Odontocetes of the Southern Ocean Sanctuary

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ABSTRACT

Twenty-eight odontocete species were identified as occupying sub-Antarctic and Antarctic habitat covered by the 1994 IWC-established Southern Ocean Sanctuary. Toothed whales evidently play an important part in the Antarctic polar ecosystem. Twenty-two species are autochthonous in showing a regular, apparently year-round, presence in the Sanctuary: *Physeter macrocephalus, Kogia breviceps, Orcinus orca, Globicephala melas edwardii, Pseudorca crassidens, Lagenorhynchus cruciger, Lagenorhynchus obscurus, Lissodelphis peronii, Cephalorhynchus commersonii, Cephalorhynchus hectori, Tursiops truncatus, Delphinus delphis, Phocoena dioptrica, Hyperoodon planifrons, Berardius arnuxii, 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*. However, vagrant status of these three mesoplodonts is only provisionally assigned, considering that improved knowledge of diagnostic features of beaked whales should, as in recent years, continue to facilitate at-sea identification. Two species are considered as having a 'contiguous' range (records less than 2° north of Sanctuary boundaries): *Mesoplodon ginkgodens* (at 39°S) and *Mesoplodon mirus* (at 38°24'S). The habitual southern range of at least four odontocetes extends significantly farther poleward than expected. *G. melas edwardii* is regularly encountered south of the Antarctic Polar Front, much like *M. grayi* which is known to reach the Ross Sea ice edge (*ca*. 67°S). *Z. cavirostris* and *L. obscurus* cross the Polar Front occasionally. The distribution of *M. peruvianus* and *M. traversii* and their relation to SST are unclear. Their southernmost records, 42°31'S and 44°17'S respectively, may either be extralimital or, more likely, reflect ordinary austral range. Temporally non-aligned distribution patterns of *Hyperoodon planifrons* in Antarctic and South African waters may suggest stock segregation.

KEY WORDS: DISTRIBUTION; MOVEMENTS; ODONTOCETES; BEAKED WHALES; ANTARCTIC; HABITAT; 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 20th century largely concentrated on baleen whales and the sperm whale. Catches of other odontocete species, particularly of the southern bottlenose whale (*Hyperoodon planifrons*) and Arnoux's beaked whale (*Berardius arnuxii*) often collectively referred to as 'bottlenose whales' and the killer whale *Orcinus orca* were much smaller and conducted on a largely opportunistic basis (e.g. Klinowska, 1991; Mitchell, 1975a; 1975b). The ecology of odontocetes within the Southern Ocean ecosystem is very different (due to the greater variety of their prey species) and more complex than 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. Branch and Williams, 2006; Jefferson *et al.*, 1991).

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

On 26 May 1994 the International Whaling Commission (IWC) at its 47th Annual Meeting, in Puerto Vallarta, Mexico, voted[8] for the creation of a whale sanctuary in the Southern Ocean. This provided for a prohibition on commercial whaling, to be reviewed at successive 10 year intervals, with the first review completed in 2004 (IWC, 2004). The northern boundary of the Southern Ocean Sanctuary (further 'the Sanctuary') was set at 40°S except between two longitudinal sections, one (50°W–130°W) in the eastern South Pacific and western South Atlantic, where the northern boundary was set at 60°S thus 'cutting out' South American waters, and the other (20°E–130°E) where the northern boundary was set at 55°S (which is the southern boundary of the existing Indian Ocean Sanctuary). The

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[8] A Schedule amendment of the International Convention for the Regulation of Whaling (ICRW) requires a 75% majority vote.

present paper[9] aims to summarise and update information on distribution for each odontocete species inhabiting the Sanctuary as a first step towards implementing the recommendation from the IWC Scientific Committee for systematic 'inventory' programmes (IWC, 2005).

The most comprehensive set of cetacean surveys in the Southern Ocean are the IWC/IDCR (International Decade of Cetacean Research) and IWC/SOWER (Southern Ocean Whale and Ecosystem Research) programmes which have involved an annual effort since 1978 (Matsuoka *et al.*, 2003). In addition, the increase in multi-disciplinary research cruises in the Sanctuary since 1994 has yielded new data on the distribution of odontocete species from opportunistic observations, visual and acoustic surveys (Gillespie, 1997; Leaper *et al.*, 2000; Leaper and Scheidat, 1998; Pierpoint *et al.*, 1997; Rendell *et al.*, 1997; Thiele, 2002; 2004; 2000; Thiele and Gill, 1999; Thiele *et al.*, 1997; 2001; 2002; 2003). While it is still not always possible to identify beaked whales to species level, the multi-disciplinary data allows examination of some of the factors that may relate to odontocete distribution. Only a handful of earlier papers discussed the distribution of ziphiids and other odontocetes of the Southern Ocean in a broader perspective (Baker, 1990; Brownell, 1974; Goodall and Galeazzi, 1985b; Kasamatsu *et al.*, 1988; Kasamatsu and Joyce, 1995; Lillie, 1915; Liouville, 1913; Miyazaki and Kato, 1988; Nishiwaki, 1977; Ohsumi *et al.*, 1994; Paulian, 1953; Sapin-Jaloustre, 1953). Abundance estimates and associated caveats for the most frequently sighted odontocete species (Leaper *et al.*, 2008) were reviewed at a joint workshop of the IWC and the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) in 2008 (IWC and CCAMLR, 2010).

MATERIAL AND METHODS

The occurrence of odontocetes within the Southern Ocean Sanctuary was reviewed and grouped in two categories: autochthonous (regular, probably year-round presence) and vagrant species (with three or less confirmed records[10]). Species that have been found in waters less than 2° latitude north of the Sanctuary boundaries were classified as 'contiguous occurring'. Three items were addressed for each species, each largely limited to information applicable to the study area: (i) systematics and populations; (ii) distribution in the Southern Ocean Sanctuary; and (iii) conservation status and exploitation. Conservation status designations are updated, for CITES up to 23 June 2005 and for CMS up to 25 November 2005 (8th Conference of the Parties, Nairobi[11]). IUCN status follows the 2008 IUCN Red List of Threatened Species[12].

The IDCR/SOWER dataset represents a large annual survey effort in the region and a potential source of abundance estimates. These cruises surveyed a different longitudinal sector of the Southern Ocean south of 60°S in each season, resulting in a total of three full sets of circumpolar surveys where each sector was surveyed at least once. These surveys are referred to as CPI, CPII and CPIII, covering the periods 1978/79–1983/84, 1985/86–1990/91 and 1991/92–2003/04 respectively. Some circumpolar abundance estimates for odontocetes have been generated using these data (Branch and Butterworth, 2001; Kasamatsu and Joyce, 1995). However, both papers note a number of caveats to their estimates. These caveats include, uncertainty in the proportion of animals directly on the trackline that are detected ($g(0)$), uncertainty in identification to species level (primarily a concern for beaked whales), and responsive movement (primarily a concern for hourglass dolphins). Kasamatsu and Joyce (1995) used a model of diving behaviour to estimate $g(0)$ for sperm whales (0.32), beaked whales (0.27), killer whales (0.96) and pilot whales (0.93). There are currently limited data from the Southern Ocean to refine these estimates or estimate $g(0)$ directly for these species. Branch and Butterworth (2001) noted that in the three sets of circumpolar surveys only 5%, 60% and 71%, respectively, of the beaked whale sightings were identified to species level. These changes in the attention given to species identification of beaked whales will have particular importance for estimates and distribution patterns of the less common species. Changes in the ice edge, latitudinal coverage and timing of the surveys also need to be considered when interpreting changes in distribution or abundance. The timing of surveys from 1994/95 to 2000/01 was later than in earlier years. Unpublished data from the IDCR/SOWER cruises, distributional data spanning the seasons 1978/79–2003/04, and unpublished data from the 'Southern Ocean Cetacean Ecosystem Program' (SOCEP) and the IWC's Southern Ocean Collaboration Working Group Program (IWC SOC) and associated cruises are included in this review. Although largely focussed on baleen whales, all cetacean species are recorded during these surveys. All odontocete records from these programmes collected up to the 2003/04 season were included in 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. Its primary objective 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 cetacean SOCEP surveys were conducted in East Antarctica (60°E–150°E) from 1995/1996 to 2002/2003. Data collected on this programme in the 1995/96 season have been published in Gill and Thiele (1997), Thiele and Gill (1999), Nicol *et al.* (2000) and Thiele *et al.* (2000). For a listing of the seventeen SOCEP survey cruises between July 1995 and March 2003, see Van Waerebeek *et al.* (2004).

The IWC commenced collaborative research with CCAMLR (IWC/SO GLOBEC/CCAMLR) in the Southern Ocean during the 1999/2000 austral summer (Hedley *et al.*, 2001; Reilly *et al.*, 2000). This initial cruise included a dedicated passive acoustic survey for odontocetes from one vessel (Leaper *et al.*, 2000). In 2001 a multi-year series of collaborative research cruises between the IWC and a

[9]An earlier version was presented to the Scientific Committee at IWC/56 as a background document to facilitate the 2004 IWC Southern Ocean Sanctuary review discussions (Van Waerebeek *et al.*, 2004).

[10]Exceptionally, despite a single record, *Mesoplodon traversii* is considered autochthonous, because the record is one of only three known for the species and originates from deep inside the Sanctuary (*ca.* 475km, at Chatham Islands).

[11] *http://www.cms.int/bodies/cop_mainpage.htm*

[12] *http://www.iucnredlist.org*

Table 1

Odontocete sightings south of 60°S during IWC-SOC surveys 2000/2001 to 2003/2004. Sightings of *Orcinus orca* were not identified to the level of the A, B, C and D morphotypes known from Antarctica (Pitman and Ensor, 2003; Pitman *et al.* 2007) and likely represent an aggregate of different species.

Voyage	GMT date	Lat south	Long west	Species code	Species	Group size best
LMG 0201A	28/02/02	60.074	63.053	5	*P. macrocephalus*	1
NBP0202	30/04/02	68.902	69.688	10	*Orcinus orca*	4
NBP0204	11/08/02	68.735	76.092	10	*Orcinus orca*	1
LMG 0302	24/02/03	68.556	70.798	10	*Orcinus orca*	12
LMG 01-03	29/03/01	68.261	70.988	10	*Orcinus orca*	10
NBP0202	12/05/02	68.220	69.812	10	*Orcinus orca*	3
LMG 0201A	18/02/02	68.049	69.389	10	*Orcinus orca*	25
LMG0203	30/04/02	67.928	69.223	10	*Orcinus orca*	10
LMG0203	11/05/02	67.693	69.319	10	*Orcinus orca*	12
LMG0203	11/05/02	67.649	69.485	10	*Orcinus orca*	6
LMG0203	19/04/02	67.450	67.746	10	*Orcinus orca*	12
LMG 01-03	05/04/01	67.412	67.815	10	*Orcinus orca*	30
LMG 0302	25/02/03	67.207	67.724	10	*Orcinus orca*	4
LMG0203	14/05/02	64.843	63.921	10	*Orcinus orca*	4
NBP0104	27/08/01	64.735	63.071	10	*Orcinus orca*	3
LMG 0302	03/03/03	64.256	62.733	10	*Orcinus orca*	22
LMG 01-03	23/03/01	64.093	61.808	10	*Orcinus orca*	6
LMG 01-03	23/03/01	63.725	61.339	10	*Orcinus orca*	8
LMG 01-03	07/04/01	65.840	65.184	11	*Ziphiidae*	1
LMG 01-03	23/03/01	64.174	61.856	11	*Ziphiidae*	4
LMG 0302	20/02/03	65.980	71.052	13	*L. cruciger*	3
LMG 01-03	01/04/01	65.502	70.297	13	*L. cruciger*	4
Polarstern ANTXVIII5b	17/04/01	65.136	70.969	13	*L. cruciger*	10
MG 0201A	09/02/02	60.632	62.850	13	*L. cruciger*	2
NBP0202	12/04/02	60.574	65.198	15	*Unidentified dolphin*	1
LMG 0201A	28/02/02	61.627	62.442	38	*Mesoplodon sp.*	
LMG 0201A	28/02/02	60.309	62.978	38	*Mesoplodon sp.*	5
LMG 0201A	28/02/02	60.076	63.049	38	*Mesoplodon sp.*	3

number of nations began with the Southern Ocean GLOBEC programme. The cruises are multidisciplinary and comprise passages for deployment of moorings, line transect surveys over a constant grid, and process studies at selected locations, within the Western Antarctic Peninsula study region in the vicinity of Marguerite Bay; and in the Ross and Weddell Seas. Their objective is to define the influence of spatial and temporal variability in the physical and biological environment on cetacean distribution (IWC, 2000, p.346) Visual surveys, passive acoustic monitoring and tissue biopsy collection were conducted by IWC SOC observers and collaborating passive acoustics scientists (see table 2 in Van Waerebeek *et al.*, 2004 for more cruise details). Odontocete sightings south of 60°S collected during IWC SOC surveys 2000/2001 to 2003/2004 are listed in Table 1.

The Antarctic Convergence and West Wind Drift are here substituted by the synonymous but currently preferred terminology of Antarctic Polar Front (Orsi *et al.*, 1995) and Antarctic Circumpolar Current (ACC), respectively. South Island and North Island refer to New Zealand. Species status designations under the IUCN Red List (*http://www.iucnredlist.org*), CITES (*http://www.cites.org/eng/app/appendices.shtml*) and CMS (*http://www.cms.int/documents/appendix/Appendices_COP9_E.pdf*) are valid as of February 2010. Frequently used terms are abbreviated as SST (sea surface temperature), NZ (New Zealand), SH (Southern Hemisphere) and ESU (evolutionary significant unit).

AUTOCHTHONOUS ODONTOCETES

We found 22 species of odontocetes as being autochthonous in the Sanctuary, as outlined in the following species accounts.

Sperm whale *Physeter macrocephalus* (Linnaeus 1758)

Systematics and populations

No subspecies are described, geographical morphological variation is minimal and mtDNA is remarkably homogeneous (Dufault *et al.*, 1999; Machin, 1974; 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). It is highly unlikely that management stocks defined by such boundaries would reflect biological population structure.

Distribution in Southern Ocean Sanctuary

The distribution of sperm whales in the Southern Ocean (Fig. 1) 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 20th century whaling operations (Clapham and Baker,

Plate 1. Sperm whale (*Physeter macrocephalus*) (PHE52190013). Photo credit: Paul Ensor. All photos by Paul Ensor were collected using camera equipment provided by Canon NZ Community Sponsorship Programme.

