2008-2009 International Whaling Commission-Southern Ocean Whale and Ecosystem Research (IWC-SOWER) Cruise

Paul Ensor[1], Hiroyuki Komiya[2], Saeko Kumagai[3], Sanna Kuningas[4], Paula Olson[5] and Yasunari Tsuda[2].

ABSTRACT

We conducted the 31st annual IWC-SOWER (formerly IDCR) Cruise in Antarctic Area IV aboard the Japanese Research Vessel *Shonan Maru No.2*. The cruise departed Benoa, Bali, Indonesia on 6 January 2009 and returned to Benoa, Bali, Indonesia on 26 February 2009. The cruise had three main objectives: 1) investigate temporal changes in the spatial distribution of minke whales in relation to recession of the pack ice using a combination of line transect survey, photo-identification studies and biopsy/mark-recapture effort; 2) continue research on blue whales, as in previous years, and; 3) continue research on humpback and southern right whales, as in previous years. The cruise duration was shorter-than-normal SOWER Antarctic cruises and the minke whale research was to have emphasis on investigation of feasibility aspects (especially with respect to the biopsy/mark-recapture effort). After transiting to the research area (spanning longitudes 082°E - 095°E), we carried out a whale survey conducted as a series of 4 repeat line-transect surveys of the research area from 19 January to 12 February. The research area extended from the pack ice edge and repeat surveys had a common northern boundary established 60 n.miles north of the ice edge determined during the first survey. A total of 1440.5 n.miles were covered during the 4 surveys, and in two survey modes: SS-II mode (611.4 n.miles) and BT-Option II mode (829.1 n.miles). The total number of minke whales sighted during the entire coverage of the research area was 49 groups, 56 animals. No substantial southward recession of the ice edge was observed during the survey period. AMSR-E satellite predictions of sea ice indicated extensive areas with low ice cover (0-3%) within the pack ice zone in the research area (the Davis Sea polynya and an adjoining large lead), however these areas were inaccessible for survey as they were south of our observed ice edge. Humpback whales were the most frequently sighted species in the research area, with 373 groups, 682 animals observed. Seven groups comprising 17 Antarctic blue whales were sighted, and biopsy samples, identification photos, video, and acoustic recordings were collected. In terms of numbers of animals encountered, killer whales were the second most frequently sighted species in the research area with a total of 255 animals observed (21 groups). Killer whale Types A, B, and C were seen as well as killer whales unclassified to Type. During the cruise biopsy samples were collected from 4 minke whales, 6 Antarctic blue whales, 23 humpback whales, and 1 killer whale. Individual identification photos of 15 minke whales, 12 Antarctic blue whales, and 74 humpback whales were obtained, as well as identification photos from 10 groups of killer whales. Trial telemetry approaches to minke whales were also to be attempted, however due to a lack of suitable minke whale groups, there was opportunity for only one trial, which was unsuccessful. Acoustic recordings were conducted at a total of 25 stations using sonobuoys. Sounds attributed to Antarctic blue whales were recorded at 3 stations conducted in the vicinity of the sighted blue whales and at 5 opportunistic stations. Notable sightings during the cruise included a mixed species feeding aggregation centered at 64°19'S 088°53'E on 9 February comprising 4 groups (51 animals) of killer whales, two fin whales, two minke whales and a humpback whale. A group of tropical killer whales (6 animals) was observed at 12°32'S 114°39'E. A southern bottlenose whale calf was recorded in a group of three whales on 21 February at position 28°21'S 111°20'E during the return transit to Benoa. During SOWER 2008-09 digital still cameras mounted above the top platform were used to collect images for the investigation of angle estimation and observer search patterns. The Estimated Angle and Distance Training Exercise and Experiment was completed as in previous years.

[1]/: Governors Bay, Lyttelton RD1, New Zealand; paulensor@xtra.co.nz

[2]/: Kyodo Senpaku Kaisha, Ltd., Toyomi Shinko Bldg, 4-5 Toyomi-cho, Chuo-ku, Tokyo 104-0055, Japan

[3]/: The Institute of Cetacean Research, 4-5, Toyomi-cho, Chuo-ku, Tokyo 104-0055, Japan; kumagai@cetacean.jp

[4]/: Sea Mammal Research Unit, University of St. Andrews, UK; sk297@st-andrews.ac.uk

[5]/: Southwest Fisheries Science Center, NMFS/NOAA, 3333 N Torrey Pines Ct., La Jolla, CA 92037, USA; Paula.Olson@noaa.gov

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The 2008-2009 International Whaling Commission - Southern Ocean Whale and Ecosystem Research Program (IWC-SOWER) Cruise was conducted from 6 January 2009 to 26 February 2009. The cruise was the thirty-first in a consecutive series of Antarctic cruises conducted by the IWC. The first eighteen cruises were conducted under the auspices of the International Decade of Cetacean Research (IDCR) and known as the IWC/IDCR Southern Hemisphere Minke Whale Assessment Cruises. The subsequent and thirteen most recent cruises were part of the IWC-SOWER Circumpolar program. The first twenty-six IDCR/SOWE cruises focused on obtaining data to estimate the population size and distribution of minke whales south of latitude 60°S and comprised the first, second and third circumpolar series of surveys. A new phase of research was initiated during the 2004-2005 cruise.

The 2008-2009 cruise continued the research begun during the 2004-2005 cruise. The main objectives for the 2008/2009 cruise were to:

1) investigate temporal changes in the spatial distribution of minke whales in relation to recession of the pack ice; to inform the design of future SOWER cruises this was to be undertaken using a combination of line-transect survey and the collection of individual identification data (biopsy/mark-recapture).

2) continue research on blue whales (including collecting biopsy samples, acoustic data, photographs for identifying individual animals and behavioural data);

3) continue research on southern right whales and humpback whales, especially on stock structure (including collecting biopsy samples and individual identification photographs).

Initial planning for the cruise was undertaken at the 2008 Meeting of the IWC Scientific Committee (IWC in Press). Logistical aspects for the cruise and operations of the ships were finalized at a Planning Meeting held in Tokyo on 26-27 September 2008 (Anon. 2008a).

The IWC provided partial funding for the cruise. The Government of Japan provided the research ship, the *Shonan Maru No. 2.* This ship has been used for all of the IWC-IDCR/SOWER cruises since the 1981-82 cruise. Specifications of the ship are given in Appendix A.

The planned research area for the cruise, 105° - 115°E (in Area IV) was the same as for last year's cruise which had been planned to coincide with an Australian Antarctic Division (AAD) aerial survey. During transit to the Antarctic the research area was revised to a new location further west in Area IV since satellite imagery indicated unsuitable pack ice conditions for the priority research item in the planned research area.

Research in Area IV area had been previously undertaken during the 1978-79, 1984-85, 1988-89 IWC/IDCR cruises and during the 1998-1999 and 2007-2008 IWC-SOWER cruises.

The cruise used Benoa, Bali, Indonesia as the home port.

Personnel

Four researchers were selected for the cruise; Paul Ensor (cruiseleader, New Zealand), Saeko Kumagai (Japan), Sanna Kuningas (Finland) and Paula Olson (USA). Yasunari Tsuda, Chief Radio Operator of the *Shonan Maru No.2* conducted acoustics research during the cruise.

Schedule

Listed below is the cruise itinerary.

