club Handbook of Whales and Dolphins*. Sierra Club books, San Francisco. 302pp.
- Lichter, A. 1986. Records of beaked whales (Ziphiidae) from the western south Atlantic. *The Scientific Reports of the Whales Research Institute*, Tokyo 37: 109-127.
- Lien, J. and Barry, F. 1990. Status of Sowerby's beaked whale *Mesoplodon bidens*, in Canada. *Canadian Field Naturalist* 104: 125-130.
- Lillie, D.G. 1915. Cetacea. British Antarctic ("Terra Nova") Expedition 1910. *Nat. Hist. Rep. Zoology* 1(3): 85-124.
- Liouville, J. 1913. Cétacés de l'Antarctique (Baleinoptères, Ziphiides, Delphinidés). Deuxième Expédition Antarctique Française (1908-1910). Masson et Cie., Paris. 276pp.
- Lipsky, J. D. 2002. Right whale dolphins *Lissodelphis borealis* and *L. peronii*. In: W.F. Perrin, B. Würsig and J.G.M. Thewissen (eds.). Pp. 1030-1033. *Encyclopedia of Marine Mammals*. Academic Press.

- Machin, D. 1974. A multivariate study of the external measurements of the sperm whale (*Physeter catodon*). *Journal of Zoology*, London 172: 267-288.
- Marcuzzi, G. and Pilleri, G. 1971. On the zoogeography of cetacea. *Investigations on Cetacea* 3(1): 101-170.
- Matthews, L.H. 1931. South Georgia. The British Empire's Subantarctic Outpost. John Wright & Sons Ltd. , Bristol. 163pp.
- Matthews, L.H. 1977. Penguin: adventures among the birds, beasts and whalers of the far south. Peter Owen Limited, London p.165.
- McAlpine, D.F. 2002. Pygmy and dwarf sperm whales *Kogia breviceps* and *K. sima*. Pp. 1007-1009. In: W.F. Perrin, B. Wursig and J.G.M. Thewissen. *Encyclopedia of Marine Mammals*. Academic Press.
- McCann, C. 1975. A study of the genus *Berardius* Duvernoy. *The Scientific Reports of the Whales Research Institute*, Tokyo 27: 111-137.
- McCann, C. 1962. The taxonomic status of the beaked whale *Mesoplodon hectori* (Gray) – Cetacea. *Records of the Dominion Museum*, Wellington 4 (9):83-94
- Mead, J.G. 1989a. Bottlenose whales *Hyperoodon ampullatus* (Foster, 1770) and *Hyperoodon planifrons* Flower, 1882. pp. 321-348. In: S.H. Ridgway and R. Harrison (eds). *Handbook of Marine Mammals*. Vol. 4. Academic Press.
- Mead, J.G. 1989b. Beaked whales of the genus *Mesoplodon*. pp. 349-430. In: S.H. Ridgway and R. Harrison (eds). *Handbook of Marine Mammals*. Vol. 4. Academic Press.
- Mead, J.G. 1989c. Shepherd's beaked whale *Tasmacetus shepherdi* Oliver, 1937. pp. 309-320. In: S.H. Ridgway and R. Harrison (eds). *Handbook of Marine Mammals*. Vol. 4. Academic Press.
- Mead, J.G. 2002. Beaked whales, Overview. Pp. 81-84. In: W.F. Perrin, B. Wursig and J.G.M. Thewissen. *Encyclopedia of Marine Mammals*. Academic Press.
- Mead, J.G. and Baker, A.N. 1987. Notes on the rare beaked whale *Mesoplodon hectori* (Gray). *J. Royal Soc. New Zealand* 17: 303-312.
- Mikhalev, Y.A., Ivashin, M.V., Savusin, V.P. and Zelenaya, F.E. 1981. The distribution and biology of killer whales in the Southern Hemisphere. *Rep.int. Whal. Commn.* 31: 551-66.
- Mitchell, E.D. (ed.) 1975a. Review of biology and fisheries for smaller cetaceans. *J. Fish. Res. Board Canada* 32 (7): 888-983.
- Mitchell, E.D. 1975b. Porpoise, dolphin and small whale fisheries of the world. Status and problems. IUCN Monograph No.3. 129pp.
- Mitchell, E.D., Mead, J.G. and Kozicki, V.M. 1981. Readability of growth layers in teeth of beaked whales, Ziphiidae. *Rep. int. Whal. Commn.* (special issue 3): 215 (abstract).