2001) in the Southern Hemisphere. Sperm whales are also relatively easy to detect and identify when at the surface and so there are 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, the sperm whale is 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), reviewing data from sightings surveys conducted between 1976/77 and 1987/88, 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 where 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 historic catch data to show the influence of the Southern Boundary of the Antarctic Circumpolar Current on sperm whale distribution. The circumpolar distribution 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. Tynan 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) with concentrations of sperm whales found along the Kerguélen Plateau. SOCEP data also shows concentrations of this species near frontal zones and eddies associated with the area south of the Southern Boundary, and also well south of this zone in association with the shelf slope and other areas of complex bathymetry (D. Thiele, unpublished data). Data collected on East Antarctic SOCEP surveys (1995/96–2003/04) also show sightings concentrated at 60°E–117°E and in January, and the southernmost record from these surveys is 66°32'S, 64°30'E (D. Thiele, unpublished data).

South of 66°S, Kasamatsu and Joyce (1995) reported high densities of sperm whales 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°S. It is likely that sperm whales within the Sanctuary 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 (NZ). Mass strandings of sperm whales on the west coast of Tasmania (41°S–43°S) in 1998 were predominantly female, indicating the presence of some female groups south of 40°S (Evans *et al.*, 2002). The only report of a female south of the Antarctic Polar Front was of a single whale caught off South Georgia (Matthews, 1938). Sperm whales at Kaikoura, NZ (42°25'S, 173°43'E) were dominantly 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

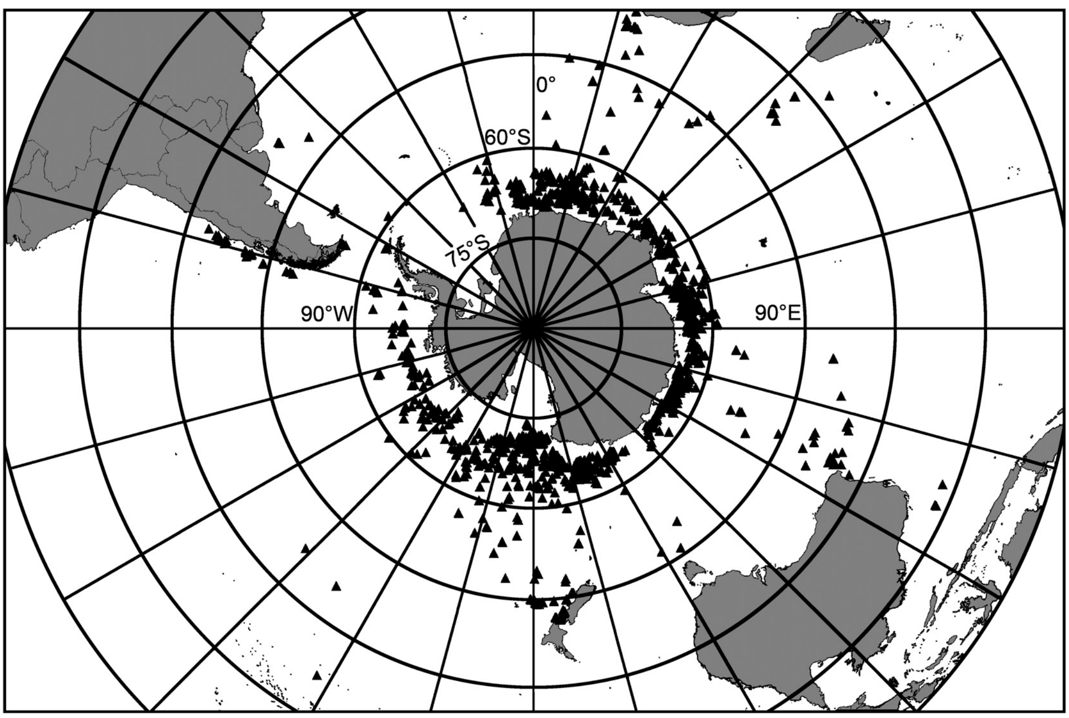

Fig. 1. Sightings of sperm whales from IDCR/SOWER cruises (black triangles).

optimal conditions (upper level sea temperatures) for squid schooling. 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).

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. For instance, Gambell (1967; 1972) and Best (1979) report on the seasonality in sightings and catches in the Durban and Donkergat whaling grounds respectively. Sperm whales are suggested by these authors to show a northward movement in autumn and a southward movement in spring. 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 males caught off Durban and Donkergat showed that Antarctic squid species were present in stomachs between May and September suggesting that male sperm whales were moving north over these months (Clarke, 1980). However, Antarctic squid beaks were only present in the stomachs of large and medium-sized sperm whales, no Antarctic squid beaks were found in the stomachs of small males. 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 at 53°30'S and Thiele and Gill (1999) found them at 44°S, 146°E in July. Sperm whales are also present off Kaikoura, NZ, 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 100 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 catches in the early 1940s due to the war, whaling increased again in the 1950s with average annual takes of 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 1978/79–1987/88. 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 1978–1984), second (1985–1991) and third (1991–1998) IDCR–SOWER circumpolar sighting surveys respectively. These latter estimates are not corrected for $g(0)$, although Whitehead (2002) applying a correction for $g(0)$ suggested around 12,000 sperm whales south of 60°S. 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 × 106 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 1,000km^2. Whitehead's (2002) $g(0)$ correction gave an average density for south of 60°S of 0.65 sperm whales per 1,000km^2. These estimates compare well with density estimates from acoustic surveys. Gillespie (1997) estimated densities of between 0.50–0.73 sperm whales per 1,000km^2 for the sector 80°E–126°E which is believed to be a relatively high density area, while Leaper *et al.* (2000) estimated 0.13 sperm whales per 1,000km^2 for the Scotia Sea, which based on the results of circumpolar surveys (Kasamatsu and Joyce, 1995) is believed to be a relatively low density area. Species status designations are Vulnerable (IUCN Red List) and Appendix I (CITES and CMS).

Plate 2. Pygmy sperm whale (*Kogia breviceps*) stranded at Whangara, E. coast of North Island, NZ. Photo credit: Alan Baker.

Pygmy sperm whale *Kogia breviceps* (de Blainville, 1838)
Systematics and populations
No subspecies are described. Recent molecular genetic research suggests limited intraspecific population structure (Plön, 2004; Plön *et al.*, 2003). Nonetheless, further genetics work and a global study of geographic variation in cranial morphology is recommended.

Distribution in the 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 (until 1990) 212 strandings occurred between 42°S and 38°S (Baker and van Helden, 1990). Seasonality has not been studied in any detail.

Conservation status and exploitation
No population estimates exist and no data specific for our study area could be sourced, however incidental mortality in fishing gear and ingestion of plastic debris may be a problem (Reeves *et al.*, 2003; Stamper *et al.*, 2006). Status designations include Data Deficient (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

Killer whale *Orcinus orca* (Linnaeus, 1758)
Systematics and populations
Lillie (1915, p.121) suggested polymorphism in Antarctic killer whales by claiming that 'high-finned whales' seen in the pack ice are 'probably only a variety of *Orcinus orca*, or possibly a new species of that genus.' The taxonomy of

Plate 3a. Type A killer whale (PHE090121-084). Photo credit: Paul Ensor.

Plate 3b. Type B killer whale (PHE090121-067). Photo credit: Paul Ensor.

Plate 3c. Type C killer whale (PAO060215-167). Photo credit: Paula Olson.

Plate 3d. Type D killer whale (PAO061226160). Photo credit: Paula Olson.

Orcinus is currently under revision, and at least two (*O. orca* and *O. nanus*; Mikhalev *et al.*, 1981), perhaps three species (with *O. glacialis*; Berzin and Vladimirov, 1982) require recognition. Much uncertainty was generated by the loss of the holotype and paratype specimens of *O. nanus* and *O. glacialis*. Pitman and Ensor (2003) and Pitman *et al.* (2007; 2011) added substantial evidence to the case for speciation, documenting four morphologically and ecologically distinct forms in Antarctic waters that do not appear to mingle in schools, and are not thought to interbreed, despite geographic range overlap. Geographic variation in vocalizations between Ross Sea and Northern Hemisphere killer whales (Awbrey *et al.*, 1982) was also congruent with morphological heterogeneity. The Northern Hemisphere form *O. orca* is thought to be the cosmopolitan species.

Distribution in Southern Ocean Sanctuary

Killer whales occur throughout Antarctic waters (Fig. 2), with highest numbers observed (January) close to the northern edge of the pack ice (Brownell, 1974; Budylenko, 1981; Kasamatsu and Joyce, 1995; Kasamatsu *et al.*, 2000; Mikhalev *et al.*, 1981). Hundreds were seen as south as 78°S, 170°E 'at the farthest point of open water to the South' (Wilson, 1907). The three forms (named A, B, C) of killer whale present in the Antarctic during summer show signs of both parapatric and partially overlapping distribution patterns and ecological traits (Pitman and Ensor, 2003). Recently, Pitman *et al.* (2011) described a fourth monotype (D) from Antarctic waters.

IWC SOC data indicate the presence of killer whales inside fjords of the western Antarctic Peninsula, and presence south to 69°S (Fig. 3). SOCEP surveys found killer whales mostly in 60°E–110°E often in ice. Distribution seems to be concentrated near (but not confined to) shelf and shelf slope areas.

Winter observations in the pack ice were documented by Taylor (1957) and Thiele and Gill (1999). Pitman and Ensor (2003) suggested that type A is an open-water species which migrates to lower latitudes during the winter and possibly that type B also migrates. Type B and C killer whales, but not A, have been found within the pack ice in winter. Type A are believed to prey primarily on Antarctic minke whales, type B primarily on seals and type C primarily on fish, such as Antarctic toothfish (Pitman and Ensor, 2003). The C type is one of the smallest killer whales known, which has been studied in the dense pack ice of the southern Ross Sea (Pitman *et al.*, 2007). Recent mtDNA evidence suggests the three pheno- and eco-types are also genetically distinct (LeDuc *et al.*, 2008).

A marked increase in the density of killer whales in the Durban whaling grounds at the height of the winter whaling season was recorded by Findlay *et al.* (1992). It is unknown if such movements reflect migration of killer whales in association with the breeding migrations of baleen whales. One specimen (type to be confirmed) taken in the Durban whaling grounds, South Africa, had remains (vibrissae and nails) of at least three elephant seals within its stomach contents (Findlay *et al.*, 1992), suggesting some migration as the closest elephant seal colony is some 2,000km from Durban. Killer whale distribution data were reviewed at the 2007 IWC Scientific Committee meeting but it was noted that the factors responsible for spatial variation in distribution were not understood (IWC, 2008). During the review, information from localised studies was provided for Macquarie Island (Morrice, 2007), Terra Nova Bay in the Ross Sea (Fortuna *et al.*, 2007), and the Antarctic Peninsula (Dalla Rosa *et al.*, 2007).

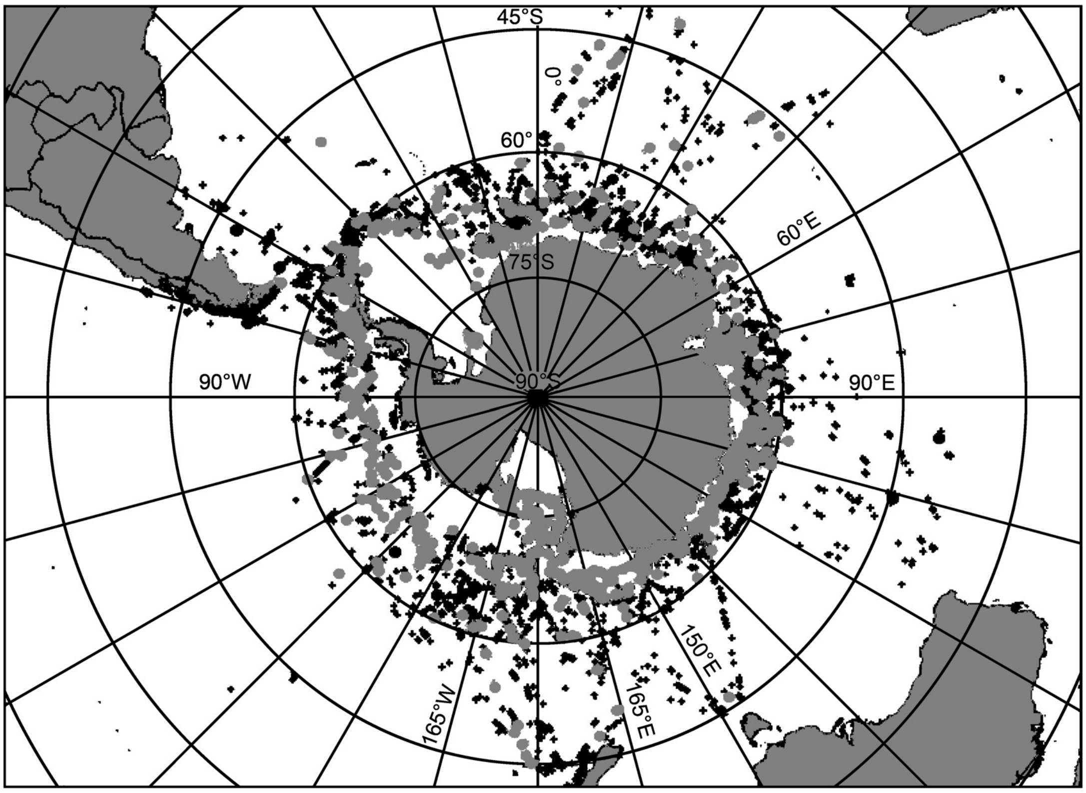

Fig. 2. Sightings of killer whales from IDCR/SOWER cruises (grey circles). Crosses indicate all sightings to give indication of survey effort.