Date	Event
4-Jan	*Shonan Maru No.2* arrived Benoa Harbour, Bali, Indonesia
5-Jan	Pre-cruise Meeting
6-Jan	*Shonan Maru No.2* departed Benoa Harbour
7-Jan	*Shonan Maru No.2* departed the 200 n.mile EEZ of Indonesia
8-Jan	*Shonan Maru No.2* intersected the 200 n.mile EEZ of Australia
11-Jan	*Shonan Maru No.2* departed the 200 n.mile EEZ of Australia
19-Jan	Estimated Angle and Distance Training
19-Jan	Minke whale survey, (First Survey, east to west) commenced at longitude 095°00'E
26-Jan	First Survey completed at longitude 082°00'E
27-Jan	Second survey (west to east survey, 082°00'E to 092°00'E) commenced
3-Feb	Second Survey, (west to east) completed at longitude 092°00'E and Third Survey (east to west, 092°00'E to 087°00'E) commenced
6-Feb	Third Survey, east to west survey completed
7 Feb	Fourth Survey (west to east survey 087°00'E to 092°00'E) commenced
12-Feb	*Shonan Maru No.2* conducted Estimated Angle and Distance Experiment
12-Feb	Fourth Survey completed and transit commenced to Benoa Harbour, Indonesia
20-Feb	*Shonan Maru No.2* intersected the 200 n.mile EEZ of Australia
23-Feb	*Shonan Maru No.2* departed the 200 n.mile EEZ of Australia
25-Feb	Post-cruise Meeting held aboard the ship
25-Feb	*Shonan Maru No.2* entered the 200 n.mile EEZ of Indonesia
26-Feb	*Shonan Maru No.2* arrived Benoa Harbour, Indonesia
1-Mar	*Shonan Maru No.2* departed Benoa Harbour, Indonesia

OBJECTIVES and METHODS

There were 3 main objectives for the 2008-2009 IWC-SOWER cruise:

(1) the priority research item for the SOWER cruise, with respect to providing information on minke whales in the pack ice, was to investigate temporal changes in the spatial distribution of minke whales in relation to recession of the pack ice. To inform the design of future SOWER cruises this was to be undertaken using a combination of line-transect survey and the collection of individual identification data (biopsy/mark-recapture). Also to be attempted were telemetry trial approaches to minke whales;

(2) continue research on blue whales (including collecting biopsy samples, acoustic data, photographs for identifying individual animals and behavioural data);

(3) continue research on southern right whales and humpback whales, especially on stock structure (including collecting biopsy samples and individual identification photographs).

24 days in the research area were allocated as follows:

- 21.5 days to the minke whale survey, including collection of minke whale biopsy samples and individual identification photographs
- 2 days for blue whale, southern right whale and humpback whale research
- 0.5 days for Angle and Distance estimation training and experiment

Minke Whale Research

The main research item for the 2008-09 cruise was an investigation of temporal changes in the spatial distribution of minke whales in relation to recession of the pack ice. This was to be undertaken using a combination of line-transect survey and the collection of individual identification data (biopsy/mark-recapture). The outcome would potentially provide important information on minke whales in the pack ice – this is relevant to both interpretation of past cruise data and the design of future SOWER cruises.

The research area spanning ten degrees of longitude was to be surveyed at least twice and possibly three times using the same cruisetrack design principles. This was the second SOWER cruise to focus on monitoring changes in spatial distribution on systematically constructed tracklines within the survey season. Last year's SOWER cruise (Ensor et al, 2008) had a similar focus during the Collaborative study with an aerial survey conducted by the Australian Antarctic Division (AAD).

Although it was recognized that a combination of line-transect and mark-recapture information had the power to determine changes in minke whale distribution with respect to changes in ice and thus the potential to address this important issue; it was clear this would require considerably more effort than the 24 days that were available for research on this cruise. The primary limitation related to sample size considerations – it was clear that any successful experiment would require a major field effort to obtain the required number of recaptures and suitable density estimates.

The results of the 2008-09 cruise, would however, potentially provide the opportunity to combine some feasibility aspects (especially with respect to biopsy/mark-recapture effort) with the ability to undertake combined analyses with data collected the previous year (2007-08) in the same research area, and to develop a targeted plan for the future.

The line-transect survey component was to be conducted using BT-Option II mode and SS-II mode (closure when abeam) methodology.

The minke whale biopsy/photo-identification work would also provide an opportunity to carry out some preparatory work with respect to telemetry studies.

Research area

The research area for the 2008-09 cruise (longitude 105°E-115°E) was selected to be in the same area as surveyed last year during the collaborative study with the AAD aerial survey.

However, during the transit from Benoa to the Antarctic, the decision was taken by the SOWER Steering Group to change the Research Area. This was in response to satellite information received prior to departure from Benoa and on transit to the Antarctic, indicating the extent of pack ice in the planned Research Area (105°E - 115°E) was considerably reduced compared to normal years, and particularly in the western section, which was

predicted to be ice-free to the Antarctic coast. Thus, there would likely be a reduced opportunity to undertake studies related to pack ice recession in the planned Research Area.

To facilitate selection of an alternative Research Area, Natalie Kelly (AAD) provided an analysis of sea ice dynamics for the Austral summer 2008-09 for the area between longitudes 080°E and 120°E. The analysis indicated that the overall sea ice density for this region in January 2009 was expected to be much lower than the average for the last five years. The analysis suggested the most likely pronounced recession feature within this longitudinal range would occur between 080°E and 090°E where the ice edge was likely to recede quickly and substantially over January and into February.

In light of this information, the area between longitudes 080°E and 090°E was tentatively selected as the revised Research Area. The likelihood of a reasonable sighting rate for minke whales and a minimum additional transit distance further supported this selection.

Longitude 095°E was later selected as the eastern boundary of the Research Area. From there, the research would be extended westward as far as possible to include the area recommended (the 080°E-090°E sector). The strategy to commence the minke whale research at 095°E, i.e. east of the recommended longitude (090°E) considered that the Davis Sea polynya was located south of the main ice edge in this region. While the AAD ice analysis indicated that it was unlikely that the band of sea ice north of this polynya would melt or move to enable ship access to the polynya; if this did occur, and research in the polynya could be accomplished later in the research period during a re-survey, the outcome of the minke whale research would be enhanced).

Longitude 082°E was subsequently selected as the western boundary, thus defining the Research Area as the area spanning longitudes 082°E to 095°E. This decision was based on our observations of the characteristics of the pack ice edge during the First survey coverage as well as the satellite-predicted expansion of leads and polynyas south of the main ice edge.

The Northern Boundary of the research area was to be the same for all the repeat surveys and would be constructed as a line 60 n.miles north of the ice edge mapped during the First survey.

Cruisetrack design and survey modes

The cruisetrack design for each of the repeat surveys was a series of zigzags, evenly spaced longitudinally, and covering the entire north-south extent of the research area. The zigzags were to be interspersed with survey segments parallel to the ice edge.

The entire survey was to be conducted in alternating SS-II and BT-Option II modes. Each of the zigzag survey legs was to be divided by survey mode to give a 2:1 ratio of BT-Option II and SS-II modes. It was planned that the segments parallel to the ice edge were divided approximately in half by mode; waypoints for mode alternation were established on lines of longitude.

Due to the limited time available, coupled with the requirement to cover the entire area at least twice, it was likely that gaps in survey coverage would be necessary as the total length of the trackline will be too great to be entirely covered. Survey effort was to be distributed as evenly as possible by latitude and longitude.

As with last years survey, BT-Option II was to be used instead of IO mode in order to further evaluate BT mode survey methodology (Buckland and Turnock, 1992) as a protocol for future SOWER minke whale surveys. For BT-Option II the location of the Tracker Platform was the Top Barrel (with the two observers searching 60° either side of the trackline using 7x50 binoculars) and the Primary Platform was the IOP (with two observers; one topman and one researcher searching 90° either side of the trackline with naked eye). Both the Tracker and the Primary Platforms tracked minke whale sightings until they were estimated abeam with all re-sightings recorded. BT-Option II was also trialled on the 2006-07 and 2007-08 cruises; full details of the methods used for BT-Option II mode trials are described in Anon (2008b).