- Miyazaki, N. and Kato, H. 1988. Sighting records of small cetaceans in the southern hemisphere. *Bull. Natn. Sci. Mus. Tokyo, Ser. A.* 14 (1): 47-65.
- Moore, J.C. 1963. The goose-beaked whale, where in the world? *Bull. Chicago Nat. Hist. Mus.* 34: 2-3.
- Moore, J.C. 1960. New records of the gulf-stream beaked whale, *Mesoplodon gervaisi* and some taxonomic considerations. *American Museum of Natural History Novitates* 1933: 1-35.
- Mörzer Bruyns, W.F.J. and Baker, A.N. 1973. Notes on Hector's dolphin, *Cephalorhynchus hectori* (Van Beneden) from New Zealand. *Records Dom. Museum* 8 (9): 125-137.
- Murase, H., Matsuoka, K., Ichii, T. and Nishiwaki, S. 2001. Relationship between the distribution of euphausiids and baleen whales in the Antarctic (35°E-145°W). *Polar Biol.* 25: 135-145.
- Murphy, R.C. 1947. Logbook for Grace; whaling brig Daisy 1912-1913. Time-Life Books, New York. 371pp.
- Newcomer, M.W., Jefferson, T.A. and Brownell, R.L. Jr. 1996. *Lissodelphis peronii*. *Mamm. Species*. 531: 1-5.
- Nichols, J.T. 1908. Notes on two porpoises captured on a voyage into the Pacific Ocean. *Bull. Am. Mus. Nat. Hist.* 24 : 217-221.
- Nicol, D.J. 1986. A review and update of the Tasmanian cetacean strandings record to the end of February 1986. University of Tasmania Environmental Studies Working Paper No. 21. 93pp.
- Nicol, S., Pauly, T., Bindoff, N. L. and Strutton, P. G. 2000. "BROKE" a biological/oceanographic survey of the coast of East Antarctica (80-150E) carried out in January-March 1996. *Deep-Sea Research II* 47: 2281-2298.
- Nishiwaki, M. 1977. Distribution of toothed whales in the Antarctic Ocean. pp. 783-791. In: G.A. Llano (ed.). *Adaptations within Antarctic Ecosystems*. Smithsonian Institution.
- Nishiwaki, S., Daisuke, T., Yuzu, S. *et al.* 1999. Cruise Report of the Japanese Whale Research programme under a special permit in the Antarctic (JARPA) Area V and Western Part of Area VI in 1998/99. Document SC/51/CAWS10 presented to IWC SC Meeting. 20pp.
- Nolan, C. P., Liddle, G. M. and Elliot, J. 2000. Interactions between killer whales (*Orcinus orca*) and sperm whales (*Physeter macrocephalus*) with a longline fishing vessel. *Marine Mammal Science* 16(3): 658-663
- Northridge, S. P. 1984. World review of interactions between marine mammals and fisheries. FAO Fisheries Technical paper 251, Rome. 190pp.
- Ohsumi, S., Kawasaki, M., and Nishiwaki, S. 1994. Biological results of beaked whales surveyed by Japanese whale research programme underspecial permit in the Antarctic and the need of their research take. Paper SC/46/SM15 presented to IWC Scientific Committee meeting.

- Oliver, W.R.B. 1922. Review of the Cetacea of the New Zealand seas. *Proceedings of the Zoological Society of London* 1922: 557-585.
- Orr, R.T. 1953. Beaked whales (*Mesoplodon*) from California with comments on taxonomy. *J. Mamm.* 34: 239-249.
- Orsi, A.H., Whitworth, T. and Nowlin, W.D. 1995. On the meridional extent and fronts of the Antarctic Circumpolar Current. *Deep-Sea Res.* 42: 641-673.
- Pastene, L. A., Numachi, K., Jofre, M., Acevedo, M. and Joyce, G. 1990. First record of the Blainville's beaked whale, *Mesoplodon densirostris*, Blainville, 1817 (Cetacea, Ziphiidae) in the eastern South Pacific. *Mar. Mamm. Science* 6(1): 82-84.
- Paulian, P. 1953. Pinnipèdes, cétacés, oiseaux des Iles Kerguelen et Amsterdam. Mission Kerguelen 1951. *Mem. Inst. Scient. de Madagascar*, Sér. A8: 111-234.
- Perrin, W.F., Goodall, R.N.P. and Cozzuol, M.A. 2000. Osteological variation in the spectacled porpoise (*Phocoena dioptrica*). *J. Cetacean Res. Manage.* 2(3): 211-215.