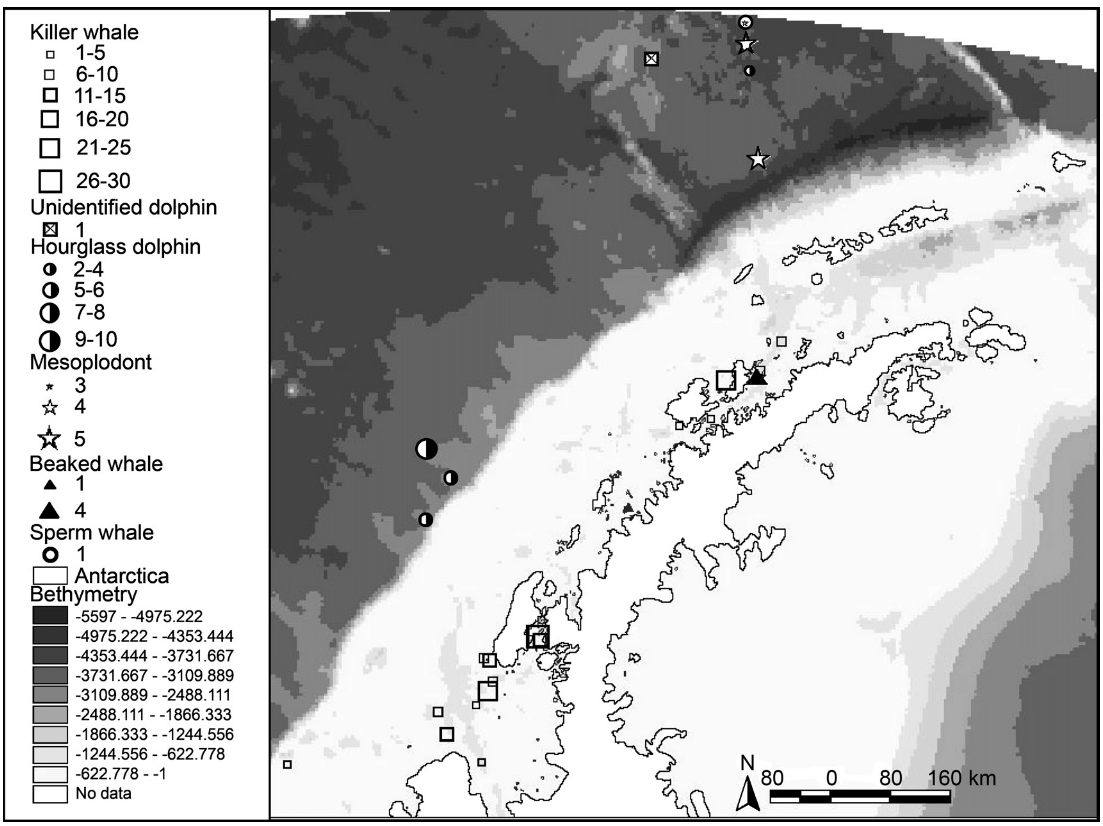

Fig. 3. Odontocete sightings during IWC SOC surveys off the Western Antarctic Peninsula.

Conservation status and exploitation

Killer whales were not a primary target 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. Killer whale catches by the former Soviet Union were usually less than 10 per annum between 1947 and 1966 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 (Centre for Russian Environmental Policy, 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 (Ivashin, 1981) compared to a total take of 738 between 1953/54 and 1978/79 (Mikhalev *et al.*, 1981). The killer whales were taken from 140°E–60°E. That year the IWC Scientific Committee (IWC, 1981b) recalled its recommendation of the previous year that the USSR be urged by the Commission to take no more than 24 killer whales from Antarctica in 1979/80 and noted that the Commission did not follow this recommendation. Referring to a complicated stock structure and insufficient evidence on which to base geographical stock boundaries, the Committee then recommended that 'catch limits for Antarctic killer whale stocks be zero' (IWC, 1981a).

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)), i.e. the moratorium on factory ship whaling for species other than minke whales. No party has filed an objection, so the Paragraph is binding on all parties. The text proposed by the Technical Committee was adopted by the Commission by consensus: '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) gave 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 IDCR-SOWER CPI, CPII, CPIII, sightings surveys respectively. These estimates are associated with a number of caveats, and may be particularly sensitive to changes in the location of the ice edge and the proportion of animals south of the ice edge. One possible explanation for the much higher abundance estimates for killer whales reported in Branch and Butterworth (2001) for CPI compared to CPII and CPIII, was that one survey vessel followed the ice edge for some of the earlier surveys.

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 killer whale, including one individual within the Sanctuary area (42°S).

Conservation status designations for *O. orca* are Data Deficient (IUCN Red List) and Appendix II (CITES, CMS).

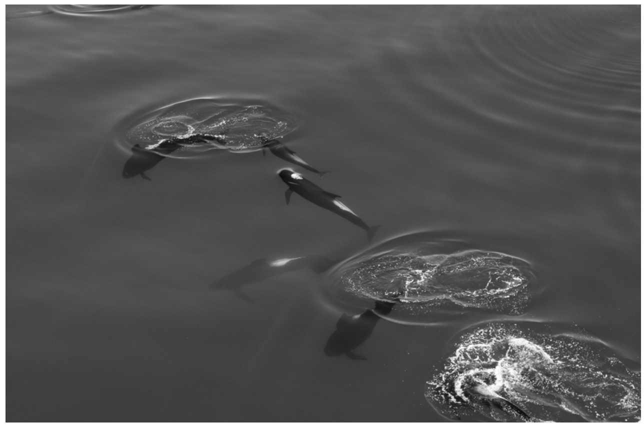

Plate 4. Southern long-finned pilot whale (*Globicephala melas edwardii*) at 36°20.20'S, 108°26.90'E on 19 Feb 2009 (PHE0902019-0370). Photo credit: Paul Ensor.

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

Systematics and populations

Davies (1960) assigned subspecific status to the Southern Hemisphere long-finned pilot whales which he nominated *G. melas edwardii* (A. Smith, 1834). This remains unchallenged. Otherwise no population structure is documented. External characters which distinguish *G. melas* from *G. macrorhynchus* are hard to ascertain if not approached closely. Southern range boundaries for *G. macrorhynchus* are imprecisely known and many sightings may in fact be presumed to be long-finned pilot whale on mere latitudinal considerations. We recommend explicit indication of diagnostic features as to allow re-evaluation of data. Stranding records of *G. macrorhynchus* on the south coast of South Africa may reflect southward movement within the warm southerly flowing Agulhas Current of the region (Findlay *et al.*, 1992).

Distribution in Southern Ocean Sanctuary

G.m. edwardii is found throughout the Southern Ocean in cold currents (Antarctic Circumpolar, Humboldt, Falkland and Benguela Currents), north of the Antarctic Polar Front (Goodall and Galeazzi, 1987). Recent data show it to occur also south of the Polar Front. Several groups were sighted in the Scotia Sea, off South Georgia, Elephant Island, South Shetlands, and South Orkneys in summer (Brownell, 1974; Goodall and Macnie, 1998; Hanson and Erickson, 1985). However, none were encountered during IWC SOC surveys off the Western Antarctic Peninsula over the two years, in any season. Also, SOWER/IDCR surveys encountered only a single group between 40°W and 75°E, south of 45°S, indicating a lowest density area (Fig. 4). During 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 generally off the shelf and at the base of the steep shelf slope, appropriate habitat for its main prey, cephalopods (Clarke and Goodall, 1994). Often observed in close association with minke whales, hourglass and dusky dolphins (Goodall and Galeazzi, 1987; Goodall and Macnie, 1998).

Strandings have occurred in Tasmania (Davies, 1960; 1963; Guiler, 1978; Scott, 1942), North and South Islands of New Zealand, Auckland Islands (Baker, 1977; 1999); South Orkneys and South Georgia (Goodall and Macnie, 1998), the latter being 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. Based on observations from whaling vessels, 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 IWC/IDCR cruises registered 26 schools (1,578 animals) south of 58°S. All but one sighting (200 animals in Area IV) was made away from the ice-edge.

Peaks in encounter rates, longitudinally in IDCR/SOWER cruises, 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. Highest encounter rates are reported for 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, but survey effort is mimimal then. The southernmost winter sighting (18 June; 25 animals) is at 55°27'S, 68°44'W, in Drake Passage (Goodall and Macnie, 1998).

Southernmost summer sightings are at 64°S (Kasamatsu and Joyce, 1995), near Scott Island (67°S,179°W) and in the central Pacific sector at 68°S, 120°W (Brownell, 1974), in the Atlantic at 67°41'S,05°44'W (SST = –1.0°C) (Kasamatsu *et al.*, 1988) and a group of six spotted NW of the Ross Sea at 66°33'S, 140°40'E. These lend credibility to a 1909 sighting at 69°53'S by Liouville (1913). Summer sightings south of the Polar Front below 60°S are nothing unusual, even with calves (Ensor *et al.*, 2009; 2008; 1999; Goodall and Macnie, 1998).

Conservation status and exploitation
Exploitation in the Southern Hemisphere has been sporadic and very low (Mitchell, 1975a; 1975b). No direct exploitation is known to occur at present in Sanctuary waters. Long-finned pilot whale is considered relatively scarce in Antarctic waters (Hanson and Erickson, 1985; Sapin-Jaloustre, 1953), and sometimes the species is not recorded over a complete summer survey (IWC SOC data; Thiele *et al.*, 2000). However, Hanson and Erickson (1985) note observations of large schools and that overall abundance would be higher than expected based on just number of schools sighted. Kasamatsu and Joyce (1995) give a January estimate of 200,000 (CV 0.35) long-finned pilot whales south of the Polar Front, based on IDCR sightings data between 1976/77–87/88, but note several caveats to this estimate in discussion. No estimates are provided by Branch and Butterworth (2001) due to the overall paucity of sightings and high variability in the number of sightings between surveys.

Status designation of *G. melas* includes Data Deficient (IUCN Red List), Appendix II (CITES) and Not listed (*G.m.edwardii*) (CMS).

False killer whale *Pseudorca crassidens* (Owen, 1846)

Systematics and populations
Pseudorca is a monotypic genus originally described as fossil. Geographical variation in cranial features has been described by Kitchener *et al*. (1990), and a subspecies, *P. crassidens meridionalis* (Flower, 1885) was erected by Deraniyagala (1945) for Indo-Pacific populations. Rice (1998) considered, however, that, in the absence of suitable defining characteristics, recognition of any subspecies would be premature.

Distribution in the Southern Ocean Sanctuary
In the Pacific and Indian Oceans, *P. crassidens* is known from New Zealand, Tasmania, South and Western Australia

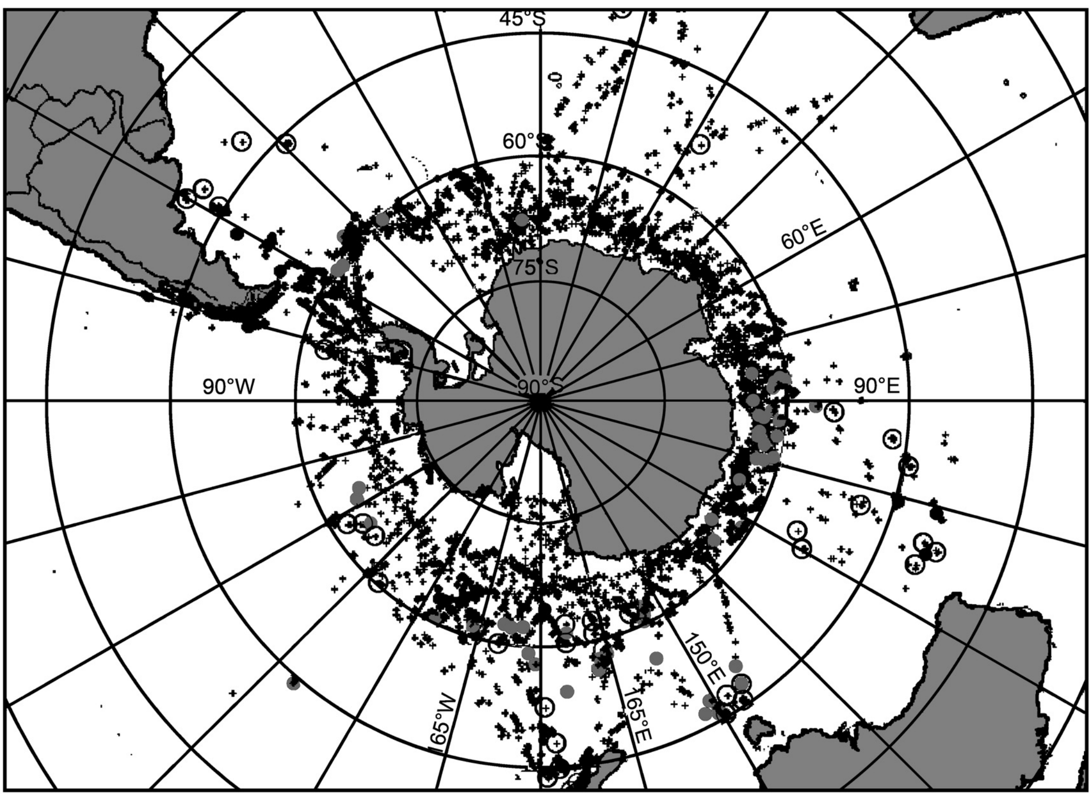

Fig. 4. Sightings of pilot whales from SOWER cruises (grey circles identified as long-finned, open circles as 'pilot whale'). Crosses indicate all sightings to give indication of survey effort.

Plate 5. Hourglass dolphin (*Lagenorhynchus cruciger*) (PHE52190006). Photo credit: Paul Ensor.

(Baker, 1999; Bannister *et al.*, 1996). North of the Sanctuary, it also occurs in South African waters (Findlay *et al.*, 1992) and in the eastern Magellan Strait at 52°27'S, southern Chile (Alonso *et al.*, 1999). In the Atlantic Ocean, Bastida and Rodriguez (2005) report occurrences in Argentina's Patagonia and Tierra de Fuego.

Conservation status and exploitation
No commercial exploitation occurs, although the false killer whale is occasionally captured for subsistence food in tropical regions, e.g. West Africa (Ofori-Danson *et al.*, 2003). Status designations include Data Deficient (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

Hourglass dolphin *Lagenorhynchus cruciger* (Quoy and Gaimard, 1824)

Systematics and populations
Taxonomic history is comprehensively reviewed by Goodall *et al.* (1997a). *L. obscurus* and *L. australis* were equivocally synonymised with *L. cruciger* (e.g. Bierman and Slijper, 1947; Liouville, 1913) until Fraser (1966) demonstrated that the name covers the hourglass dolphin only. Hence pre-1966 *L. cruciger* records can be either of three SH species, unless supported by diagnostic evidence. Discovery of *L. cruciger* is often (Goodall *et al.*, 1997a; Rice, 1998) attributed to Quoy and Gaimard (1824) thanks to an unmistakable description and a rough sketch, but no specimen. True (1889) and Robineau (1990) argued that d'Orbigny and Gervais (1847) should be considered the original species description since these authors described a first type specimen collected SE of Cape Horn. No subspecies or population structure are recognised and the species is most likely panmictic.

Distribution in the 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 was at 67°38'S in the South Pacific (Goodall, 2002; Goodall *et al.*, 1997a). D'Orbigny and Gervais (1847) stated that they found *Delphinus cruciger* from '57°S–76°S', with the southernmost latitude presumably a misprint. SOWER/IDCR data suggests a dearth of sightings south of 60°S and east of the Antarctic Peninsula as far as 70°E, despite extensive effort (Fig. 5).

During IWC SOC surveys, hourglass dolphins were seen south to 66°S, off the Western Antarctic Peninsula. In the SOCEP surveys, they were concentrated on the shelf slope and the outer edges of steep bathymetry (like Kerguélen 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, the southernmost group was encountered at 64°31.2'S.