Investigation of minke whale school size estimation was to be continued during this cruise and SS-II mode (abeam closure from Passing mode (NSP)) was to be used instead of normal closing mode (NSC). The aim was to continue the investigation into the difference between confirmed school sizes of minke whales (mainly obtained during NSC mode) and unconfirmed school sizes (mainly obtained during Passing mode). Abeam closure was attempted on all minke whale and 'like minke whale' sightings with the proviso that only sightings for which the initial estimates of perpendicular distance from the trackline was less than or equal to 1.5 n.miles were considered for closure. The methods to be used for the SS-II mode trials are provided in Anon (2008b).

Research was conducted for 12 hours between 06:00-18:00 hrs. During days when survey was conducted in BT-Option II mode (effectively involving the same crew schedule as Passing mode with independent observer (IO

mode)) research was scheduled for 12 hrs a day between 06:00-19:00 hrs to allow for potentially two 30-minute meal breaks. Research was scheduled for 12 hrs a day during the transits to and from the research area.

Minke whale biopsy and photo-identification studies

Biopsy sampling and photo-identification of Antarctic minke whales was to be undertaken as a part of normal operations during the survey (and particularly during SS-II mode).

Video distance and angle measurement (SCANS II)

With respect to the continuing concerns related to SOWER distance and angle estimates, the IWC Scientific Committee recommended that more data related to distance and angle measurements should be obtained on the 2008-09 cruise. The SCANS II video equipment was used to estimate distance and two digital still cameras were used to record angle estimation and observers search patterns.

SCANS video equipment

The SCANS II video equipment had been used on the 2006-07 and 2007-08 cruises, however few minke whale blows were detected on video. The main reason for the paucity of blows recorded during 2006-07 appeared to be related to poor image quality and the characteristics of minke whale blows. For the 2007-08 cruise, video recordings of minke whale cues detected by one observer in the Top barrel were attempted using improved equipment, however, very few minke whale blow cues were recorded on that cruise as well since almost all detections were of body cues. With the aim of further testing of the utility of the equipment, the same set up (a high definition video camera (Canon HV20) attached to 7x50 binoculars) was to be used during the 2008-09 cruise. However on the 2008-09 cruise, the equipment was to be used by a researcher on the upper bridge instead of by a Top barrel observer. This was to avoid the requirement for a researcher to be stationed in the Top Barrel to operate the recording system for the SCANS II video camera.

Digital still equipment to record angle estimation and observers search patterns

Two digital still cameras were mounted in a waterproof housing directly above one of the observers the Top barrel. The cameras were set up to record images of the orientation of reference lines on the observer's binoculars in relation to reference marks on the angle boards of the Top barrel.

To record angle estimation, a digital camera (Pentax Optio S) with a remote control was set up to be triggered by the observer, on detection of a sighting.

To investigate observers scanning patterns a set of bearing images was to be recorded by the other camera (GEA835). This camera was programmed to take pictures every 30 seconds whenever possible during normal survey modes.

Minke whale visual dive time experiment

Given the lack of shorter-than-normal duration of research time on this cruise, continuation of the minke whale visual dive time experiment was given a low priority when planning this cruise.

Angle and distance experiments

An Estimated Angle and Distance Training Exercise and Estimated Angle and Distance Experiment were planned using the same protocol as on recent cruises (Anon. 2008b).

Blue whale research

Blue whale research was to be conducted during a maximum of two days allocated to biopsy and photo-identification of the priority designated species during the cruise. The blue whale research included a continuation of research focused on trying to discriminate between the 'Antarctic' and 'pygmy' subspecies of blue whale, including the collection of skin samples for genetic analysis, photographs for identification of individuals, acoustics recordings, and behavioural observations including collection of video recordings. During the Blue Whale Research Component we used the same research protocol as on recent IWC-SOWER cruises. Methods and equipment used for biopsy, photo-identification, and acoustic recordings are given below.

Blue whales were to be approached to within 1 n.mile and for at least a 30-minute duration, dive times were recorded if feasible. The whales were then approached for biopsy, photo-identification, and videotaping. The surfacing behaviour of blue whales was recorded from the Top Barrel on high-resolution digital video (Panasonic digital video camera NV-GS200K). Acoustic recording using sonobuoys was to be conducted.

Southern right and humpback whale biopsy sampling and photo-identification

Although the SOWER priority species for biopsy and photo-identification studies remained unchanged from recent cruises (blue, fin, southern right, and humpback whales), for the 2008-09 cruise, which was of shorter

duration than recent cruises, emphasis was to be placed on blue, southern right, and humpback whales. Two days of research time was allocated to biopsy and photo-id studies. Priority was to be given to blue and southern right whales during the early part of the cruise, with additional priority allocated to humpback whales later in the cruise, depending on time available; this was because humpback whales were expected to be abundant throughout the area for the duration of the research.

Opportunities were to be taken for collection of biopsy samples from sperm and killer whales as well as other 'incidental' species during the normal process of confirming species identification and numbers, or if animals approach the vessel while off-effort.

Two types of biopsy equipment were available on board: Larsen guns and compound crossbows. The IWC-owned Paxarms guns, were also on board, however due to delays in airfreight no ammunition was available so this system could not be used.

Biopsy tissue samples were split, with one half for Japan and the other half for IWC. All samples were frozen. When samples had a "significant" amount of blubber attached, the blubber was removed from the skin, and frozen.

Photographs for identifying individual whales were obtained using digital cameras (Canon EOS 20D) each equipped with a 100-400 mm image-stabilized zoom lens. Additionally, researchers used their personal digital cameras and contributed images.

Telemetry studies

While it was not possible to consider the collection of telemetry data on the present cruise for a number of reasons, not least the lack of suitable equipment. Given the great potential value of the method regarding minke whales and their use of the pack ice habitat, on this cruise information relevant to future deployment of telemetry equipment was to be collected.

Tagging of whales normally has the greatest chance of success if the deployment is undertaken using a small boat as a research platform as it is essential to make very close approaches to slow-swimming whales. On the 2008-09 cruise, trial approaches to minke whales were to be undertaken. The aim was to gather data to assess the practicality of being able to reliably close, at relatively slow speeds on Antarctic minke whales to such a distance that the deployment of tags from the bow of the vessel was likely to be possible. Whales were to be filmed on video and the closest distances of the approaches to the whales estimated (or measured with a laser range finder). In particular these data could be valuable in assessing the feasibility of attaching telemetry devices to Antarctic minke whales from a large vessel such as *Shonan Maru No. 2*. Details of the methods used for telemetry trial approaches are described in Anon (2008b).

Acoustics Research

As for recent SOWER cruises acoustic recording this year focused on obtaining blue whale recordings, with the aims of potentially distinguishing 'Antarctic' from pygmy blue whales and comparison with other regions worldwide. Acoustic recordings were made using sonobuoys (Ultra Electronics 53D DiFAR, manufactured 2003 and Hermes Electronics 53D DiFAR, manufactured 1990). The majority of the sonobuoys were programmed for 30 m depth (with a few set to 120m) and all were set for 8 hours. Channels 80-90 were primarily used as these most closely matched the frequency response of the *Shonan Maru No. 2* antenna. Sonobuoy signals were received by an Icom IC-R100 communications receiver, with output to a computer for recording to hard disc. Signals were monitored in real time using the program Ishmael (D. Mellinger) on the ship's NEC computer as well as a Dell Inspiron 6000 computer

Ice Edge Information

Ice edge information was critical for construction of the cruisetrack for the SOWER vessel and ice information was received from two sources:

1) daily Advanced Microwave Scanning Radiometer (AMSR-E) passive microwave images (available at http://iup.physik.uni-bremen.de:8084/amsr/amsre.html); were sent to the SOWER vessel from the Australian Antarctic Division (after transformation at AAD). See Appendix B for details.