- Pichler, F.B. 2002. Genetic assessment of population boundaries and gene exchange in Hector's dolphin. *NZ Department of Conservation Science Internal Series* 44. 37pp.
- Pichler, F. B., Robineau, D., Goodall, R. N. P., Meyer, M. A. and Olivarria, C. 2001. Origin and radiation of southern hemisphere coastal dolphins (genus *Cephalorhynchus*). *Molecular Ecology* 10: 2215-2223.
- Pierpoint, C., Gordon, J., Matthews, J., Sargent, T. and Frizell, J. 1997. Acoustic detections and incidental sightings of cetaceans in the Southern Ocean Sanctuary. *Rep. int. Whal. Comm.* 47: 955-962.
- Pitman, R.L. 2002. Mesoplodont whales (*Mesoplodon* spp.) pp. 738-742. In: W.F. Perrin, B. Würsig and J.G.M. Thewissen (eds.). *Encyclopedia of marine mammals*. Academic Press.
- Pitman, R.L. and Ensor, P. 2003. Three forms of killer whales (*Orcinus orca*) in Antarctic waters. *Journal of Cetacean Research and Management* 5(2): 131 – 139.
- Pitman, R. L. and Lynn, M. S. 2001. Biological observations of an unidentified mesoplodont whale in the eastern tropical Pacific and probable identity: *Mesoplodon peruvianus*. *Mar. Mamm. Science* 17(3): 648-657.
- Plön, S., Best, P., Kemper, C., Lavery, S., Van Waerebeek, K., Bernard, R. and Baker, C.S. 2003. "They are small, but they get around" –the population structure of pygmy (*Kogia breviceps*) and dwarf (*Kogia sima*) sperm whales in the Southern Hemisphere. Abstracts, Greensboro, NC, USA, December 2003.
- Ponganis, P. J., Kooyman, G. L. and Castellini, M. A. 1995. Multiple sightings of Arnoux's beaked whales along the Victoria Land coast. *Marine Mammal Science* 11(2) : 247-250.
- Quoy, J.R.C. and Gaimard, J.P. 1824. Voyage autour du monde ... sur les corvettes de S.M. l' Uranie et la Physicienne, pendant les années 1817, 1818, 1819, 1820. Zoologie, Paris.
- Reeves, R.R. and Leatherwood, S. (compilers). 1994. Dolphins, porpoises and whales; 1994-1998 Action Plan for the Conservation of Cetaceans. IUCN/SSC, Gland, Switzerland, 91pp.
- Reeves, R.R., Smith, B.D., Crespo, E.A. and Notarbartolo di Sciarra, G. (compilers). 2003. Dolphins, whales and porpoises; 2002-2010 Conservation Action Plan for the World's Cetaceans. IUCN/SSC, Gland, Switzerland, 139pp.
- Reilly, S., Hedley, S., Hewitt, R., Leaper, R., Thiele, D., Pitman, R. L., Naganobu, M., Watkins, J., Holland, R. 2000. SOWER 2000: initial results from the IWC-CCAMLR program to study whales and krill in the Southern Ocean. Paper SC/52/E21, IWC Scientific Committee, June 2000, Adelaide.
- Rendell, L. E., Monker, H., Gillespie, D. and Gordon, J. C. D. 1997. Preliminary results of an acoustic survey in the southern Pacific Ocean conducted from the MV Arctic Sunrise. Paper SC/49/SH24 presented to IWC Scientific Committee.
- Reyes, J.C. 1996. A possible case of hybridism in wild dolphins. *Mar. Mamm. Science* 12: 301-307.
- Reyes, J. C., Mead, J. G. and Van Waerebeek, K. 1991. A new species of beaked whale *Mesoplodon peruvianus* sp.n. (Cetacea: Ziphiidae) from Peru. *Mar. Mam. Science* 7(1): 1-24.
- Reyes, J.C., Van Waerebeek, K., Cárdenas, J.C. and Yañez, J.L. 1995. *Mesoplodon bahamondi* sp.n. (Cetacea, Ziphiidae), a new living beaked whale from the Juan Fernández Archipelago, Chile. *Boletín Museo Nacional de Historia Natural de Chile* 45: 31-44.
- Rice, D.W. 1998. Marine Mammals of the World. Systematics and Distribution. Special Publication No. 4. The Society for Marine Mammalogy. 231pp.