The northern range boundary of *L. cruciger* is unclear, but unsupported reports at Atico (16°13'S,73°39'W) in southern Peru (Heintzelman, 1981), 'about 25°S' (Scheffer and Rice, 1963) and 36°14'S,52°43'W off the Rio de la Plata, Uruguay (Nichols, 1908) are not credible without authentication. All could have been dusky dolphins, *L. obscurus*. An alleged sighting off Valparaiso at 33°40'S, 74°55'W (Clarke, 1962) likely also involved dusky dolphins and its naming as *L. cruciger* may simply be the result of the pre-1966 instability in nomenclature, as explained higher[13]. The northernmost substantiated records in the Southeast Pacific Ocean are a 163cm specimen captured some 170km west of Isla Esmeralda in southern Chile at 49°S,78°W (Nichols, 1908), and another at 53°13'S,106°20'W in the South Pacific (N. Miyazaki, in Brownell and Donahue, 1999). A sighting in the Argentine basin at 42°24'S, 42°28'W on 14 November 1912 (Murphy, 1947) is unauthenticated. An alleged specimen from Tasmania (Guiler, 1978) was re-identified as *Lissodelphis peronii* (Van Waerebeek, 1993b).

L. cruciger is often reported from around South Georgia (e.g. Matthews, 1977). Gaskin (1968, in Brownell, 1974) recorded a number of sightings from southeast of the Chatham and Antipodes Islands (50°–60°S) and Gaskin (1972) claimed a winter record from Kaikoura, New Zealand, at 42°20'S, 174°05'E in 1963, without supporting evidence. Goodall *et al.* (1997a) listed four specimens from the east coast of South Island, NZ, including a skull in the Otago Museum. An alleged sighting in the western Gulf of Aden, off Somalia were referred to as 'unusual dolphins' that most closely resembled hourglass dolphins (Small and Small, 1991). Van Waerebeek *et al.* (1997) reviewing warm-water *Lagenorhynchus* records suggested that another, perhaps unrecognised, *Lagenorhynchus*-like delphinid may be involved.

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). However, neither author offered any authentication. Bierman and Slijper (1947) reported *Lagenorhynchus wilsoni* (junior synonym of *L. cruciger*) from the SE 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. As their drawing confirms *L. cruciger*, these can be

[13] Robert Clarke (1962), who clarified that in 1896 Philippi recorded the species he sighted as '*Tursio obscurus* Gray' [a synonym for dusky dolphin *L. obscurus*, see Gray, 1866], logically applied the pre-1966 used name '*L. cruciger*' for any southern *Lagenorhynchus*, including dusky dolphin *L. obscurus*. On his survey Clarke did otherwise not report any *L. obscurus*, one of three most common cetacean species off Chile (Van Waerebeek, 1992a; 1992b).

considered the northernmost positive records of the species. Southernmost sightings include one in the northern Ross Sea, near Scott Island (66°36'S,177°51'E) (G. Joyce photo in Leatherwood *et al.*, 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 Stahl (1982) reported two February sightings from south of the Crozet Islands 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, 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 the two oceanographic regions 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 and were not seen south of 66°S in the South Atlantic and Indian Ocean sectors. 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, namely from South Island, NZ and Livingston Island, South Shetlands (Fraser and Noble, 1968; Goodall *et al.*, 1997a).

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). Thiele and Gill (1999) came upon two groups in winter (July 1995) in open water (55°01.8'S,141°00.6E and 57°14.2'S,139°51.9'E) of, respectively, 1.4°C and 1.1°C SST. Prey has included more or less digested small fish such as Myctophidae (Best, 2007; Goodall, 1997; Nichols, 1908) and squid (Ash, 1962; Clarke and Goodall, 1994) including Onychoteuthidae and Enoloteuthidae (Goodall, 1997).

Conservation status and exploitation

Some have been harpooned for food and a few for research purposes, but otherwise no exploitation of hourglass dolphin existed (Ash, 1962; Brownell and Donahue, 1999; Fraser, 1964; 1966; Nichols, 1908). 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, including the second and third circumpolar, but did not consider these estimates reliable. They noted large potential biases due to attraction to the vessel but also that the estimates had little biological meaning because the main distribution for the species was outside of the survey area. No conservation problem is identified (Goodall *et al.*, 1997a; Reeves and Leatherwood, 1994; Reeves *et al.*, 2003). Status designations: Least

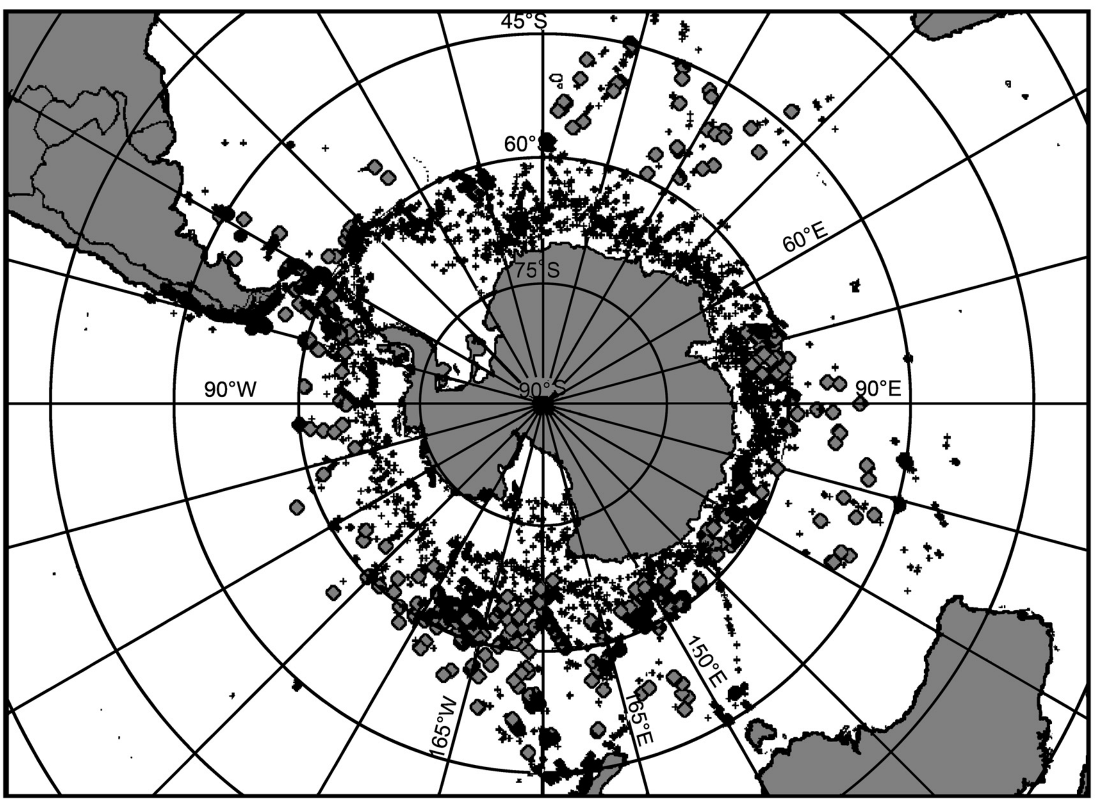

Fig. 5. Sightings of hourglass dolphins from IDCR/SOWER cruises (grey diamonds). Crosses indicate all sightings to give indication of survey effort.

Plate 6. Dusky dolphin (*Lagenorhynchus* obscurus), Kaikoura, NZ (PHE14032010-0013). Photo credit: Paul Ensor.

Concern (IUCN Red List); Appendix II (CITES) and Not listed (CMS).

Dusky dolphin *Lagenorhynchus obscurus* (Gray, 1828)

Systematics and populations

Van Waerebeek (1992a; Van Waerebeek, 1993a) found significant geographic variation in morphology, some considered at subspecific level, but refrained from describing subspecies pending additional evidence. Rice (1998) named three subspecies (for South America, South Africa and New Zealand) without offering diagnoses or types. Molecular genetic analyses support divergent SE Pacific and Atlantic lineages, and reveal an intricate phylogenetic pattern. Peruvian dusky dolphins form a distinct ESU (Cassens *et al.*, 2003; 2005). A probable hybrid of *L. obscurus* with *L. peronii* was photographed off Argentina (Yazdi, 2002)[14] and a skull from Peru suggested hybridism with *Delphinus capensis* (Reyes, 1996).

Distribution in the Southern Ocean Sanctuary

Van Waerebeek *et al*. (1995) comprehensively reviewed *L. obscurus* global distribution. Gill *et al.* (2000) demonstrated its presence off Tasmania and southern Australia by 13 sightings and a stranded mother/calf pair. Van Waerebeek *et al*. (1995) reported a few sightings south of Gough Island (40°20'S,09°54'W) in the mid-Atlantic. Baker (1977) indicated Campbell Island (52°30'S,169°10'E) as the southernmost range for the New Zealand stock. Lillie (1915, p.122) reported its southernmost sighting (7 February 1913) at 51°56'S,168°02'E, and stated that it does not seem to occur further south than about 58°S, however no substantiation is available for this pre-1966 record. Nishiwaki (1977), repeating the 58°S, stated that *L. obscurus* stays 300–500km to the north of the convergence (Antarctic Polar Front). However, two Drake Passage sightings south of the Polar Front, one at 57°50'S and another at 60°29'S, north of the South Shetland Islands (Goodall *et al.*, 1997b; fig.9) seem to contradict this.

A group of two dolphins sighted by KPF at 60°33.65'S, 054°35.70'W off Elephant Island in 13 March 1990 were 'similar to a gray *Lagenorhynchus* and definitely not hourglass dolphin colouration'.

Thiele *et al*. (1997) encountered dolphins closely resembling dusky dolphins and 'distinctly unlike hourglass dolphins' at 64°28'S,120°02'E on 1 March 1997. If *L. obscurus* ventures south of the Polar Front, it remains a rare event. During SOCEP surveys, the species was seen to 48°S. Although dusky dolphins can move over great distances, there is no evidence of regular oceanic migration (Cassens *et al.*, 2003; Cassens *et al.*, 2005; Van Waerebeek *et al.*, 1995). Movements around New Zealand are related to SST (Gaskin, 1968).

Conservation status and exploitation

Unlike the Peru and Argentina populations (Dans *et al.*, 2003; Van Waerebeek, 1992a), the New Zealand/Australia stock is not known to be subjected to any exploitation. If catches occur off South Africa they would be small and difficult to demonstrate as catches are illegal.

Status designations for the dusky dolphin are 'Data Deficient' (IUCN Red List) and Appendix II (CITES and CMS).

Southern right whale dolphin *Lissodelphis peronii* (Lacépède 1804)

Systematics and populations

No subspecies or populations are named. Suggested conspecificity with northern right whale dolphin *L. borealis* (Honacki *et al.*, 1982) is unfounded, although all-black individuals have been sighted (e.g. photo p.261 in Jefferson *et al.*, 2008). *L. peronii* is cranially (Van Waerebeek, 1993b) and genetically (cytochrome b gene, LeDuc *et al.*, 1999) very close to *L. obscurus* with which it can hybridize in the wild (Yazdi, 2002), as well as close to the other southern *Lagenorhynchus* and *Cephalorhynchus* species (100% bootstrap support for subfamily *Lissodelphininae*).

Distribution in the Southern Ocean Sanctuary

Brownell (1974) called *L. peronii* a 'marginal Antarctic species', with associated SST range, 1.4–13.8°C (Kasamatsu *et al.*, 1988). Circumpolar, from about 40°S–55°S (Baker, 1981; Jefferson *et al.*, 1994) but extending much further north in cold currents, with a northernmost record at Pucusana (12°28'S,76°48'W), Peru, in the Humboldt Current system (Van Waerebeek *et al.*, 1991). It is fairly common off South Island, New Zealand, in the Tasman Sea and waters directly south of Australia (Gaskin, 1968; 1972). 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 species schools. The southernmost specimen, according to Goodall and Galeazzi (1985a), is a skull collected from the South Shetland Islands. During SOCEP, four sightings were recorded from 47°S–49.23°S and 131°E–137°E, with 'like hourglass' sightings south of 65°S between longitudes 85°E and 145°E. One was a large group of 75 animals, but other groups were small (2–10 animals).

L. peronii is present off Namibia having been recorded in summer (eight sightings between November and January),

[14] 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.*

autumn (two sightings in April) and winter (two sightings in August) although this possible summer seasonality may reflect observer effort bias (Findlay *et al.*, 1992). Further sightings from this region were reported by Rose and Payne (1991) and include one just south of the South African/Namibian border. There is no evidence of any significant migratory movement, however this may be due to a lack of dedicated research.

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 bycatches, anthropogenic mortality in the Sanctuary is thought to be minimal; mortality in gillnet fisheries off Chile may not be insignificant (Van Waerebeek *et al.*, 1991).

Status designations include Data Deficient (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

Commerson's dolphin *Cephalorhynchus commersonii* (Lacépède 1804)

Systematics and populations

Rice (1998) recognised two subspecies[15], coinciding with the population off South America, including Drake Passage (Sanctuary waters), and the population from the Kerguélen Archipelago (Paulian, 1953; Robineau, 1989a; 1990). Their plausible origin and radiation is discussed by Pichler *et al.* (2001). Robineau *et al.*(2007) described and documented a new subspecies from Kerguelen Islands as *C. commersonii kerguelenensis*.

Distribution in the Southern Ocean Sanctuary

Commerson's dolphins are distributed mostly, with highest abundance, in nearshore areas outside the Sanctuary, i.e. east coast of southern South America, Peninsula Valdéz south to Tierra del Fuego and near Burdwood Bank. It is fairly common in the Magellan Straits and Falklands Islands and off Chile, south of 50°S. The northernmost range in the SW Atlantic is unclear but probably close to 41°26'S (Goodall, 1994; Goodall *et al.*, 1988). There is only one area of reported occurrence within the Sanctuary, i.e. the southern stratum of Drake Passage (Dawson, 2002): the two southernmost sighting records were south of the Antarctic Polar Front, NW of Livingstone Island, South Shetlands (n = 1, 61°59'S,63°05'W, 27 Feb. 1966; n = 2, 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, 1975; Aguayo and Torres, 1967). 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) saw 'a film of 15 or so Commerson's dolphins pacing a U.S. Coast Guard icebreaker in the Antarctic'. This film should be re-examined, but it would seem hard to confuse Commerson's dolphin with any other cetacean.

