MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

CSG 15

Research and Development

Final Project Report

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Project title	SOWER 2000: FUNDING OF FOUR MARINE MAMMAL OBSERVERS ON IWC/CCAMLR SIGHTINGS SURVEY IN ANTARCTIC
MAFF project code	
Contractor organisation and location	INTERNATIONAL WHALING COMMISSION, THE RED HOUSE, 135 STATION ROAD, IMPINGTON, CAMBRIDGE. CB4 9NP
Total MAFF project costs	£ 20,000.00
Project start date	DECEMBER 1999
Project end date	17 FEBRUARY 2000

Executive summary (maximum 2 sides A4)

OBJECTIVE OF THE RESEARCH

To support the IWC SOWER 2000 - CCAMLR sub-project as part of a co-operative programme of environmental research between the International Whaling Commission and the Convention for the Conservation of Antarctic Marine Living Resources.

APPLICATION OF FUNDS

To fund four marine mammal observers on the UK research vessel, the James Clark Ross, to collect specified data on all marine mammal sightings made during the Antarctic research cruise.

SCIENTIFIC APPROACHES

Application of accepted line-transect protocols to enable the density and abundance of marine mammals to be estimated in the research area. The observers will not be expected to analyse the data. Details of the protocols and the research programme in general can be obtained from the Office of the International Whaling Commission and from British Antarctic Survey.

DURATION OF PROJECT

Start December 1999. Field work finished on 17 February 2000.

Scientific report (maximum 20 sides A4)

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CCAMLR Krill Synoptic Survey 2000:
IWC Research on the *RRS James Clark Ross*

Objectives

As part of its SOWER[1] programme, the International Whaling Commission (IWC) has an overall long-term objective to

> 'Define how spatial and temporal variability in the physical (e.g. sea surface temperature, salinity, mixed layer depth, upwelling, extent of ice cover) and biological (e.g. prey availability) environment influence cetacean species in order to determine those processes which best predict long term changes in cetacean distribution, abundance, stock structure, extent and timings of migrations and fitness'.

A specific objective of the programme is to relate distribution, abundance and biomass of baleen whale species to the same parameters for krill in a large area in a single season. Detailed planning for collaboration with CCAMLR[2] took place at a workshop held in Edinburgh in March 1999 (Anon, 1999). The aim of the IWC research during the synoptic krill survey was to obtain quantitative data on cetacean abundance which could provide a large scale 'snapshot' biomass comparison between whales and krill, and also relate cetacean distribution to other biological and oceanographic parameters.

Sightings Survey Methods

A team of four observers were aboard *RRS James Clark Ross* and searched for cetaceans from a viewing height of 18.3m on the Monkey Island. Sightings of pinnipeds were also recorded except in localised areas such as shelf breaks, where Antarctic fur seals were encountered at such high densities that recording pinnipeds would have compromised the cetacean survey data. Data collection was based on line-transect methods and two modes of surveying for cetaceans were used: Primary (single observation team) mode and BT mode (two independent teams, as described in Buckland and Turnock, 1992). Environmental data that might affect the probability of detecting whales were recorded during all searching effort. These included weather, sea state and visibility data as judged by the observers and also data from the ship's underway instrumentation. Weather conditions were considered unsuitable for surveying if the wind speed was stronger than Beaufort force 6 or visibility was less than 1 nautical mile.

In Primary mode, two observers searched for cetaceans with Fujinon 7x50 binoculars. Each observer searched a 100° sector ahead and on one side of the vessel from 10° on the opposite side, to abeam. When a sighting was made, the time, species, visual cue and number of animals in a group were recorded. For the purposes of line transect analyses, the range and bearing of the animals when they are initially detected is also required. The binoculars displayed reticles in the field of view and these were used to aid distance estimation. Angle-boards, with moveable pointers, mounted on the forward rail on the Monkey Island, facilitated estimation of the bearing of each sighting relative to the ship's heading. A software package ('*WinCruz*') developed at the Southwest Fisheries Science Center, La Jolla, and modified specifically for the purposes of this survey, was used to record the data directly to a weatherproofed personal computer. The computer was interfaced to a portable GPS receiver and recorded the time of each event entered.