- Risting, S. 1922. Av Hvalfangstens Historie. Public. 2 from C. Christensens Hvalfangstmuseum I Sandefjord. Kristiana. [not seen, cited in Harmer, 1928].
- Robineau, D. 1984. Les cétacés des Iles Kerguelen. *Mammalia* 53(2): 265-278.
- Robineau, D. 1989a. Les types de cétacés actuels du Muséum national d'Histoire naturelle I. Balaenidae, Balaenopteridae, Kogiidae, Ziphiidae, Iniidae, Pontoporiidae. *Bull. Mus. natn. Hist. nat.*, Paris, 4e sér. 11, section A, 1: 271-289.
- Robineau, D. 1989b. Les types de cétacés actuels du Muséum national d'Histoire naturelle II. Delphinidae, Phocoenidae. *Bull. Mus. natn. Hist. nat.*, Paris, 4e sér. 12, section A, 1: 197-238.
- Robson, F.D. 1984. Strandings. ways to save whales. The Science Press, Johannesburg. 124pp.
- Rodhouse, P. G. 1997. Precautionary measures for a new fishery on *Martialia hyadesi* (Cephalopoda,

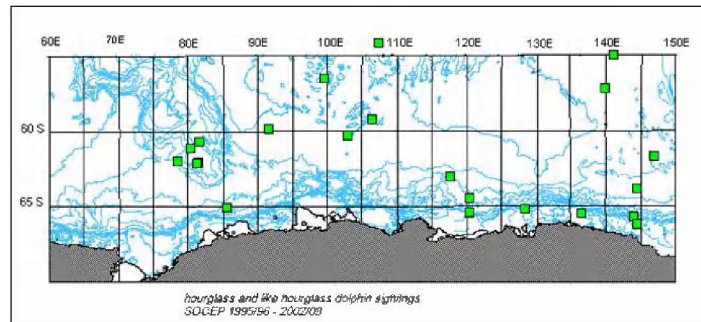
- ommastrephidae*) in the Scotia Sea: An ecological approach. *CCAMLR Science* 4: 125-139.
- Rogers, T.L. and Brown, S.M. 1999. Acoustic observations of Arnoux's beaked whale (*Berardius arnuxii*) off Kemp Land, Antarctica. *Marine Mammal Science* 15: 192-198.
- Rosel, P.E., Haygood, M.G. and Perrin, W.F. 1995. Phylogenetic relationships among the true porpoises (Cetacea: Phocoenidae). *Molecular phylogenetics and Evolution* 4: 463-474.
- Ross, G.J.B. 1979. The smaller cetaceans of the southeast coast of southern Africa. PhD thesis, University of Port Elizabeth. 415pp.
- Santos, M. B., Clarke, M. R. and Pierce, G. J. 2001. Assessing the importance of cephalopods in the diets of marine mammals and other top predators: problems and solutions. *Fisheries Research* 52: 121-139.
- Sapin-Jaloustre, J. 1953. L'identification des cétacés Antarctiques à la mer. *Mammalia* 17: 221-259.
- Scheffer, V.B. and Rice, D.W. 1963. A list of the marine mammals of the world. US Fish and Wildlife Service Special Scientific Report – Fisheries no. 431.
- Scott, E.O.G. 1942. Records of Tasmanian Cetacea No. 2. A large school of the pilot whale *Globicephala melas* (Traill, 1809), stranded at Stanley, northwestern Tasmania, in October 1935. Records Queen Victoria Museum, Launceston, Tasmania 1 (2): 5-34.
- Sekiguchi, K., Klages, N., Findlay, K. and Best, P.B. 1993. Feeding habits and possible movements of southern bottlenose whales (*Hyperoodon planifrons*). *Proc. NIPR Symp. Polar Biol.* 6: 84-97.
- Slip, D.J., Moore, G.J. and Green, K. 1995. Stomach contents of a southern bottlenose whale, *Hyperoodon planifrons*, stranded at Heard island. *Marine Mammal Science* 11(4): 575-584.
- Slooten, E. and Dawson, S.M. 1994. Hector's dolphin *Cephalorhynchus hectori* (Van Beneden, 1811). Pp. 311-334. In: S.H. Ridgway and R. Harrison (eds). Handbook of Marine Mammals, 5.
- Slooten, E. and Lad, F. 1991. Population biology and conservation of Hector's dolphin. *Can. J. Zoology* 69: 1701-1707.