Unsubstantiated reports of *C. commersonii* off South Georgia (Hart, 1935; Matthews, 1931) were questioned (Brown, 1988; Brownell and Praderi, 1985), but seeped widely into the literature (e.g. Brownell, 1974; Fisher and Hureau, 1985; Leatherwood *et al.*, 1983; Strange, 1992). If Commerson's dolphin makes occasional excursions offshore and south into Drake Passage it could enter the Scotia Sea off South Georgia. The former existence of a third, relict population off islands in the Scotia Sea is another possibility. Immediately north to the Sanctuary, a reproductively isolated, both morphologically and genetically distinct, population resides in waters of the Kerguélen archipelago (48°30'–50°S, 68°30'–70°45'E) (de Buffrenil *et al.*, 1989; Goodall, 1994; Paulian, 1953; Pichler *et al.*, 2001; Robineau, 1989a; 1990; Stahl, 1982), now recognised as a new subspecies (Robineau *et al.*, 2007). A sighting of a presumed vagrant of unknown origin at the southern African continental shelf (de Bruyn *et al.*, 2006), suggests a less restricted distribution than hitherto believed. This and rare Drake Passage sightings could point to irregular wandering movements offshore and south, or east, from Patagonia, under (indeterminate) favourable oceanographic conditions. Conceivably, a higher population size half a century ago may have led to more frequent 'extralimital' records. Some individuals from the Kerguélen population may perhaps cross into the Sanctuary's Indian Ocean sector.

Conservation status and exploitation

Although some localised abundance estimates have been made (Leatherwood *et al.*, 1988; Lescrauwaet *et al.*, 2000; Venegas, 1996) these are only for small areas of the Strait of Magellan which is outside the Sanctuary. No abundance data exist within the Sanctuary area. Good estimates are lacking 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 taken for research purposes at Kerguélen (Angot, 1954; Paulian, 1953). French observers on board Russian trawlers fishing on the Kerguélen plateau did not report any incidental dolphin kills (D. Robineau, in Reeves and Leatherwood, 1994). At least 18 dolphins were taken in Tierra del Fuego for captive display purposes (Goodall *et al.*, 1988). Status designations are Data Deficient (IUCN Red List), Appendix II (CITES) and Appendix II (CMS) only for the South American population.

Hector's dolphin *Cephalorhynchus hectori* (P.J. Van Beneden, 1881)[16]

Systematics and populations

A complete taxonomic history with synonymies of Hector's dolphin, endemic to New Zealand, was given by Baker (1978). Since then, mtDNA analysis has identified four regional populations (Pichler, 2002), followed by a study of

[15]However without presenting names, diagnoses or types.

[16] *non* 'P.J. van Bénéden' (erroneous spelling) *in* Hershkovitz (1966), Rice (1998), and many others. Pieter-Jozef Van Beneden (1809–1894), a Flemish professor of zoology at the Katholieke Universiteit van Leuven, Belgium. Confusingly, his son Edouard Van Beneden, professor of zoology at Luik University, also published on cetacean taxonomy (described *Sotalia brasiliensis*), therefore given name initials are required.

morphological variation showing consistent differences between the North and South Island populations which resulted in Baker *et al.* (2002) describing 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 the Southern Ocean Sanctuary

Hector's dolphin occurs around most of South Island (except for the southern fiords), thus within the Sanctuary; in contrast, the entire range of Maui's dolphin falls north of it. No indications exist of any significant seasonal or migratory movements. Satellite tagging has been trialed to track the movements of Hector's dolphin. Both subspecies are exclusively neritic, most often seen within 0.5 n.miles from shore (Baker *et al.*, 2002; Brager, 1999; Dawson and Slooten, 1988), but they range to at least 18 n.miles offshore (ANB, pers. obs.). Local populations occupy relatively small geographic ranges, e.g. of approximately 33 n.miles (Brager, 1999). Three genetically distinct regional populations are distributed on the eastern, southern and western coasts of the South Island (Pichler, 2002).

Conservation status and exploitation

This species is occasionally taken in trawl fishing operations (Baker, 1978; Mitchell, 1975b), gillnets (Dawson, 1991; 2002; Mörzer Bruyns and Baker, 1973; Slooten and Lad, 1991; van Bree, 1972) 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 an estimated 7,300 animals. Incidental takes in inshore gillnets are the biggest threat to its survival (Dawson, 1991; 2002; Slooten and Lad, 1991). The IUCN Red List status is 'Endangered' (*C. hectori*). The northern Maui's dolphin may number fewer than 100 individuals and is listed as 'Critically Endangered'. The species is listed on Appendix II (CITES) and Appendix I (CMS).

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

Systematics and populations

Of the two species of bottlenose dolphin widely recognised in the Southern Hemisphere, only *T. truncatus* is eurythermic enough to penetrate the northern sectors of the Sanctuary. The Indo-Pacific bottlenose dolphin *T. aduncus* (Ehrenberg, 1833) occupies solely tropical and warm temperate latitudes. 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 although absent from polar waters (Marcuzzi and Pilleri, 1971; Wells and Scott, 2002). Within the Sanctuary the species occurs around Tasmania and New Zealand where it is common in the Bay of Islands, Hauraki Gulf, and Marlborough Sounds (Baker, 1972; 1983; Bannister *et al.*, 1996) and in Fiordland (Haase and Schneider, 2001). De Boer *et al.* (1999) reported a group of six bottlenose dolphins near Hobart (depth 36m; 20°C). Contiguous to the Sanctuary, specimen records exist from the Falkland Islands (Strange, 1992) and Bahía San Sebastian, southern Patagonia, Argentina (Goodall, 1978; Goodall and Galeazzi, 1985a; RNP Goodall, e-mail to KVW, 29 September 2003). The southern distribution boundary is only vaguely known, but 55°S (Bannister *et al.*, 1996) seems plausible. Suggestions of 48°S (map in Wells and Scott, 2002) and 45°30'S (Haase and Schneider, 2001) are disproved by the Falklands records (51°–52°S), but (sub)Antarctic waters proper lie beyond its range (Brownell, 1974; Kasamatsu and Joyce, 1995; Miyazaki and Kato, 1988; authors, pers. obs.), presumably related to SST and prey distribution.

Plate 7. Short-beaked common dolphin (*Delphinus delphis*), SW of South Africa, 24 Feb 1998, 37°20.15'S, 15°10.24'E. Photo credit: Paul Ensor.

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

Conservation status and exploitation

No population estimates for the Southern Ocean and no examples of exploitation are identified. A rare mass stranding[17] of 21 animals occurred in Delaware Bay (41°08'S, 173°28'E), South Island, in March 1982, all of which were rescued (Robson, 1984). Status designations include Least Concern (IUCN Red List), Appendix II (CITES), and unlisted populations (CMS).

Short-beaked common dolphin *Delphinus delphis* (Linnaeus, 1758)

Systematics and populations

Bannister *et al.* (1996) reported that two forms of common dolphin exist in South Australia (contiguous to the Southern Ocean Sanctuary) but 'it is not known whether these represent the short- or long-beaked types'. Jefferson and Van Waerebeek (2002) tentatively assigned all available *Delphinus* specimens from South Australia to *D. delphis,* which was in agreement with molecular genetic analysis (White, 1999).

Distribution in Southern Ocean Sanctuary

Common dolphins frequent coastal waters all around New Zealand (Baker, 1972) but their austral range is unclear. The

[17]Likely a tidal trapping (ANB).

short-beaked form is recorded from Tasmania and southern Australia. *D. delphis* is not reported from territories in the Antarctic or Heard and Macquarie Islands (Bannister *et al.*, 1996). It is not known to be migratory off Australia and New Zealand.

Conservation status and exploitation

Designations include Least Concern (IUCN Red List), Appendix II (CITES) and unlisted population(s) (CMS).

Spectacled porpoise *Phocoena dioptrica* (Lahille, 1912)

Systematics and populations

Barnes (1985) created a new genus for the spectacled porpoise, *Australophocoena.* However, Lahille's (1912) recognition of close morphological affinity with other *Phocoena spp*. is supported by mtDNA cytochrome b analysis (Rosel *et al.*, 1995). No subspecies or population structure is defined, but the relative rostrum length of a skull from Auckland Island (50°45'S,166°06E) was shorter than in other regions (Perrin *et al.*, 2000).

Distribution in Southern Ocean Sanctuary

Showing a circumpolar distribution (Baker, 1977; Goodall and Schiavini, 1995; Sekiguchi *et al.*, 2006), the spectacled porpoise appears particularly common in the southwestern South Atlantic off Tierra del Fuego (Goodall and Cameron, 1979) and, based on IDCR/SOWER sightings (Fig. 6), in the Antarctic sector south of NZ and Tasmania (Sekiguchi *et al.*, 2006). Within the Sanctuary, stranded specimens are reported from South Georgia (Burton, 1997; Fraser, 1968; Strange, 1992), Bruny Island, Tasmania (K. Evans in Brownell and Clapham, 1999), Macquarie Island (Fordyce *et al.*, 1984), South Island of New Zealand (Baker, 1999) and Auckland Islands (Baker, 1977). It has been seen near Antipodes Islands (Kasamatsu *et al.*, 1990) and Auckland Islands (M.Cawthorn in Goodall and Schiavini, 1995). In the Indian Ocean, the spectacled porpoise was recorded at Heard and Kerguélen Islands (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.

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. In the western South Atlantic the spectacled porpoise seems to breed in spring.

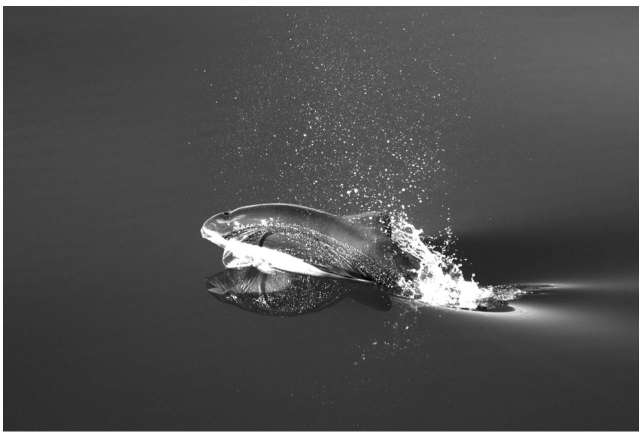

Plate 8a. Spectacled porpoise (*Phocoena dioptrica*) (PE080111-0388). Photo credit: Paul Ensor.

Plate 8b. Spectacled porpoise (*Phocoena dioptrica*) (PE080111-0517). Photo credit: Paul Ensor.

Conservation status and exploitation

Population abundance is unknown, but it is considered 'rare' from small group size ranging from 1–3 animals and low encounter rates (Ensor *et al.*, 2001; Goodall and Schiavini, 1995; Sekiguchi *et al.*, 2006). Kasamatsu *et al.* (1990) concluded, possibly prematurely in view of the small number of sightings, that the spectacled porpoise does not form large schools. A similar claim about Burmeister's porpoise *Phocoena spinipinnis* was dismissed after a school of *ca.* 150 individuals was sighted off Peru (Van Waerebeek *et al.*, 2002). Hamilton (1952) indicated that 'the species [*P.dioptrica*] had been taken off South Georgia'. A live-stranded animal in South Georgia was eaten; moreover according whaling captains these porpoises were sometimes shot for food (Brownell and Clapham, 1999; Fraser, 1968). It also used to be hunted by fishermen from Uruguay and southern Chile (Goodall and Schiavini, 1995; Praderi and Palerm, 1971). Some mortality may occur by 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.*, 2003).

Conservation status designations include Data Deficient (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

Beaked whales *Ziphiidae*

During SOCEP and IWC SOC surveys beaked whales could not be identified to species because most individuals were too distant from the vessel for diagnostic features to be seen. Implementation of closing mode for long-diving species such as beaked whales is problematic due to the relatively short duration of their surfacing bouts. Experience during the IWC/IDCR and IWC/SOWER programmes indicate that some of the best opportunities for identifying and documenting such species are the occasions when they are detected close to the vessel irrespective whether the vessel is in passing or closing mode (e.g. Van Waerebeek *et al.*, 2005). SOCEP found ziphiids mostly on the shelf slope and near ice. During IWC SOC surveys, three mesoplodont

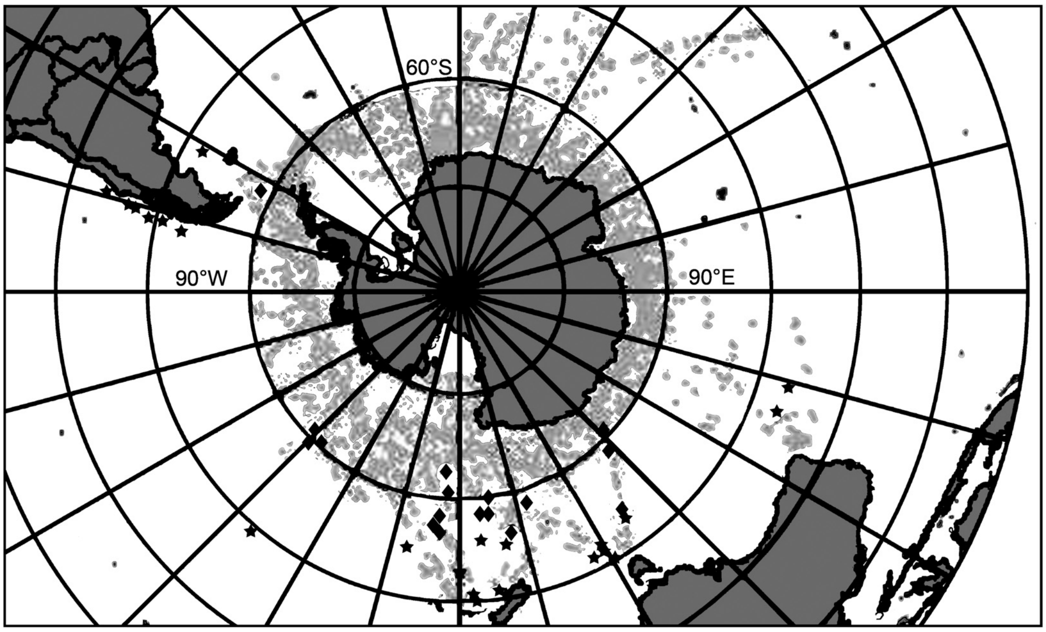

Fig. 6. Sightings of spectacled porpoise (black diamonds) and southern right whale dolphins (black stars) from IDCR/SOWER cruises.

sightings were recorded across Drake Passage, and unidentified beaked whales were seen in Gerlache Strait and in the fjords of the Western Antarctic Peninsula (see Fig. 2).