2) via the Internet from the US National Ice Center (NIC) during the cruise. (Available at http://www.natice.noaa.gov: SSM/I satellite image data provided on a daily basis.) As with recent cruises the SSM/I data were transformed aboard the vessel (by programs developed at ICR), from polar stereographic to Mercator projection.

Oceanography

No oceanographic sampling was planned. As on the last two year's cruises, two ARGO floats were provided under the ARGO oceanographic programme to be deployed during the southward transit (at latitudes 54°S and 55°S).

NARRATIVE, RESULTS AND DISCUSSION

The following section is a descriptive account of the major aspects of the cruise. Details of the survey area and cruisetracks are presented in Figures 1a-e.

PRE-CRUISE MEETING AND TRANSIT TO THE ANTARCTIC RESEARCH AREA

The *Shonan Maru No. 2* arrived in Benoa Harbour, Bali on 4 January 2009, and a Pre-cruise Meeting was held on 5 January at the Inna Sindu Beach Hotel. The ship departed Benoa at 16:50 hrs on 6 January. The vessel departed the 200 n.mile Exclusive Economic Zone (EEZ) of Indonesia on 7 January at position 12°11'S 114°44'E at 10:12 hours. No research was planned or conducted within the EEZ of Indonesia.

Given the time constraints in reaching the research area from Benoa, only Passing mode survey was planned during the remainder of the transit after departing the Zone of Indonesia. This included within the Australian EEZ which was intersected en route. Permission had been granted by the Australian Department of Foreign Affairs and Trade for Passing mode research in the Australian EEZ.

Between the EEZ of Indonesia and the EEZ of Australia 8.32 hours of research in NSP mode (97.3 n.miles) was conducted.

The EEZ of Australia was intersected on 8 January at position 16°51'S 113°51'E at 09:34 hours. The vessel departed the Australian EEZ on 11 January at 13:55 hours at position 31°21'S 111°08'E. A total of 11.72 hours of research in NSP mode was conducted in the Zone (134.5 n.miles). Windy conditions, unsuitable for research, were experienced in the southern part of the Zone.

Between the boundary of the Australian EEZ and the intercept with latitude 60°00'S weather conditions were poor; a total of 9.03 hours (106.4 n.miles) of searching in NSP mode was conducted.

Two Argo buoys were successfully deployed on 17 January at positions 54°00'S 097°38'E and 55°00'S 096°57'E.

The vessel intersected 60°00'S (at longitude 095°55'E) at 18:38hrs on 18 January. Between latitude 60°00'S and the ice edge, a total of 3.94hrs (42.7 n.miles) of research was conducted

The ship arrived at the starting point for the minke whale research and commenced the survey on the afternoon of 19 January.

Estimated Angle and Distance Training Exercise

The Estimated Angle and Distance Training Exercise was conducted prior to reaching the ice edge on 19 January during 2.50 hours. During the exercise the observers familiarized themselves with naked eye estimates from the IOP in preparation for BT–Option II mode.

MINKE WHALE SURVEY

As planned, the minke whale survey was conducted as a series of repeat surveys of the research area. The boundaries of the research area were established on lines of longitude 095°00'E and 082°00'E.

The northern boundary of the research area for all of the repeat surveys was constructed as a line 60 n.miles north of the ice edge mapped during the First survey.

Four repeat surveys in the research area were conducted. The First survey was carried out from longitude 095°00'E to 082°00'E; the Second survey covered the area between longitudes 082°00'E and 092°00'E. The Third and Fourth surveys spanned the area between longitudes 087°00'E and 092°00'E.

During all four surveys combined a total of **127.7** hours of searching was conducted and **1440.5** n.miles were covered on primary effort: SS-II mode – **611.4** n.miles (**54.55** hours) and BT-Option II mode – **829.1** n.miles (**73.15** hours).

The cruisetrack design for the first three surveys was constructed, as planned, as a series of zigzag tracklines covering the entire north-south extent of the research area. Each zigzag spanned two degrees of longitude and was alternated with segments parallel to the ice edge, and spanning one degree of longitude.

The Fourth survey was conducted entirely parallel to the ice edge. During the Fourth survey, emphasis was placed on a thorough investigation of the ice edge in an attempt to find a route to the satellite predicted lead and the Davis Sea polynya south of the main ice edge.

During the first three surveys, the cruisetrack was constructed in relation to an estimated ice edge based on satellite information.

The four surveys were all conducted in alternating SS-II mode and BT-Option II mode. During the first three surveys, each of the zigzag survey legs was divided by survey mode to give a 2:1 ratio of passing mode (BT-Option II) and closing mode (SS-II). The trackline segments parallel to the ice edge on these three surveys were equally divided by longitude (with the aim of dividing each ice edge segment roughly in half by mode). During the Fourth survey, research mode was alternated at approximately 40 n.mile intervals along the ice edge.

First survey (East to West, 095°00'E - 082°00'E)

The First survey of the research area commenced from the eastern border of the research area (095°00'E) at an ice edge waypoint at position 63°43'S 095°00'E on 19 January (15:44hrs) and was completed at 082°00'E on 26 January (18:00hrs).

Longitude 095°00'E was selected as the starting point for the First survey as this would provide coverage of the ice edge north of the longitudinal range of the Davis Sea polynya (potentially the polynya could be surveyed later in the cruise).

During the First survey coverage a total of **55.05** hours of searching was conducted and **626.3** n.miles were covered on primary effort: SS-II mode – **262.6** n.miles (**23.35** hours) and BT-Option II mode – **363.7** n.miles (**31.70** hours).

The cruisetrack for the First survey totalled approximately 738.0 n.miles and a total of 626.3 n.miles (approximately 85%) were covered on effort. A total of about 112.0 n.miles was steamed off effort during poor weather.

A summary of research effort by mode during the First survey is presented in Table 1. Sections of the trackline covered on primary effort during the First survey are shown in Figure 1b.

For almost all of the survey period reasonably good weather conditions were experienced. Of the 86.5 hours available for research 28.3 hours (33%) were lost to poor weather.

During the First survey, images of minke whales (potentially of use for photo-id) were obtained and biopsy sampling of minke whales was undertaken during SS-II closures (see Minke Whale Biopsy and Photo-ID Section below). Research on humpback and killer whales was also conducted (see Table 2 and Biopsy and Photo-id Section below).

Second Survey (West to East, 082°00'E - 092°00'E)

Re-survey of the research area was commenced from 082°00'E on 27 January (06:00hrs) at the western border of the research area and continued until 3 February (09:43hrs).

Longitude 082°00'E was selected as the eastern limit for the Second survey based on our observations of heavy ice conditions at the ice edge east of this longitude during the First survey, as well as the stable, high concentrations of ice in this area indicated in subsequent satellite images. Thus there appeared to be a low likelihood of southward ice edge recession occurring between longitudes 092°E and 095°E during the survey period.

During the re-survey, the same principles were used for cruisetrack construction and for division of the trackline segments by research mode.

During the Second survey the vessel conducted a total of **40.68** hours of searching and **463.3** n.miles were covered on primary effort: SS-II mode – **155.0** n.miles (**13.65** hours) and BT-Option II mode – **308.3** n.miles (**27.03** hours).

The cruisetrack for the Second survey totalled 544.0 n.miles and 463.3 n.miles (85%) were covered on effort. A total of about 81.0 n.miles was steamed off effort during poor weather.