- Slooten, E., Dawson, S. and Rayment, W. 2002. Quantifying abundance of Hector's dolphins between Farewell Spit and Milford Sound. Published Client Report on Contract 3076, funded by Conservation Services Levy. Department of Conservation, Wellington, New Zealand.
- Stahl, J.-Cl. 1982. Observations de Cétacés dans le sud-ouest de l'océan Indien. *Annales Soc. Sciences Nat. Charente-Maritime*, suppl. déc. 1982: 59-63.
- Stone, G. and Yoshinaga, A. 2000. Hector's dolphin (*Cephalorhynchus hectori*) calf mortalities may indicate new risks from boat traffic and habituation. *Pacific Conservation Biology* 6: 162-172.
- Stonehouse, B. 1972. Animals of the Antarctic: The ecology of the south. Holt, Rinehart & Winston, New York [not seen, in Ponganis *et al.* 1995].
- Strange, I.J. 1992. *A field guide to the Wildlife of the Falkland Islands and South Georgia*. Harper Collins Publishers. 188pp.
- Taylor, R.J.F. 1957. An unusual record of three species of whale being restricted to pools in Antarctic sea ice. *Proc. Zool. Soc. London* 129 (3): 325-331.
- Tomilin, A.G. and Latyshev, V.M. 1967. Novye dannye o ploskolobom butylkonose- *Hyperoodon planifrons* Flower, 1882. [New data on the flat-fronted bottlenose- *Hyperoodon planifrons* Flower, 1882.]. *Mosk. Obshch. isp. Prirody, Byull. Biol.* 72: 119-122. [Not seen, cited in Mead, 1989].
- Thiele, D. 2002. International Whaling Commission – Southern Ocean GLOBEC collaboration. Update from the Western Antarctic Peninsula. *GLOBEC International Newsletter* 8 (2): 7 – 9.
- Thiele, D., Chester, E.T. and Gill, P.C. 2000. Cetacean distribution off eastern Antarctica (80-150°E) during the Austral summer of 1995/1996. *Deep-Sea Research II* 47: 2543-72.
- Thiele, D., Gill, P.C., Bindoff, N.L., Nicol, S. and Hosie, G. 1997. Using a multidisciplinary ecosystem approach to the study of cetaceans in the southern Ocean. Paper SC/49/SH5 presented to IWC Scientific Committee, 1997. 14pp.
- Thiele, D., Hofmann, E., Friedlaender, A., Moore, S., McDonald, M. 2001. Preliminary report on IWC- SO GLOBEC collaborative research in the Western Antarctic Peninsula study area March-June 2001. SC/52/E8, IWC Scientific Committee, June 2001, Adelaide.
- Thiele, D., Moore, S., Hildebrand, J., Friedlaender, A., Sirovic, A., Pirzl, R., McDonald, M., Wiggins, S., Hofmann, E., Klinck, J. 2002. Second annual report on IWC collaborative research in the SO GLOBEC Western Antarctic Peninsula study area. Unpublished paper submitted to the International Whaling Commission Scientific Committee June 2002, Shimonoseki, SC/52/E12.
- Thiele, D., Moore, S., Hildebrand, J., Sirovic, A., Friedlaender, A., Glasgow, D., Leaper, R., Van Waerebeek, K., McDonald, M., Wiggins, S., Pirzl, R., Viddi, F. and Hofmann, E. 2003. IWC- SO GLOBEC/CCAMLR collaboration, Cruise report 2002–2003. Paper SC/55/E10 presented to IWC Scientific Committee, May 2003, Berlin.
- Thiele, D., Asmus, K., Dolman, S., Glasgow, D., Hodda, P., McDonald, M. and D., McKay, S., Oleson, E., Širović, A., Souter, A., Moore, S. E., Hildebrand, J., Wiggins, S. 2004. IWC Southern Ocean collaboration cruise report 2003 – 2004. Paper SC/56/E24 presented to IWC Scientific Committee, June 2004, Sorrento.

- Thiele, D. and Gill, P.C. 1999. Cetacean observations during a winter voyage into Antarctic sea ice south of Australia. *Antarctic Science* 11(1): 48-53.
- True, F. 1889. Contributions to the natural history of the cetaceans. A review of the family Delphinidae. *Bull. US Nat. Mus.* 36: 1-191, 47 lam.
- Tynan, C. T. 1998. Ecological importance of the Southern Boundary of the Antarctic Circumpolar Current. *Nature* 392 (16th April): 708-710.