Southern bottlenose whale *Hyperoodon planifrons* (Flower, 1882)

Systematics and populations

No subspecies are named and no population structure is documented (Mead, 1989b; Mitchell, 1975b), however mtDNA control region sequences of two specimens from New Zealand differed 4.12%, considerably higher than the normal interspecific variation of 2% in other beaked whales (Dalebout *et al.*, 1998). Intraspecific variation in colouration pattern may be mostly ontogenetic and sexual, but geographic variation is not ruled out (Van Waerebeek *et al.*, 2005). A global phylogenetic study is necessary.

Plate 9a. Southern bottlenose whale (*Hyperoodon planifrons*) (PE080124-0594). Photo credit: Paul Ensor.

Plate 9b. Southern bottlenose whale (*Hyperoodon planifrons*) (PE080124-0753). Photo credit: Paul Ensor.

Distribution in Southern Ocean Sanctuary

Extensive circumpolar distribution (Fig. 7), from the Antarctic continent north to Dampier Archipelago, NW Australia at *ca*.20°35'S,116°39'E where the holotype was found (Flower, 1882). In the Sanctuary, strandings are known from the South Island, NZ (Baker, 1999) and at 54°19'S on South Georgia (G.J.B. Ross, pers. comm. to ANB, October 2001). Aerial survey sightings of 'like-bottlenose whale' off Durban, South Africa, during whaling operations show strong seasonality with peaks in February and October (but no data for November–January) (Findlay *et al.*, 1992; Sekiguchi *et al.*, 1993). It remains unclear whether or not the February peak results from a general late summer movement northward out of the Antarctic, and alternatively perhaps two parapatric stocks exist. Ross (1984) noted an apparent summer seasonality of this species in South African waters. Findlay *et al.* (1992) found bottlenose whales of the southern African subregion to be confined to temperate and subtropical waters of the Agulhas Current and few records within the cold temperate Benguela system. Although these data may be biased by the paucity of offshore sighting survey effort in the Benguela system, the records from the warm temperate and subtropical Agulhas Current (in relation to the Southern Ocean distribution patterns) suggest some stock segregation or migration. Nemoto *et al*. (1980) report evidence of the skin diatom *Cocconeis ceticola* on a specimen of *H. planifrons* from South African waters, while Sekiguchi *et al*. (1992) recorded beaks from Antarctic squids in the stomachs of animals from South African waters.

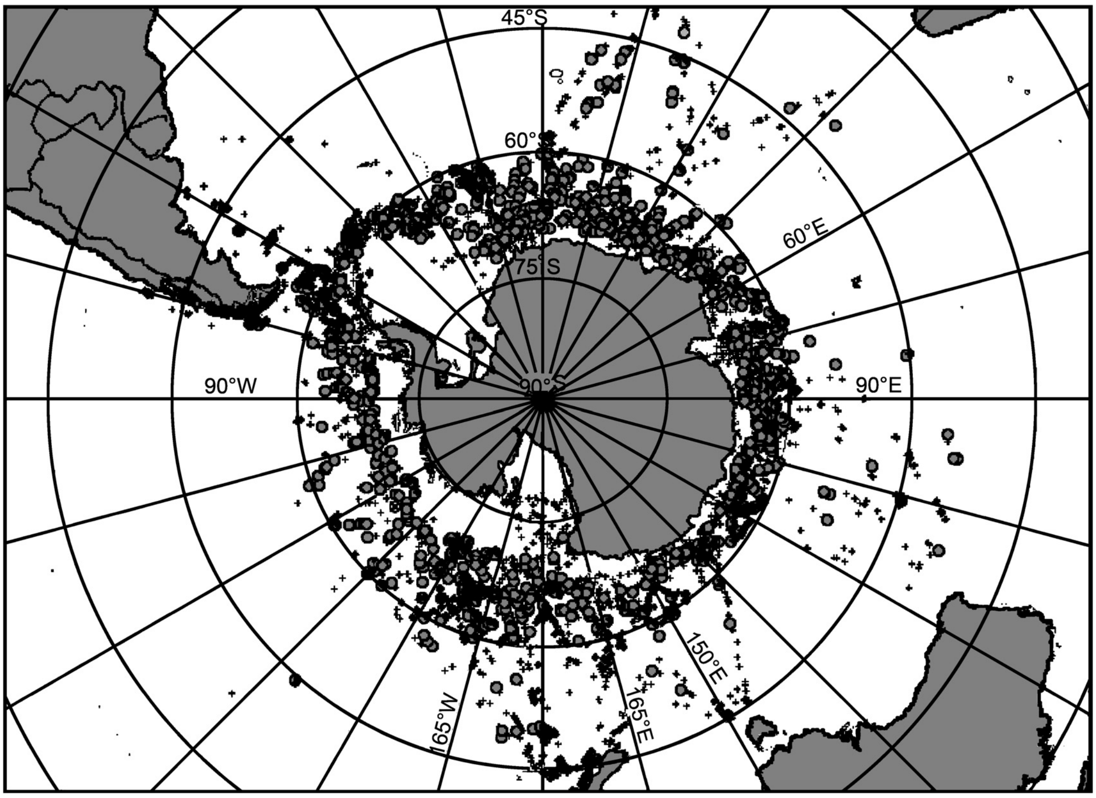

Fig. 7. Sightings of southern bottlenose whales from IDCR/SOWER cruises (grey circles). Crosses indicate all sightings to give indication of survey effort.

Conservation status and exploitation
Southern bottlenose whale 'is sometimes encountered by whalers and killed' (Mitchell, 1975a). 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 (1989b) 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 in an indeterminate year. A few specimens were taken by Soviet whalers for research purposes (Tomilin and Latyshev, 1967; Zemskii and Budylenko, 1970) while Japanese whalers took 42 specimens in Antarctic waters, from 1970–1982 (Kasamatsu *et al.*, 1988). Before 1990, population estimates and even relative abundance data of *H. planifrons* were lacking (Mead, 1989b). Sekiguchi *et al.* (1993) indicated it as the second most frequently encountered cetacean in high latitudes, probably based on the claim by Kasamatsu *et al.* (1988) that southern bottlenose whales account for more than 90% of ziphiid sightings. 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 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: Least Concern, (IUCN Red List), Appendix I (CITES) and Not listed (CMS).

Arnoux's beaked whale *Berardius arnuxii* (Duvernoy, 1851)

Systematics and populations
Duvernoy (1851) described Arnoux's beaked whale from a 975cm male stranded in Akaroa, New Zealand, the skull of which is curated at the Muséum national d'Histoire naturelle, Paris (Robineau, 1989b). No subspecies, populations or stocks are defined. The species is reviewed by Balcomb (1989), Klinowska (1991), Mead (2002) and Mitchell et al. (1981).

Plate 10. Arnoux's beaked whales (*Berardius arnuxii*). Photo credit: Meike Scheidat.

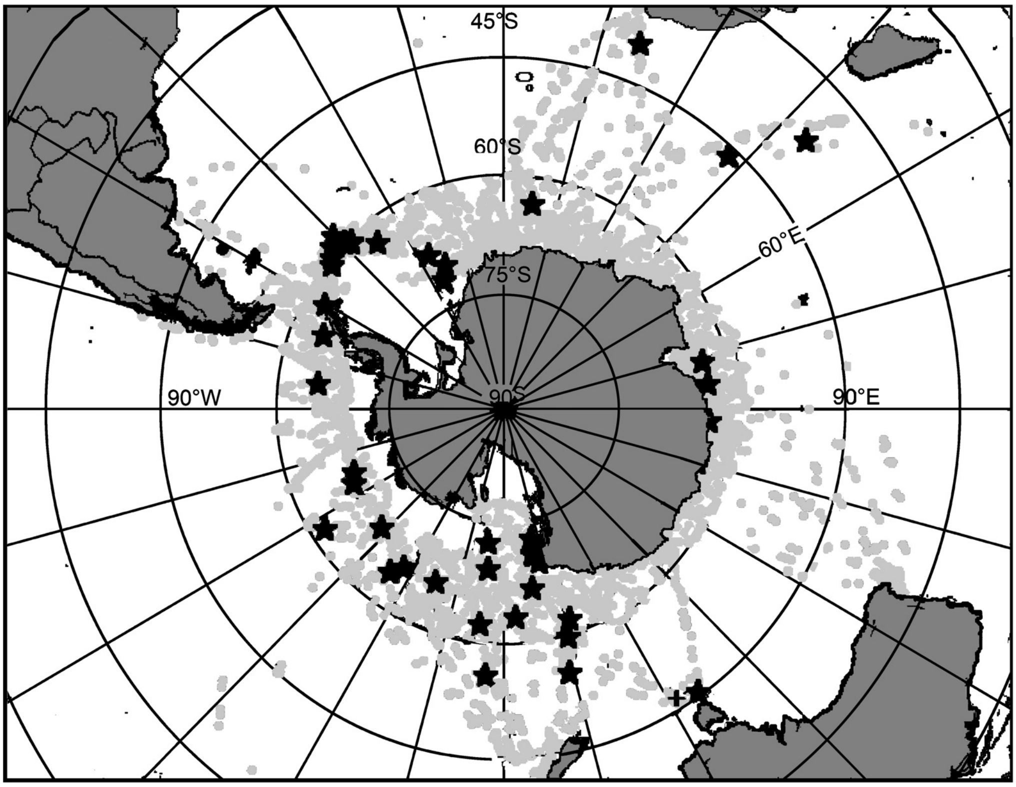

Fig. 8. Sightings of Arnoux's beaked whale (black stars) from IDCR/SOWER cruises.

Distribution in Southern Ocean Sanctuary

Arnoux's beaked whale has a wide circumpolar distribution (Fig. 8), 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 (Baker, 1999; Balcomb, 1989; Bannister *et al.*, 1996; Fraser, 1937; Jefferson *et al.*, 1993). Sighted predominantly in Antarctic and subantarctic regions, and frequently close to the ice edge, with many reports along the Antarctic Peninsula and in the Weddell Sea (Hobson and Martin, 1996; Lichter, 1986; McCann, 1975; Stonehouse, 1972; Taylor, 1957). 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 at 66°56'S,61°54'E off Kemp Land, east Antarctic coast (Rogers and Brown, 1999).

B. arnuxii occurs both north and south of the Antarctic Polar Front, but there is no information available on seasonal shifts or migration. All stranding records from the South African coast are from summer (Findlay *et al.*, 1992). It is recorded among sea ice, even in winter when trapped (Taylor, 1957).

Conservation status and exploitation

No abundance estimates exist, but it is notably rare compared to the sympatric southern bottlenose whale. The usual dive duration is 15–25min, but *B. arnuxii* can stay submerged for an hour, which complicates sightings-based surveys. Rarely taken in the Antarctic (Mitchell, 1975b). A specimen of *B. arnuxii* was caught outside Deception Island, South Shetlands (Fraser, 1937), another ice-trapped individual was probably killed by gun (Taylor, 1957).

Status designations are Data Deficient (IUCN Red List), Appendix I (CITES) and Not listed (CMS).

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

Systematics and populations

No subspecies are currently recognised but, like most other cosmopolitan cetaceans, it is likely that significant population structure exist in this ziphiid, and research is needed. For instance, the status of a named Indo-Pacific subspecies (*Z. cavirostris indicus* Van Beneden, 1863) deserves verification. Rice (1998) dismissed it without any useful argument.

Distribution in Southern Ocean Sanctuary

Until recently, Cuvier's beaked whale was said to be found in all oceans and major seas except in the polar regions (Heyning, 1989). Since Goodall and Galeazzi (1985b) first mentioned 'sightings south of 60°S' several others demonstrated Antarctic penetration. Two observations south of the Antarctic Polar Front in Areas I and VI (Kasamatsu *et al.*, 1988), and three summer sightings were reported at 63.7°S,90°E; 63.3°S,119.6°E and 64.6°S,128.5°E[18] (mean group size = 2) (Ensor *et al.*, 1999). In February 2004, a small group of Cuvier's beaked whales was encountered at close range in Drake Passage, en route to Livingston Island (AMLR 2004 Weekly Report 7, unpublished data). The evidence for Balcomb's (1989) 'from the Antarctic continent and ice edge (78°S) north to about 34°S' is unclear. Southernmost specimens are from the Falkland Islands (at 693cm the largest known specimen; Heyning, 1989), SE of Auckland Islands at 52°08'S (Baker, 1977), New Zealand mainland near Cook Strait (41°24'S) (Baker, 1990), and Tasmania (Guiler, 1978). No migratory movements are known.

[18]Approximate locations read from published chart.

Conservation status and exploitation
No abundance estimates for this offshore, deep-diving species are available for any region in the Southern Hemisphere. Cuvier's beaked whale has not been subjected to any fishery in the Southern Hemisphere (Klinowska, 1991; Mitchell, 1975a; 1975b). Some incidental mortality may occur in high-seas gillnet fisheries. The species appears to be exceptionally vulnerable to acoustic trauma (Reeves *et al.*, 2003). Status designations are Least Concern (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

Shepherd's beaked whale *Tasmacetus shepherdi* (Oliver, 1937)
Systematics and populations
Shepherd's beaked whale (or Tasman beaked whale) is almost exclusively known from about 42 strandings in New Zealand, southern Australia, Argentina, Juan Fernández Islands and Tristan da Cunha (Best *et al.*, 2009; Pitman *et al.*, 2006). There are no confirmed sightings. No subspecies nor stocks are discerned, their study made difficult by the scarcity of specimens.

Distribution in Southern Ocean Sanctuary
Probably circum-global in temperate waters of Southern Hemisphere (Mead, 1989c; Rice, 1998), associated with cooler waters from 33°S to at least 53°50'S (Klinowska, 1991; R.N.P. Goodall, pers. comm. to ANB, October 2000). Occurrence further south into (sub-) Antarctic is likely. Most strandings in the New Zealand region are from South Island, Stewart and Chatham Islands, (Rice, 1998); six strandings have occurred in summer (November–March) and one in winter (August), however conclusions on seasonality are premature. Putative sightings were reported in the western South Atlantic (53°45'S, 42°30'W) (Laughlin, 1996) and off Christchurch, on the East coast of South Island (Watkins, 1976), besides three others, but none are convincingly supported (Pitman *et al.*, 2006).

Conservation status and exploitation
Although Shepherd's beaked whale seems ichthyophagous, it is not bycaught in any fisheries (Mitchell, 1975a; 1975b; Northridge, 1984). An oceanic species feeding in deep water, it would be unlikely to suffer any major interactions or habitat problems (Klinowska, 1991; Northridge, 1984). Nonetheless its conservation status remains unknown (Reeves *et al.*, 2003) as reflected in its status designations which include Data Deficient (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

Strap-toothed beaked whale *Mesoplodon layardii* (Gray, 1865)
Systematics and populations
Largest of mesoplodonts, also known as Layard's beaked whale. No subspecies, populations or stocks are described. May be confused with another large tusked mesoplodont, *M. traversii*, whose external characteristics and behaviour are unknown. At sea, teeth of males *M. traversii* and *M. layardii* may hardly be distinguishable, and it is hoped that the bold colouration pattern of the latter will remain diagnostic once the *M. traversii* colouration will be documented.