A summary of research effort by mode during the Second survey is presented in Table 1. Sections of the trackline covered on primary effort during the Second survey are shown in Figure 1c.

Average weather conditions were experienced during the Second survey. Of the 88.7 hours available for research 45.8 hours (52%) were lost to poor weather.

During the Second survey, images of minke whales (potentially of use for photo-id) were collected and the collection of biopsy samples from minke whales was continued (see Minke Whale Biopsy and Photo-ID Section below). Research on blue whales, humpback and killer whales was also conducted (see Table 2, Blue Whale Research and Humpback Research Sections below

Third Survey (East to West, 092°00'E - 087°00'E)

The Third survey coverage of the research area was commenced on 3 February (09:43hrs) from 092°00'E and was continued until 6 February (18:00hrs). The same principles were used for cruisetrack construction and for division of the trackline segments by research mode

During the Third survey longitude 087°E was reached on 6 February, and instead of continuing the Third survey coverage westward to the western boundary of the research area (082°E), we returned eastward and the Fourth survey coverage (087°E-092°E) was commenced. This decision was undertaken since, based on ice information, there appeared more chance of ice recession (and/or or changes in the concentration of ice at the ice edge) in the east between 087°E and 092°E during the remaining 6 days of research time.

The remaining research time was unlikely to be sufficient to ensure completion of third survey coverage westward to 082E, as well as to allow for additional coverage in the area between 087°E and 092°E if recession or changes in the ice edge occurred there. The best potential chance existed in this longitudinal range for access to satellite-predicted lead system (coincident with the continental slope front) and the Davis Sea polynya where AMSR-E sea ice predictions indicated low ice concentrations (0-3% ice).

However, too much ice prevented our attempts to navigate southward of our observed ice edge to reach these areas.

During the Third survey the vessel conducted a total of **17.73** hours of searching and **189.2** n.miles were covered on primary effort: SS-II mode –**95.6** n.miles (**8.95** hours) and BT-Option II mode – **93.6** n.miles (**8.78** hours).

The cruisetrack for the Third survey totalled approximately 285.0 n.miles and a total of 189.2 n.miles (66%) were covered on effort. A total of 96.0 n.miles was steamed off effort during poor weather. Most of the survey effort was in the vicinity of the ice edge, as off effort steaming was mainly conducted on the zigzag transects where poorer conditions were experienced.

A summary of research effort by mode during the Third survey is presented in Table 1. Sections of the trackline covered on primary effort during the Third survey are shown in Figure 1d.

Weather conditions were experienced during the Third survey were about average. Of the 44.3 hours available for research 20.6 hours (46%) were lost to poor weather.

During the Third survey, images of minke whales (potentially of use for photo-id) were obtained and the collection of biopsy samples from minke whales was continued (see Minke Whale Biopsy and Photo-ID Section below). Research on blue whales, humpback and killer whales was also conducted (see Table 2, Blue Whale Research and Humpback Research Sections below).

Fourth Survey (West to East, 087°00'E - 092°00'E)

The Fourth survey coverage of the research area was commenced on 7 February (06:00hrs) from 087°00'E and was continued until 12 February (18:17hrs). The Fourth survey was conducted entirely parallel to the ice edge.

On the Fourth survey the north-south extent of pack ice was about the same, however the ice edge was of much higher ice concentration due to compaction by the prevalence of northerly winds and there was no chance to navigate southward.

During the Fourth survey the vessel conducted a total of **14.24** hours of searching and **161.7** n.miles were covered on primary effort: SS-II mode – **98.2** n.miles (**8.60** hours) and BT-Option II mode – **63.5** n.miles (**5.64** hours).

The cruisetrack for the Fourth survey totalled approximately 257.0 n.miles and a total of 161.7 n.miles (about 63%) were covered on effort. A total of 57.0 n.miles was steamed off effort during poor weather. The poor weather conditions delayed survey progress with the result that there was no coverage of the ice edge between longitudes 091°00'E and 092°00'E.

A summary of research effort by mode during the Fourth survey is presented in Table 1. Sections of the trackline covered on primary effort during the Fourth survey are shown in Figure 1e.

Conditions experienced during the Fourth survey were more changeable and generally not as good as for the previous surveys. Of the 68.6 hours available for research 36.5 hours (53%) were lost to poor weather.

During the Fourth survey, images of minke whales (potentially of use for photo-id) were obtained and the collection of biopsy samples from minke whales was continued (see Minke Whale Biopsy and Photo-ID Section below). Research on blue whales, humpback and killer whales was also conducted (see Table 2, Blue Whale Research and Humpback Research Sections below). In addition, a trial Telemetry approach to a group of minke whales (comprising 3 animals) was attempted (see Telemetry section below).

Estimated Angle and Distance Experiment

The Estimated Angle and Distance Experiment was conducted on 12 February during a total of 6.07 hours. Two attempts were made at conducting the experiment; the first attempt was interrupted by a passing front accompanied by snow fog. In addition to the normal trials, observers made naked-eye estimates from the IOP (as for BT–Option II mode).

ICE EDGE and PACK ICE EXTENT

For this survey, our best estimate of the position of the ice edge was based on our visual and radar observations of the ice edge as well as satellite predictions.

The general shape of the ice edge in the research area was approximately the same throughout the research period. The shape appeared to reflect a combination of a westerly set to the underlying water current and the prevailing southwest wind direction. In the east of the research area, between 090°00'E and 095°00'E, the ice edge comprised the northern margin of a band of sea ice north of the Davis Sea polynya. The position of this ice edge was largely unchanged throughout the survey period (although an extensive belt of pack ice was observed streaming to the northwest at approximately 091°00'E during the Second survey). During all four surveys, a southward indentation in the ice edge was centered on approximately 090°00'E. On the western side of this the pack ice extended northward (approximately 60 n.mile north-south), the eastern edge of which oscillated between roughly 088°00'E and 089°00'E depending on the prevailing wind direction. The ice edge in the west of the research area between 082°00'E and 088°00'E was quite complex in shape due to northward projecting streams of pack ice.

For the entire research area and duration of the research, the ice type observed at the ice edge comprised quite heavy rafted first year floes and brash ice. The diameter of the floes was generally up to about 20m, freeboard approximately 1.75m and with occasional rafting to a height of 3.5m. The ice edge in the east of the research area (090°00'E to095°00'E) was generally of more developed ice and of higher concentration.

The main changes in the location and ice concentration at our observed ice edge were apparently related to wind direction and strength. No extreme storm events to substantially move or disintegrate the pack ice were experienced; wind strengths were quite moderate during the survey period (most commonly 10-14 knots) and most often from the southwest.

Icebergs were abundant throughout the pack ice edge and in all the sea ice-free water of the research area; water temperatures ranged most commonly between –1. 0°C to +1.0°C.

The underwater topography in the entire research area is characterised by deep water with rapid shelving in the vicinity of the continental slope front (defined by the 1000m isobath). The continent slope front was far south of the pack ice edge and at least 40 n.miles south of the southern limit of our ice edge navigation reached during this cruise. The water depth at our observed ice edge was always in excess of 3000m. In the east of the research area the continent slope front coincided with the northern margin of the Davis Sea polynya and in the west the front in coincided approximately with a section of the southern margin of a satellite predicted lead: The remainder of the slope front was within the pack ice zone.

There was no substantial southward recession of our observed ice edge during the survey period. During the research period, based on our observations of the distribution and relative abundance of minke whales, other species of baleen whales, pack ice seals and feeding events of seabirds, there was no evidence to suggest any change in the location of our observed ice edge in relation to features likely to have a marked influence on minke whale abundance and distribution. There were no surface swarms of krill detected visually in the research area.