- USSR. 1981. A note on the investigation of killer whales in the Antarctic, 1979/80 (Data from Sovetskaya Rossia). Appendix 1 to USSR Progress Report on Cetacean Research. *Rep. int. Whal. Commn* 31:225
- van Bree, P.J.H. 1972. On the validity of the subspecies *Cephalorhynchus hectori bicolor* Oliver, 1946. *Invest. on Cetacea* (ed. G. Pilleri) 4: 182-186.
- van Helden, A.L., Baker, A.N., Dalebout, M., Reyes, J.C., Van Waerebeek, K. and Baker, C.S. 2002. Resurrection of *Mesoplodon traversii* (Gray, 1874), senior synonym of *M. bahamondi* Reyes, Van Waerebeek, Cárdenas and Yañez, 1995 (Cetacea: Ziphiidae). *Mar. Mam. Science* 18 (3): 609-621.
- Van Waerebeek, K. 1992a. Population identity and general biology of the dusky dolphin *Lagenorhynchus obscurus* (Gray, 1828) in the Southeast Pacific. PhD thesis, University of Amsterdam. 160pp.
- Van Waerebeek K. 1992b. Records of dusky dolphins *Lagenorhynchus obscurus* (Gray 1828) in the eastern South Pacific. *Beaufortia* 43(4): 45-61.
- Van Waerebeek, K. 1993a. Presumed *Lagenorhynchus* skull at Tasmanian museum reidentified as *Lissodelphis peronii*. *Austral. Mamm.* 16: 41-43.
- Van Waerebeek, K. 1993b. Geographic variation and sexual dimorphism in the skull of the dusky dolphin *Lagenorhynchus obscurus* (Gray 1828). *Fishery Bulletin* 91: 754-774.
- Van Waerebeek, K., Canto, J., Gonzalez, J., Oporto, J. and Brito, J.L. 1991. Southern right whale dolphins *Lissodelphis peronii* off the Pacific coast of South America. *Zeitschrift für Säugetierkunde* 56: 284-295.
- Van Waerebeek, K., van Bree, P. J. H. and Best, P. B. 1995. On the identity of *Prodelphinus Petersii* Lütken, 1889 and records of dusky dolphins *Lagenorhynchus obscurus* (Gray, 1828) from the Indian and southern mid-Atlantic Oceans. *South African Journal of Marine Science* 16: 25-35.
- Van Waerebeek, K., Santillan, L. and Reyes, J.C. 2002. An unusually large aggregation of Burmeister's porpoise *Phocoena spinipinnis* off Peru, with a review of sightings from Pacific South America. *Noticiario Mensual Museo Nacional de Historia Natural, Santiago* 350: 3-8.
- Van Waerebeek, K., Van Bresse, M.F., Alfaro-Shigueto, J., Sanino, G.P., Montes, D., Ontón, K. 1999. A preliminary analysis of recent captures of small cetaceans in Peru and Chile. Paper SC/51/SM17, 51<sup>st</sup> Annual Meeting of the IWC Scientific Committee, May 1999, Grenada. 14pp.
- Venegas, C. and Sielfeld, W. 1980. Un varamiento masivo de ballenas piloto (*Globicephala melaena* Traill) en Magallanes. *Ans. Inst. Pat., Punta Arenas (Chile)* 11: 239-246.
- Visser, I.N. 1999. Propeller scars on, and known home range of two Orca (*Orcinus orca*) in New Zealand waters. *New Zealand J. Mar. & Freshwat. Res.* 33:635-642.
- von Haast, J. 1877. On *Oulodon*, a new genus of ziphoid whale, *Trans, NZ Inst.* 9: 450-457.
- Watkins, W.A. 1976. A probable sighting of a live *Tasmacetus shepherdi* in New Zealand waters. *J. Mammal.* 57: 415.
- Webber, M.A. 1987. A comparison of dusky and Pacific white-sided dolphins (genus *Lagenorhynchus*) : morphology and distribution. Thesis, Master of Arts, San Francisco State University. 102pp.
- Wells, R.S. and Scott, M.D. 2002. Bottlenose dolphins *Tursiops truncatus* and *T. aduncus*. Pp. 122-128. In: W.F. Perrin, B. Würsig and J.G.M. Thewissen (eds.). *Encyclopedia of Marine Mammals*. Academic Press.