Plate 11. Strap-toothed beaked whale (*Mesoplodon layardii*) (ILB061230596). Photo credit: Isabel Beasley.

Distribution in Southern Ocean Sanctuary
Distributed throughout the southern oceans in cold temperate waters (Fig. 9). Specimens have stranded in southern Australia, Tasmania, southern New Zealand (Dixon, 1980; Mead, 1989a; Rice, 1998), and South Georgia[19]. In the past few years a fair number of sightings are reported 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), situated just north of the Sanctuary (Guiler *et al.*, 1987). Most strandings of *M. layardii* occur between 33°S and 53°S (G.J.B. Ross, pers. comm. to ANB, October 2001). Migratory movements cannot be evaluated due to the limited number of confirmed sightings, although the marked seasonality of records from South Africa (January to June) (Findlay *et al.*, 1992) is suggestive of a possible northward shift in distribution during autumn and winter.

Conservation status and exploitation
No catches of *M. layardii* are reported. Status designations include Data Deficient (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

Spade-toothed whale *Mesoplodon traversii* (Gray, 1874)
Systematics and populations
No subspecies, populations or stocks are known. The holotype, a mandible with large teeth, from the Chatham Islands was incorrectly assigned to *M. layardii* for over 125 years. *M. traversii* was resurrected after re-examination of the holotype at the Museum of New Zealand, as well as a White Island specimen (van Helden *et al.*, 2002). A morphological linkage with Bahamonde's beaked whale *Mesoplodon bahamondi* (Reyes *et al.*, 1995) from Chile supported by mtDNA analysis (van Helden *et al.*, 2002), recognised *M. bahamondi* as a junior synonym of *M. traversii*. At sea, this species may potentially be mistaken for *M. layardii* in view of the lack of known distinguishing features and great similarity in male tusks.

[19] The skull and four ribs of an adult female *M. layardii* are curated at the Museum of South Georgia and were examined and photographed by KVW in December 2003. The *ca*. 5m specimen, found beached at Larsen Harbour, was donated to the museum by Philippe Poupon, skipper of the yacht *Fleur Austral*.

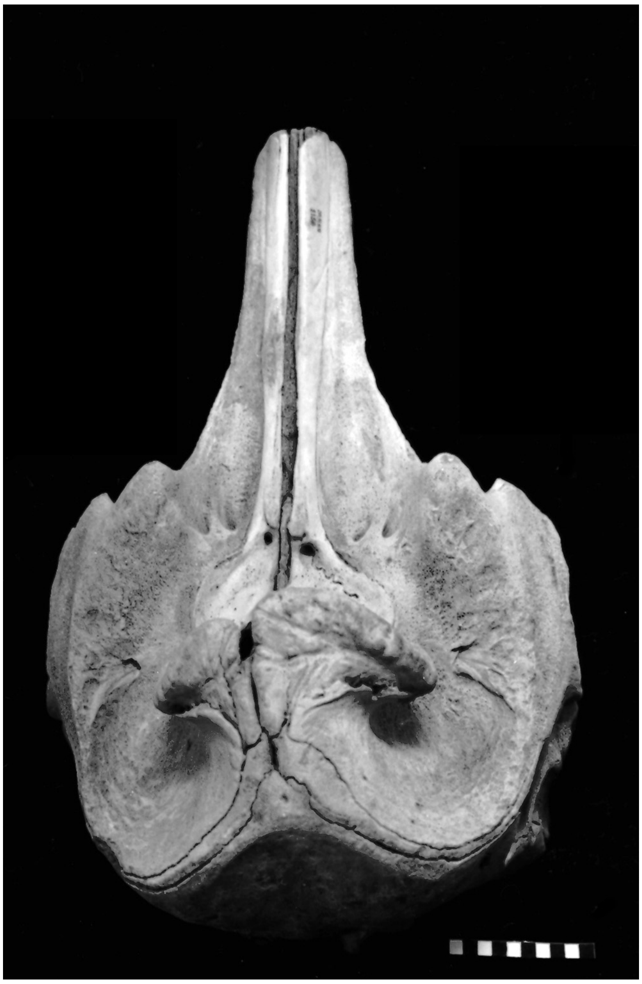

Plate 12. Spade-toothed beaked whale (*Mesoplodon traversii*), dorsal view of holotype skull *M. bahamondi* (MNHN, Santiago). Photo credit: Julio C. Reyes. Scale = 10cm.

Distribution in Southern Ocean Sanctuary

Spade-toothed whale is the least-known of all living species of cetaceans with only three recognised, skeletal, specimens (Reyes *et al.*, 1995; van Helden *et al.*, 2002): one each from Robinson Crusoë Island, Juan Fernández Islands (33°37'S,78°53'W), White Island, NZ (35°31'S,177°11'E) and the only Sanctuary record, from Pitt Island, Chatham Islands (44°17'S,176°15'W). This medium- to large-sized mesoplodont (5.5m estimated adult size; Reyes *et al.*, 1995) may possibly visit (sub-)antarctic waters. No data exist on migratory movements; the three specimens stranded in an indeterminate season.

Conservation status and exploitation

No catches are reported. Conservation status designations of spade-toothed whale are Data Deficient (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

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

Systematics and populations

No geographic variation or subspecific division is reported. A North Sea stranding, the only extralimital record from the Northern Hemisphere, is genetically similar to *M. grayi* specimens from New Zealand (M. Dalebout, pers. comm. to ANB, 2001).

Plate 13. A juvenile/female *Mesoplodon* sp., without visible teeth at 55°29.44'S, 19°32.47'E on 31 Dec 2005 (PHE051231), possibly a strap-toothed beaked whale *M. layardii*, or spade-toothed beaked whale *M. traversii*. Photo credit: Paul Ensor.

Distribution in the Southern Ocean Sanctuary

The long-held view was that Gray's beaked whale has an austral circumglobal distribution in temperate or cold temperate waters between 30°S–45°S (e.g. Marcuzzi and Pilleri, 1971; Mead, 1989a; Pitman, 2002; Rice, 1998; Ross, 1979), but not further south. Indeed, most strandings happen between 35°S and 45°S (G.J.B. Ross, pers. comm. to ANB, October 2001). In New Zealand, *M. grayi* is the second commonest single strander after *Kogia breviceps*, with some 180 recorded specimens from both North and South Islands[20]. These strandings and the absence of regular inshore sightings at sea, indicate an offshore population close to New Zealand's east coast. It is known from Tasmania (Baker, 2001; Bannister *et al.*, 1996; Nichols, 1986)[21] .

Pitman (2002) summarised *M. grayi* distribution as 'circumglobal in temperate waters of the southern hemisphere', however the same paper also features a photo taken in Antarctic waters by Richard A. Rowlett. Ohsumi *et al*. (1994) indicate a sighting of Gray's beaked whale, made during a JARPA (Japanese whale research program under special permit) expedition at *ca.* 62°30'S,150°E (from map) in the Australian Antarctic basin. De Boer *et al*. (1999) sighted two Gray's beaked whales near the Balleny Islands, also off the Ross Sea ice edge (*ca.* 67°S; 7–20 January 1999) in 950m of water and 2°C. *M. grayi* also occurs in the Scotia Sea, south of the Polar Front (e.g. Table 2). A 25-year history of IWC/IDCR and IWC/SOWER cruises, till 2003, yielded 31 groups sighted, with mean group size of 3.1 (SD 1.85) animals, and of which 11 groups were sighted south of 60°S, with 65°40'S,014°60'E (sic) the southernmost record (see Dalebout *et al.*, 2004, table 2). Clearly, circumpolar, (sub-)antarctic waters are part of the normal range of *M. grayi* (Fig. 9).

Goodall and Galeazzi (1985a) referred to 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 (1989a), followed by Ohsumi *et al.* (1994), discussed specimen NMNZ612 in the Museum of New Zealand which he said 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

[20] New Zealand Whale Stranding Database, Museum of New Zealand, Wellington, courtesy A.L. van Helden.

[21] A presumed *M. bowdoini* specimen in the Tasmanian Museum (A748) was re-assigned to *M. grayi* (Baker, 2001).

Table 2
New sightings of (like-) Gray's beaked whale in the Scotia Sea by two authors (KVW and RL), observed from the RRV *James Clark Ross*.

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

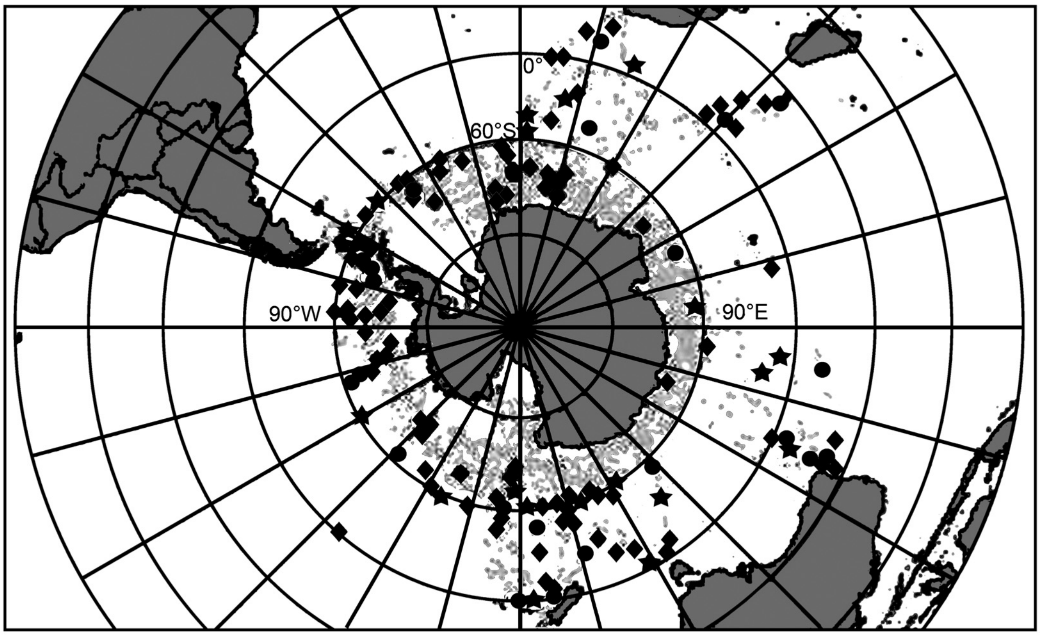

Fig. 9. Sightings of Gray's beaked whale (black stars), strap-toothed beaked whale (black circles) and Shepherd's beaked whale (black diamonds) from IDCR/SOWER cruises.

known to stray before'. However, the origin of this specimen is of particular interest here. Anton van Helden, Collection Manager (marine mammals) at the Museum of New Zealand questions Mead's (1989a) conclusion (in litt. to KVW, 8 April 2003) and believes the specimen is from the Chatham Islands[22]. No information on migration is available, but strandings between 30°S and 50°S occur most frequently from December through March, suggesting a nearshore movement in summer (ANB, unpublished data). 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).

Conservation status and exploitation
It is the only one of two mesoplodonts[23] known to have mass-stranded: 25 came ashore on the Chatham Islands in 1873 (von Haast, 1877). No information is available on abundance. No catches have been reported in the Southern Ocean. Status designations include Data Deficient (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

Andrews' beaked whale *Mesoplodon bowdoini* (Andrews, 1908)
Systematics and populations
No subspecies, populations or stocks have been designated. At one time suggested to be possibly conspecific with *M. stejnegeri* and *M. carlhubbsi* from the North Pacific (IWC, 1989; Mead, 1989a; Orr, 1953), *M. bowdoini* is now firmly confirmed as a distinct species both morphologically and by molecular genetics (Baker, 2001; Dalebout *et al.*, 1998).

Distribution in Southern Ocean Sanctuary
No confirmed at-sea sightings, and only 35 specimens (strandings) are registered. In New Zealand, stranded specimens are documented from South Island, Stewart, Chatham and Campbell Islands (Andrews, 1908; Baker, 2001; Mead, 1989a). A rostrum was retrieved also from Macquarie Island (Baker, 2001), at 54°30'S the southern-most authenticated record. The northern-most record is from Bird Island, Western Australia, at 32°12'S, 115°40'E.

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)

[22] *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. shepherdi*, 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'.
[23] The other species is *Mesoplodon layardii*, with one known mass stranding in South Africa (Findlay *et al.*, 1992).

was re-identified as *M. grayi* (Baker, 2001). Nothing is known of migratory movements.

In the New Zealand region, calving period is thought to be summer/autumn (Baker, 2001; Klinowska, 1991).

Conservation status and exploitation
No captures have been recorded. In the absence of an abundance estimate, the conservation status of Andrews' beaked whale is unknown. Species status designations include Data Deficient (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

Hector's beaked whale *Mesoplodon hectori* (Gray, 1871)
Systematics and populations
The systematic status of *M. hectori* has attracted a considerable amount of discussion (Dalebout *et al.*, 2002; Fraser, 1950; Mead and Baker, 1987; Moore, 1960; Ross, 1970). MtDNA polymorphism analysis suggests no subspecies in samples from New Zealand and Australia (M. Dalebout, pers. comm. to ANB, 2001).

Distribution in Southern Ocean Sanctuary
Hector's beaked whale is limited to the Southern Hemisphere. Four presumed specimens from the Northern Hemisphere (California) represent a new species, Perrin's beaked whale *Mesoplodon perrini* (Dalebout *et al.*, 2002; 1998). External features of *M. hectori* are known from only three documented live individuals. A male and female stranded alive in the Buenos Aires Province (Cappozzo *et al.*, 2005) and one juvenile individual, confirmed genetically, was sighted porpoising off southwest Australia (see photos in Best, 2007, p.121 and Jefferson *et al.*, 2008, p.121). Only some 40 stranded specimens have been positively identified, 15 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, 13 of those within the Sanctuary, followed by Argentina, Tasmania, South Africa and Chile (Cappozzo *et al.*, 2005; Goodall, 1978; Mead and Baker, 1987). Four specimens have stranded on the Falkland Islands (Scheffer and Rice, 1963; R.N.P. Goodall, pers. comm. to ANB, October 2000). The southernmost specimen record is from Navarino Island, Tierra del Fuego at *ca.* 55°07'S, 67°05'W (R.N.P. Goodall, pers. comm. to ANB, April 2003) and, according to Rice (1998) it appears circumglobal in temperate waters of the Southern Hemisphere. Nothing however suggests *M. hectori* would not occur in (sub-)antarctic waters. With only recent, limited information on diagnostic external features, it may have gone unnoticed so far as unidentified small beaked whales. The seasonal nature of stranding records (December through April in New Zealand) suggests an inshore movement in summer. A mother with calf recorded in early April at Stanley (40°45'S, 147°19'E), northern Tasmania, and in January in both northern Argentina and New Zealand, would be concordant with a summer calving season.