Sources of Ice Information

An extensive coastal polynya (the Davis Sea polynya) south of the main ice edge in the eastern part of the research area was indicated on satellite predictions for the entire duration of the research. The polynya is an inter-annual feature of the pack ice in this region (and in some years becomes contiguous with ice-free water to the north of the main ice edge). The location is shown in AMSR-E satellite images in Appendix B (Appendix B, Figures A-E). The extent of the Davis Sea polynya as estimated from the AMSR-E satellite images increased in

size (from roughly 6,600 n.miles^2 to roughly 10,000 n.miles^2) during the research period. After 7 February it was predicted to be confluent with ice-free water north of the main ice edge. (As explained above the polynya was inaccessible to the SOWER vessel due to too much ice).

In addition, based on satellite predictions, an extensive lead developed south of the central part of the research area (as stated above, we speculate due to a general northwest motion of the pack ice). The location of the lead approximately coincided with the continental slope front. The lead system was an obvious feature on satellite images after 21 January (Appendix B, Figure B) and after 28 January it was predicted to be more or less confluent with ice-free water north of the main ice edge (Appendix B, Figure C). The predicted extent of the lead varied with dynamics of the pack ice; a rough estimate of its extent (based on satellite images) at the end of the research period was 6000 n.miles^2. (However, as explained above, as with the Davis Sea polynya, this lead in the pack ice was inaccessible to the SOWER vessel due to too much ice).

The Davis Sea polynya and the lead system represent extensive areas of predicted ice-free water south of the main ice edge, which were unsurveyed, as they were inaccessible to the SOWER vessel.

The ships officers, usually by a combination of visual and radar observations, recorded the location of the ice edge routinely during the cruise. For each of the four surveys a best estimate of the position of the ice edge was made (as normally produced on SOWER cruises aimed at abundance estimation). The precision of the best estimates of these four ice edges was higher than for recent SOWER cruises, since there was closer spacing of ice edge waypoints than on normal SOWER tracklines and also there were many segments of trackline paralleling the ice edge. The Fourth survey had the highest precision estimate as this survey entirely paralleled the ice edge; thus most of the ice edge between 087°E and 090°E was mapped.

The AMSR-E analyses received during this cruise indicated substantially less pack ice extent than our observed ice edge for the entire duration of the research. The 3-20% ice concentration boundary as indicated on AMSR-E satellite images (transformed and dispatched from AAD to the SOWER vessel) was usually approximately 20-30 n.miles southward compared to the observed ice edge from the vessel. Checks at AAD, revealed no faults in the algorithm used to transform the images prior to dispatch to the ship, and the source of the difference was possibly that the satellite could not detect the type of ice at our observed ice edge, coupled with ice movement and delays in the ice analyses being released on the web site.

BT-Option II

This was the second SOWER cruise to incorporate BT-Option II as part of standard survey protocol. During the entire survey of the research area, BT-Option II mode survey was used on alternate trackline mode segments instead of IO mode. BT-Option II mode survey was conducted for a total of 829.1 n.miles covered during 73.15 hours of research. BT-Option II was conducted in conditions representative of normal SOWER survey strata and in a range of sighting conditions. Sighting rates for minke whales were low and almost all were solitary animals of small body size and initial cue types for minke whales were mainly body cues.

Sightings during BT-Option II mode, from all platforms combined, included a total of 23 groups of minke whales (comprising 27 animals). The Tracker platform detected a total of 13 groups of Antarctic minke whales. The Primary platform subsequently detected 2 of those minke whale groups. (In addition the Primary platform detected 5 other minke whale groups that were not seen by the Tracker Platform). Two additional sightings of minke whales were sighted only by the Upper Bridge.

Sightings classified as ‘like minke whale’ from all platforms combined, included a total of 6 groups (comprising 7 animals). The Tracker platform detected 3 groups classified as ‘like minke whale’. These groups were not detected by the Primary platform. The Primary platform detected one group classified as ‘like minke whale’ that was not detected by the Tracker platform.

As with the trials conducted last cruise the Tracker and Primary platforms tracked only those sightings believed to be minke whales. Tracking of all sightings and recording re-sightings data for minke whales was accomplished this year without the aid of the Miyashita voice recording system which was currently being upgraded and was not available for this year’s cruise.

Humpback whales were the most frequently encountered species and sightings during survey in BT-Option II mode included a total of 197 groups of humpback whales comprising 364 animals (from all platforms combined).

The Primary observers, searching with the naked eye, did not have the usual aids (a pointer attached to the binocular stick and reticle binoculars) to assist with angle and distance estimation. To assist the Primary observers with estimation of angles, pointers were used on the IOP angle boards. During survey in BT-Option II

research was usually not interrupted for the 30-minute meal breaks. (Although BT-Option II survey requires the same number of crew and same rotation schedule as IO mode).

BT-Option II mode was easily implemented on this cruise as one of the main survey methods. As with the experimental trials conducted last cruise, no major problems were encountered.

SS-II

In the research area on this cruise, SS-II mode survey was used as a standard survey mode instead of normal closing mode. SS-II mode survey was conducted for a total of 611.4 n.miles covered during 54.55 hours of research.

Sightings during SS-II mode included a total of 22 groups of minke whales (there were no groups in SS-II mode that were classified as 'like minke whale'). Numbers for 2 groups was confirmed from Passing mode without deviation from the course. Abeam closures were attempted for a total of 20 groups. (All of the groups selected for closure were identified from abeam as minke whales). Successful closure was completed for 14 groups. The main reason contributing to the unsuccessful closure on the other 6 groups was that the whales moved amongst pack ice.

The abeam estimates of group size for groups for which closure was successfully completed and numbers confirmed, ranged 1 – 2 (13 solitary animals and a pair).

The confirmed group sizes after closure ranged 1 - 3 (13 solitary animals and a group of 3).

The sighting rate for minke whales was low during this cruise, however SS-II mode was conducted in a range of sighting conditions and initial cue types. Also, since only one minke whale group was detected prior to each closure attempt, return to trackline procedures were easily carried out. There were no secondary sightings of minke whales during the closure attempts. As on the previous two cruises, SS-II mode was easily implemented on this cruise as one of the main survey methods.

MINKE WHALE BIOPSY AND PHOTO-IDENTIFICATION STUDIES

A total of 14 groups of minke whales (comprising 16 animals) were approached for biopsy sampling and collection of photographs for individual identification during 2.45 hours of research time. Included in this is a total of 0.62 hours allocated to approaches to 4 solitary minke whales for photo-id without biopsy being attempted (close approaches to these groups for biopsy was not attempted because of the presence of too much ice).

A total of 6 biopsy samples were collected from 4 solitary Antarctic minke whales. The average time taken to sample an individual whale was 0.46 hours.

Photographs were obtained of 15 individual minke whales from 11 groups, including all the biopsied individuals (Tables 10 and 11). There was no opportunity to obtain photographs of the other 3 groups of minke whales approached for biopsy and photo-identification studies.

Conditions were difficult for biopsy sampling and photo-identification studies of minke whales during this cruise as most detections were of solitary animals. Tracking whales underwater was problematic due to poor water transparency and several of the groups were encountered near the pack ice where scattered ice often posed a further difficulty for approach.

Examination of digital images of the 15 individual minke whales photographed revealed no re-sightings.