In BT mode, all four observers searched simultaneously from two independent observation points – the Primary platform and the Tracking platform. On JR47, both platforms were situated on the Monkey Island and visual and auditory independence between platforms was achieved by erecting a tarpaulin between them. The two observers on the Primary platform searched for cetaceans as described above, and were not informed of sightings made from the Tracking platform. The Tracking platform comprised a 'Recorder' and a 'Tracker'. The Tracker searched for cetaceans using Fujinon 25x150 binoculars (known as 'Big Eyes') which were mounted on a tilting, rotating cradle fixed to the deck. These binoculars had reticle marks and an angle scale to allow measurement of range and bearing. The Recorder was informed of sightings made by both teams and entered all data onto the computer using *WinCruz*. When not entering data, the Recorder also searched with 7x50 binoculars. The Recorder judged whether sightings were new

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[1] Southern Ocean Whale and Ecosystem Research
[2] Convention for the Conservation of Antarctic Marine Living Resources

sightings from either platform or 'duplicates' (whales seen first by the Tracking team and then seen subsequently by the Primary team).

There are several reasons why the BT survey mode enables more precise and accurate estimates of whale density compared to just using a single Primary observer team:

a) It may enable the determination of correction factors for cetaceans missed on the trackline (standard line transect methods assume that all animals on the trackline are detected).
b) Because animals are detected at greater distances using high powered binoculars, it is less sensitive to responsive animal movement and can provide information on possible ship avoidance (standard line-transect methods assume that the animals do not react to the vessel. Failure to take account of responsive movement can lead to severely biased results).
c) It provides more confidence in species identification and school size estimation.
d) It provides information on differences in observer efficiencies.

However, it was not possible to use the big eyes in high sea states or in poor visibility conditions, and the observer team was too small to maintain continuous effort in BT mode during good weather. Thus effort was divided between Primary and BT mode according to conditions and to incorporate rest periods and meal breaks.

In addition to all observers estimating range and bearing using reticles and angle boards, one observer also used a system to attempt to measure these photogrammetrically. This system involved using the 7x50 binoculars mounted to a frame with a video camera with a known focal length lens aligned to the same field of view. A downward pointing digital still camera was used to measure bearing from reference points on the deck. Ranges to whales were measured from video images captured on a PC using the angle of dip to the horizon in the same way as for reticle binoculars. The system enabled data on range and bearing to be collected without the observer needing to take his eyes away from the binoculars. A wind-shielded microphone also allowed a detailed commentary to be recorded on the video soundtrack. Because this system is still in the developmental stages, priority was given to first collecting data in the standardised way.

Passive Acoustic Survey Methods

The passive acoustic component of the survey was designed to allow data to be collected which complements the visual observations without interfering with any of the other elements of the programme. The operator of the acoustic equipment was also a member of the visual observation team, and therefore the acoustic data collection had to be fully automated with only minimum maintenance.

Acoustic monitoring provides an opportunity to collect data in conditions such as darkness, poor visibility or high sea states - all of which are unsuitable for visual observations. Many cetacean species are highly vocal and sound propagates well in the sea, enabling passive acoustics to be used to detect many species. The main limiting factor to detecting whales acoustically from a moving vessel is the noise from the vessel. The *RRS James Clark Ross* is particularly suitable for this kind of work because the ship was designed to be as quiet as possible. Nevertheless, the vessel was still the dominant source of low frequency noise and high pass filters were employed to reduce levels below 200Hz. This precluded monitoring for baleen whales. The acoustic survey was aimed at odontocete whales whose vocal behaviour included sounds in the 200Hz – 20kHz range. Acoustic methods are particularly appropriate for sperm whale population assessment which are also a difficult species to survey visually because of their long dive cycle.

The equipment used consisted of a hydrophone array towed behind the ship and an automated recording and monitoring system. The array was towed on a 400m kevlar reinforced cable and consisted of a 10m long, 30mm diameter, oil-filled, polyurethane tube containing two Benthos AQ-4 elements, 3m apart. Each AQ-4 element had a separate pre-amplifier with 29dB gain and a bandwidth of 200Hz to 40kHz. The complete array and cable configuration will be calibrated after the cruise. Previous tests using the same pre-amplifier design, but different oil and tube wall material, gave a flat response with a sensitivity of -170dB re 1V/µPa at 20kHz. The array was streamed from the stern of the vessel at speeds of up to 12 knots and recovered using a deck winch.

The recording system used a standard Digital Audio Tape (DAT) recorder controlled by a personal computer to make 30 second recordings every two minutes. All recordings were made in stereo and the time between signals arriving at each element was used to calculate bearings relative to the axis of the array. Some of the recordings were listened to during the cruise but the majority will be analysed following the cruise. In addition, real time monitoring software (*Rainbow Click* developed by Dr. Douglas Gillespie) designed to detect and measure bearings to sperm whale clicks was run continuously whenever the hydrophone was deployed.