- Whitehead, H. 2002. Estimates of the current global population size and historical trajectory for sperm whales. *Mar. Ecol. Prog. Ser.* 242: 295-304
- Wilson, E.A. 1907. National Antarctic Expedition 1901-1904. *Nat. Hist. Reports*. Vol. 2. Zoology: Mammalia, Cetacea. *Brit. Museum London*: 1-9.
- Würsig, B., Cipriano, F., Slooten, E., Constantine, R., Barr, K. and Yin, S. 1997. Dusky dolphins (*Lagenorhynchus obscurus*) off New Zealand: status of present knowledge. *Rep. Int. Whal. Commn.* 47: 715-722.
- Yazdi, P. 2002. A possible hybrid between a dusky dolphin (*Lagenorhynchus obscurus*) and the southern right whale dolphin (*Lissodelphis peronii*). *Aquatic Mammals* 28(2): 211-217.
- Zemskii, V.A. and Budylenko, G.A. 1970. Ploskolobyte butylkonosy iz Antarktiki [the flat-headed bottlenose in the Antarctic]. pp. 193-202. In: (Ed. V.A. Zemskii). *Kity Iuzhnovo Polushariia (Biologiya i Morfologiya)* [Whales of the Southern Hemisphere (Biology and Morphology)]. Trudy Atlant Niro, no. 29. [Not seen, cited in Mead, 1989].

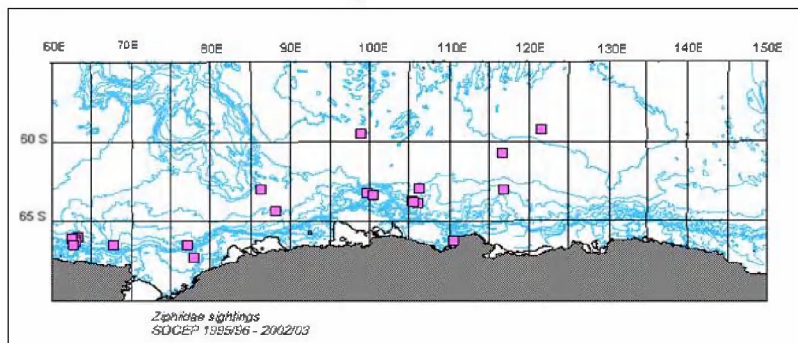
**Fig. 2. Odontocete sightings during SOCEP surveys 1995/96 till 2002/03 (see Table 1) .**  
pp. 33 and 34



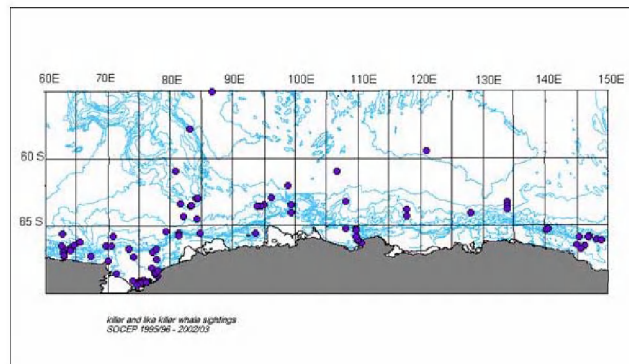
## Hourglass and like dolphins



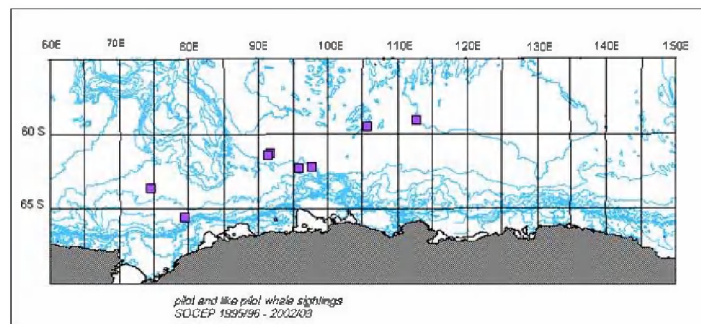
## ziphiidae



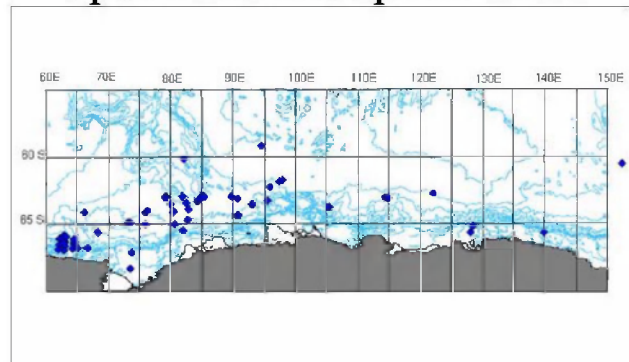
## Killer and like killer whales



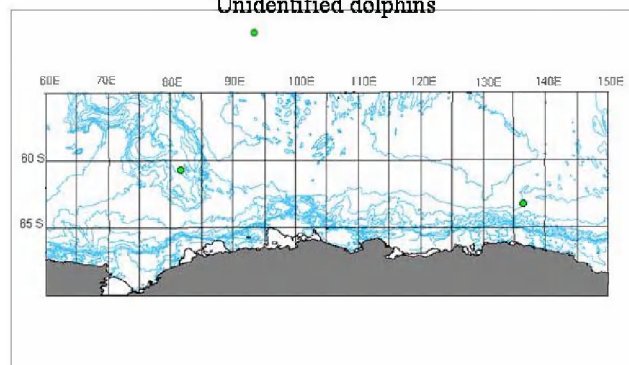
## Pilot and like pilot whales



## Sperm and like sperm whale



## Unidentified dolphins



VOYAGE	GMT DATE	Lat South	Long West	SPECIES CODE	SPECIES	GROUP SIZE BEST
LMG 0201A	28-Feb-02	60.074	63.053	5	<i>P. macrocephalus</i>	1