MINKE WHALE TELEMETRY TRIAL APPROACH

There were few opportunities for telemetry trial approaches to minke whales on this cruise because there were few occasions when minke whale sightings coincided with reasonably good water clarity for tracking the whales underwater. One telemetry trial approach to a group comprising 3 Antarctic minke whales was conducted during 0.55 hours of research time on 9 February. The trial was judged as unsuccessful; although the whales were seen underwater very close to the bow they did not surface within 0.1 n.miles of the ship. Video was recorded of this approach for a total of 27min 31sec. During the trial approaches the video was recorded from the Top Barrel, instead of as instructed from the bow. This modification was made as it was thought it would provide better perspective and scale for the reviewer. Video was also recorded from the Top barrel for 3 approaches to minke whales during biopsy sampling attempts.

MINKE WHALE DIVE TIME EXPERIMENT

The Minke Whale Visual Dive Time Experiment had been assigned a low priority for this cruise due to the shorter-than-normal duration of the cruise. No trials of the Minke Whale Visual Dive Time Experiment were conducted during the cruise. Suitable opportunities for the experiment did not occur.

VIDEO DISTANCE MEASUREMENT (SCANS-II)

The SCANS-II system was operated on 7 days with a high definition video camera attached to one set of 7X50 binoculars used by researchers in the Upper bridge. The video camera was operated during SS-II mode when conditions were suitable (periods with lower swell height, stable weather free from snow showers, when the horizon was not obscured by pack ice and when minke whale blow cues were being seen). To maximize the likelihood of recording minke whale blow cues the video camera was used on full zoom (10x). One initial detection of a minke whale (body cue; 0.8 n.mile) was recorded. No blow cues were detected with the system. (Only 4 of the initial cues for the 49 minke whale detections on this entire cruise were blow cues).

DIGITAL CAMERAS TO RECORD ANGLE ESTIMATION AND OBSERVERS SEARCH PATTERNS

The two digital still cameras mounted above one observer in the Top barrel were operated on 12 days in the research area to obtain images for measurement of detection angles and observer search patterns. Images for angle estimation were collected for 74 sightings. Approximately 11,000 photographs at 30-second intervals were collected for investigation of observer search patterns.

BLUE WHALE RESEARCH

There were 7 sightings of blue whales (comprising 17 animals) during the cruise. They were all identified as Antarctic blue whales.

Group sizes of blue whales were: 2 solitary animals; 2 groups of 2; 1 group of 3; and 2 groups of 4. No calves were seen this year.

All the blue whales were seen in the minke whale research area and usually in close proximity to the ice edge (Figure 2e).

During the cruise, 6 groups (comprising 13 individuals) were approached for biopsy and photo-id research, which was conducted for a total of 8.57 hours (including 3.18 hours in conditions unsuitable for minke whale survey). A total of 9 biopsy samples were collected from 6 individual blue whales. Results of biopsy sampling are given in Table 10. The collection of individual identification photographs of blue whales occurred simultaneously with biopsy sampling. 12 individual blue whales were adequately photographed (Table 11) including all of the biopsied whales.

Based on examination of digital images, two individual blue whales were re-sighted during the cruise.

Video was recorded for 6 sightings comprising 13 animals during 1hr 9min. 50sec. Video images of 11 animals were obtained (Table 12).

Acoustic recording was conducted in the vicinity of all of the sightings of blue whales (see Acoustics Research Section below).

Blue Whale Dive Time Experiments were not undertaken on this cruise. The whales were either in the vicinity of the pack ice or were moving towards the ice when initially detected. Thus, we were concerned that the whales would move into the pack ice and thus be inaccessible for photo-ID and biopsy sampling, so no dive time experiment or pre-approach acoustic recording could be conducted. Similarly, two of the detections of blue whales were made close to the end of the scheduled research day. The whales were approached for photo-id and biopsy and acoustic recording was conducted during and after approach (see Acoustics Research Section below).

HUMPBACK WHALE RESEARCH

A total of 23 humpback whales were biopsied during the cruise during a total of 10.06 hours of research (including 9.22 hours in conditions unsuitable for minke whale survey).

74 individuals were photographed including all of the whales approached for biopsy (Tables 10 and 11) Most of the photo-ID images were obtained opportunistically during passing mode survey with no allocation of research time. During passing mode, the attempt was made to photograph every humpback whale that surfaced with 0.3 n.miles of the ship.

Notable this year was the large proportion of fluking humpbacks. On previous cruises, fluking behavior was not often observed. Of the 74 photographed whales, 40 (54%) were photographed fluking. Of the 40 fluke photographs, 5 were considered to be excellent (perpendicular angle, full frame, clear photograph), 20 good (photo quality somewhat compromised by angle or resolution), 2 fair (photo compromised by angle or resolution but still possible to obtain ID), and 13 poor (photo severely compromised by angle or poor resolution). Of the 23 biopsied humpback whales, fluke photographs of fair to excellent quality were obtained for 9 individuals.

Examination of digital images of the 40 individual humpback flukes photographed revealed no re-sightings.

Other Species

Killer whale
Two groups of killer whales were approached for biopsy and or photo-ID during the cruise. One biopsy sample was collected and individuals of a group comprising 15 whales (classified as type C) were also photographed during 1.16 hours of research (Tables 10 and 11). 7 groups were photographed in Passing mode. For more results on killer whales see Appendix E.

The Larsen system was used for all biopsy attempts on all species. Ammunition for the guns was provided by The National Research Institute of Far Seas Fisheries (Yokohama) and had been placed aboard the ship in Japan. A total of 74 rounds were fired during the cruise (including those used for cleaning the guns) and 106 unused rounds were returned to Japan aboard the vessel.

ACOUSTICS RESEARCH

A total of 43hrs 23min of acoustic recording was performed during the cruise. Twenty-five sonobuoys[6] were deployed (25 stations) between 21 January and 9 February 2009 (Figure 2e, Table 13). Acoustic recording was conducted in the presence of blue whale sightings, as well as at opportunistic stations conducted either during research hours while the vessel was drifting due to poor conditions, or in the evenings. Eleven of the acoustic stations were in the vicinity of Antarctic blue whale sightings (2 sonobuoys targeted fin whales and 1 targeted killer whales).

Very good recordings of Antarctic blue whale sounds were made at 3 of the targeted stations, including very strong downsweeps (3 stations) and very strong 28HZ tonal calls (2 stations). Examples of spectrograms of the sounds are included in Appendix D).

Antarctic blue whale sounds were also recorded at 5 opportunistic stations (on 1, 2, 3, 4 and 6 February) when blue whales had not been visually detected (downsweeps and 28HZ tonal calls, 2 stations; 28HZ, 2 stations and downsweeps; 1 station) (see Table 13).

Good recordings of fin whale calls were made at 2 stations; at one of these stations fin whales were seen (in the vicinity of a blue whale sighting) while at the location of other station no fin whales were detected.

Overall, biosounds were recorded at 20 of the 25 stations and, in addition to blue whale and fin whale other species recorded included sperm whales (at 16 stations) and an unknown biosound (at one station). Of the 5 stations at which no biosounds were recorded, 4 stations were of short durations due to sonobuoy audio failure and giant petrels were suspected to have destroyed the other sonobuoy.

As we did not conduct Blue Whale Dive Time Experiments during this cruise, there was limited opportunity for acoustics recording of undisturbed animals prior to approaching blue whales for biopsy attempts. The reception distance of the sonobouys used this year was confirmed at 14 miles (Station #20).

No sounds attributed to pygmy blue whales were recorded.

Effort was made this year to ensure that DiFAR signals were recorded correctly. Both the output volume on the ICOM receiver and the input volume into the computer were set very low, and no preamplifier was used following the suggestions provided by Greenridge Sciences, Inc. (see Appendix B). The DiFAR program with an Ishmael-Matlab interface was not available for use on the ship so magnetic bearings from a sonobuoy to a sound source could not be determined during the cruise.