Similar equipment has been used on previous studies from similar vessels in the Southern Ocean (Gillespie, 1997; Leaper and Scheidat, 1998), including from the *RRS James Clark Ross* as part of the BAS Core Programme (Leaper and Papastavrou, 1999).

Data

The data collected on JR47 will be validated and entered into an IWC database, together with the other cetacean data collected during the Synoptic Survey from the *Kaiyo Maru* and the *Yuzhmorgeologiya.*

Visual survey results

Poor weather conditions were encountered in the Scotia Sea resulting in low trackline coverage in that region. Conditions substantially improved around the Antarctic Peninsula and excellent coverage was achieved. The distribution of visual effort throughout the survey is shown in Figure 1. The total amount of visual effort was 148 hours achieved along 3189 km (1722 nm) of trackline.

The following fourteen species of cetaceans were positively identified: fin whale; sei whale; minke whale; sperm whale; southern right whale; killer whale; long-finned pilot whale; strap-toothed whale; Arnoux's beaked whale; southern bottlenose whale; hourglass dolphin; Peale's dolphin; Commerson's dolphin. In addition a single animal, thought to be a blue whale, was recorded at 60° 40' S, 062° 28' W. Humpback whales were the most frequently encountered species, with 101 sightings. Most of these occurred around the Antarctic Peninsula, although an aggregation was encountered to the northeast of South Georgia around the northernmost waypoint of transect SS01 (Figure 3). Most southern right whale sightings were made off the north and northwest of South Georgia (Figure 4). Several large aggregations of fin whales were encountered (Figure 5), often in association with myctophid layers detected on the EK500. Minke whales and southern bottlenose whales were also encountered quite frequently, with highest densities of minke whales being recorded in the Gerlache Strait and through the narrow Lemaire and Neumayer channels (Figure 6). The location of southern bottlenose whale sightings is shown in Figure 7. It should be noted that these plots are not necessarily indicative of the relative distribution of each species because no allowance has been made for any variation in detection probabilities, for example, to account for the weather conditions encountered in different areas.

As expected, Antarctic fur seals were encountered in large numbers off the shelf break of South Georgia. In addition, 73 offshore sightings of this species were recorded. Four elephant seals and 1 leopard seal were also recorded. The high cetacean density around the Peninsula prevented recording of pinnipeds in this region.

Acoustic survey results

The equipment worked well and required little attention apart from changing tapes, backing up data files, and deploying and recovering the hydrophone. A total of 353 hours of acoustic effort was achieved along 7292km (3937nm) of trackline (Figure 2). Only a small amount of analysis was possible on the ship because of the limited time available. It is intended that the remaining analysis will be completed by June 2000.

Sperm whales were detected on several occasions at ranges of up to 10 miles; vocalisations from killer whales and hourglass dolphins were also detected. Initial inspection of the data indicates that the *Rainbow Click* real time monitoring software performed well and might allow fully automated detection of sperm whale vocalisations on future surveys without the need to listen to tape samples.

Recommendations

Both the visual and the acoustic surveys were carried out successfully. However, more wind protection for the observers on the Monkey Island would probably improve the data quality and would certainly increase the amount of searching effort possible. The wind dam in front of the compass provided excellent protection for the Tracker and for one of the Primary observers, but the lower rail either side of the dam left the other two observers quite exposed, especially when the wind was coming from the bow. A solution would be to provide wooden housing for the observers, preferably with protection from rain, but still allowing good views forward and abeam of the ship. The housing could be constructed in such a way as to provide visual and auditory independence between platforms. (In general, this was provided by the tarpaulin on JR47, but in low winds the auditory independence was compromised somewhat). The observers should also be provided with chairs with adjustable height.

It was noted that because all observers were searching with binoculars, cetaceans (generally hourglass dolphins) which appeared for the first time close to the vessel often went undetected by both the Tracking and Primary teams. If an additional berth was available on the vessel, one solution would be to have a fifth observer searching for mammals with naked eye. This fifth observer would be particularly useful in areas of high cetacean density. In such areas, the data quality on this survey was probably compromised to some degree since the Recorder was preoccupied with entering data rather than assessing duplicate status of sightings made from the two platforms.