NBP0202	30-Apr-02	68.902	69.688	10	<i>Orcinus orca</i>	4
NBP0204	11-Aug-02	68.735	76.092	10	<i>Orcinus orca</i>	1
LMG 0302	24-Feb-03	68.556	70.798	10	<i>Orcinus orca</i>	12
LMG 01-03	29-Mar-01	68.261	70.988	10	<i>Orcinus orca</i>	10
NBP0202	12-May-02	68.220	69.812	10	<i>Orcinus orca</i>	3
LMG 0201A	18-Feb-02	68.049	69.389	10	<i>Orcinus orca</i>	25
LMG0203	30-Apr-02	67.928	69.223	10	<i>Orcinus orca</i>	10
LMG0203	11-May-02	67.693	69.319	10	<i>Orcinus orca</i>	12
LMG0203	11-May-02	67.649	69.485	10	<i>Orcinus orca</i>	6
LMG0203	19-Apr-02	67.450	67.746	10	<i>Orcinus orca</i>	12
LMG 01-03	05-Apr-01	67.412	67.815	10	<i>Orcinus orca</i>	30
LMG 0302	25-Feb-03	67.207	67.724	10	<i>Orcinus orca</i>	4
LMG0203	14-May-02	64.843	63.921	10	<i>Orcinus orca</i>	4
NBP0104	27-Aug-01	64.735	63.071	10	<i>Orcinus orca</i>	3
LMG 0302	03-Mar-03	64.256	62.733	10	<i>Orcinus orca</i>	22
LMG 01-03	23-Mar-01	64.093	61.808	10	<i>Orcinus orca</i>	6
LMG 01-03	23-Mar-01	63.725	61.339	10	<i>Orcinus orca</i>	8
LMG 01-03	07-Apr-01	65.840	65.184	11	<i>Ziphiidae</i>	1
LMG 01-03	23-Mar-01	64.174	61.856	11	<i>Ziphiidae</i>	4
LMG 0302	20-Feb-03	65.980	71.052	13	<i>L. cruciger</i>	3
LMG 01-03	01-Apr-01	65.502	70.297	13	<i>L. cruciger</i>	4
Polarstern ANT XVIII5b	17-Apr-01	65.136	70.969	13	<i>L. cruciger</i>	10
LMG 0201A	09-Feb-02	60.632	62.850	13	<i>L. cruciger</i>	2
NBP0202	12-Apr-02	60.574	65.198	15	<i>unidentified dolphin</i>	1
LMG 0201A	28-Feb-02	61.627	62.442	38	<i>Mesoplodon sp.</i>	
LMG 0201A	28-Feb-02	60.309	62.978	38	<i>Mesoplodon sp.</i>	5
LMG 0201A	28-Feb-02	60.076	63.049	38	<i>Mesoplodon sp.</i>	3

Table 4. Odontocete sightings south of 60°S during SO-GLOBEC surveys 2000/2001 to 2003/2004 (see also Table 1).