Conservation status and exploitation
Hector's beaked whale is not exploited, but its conservation situation is indeterminate. International conservation status designations include Data Deficient (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

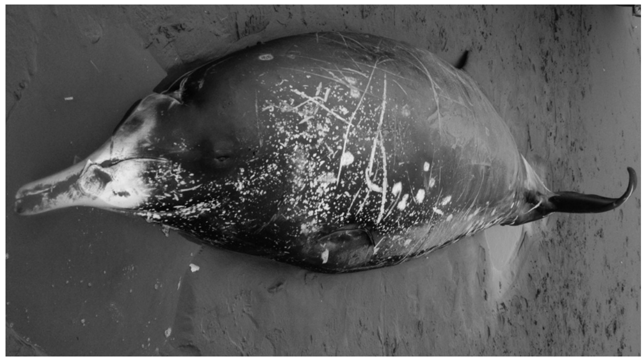

Plate 14. Adult male Gray's beaked whale (*Mesoplodon grayi*) stranded at Canterbury, New Zealand, 19 Sept 2005. Photo credit: Al Hutt.

ODONTOCETES VAGRANT INTO THE SANCTUARY

Six species of odontocetes were determined to be vagrant into the Southern Ocean Sanctuary as outlined in the following species accounts.

Dwarf sperm whale *Kogia sima* (Owen, 1866)
Systematics and populations
No subspecies are recognised, however molecular genetic research suggests significant population structure (Chivers *et al.*, 2005; Plön *et al.*, 2003). Further work should also encompass a study of cranial variation world wide, considering that ample museum specimens are available.

Distribution in Southern Ocean Sanctuary
Cosmopolitan, but not in polar waters (McAlpine, 2002). In the Sanctuary, it is known only from stranded specimens in Tasmania (Bannister *et al.*, 1996; Guiler, 1978). One of us (DT) collected a female with full-term foetus at Cloudy Bay, Bruny Island (*ca.* 43°20'S, 147°19'E), Tasmania. In contiguous waters, strandings are known from South Australia (Bannister *et al.*, 1996), South Africa (Findlay *et al.*, 1992) and three records from northern New Zealand (Baker and van Helden, 1990; ANB, unpublished data) *K. sima* is more coastal than pygmy sperm whale, and thought to prefer warmer water (McAlpine, 2002). Information is lacking on migration in and around Sanctuary waters.

Conservation status and exploitation
No population estimates or other data specific to the study area exist; however incidental mortality in fishing gear and ingestion of plastic debris may be problematic (McAlpine, 2002; Reeves *et al.*, 2003). Status designations include Data Deficient (IUCN Red List), Appendix II (CITES) and Not listed (CMS)

Lesser beaked whale *Mesoplodon peruvianus* (Reyes, Mead and Van Waerebeek, 1991)
Systematics and populations
Also named Peruvian beaked whale or pygmy beaked whale. No subspecies or populations are identified, however *M. peruvianus* from the eastern and western Pacific, and from Southern and Northern Hemispheres may belong to different stocks. Sightings of 'Mesoplodon sp. A' in the offshore eastern Pacific, tentatively assigned to *M. peruvianus* by Pitman and Lynn (2001) based on remotely estimated body size and adult male tooth position remain to be confirmed as

such by specimens or molecular genetics and until then can not be 'identified' as *M. peruvianus*.

Distribution in the Southern Ocean Sanctuary
Lesser beaked whale specimens have been reported from the temperate eastern Pacific including Peru, Chile, Mexico (Reyes *et al.*, 1991; Sanino *et al.*, 2007) and California, USA (Dalebout *et al.*, 2007). One 372cm physically mature individual stranded at Kaikoura (42°31'S,173°30'E), New Zealand (Baker and van Helden, 1999), the hitherto southernmost record for the species, locating it firmly within the Sanctuary. Pitman and Lynn (2001) referred to the latter as 'almost certainly an extralimital record', perhaps prematurely, taking into account that few positive sightings of *M. peruvianus* exist and that recent records in coastal waters around 29°S in north-central Chile, including a specimen (Sanino *et al.*, 2007) have moved the known range in the eastern Pacific 14° latitude to the South. The true austral distribution range of lesser beaked whales remains uncertain, and it could extend further south into the Sanctuary.

Little is known on seasonality and even less on migration. Most fresh specimens in Peru were landed during summer months (Reyes *et al.*, 1991; K.Van Waerebeek and J.C. Reyes, unpublished data), possibly related to inshore movements linked to reproductive behaviour or prey availability. Apparent correlation with SST may be spurious, indeed in the Humboldt Current system the low SST year round is only weakly linked to seasons.

Conservation status and exploitation
Off Peru, lesser beaked whales are incidentally taken with some regularity (Reyes *et al.*, 1991; K. Van Waerebeek and J.C. Reyes, unpublished data). A skull retrieved from a beach in northern Chile showed two bullet lesions (Sanino *et al.*, 2007; Van Waerebeek *et al.*, 1999). No abundance estimates, nor precise distribution data are on hand, hence it is listed as Data Deficient in the IUCN Red List, Appendix II (CITES) and Not listed (CMS).

Dense-beaked whale *Mesoplodon densirostris* (de Blainville, 1817)[24]
Systematics and populations
Also referred to as Blainville's beaked whale. No subspecies or populations have been described, but given its global distribution (see Pastene *et al.*, 1990), studies of geographic variation are needed. Besharse (1971) studied individual cranial variation.

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 (Findlay *et al.*, 1992), New Zealand (at 39°19'S,176°57'E, 90 Mile Beach, Northland and Tangoio, Hawke Bay), just north of the Sanctuary boundary (Baker and van Helden, 1999), and southern Chile at 41°28'S,73°00'W (Bannister *et al.*, 1996; Guiler, 1966; Pastene *et al.*, 1990). The only record firmly within the Sanctuary boundaries is a specimen from Tasmania, at 40°50'S (Bannister *et al.*, 1996; Guiler, 1966). 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).

No evidence of migratory movements. Dense-beaked whale's normal warm-water distribution suggests that it penetrates northernmost Sanctuary strata (circa 40°S) predominantly in summer months. Its most boreal incursion is off Nova Scotia, Canada, at 45°N (Pastene *et al.*, 1990), and austral latitudinal penetration is likely comparable.

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 are Data Deficient (IUCN Red List), CITES Appendix II and Not listed (CMS).

Risso's dolphin *Grampus griseus* (G. Cuvier, 1812)
Distribution in the Southern Ocean Sanctuary
Risso's dolphin normal distribution includes 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 strandlings on the northern coast of Cook Strait at 41°17'S,174°54'E. An adult Risso's dolphin, the celebrated 'Pelorus Jack', accompanied ships across Admiralty Bay, Marlborough, New Zealand (40°58'S, 173°51'E) between 1880 and 1912 (Baker, 1974). Off southern Patagonia, Risso's dolphin has been encountered as far south as Punta Catalina, Magallanes, Chile (Venegas and Sielfeld, 1978) situated at 52°33'S, 68°46'W, and Puerto Roca, Isla de los Estados, Argentina (54°45'S, 63°53'W) (Goodall, 1986) so it may penetrate considerably farther south into the Tasman Sea than the Cook Strait record suggests.

Conservation status and exploitation
Listed as Least Concern (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

Rough-toothed dolphin *Steno bredanensis* (Lesson, 1828)
Distribution in Southern Ocean Sanctuary
Typically a warm-water species, the rough-toothed dolphin is known from the Sanctuary only at 41°30'S,174°03'E, Cloudy Bay, east coast of South Island, New Zealand, where two specimens stranded together in June 1990 (ANB, unpublished data). *S. bredanensis* has occasionally stranded in cold-water upwelling influenced areas. One specimen was retrieved from a beach in northern Chile (Van Waerebeek and Guerra, 1988), still the only positive record for Chile, while a second specimen was found in a collection in northern Namibia (assumed by Findlay *et al.*, 1992 to be a local specimen). Both rough-toothed dolphins most likely accidentally penetrated these cool areas from warm offshore waters. Ross (1984) noted that the specimens attributed to the Cape of Good Hope may have been collected elsewhere by vessels en route to Europe via the Cape Colony.

Conservation status and exploitation
Steno bredanensis is classified as Least Concern (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

[24] de Blainville, Henri Marie Ducrotay (1777–1850), French physician. *Non* 'Blainville' (Hershkovitz, 1966; *et alii*).

ODONTOCETE OCCURRING CONTIGUOUS TO THE SANCTUARY

Two species, both beaked whales, have been encountered contiguous to the Southern Ocean Sanctuary, i.e. less than 120 n. miles north of its northern boundaries. It is plausible that at some point these species will be found within 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). We conclude that *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), junior synonym of *M. traversii* (see van Helden *et al.*, 2002).

Conservation status and exploitation

Status designations for *M. ginkgodens* are Data Deficient (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

True's beaked whale *Mesoplodon mirus* (True, 1913)

Systematics and populations

No subspecies or populations are described, however divergent Southern and Northern Hemisphere ESU may exist taking into consideration the lack of records in equatorial waters.

Distribution in the Southern Ocean Sanctuary

In the Southern Hemisphere, just a few strandings are known, including from areas contiguous to the Southern Ocean Sanctuary, namely South Africa (Findlay *et al.*, 1992; Ross, 1969) and southern Australia at 38°24'S (Bannister *et al.*, 1996; Dixon and Frigo, 1994). Reports from Tasmania and western Australia (Bannister *et al.*, 1996) have to date not been substantiated. No evidence of migratory movements exists.

Conservation status and exploitation

Status designations include Data Deficient (IUCN Red List), Appendix II (CITES) and Not listed (CMS).

DISCUSSION

The design of the majority of cetacean surveys in the Southern Ocean has been focused on those species subject to commercial exploitation although many surveys recorded sightings of all species. The Southern Ocean Sanctuary was established in 1994 and in recent years, there has been a much greater emphasis on multi-disciplinary research programmes. Many of these have provided data resulting in an enhanced basic knowledge of the distribution of odontocetes in the Southern Ocean. Nonetheless, many species remain very poorly known but this review shows that odontocete diversity south of the Antarctic Polar Front is higher than previously thought and that several species venture significantly further south.

Beaked whales

Despite hundreds of biologists navigating in Antarctic waters for two centuries, until recently, the only two ziphiids recognised from the Antarctic Ocean have been the southern bottlenose whale and Arnoux's beaked whale (e.g. Brownell, 1974; Kasamatsu and Joyce, 1995; Miyazaki and Kato, 1988; Nishiwaki, 1977; Ponganis *et al.*, 1995), easily identified due to large size and highly visible bulbous head. Other species of beaked whales are not uncommon, 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. Goodall and Galeazzi (1985a) first suggested that 'a species of Mesoplodon' may reach the South Shetland Islands.

Until fairly recently, many research cruises pooled mesoplodonts under ziphiid whales (e.g. Nishiwaki *et al.*, 1999; most SOCEP cruises) as the positive identification of several beaked whale species, considering their often still poorly described diagnostic external features, was not considered feasible at sea. 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 not including searching for stranded cetaceans. Despite these limitations, evidence presented in this paper suggests that mesoplodonts are widely distributed throughout (sub-)Antarctic seas. *M. layardii, M. grayi* and unidentified mesoplodonts (Tables 2 and 3) 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 *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) taking into consideration that external features of the latter are unknown and no sightings have been reported. The tusk-size teeth of adult male *M. traversii* are so similar to these of *M. layardii* that the two were confused for over a century (see van Helden *et al.*, 2002). Future morphological data hopefully should pin-point discriminating features.

While earlier some authors denied a distribution of Cuvier's beaked whale in polar regions (Heyning, 1989; Moore, 1963; Rice, 1998), their occurrence south of the Antarctic Polar Front is now well established.

If many earlier surveys in (sub-) Antarctic waters did not reveal Mesoplodon spp., it may be readily explained by a bias in research effort focused on large whales[25] and a lack of confidence in beaked whale identification leading to lumping species as ziphiids (e.g. Kasamatsu and Joyce, 1995; Miyazaki and Kato, 1988; Ohsumi *et al.*, 1994). This

[25] Closing on ziphiids is rarely attempted during surveys.

does not exclude a potential austral shift in mesoplodont latitudinal distribution over time. Increasingly experienced observers, the use of high magnification binoculars, and enhanced dedicated research effort will continue adding positively identified sightings and shed light on the issue. Rapid advances in digital camera and lens technology over the last decade has facilitated obtaining high resolution images of diagnostic features at sea.

Status

It is obvious from the above review that the abundance and status of 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 species such as sperm whale and southern bottlenose whale, the assumption of $g(0) = 1$ is not realistic and will result in an unquantified but possibly substantial negative bias. For hourglass dolphins and southern right whale dolphins in particular, estimates are also complicated by responsive movement because these delphinids are 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 (due to small sample sizes) from the IDCR surveys between 1976/77 and 1987/88. This included data from 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. Branch and Butterworth (2001) did not find reliable evidence of any trends in odontocete numbers.

Trophic relationships

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 (Hindell *et al.*, 2003; Santos *et al.*, 2001). These comparisons are complicated by the exact area considered, assumptions about factors such as energy requirements that affect estimates of total prey consumption and the data used for abundance estimates. Kasamatsu and Joyce (1995) estimated that beaked whales consumed around three times more prey mass than sperm whales, 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. Understanding the feeding ecology of odontocetes is further complicated by the lack of data on cephalopods. There have only been limited exploratory fisheries for squid in Antarctic waters and most population data that exist have been derived from remains, especially beaks, in the gastro-intestinal tracts of higher predators. Estimates of the proportion of diet consisting of squid compared to other invertebrates and fish may be biased by squid beaks remaining undigested for longer than other prey items (IWC and CCAMLR, 2010).

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 (*Thalassarche chrysostoma*) and black-browed albatross (*Thalassarche melanophris*), 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 the wandering albatross.

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, 2006).

A workshop on ecosystem models in the Antarctic held by CCAMLR and IWC in 2008 noted that the lack of information on absolute and relative abundance for squid severely limits the ability to include this component in ecosystem models (IWC and CCAMLR, 2010). Thus predicting the effects of changes in environment or prey abundance on odontocetes will be especially difficult.

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, 2006). Leaper *et al.* (2000) 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 (e.g. 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. This could optimally be addressed by more directed research effort, instead of relying mostly on incidental encounters during cruises with research protocols targeting baleen whales.

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