Acknowledgements

Thanks are due to the officers and crew of the *RRS James Clark Ross,* for their assistance in setting up the observation platforms, their help with the deployment of the hydrophone, and for their kind hospitality. A number of scientists on board have also been very helpful to our work, with particular thanks to Jon Watkins and Mark Brandon. The survey would not have been possible without the loan of binoculars, big eyes and Argonaut computers from the Southwest Fisheries Science Center, La Jolla. Thanks to Anne Nimershiem for her help with the shipping of equipment and Robert Holland for making modifications to the *WinCruz* software in a short space of time, and also to Tom Hedley for making the angleboards and monopoles for the binoculars. The International Fund for Animal Welfare provided the passive acoustic equipment and funding for the acoustic data analysis. Finally, we would like to express our appreciation to the British Antarctic Survey for providing the opportunity to collaborate on this project.

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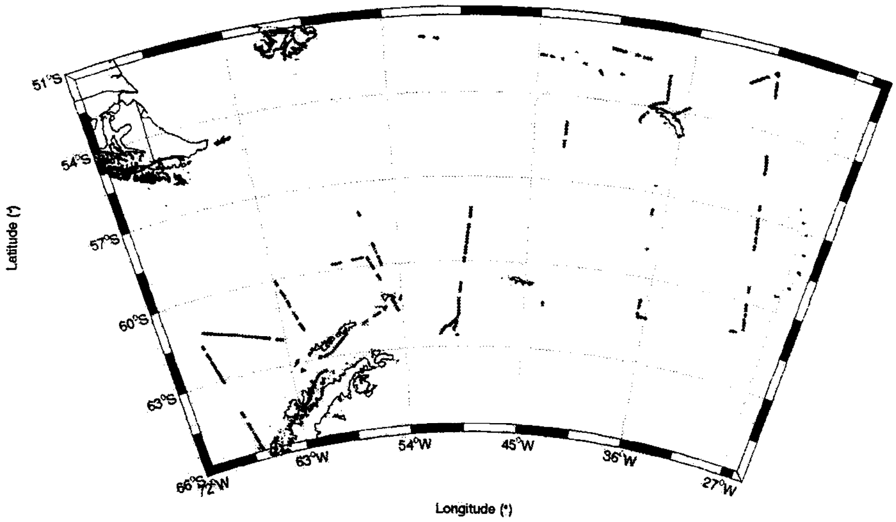

Figure 1 Visual survey effort

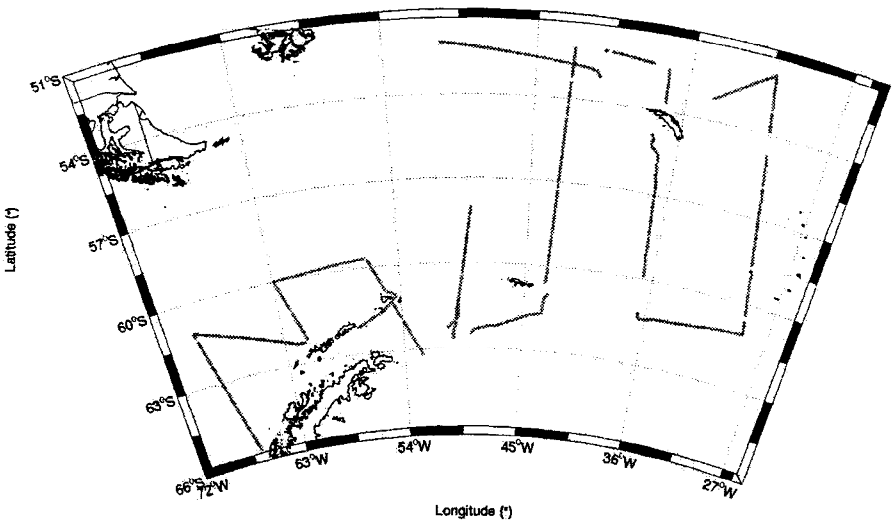

Figure 2 Acoustic survey effort

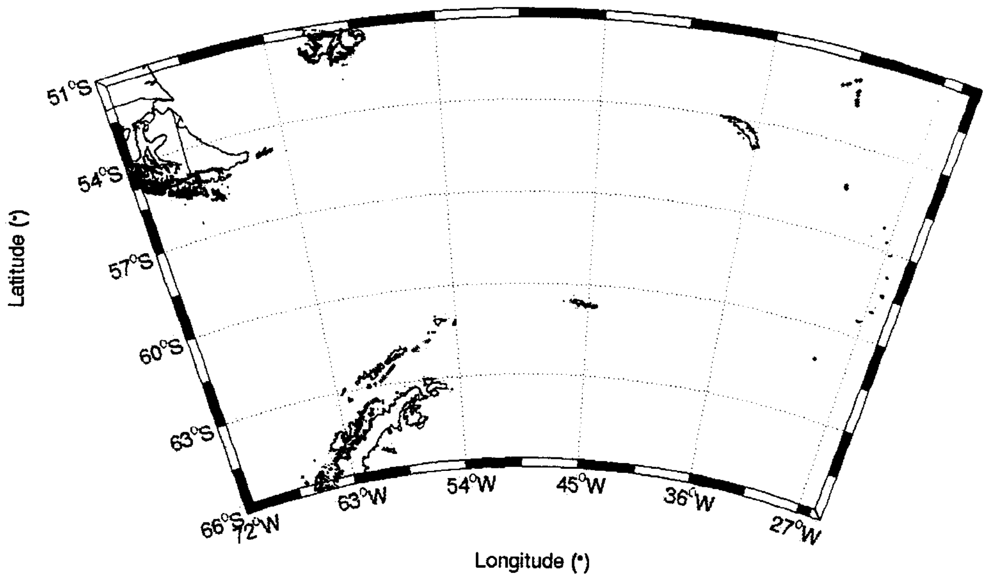

Figure 3 Location of humpback whale sightings

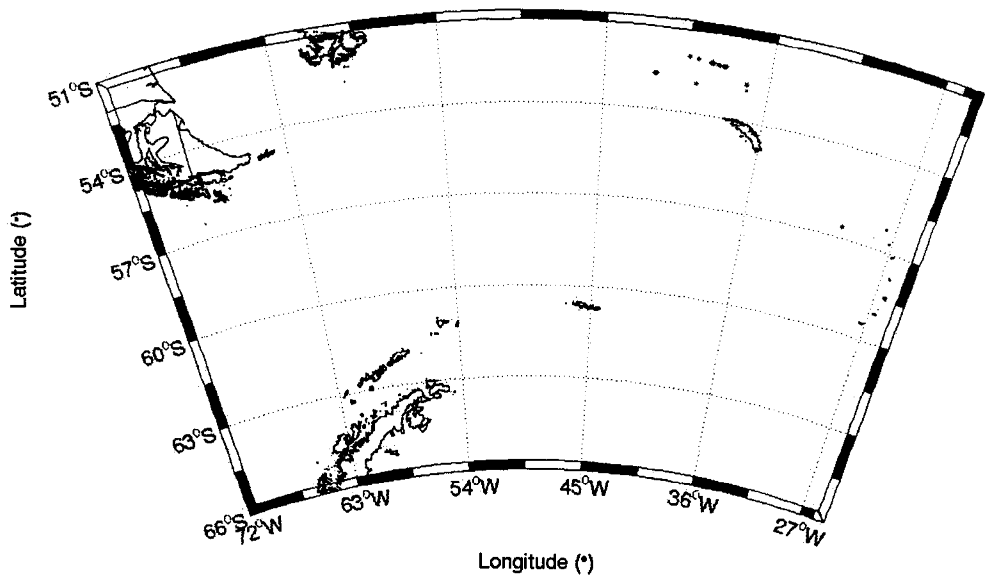

Figure 4 Location of southern right whale sightings

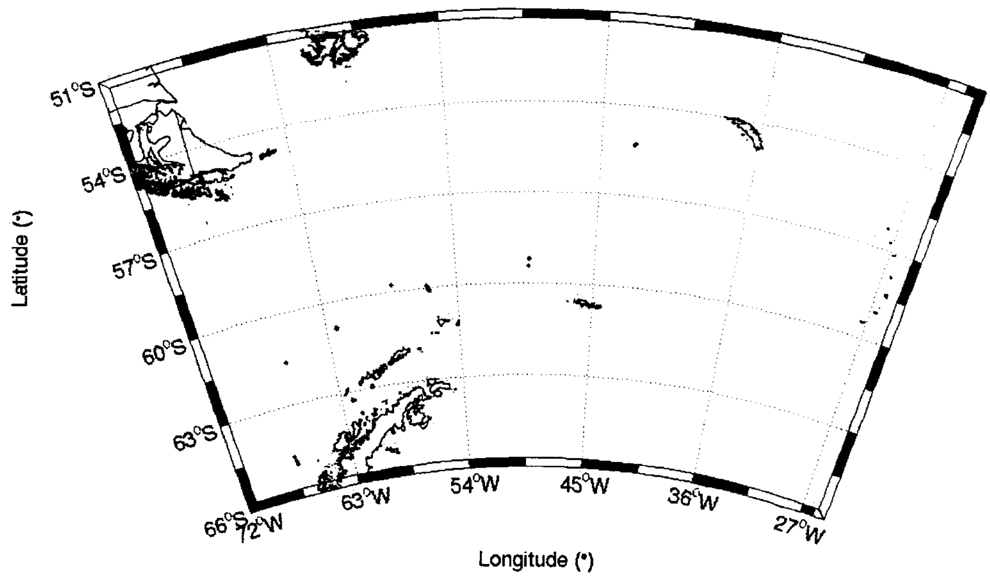

Figure 5 Location of fin whale sightings

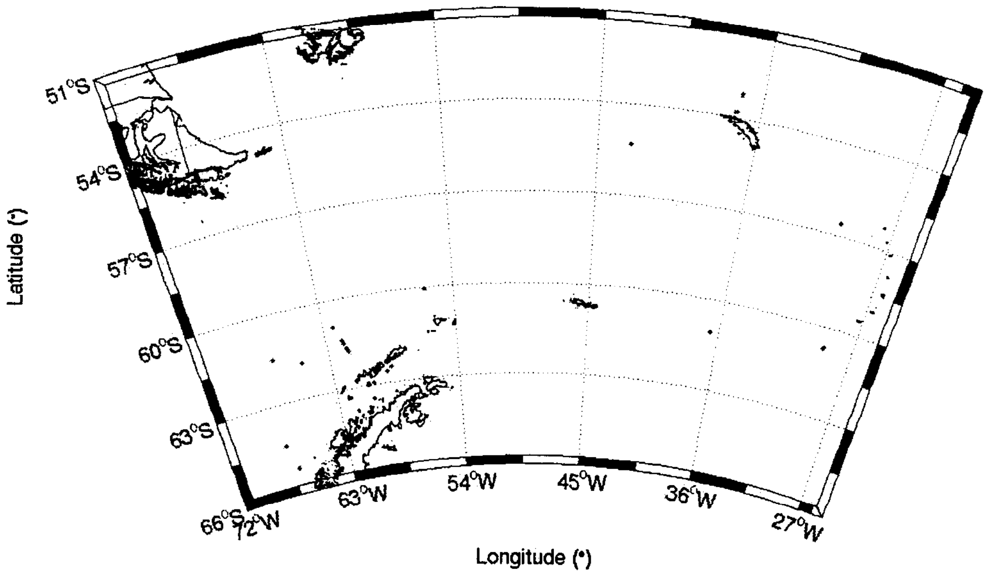

Figure 6 Location of minke whale sightings

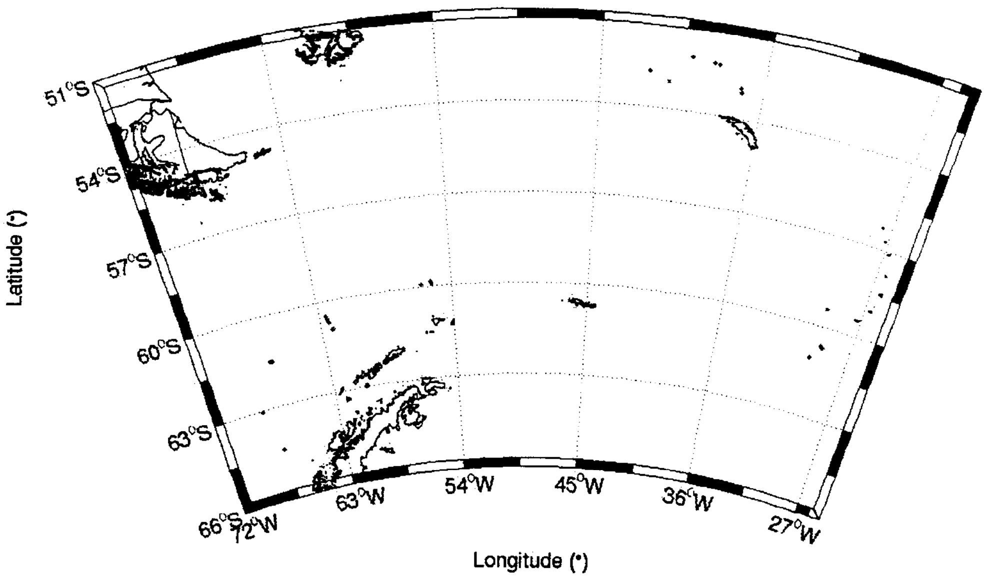

Figure 7 Location of southern bottlenose whale sightings