[6] Of the 25 sonobuoys deployed, only 5 performed poorly, failed either from the time of deployment or within the first 30 minutes, for a 20% failure rate. This is consistent with the sonobouy failure rates experienced during recent cruises. Of the 20 ‘good’ buoys, whale vocalizations were recorded on 19 (95.0%: similar to the success rate on recent cruises).

SIGHTINGS

A list of all the sightings recorded in the minke whale research area, by species and by effort mode, is presented in Table 4. Tables 3a - d summarize the sightings recorded during the four surveys of the research area. Figures 2a - h illustrate the location of the sightings.

Tables 5 - 8 list the sightings observed during transits to and from the research area (including those south of latitude 60°S) and in the EEZ of Australia. An additional summary of observations of cetaceans during transit within the 200 n.mile EEZ of Australia is presented in Appendix D.

Table 9 summarizes all the sightings observed during the entire cruise.

Minke Whale Research Area

A total of 49 groups, 56 minke whales were observed in the minke whale research area; 21 solitary animals during the First survey, 8 groups (9 animals) during the Second survey, 13 groups (16 animals) during the Third survey and 7 groups (10 animals) during the Fourth survey (Figures 2a-d). Mean group size of minke whales during each of the four surveys was 1.00, 1.13, 1.23 and 1.43. Most minke whale sightings were recorded in the vicinity of the ice edge. Survey coverage was however, highest near the ice edge; during the Third survey coverage was mostly near the ice edge and the Fourth survey coverage was entirely at the ice edge. The sighting rate for minke whales was highest during the Third survey on a north-south oriented section of ice edge at approximately 088°00'E. Almost all the minke whales seen during the survey were of small body length. Additionally, 6 groups (7 animals) classified as 'like minke whale' were recorded in the minke whale research area. With reference to minke whales in particular, the Davis Sea polynya and the large lead inaccessible to the SOWER vessel (see above Section: Ice edge and Pack Ice Extent) represent very large areas of satellite predicted ice-free water south of the main ice edge. As both features span the continental slope front, and are bordered by high concentrations of well-developed pack ice and ice shelves, they are large areas that were un-surveyed of potentially suitable habitat for minke whales within the longitudinal bounds of the research area.

Humpback whales were the most frequently encountered species (373 groups, 682 animals). This species was sighted throughout the minke whale research area and on all four surveys. The sighting rate was highest between 087°00'E and 089°00'E where they were distributed across the entire north-south extent of the research area. Mean group size was 1.82. (See also Humpback Whale Research section above).

Based on the number of animals observed, the second most frequently detected species in the research area was killer whale; 255 animals (21 groups) were seen. Killer whales were observed on all four surveys and throughout the research area, mostly near the ice edge. Appendix E presents a more detailed synopsis of killer whale observations.

Seven groups (comprising 17 animals) Antarctic blue whales were sighted in the research area. Blue whales were observed in the central part of the research area (between 087°00'E and 091°00'E) on the Second, Third and Fourth surveys and mainly near the pack ice. (See also Blue Whale Research section above).

Fin whales (5 groups, 23 animals) were observed in the minke whale research area and mostly near the pack ice.

Sperm whale sightings (59 groups, 61 animals) occurred throughout the study area. Most sightings were away from the ice edge.

Southern bottlenose whales (36 groups, 85 animals) were observed regularly within the research area, and as for sperm whales, most sightings were away from the pack ice.

Pilot whales were seen on three occasions (3 groups, 120 animals). All sightings were about 30 n.miles north of the ice edge in the central part of the research area between 088°00'E and 091°00'E.

One group of hourglass dolphins (4 animals) was detected in the research area.

Multiple re-surveys in the same research area were accomplished during this cruise as planned for the second time during this series of cruises (as for last years cruise) and thus the second time that SOWER has been able to monitor temporal changes in spatial distribution of whale species within the survey season. Although different longitudinal ranges were covered during the re-surveys, and there was a higher proportion of coverage near the ice edge on the Third and Fourth surveys, there were obvious similarities in the observed distributions of species between the surveys.

Transit sightings

During the 7000 nmi transit (round trip) between Benoa, Indonesia and the Antarctic research area Passing mode research was conducted for a total of **85.75** hours and **975.2** nmiles were covered (Table 1.). There were

103 cetacean sightings of 16 different species. The diversity of species was exemplary of the range of water masses transited, from polar to temperate to tropical. Near the research area, large whales comprised the majority of the sightings, including sperm and baleen whales (humpback fin, and minke). Killer whales, pilot whales, and hourglass dolphins were also seen. Especially good sighting conditions were experienced on the northbound transit, north of latitude 37°00'S, beginning on 19 February. On several days, the sea conditions were very calm, yielding sightings of beaked whales (southern bottlenose whales, *Mesoplodon sp.*, and unidentified Ziphiids), dwarf/pygmy sperm whales, and pygmy killer whales. Delphiniid species became dominant as the ship reached tropical waters and schools of striped, spotted, and mixed spotted and spinner dolphins were also seen.

Notable sightings

A multi-species aggregation comprising killer whales (4 groups 51 animals), a pair of fin whales, a pair of minke whales and a solitary humpback whale was observed on 9 February centered on position 64°19'S 088°53'E (see also Appendix E).

A feeding aggregation of killer whales comprising two Types together (A and B) was observed on 21 January at position 63°45'S 092°18'E (see also Appendix E). A killer whale sighting comprising mixed Types has not previously been described.

A group of tropical killer whales (6 animals) was detected on 8 January at position 12°32'S 114°39'E during the transit from Benoa to the Antarctic.

A southern bottlenose whale calf was recorded in a group of three whales on 21 February at position 28°21'S 111°20'E during the return transit to Benoa.

KRILL – VISUAL OBSERVATIONS

No krill patches were recorded during the cruise. There was not a dedicated search effort to detect surface krill patches (and lack of sightings does not indicate lack of presence).

MARINE DEBRIS

No marine debris was encountered during the cruise south of latitude 60°S.

OCEANOGRAPHY

No oceanographic sampling was undertaken, as on last year's cruise. Two ARGO floats were deployed under the ARGO oceanographic programme. The deployments were made at latitudes 54°S and 55°S during the transit from Benoa to the Antarctic.

TRANSIT TO BENOA

The *Shonan Maru No.2* commenced transit to Benoa, Bali, Indonesia from position 64°03'S 090°32'E on the evening of 12 February. During transit south of 60°00'S, due to the poor weather experienced no research was conducted. Latitude 60°00'S was intersected on 13 February at 16:14hrs.

The transit course intersected the EEZ's of Australia and Indonesia. The vessel entered the EEZ of Australia on 20 February at 31°21'S 111°08'E at 16:47hrs and departed the zone on 23 February at 16°51'S 113°51'E at 22:04hrs.

During the transit between the research area and the intercept with the 200 n.mile EEZ of Indonesia, mainly very poor conditions were experienced in the south however conditions improved further north and a total of 594.3 n.miles was covered during 52.72 hours of research in NSP mode. Between the research area and the intercept with the 200 n.mile EEZ of Australia a total of 148.4 n.miles was covered during 12.92 hours of research in NSP mode (all of this effort was north of latitude 60°00'S). Within the EEZ of Australia on the northbound transit a total of 358.9 n.miles was covered during 32.27 hours of research. Between the EEZ of Australia and the intercept with the 200 n.mile EEZ of Indonesia, good conditions were experienced and a total of 87.0 n.miles was covered during 7.53 hours of research.

The Indonesian EEZ was intersected adjacent to the coast of Bali. The vessel entered the EEZ on 25 February at 12°11'S 114°56'E at 01:20 hours. No research was conducted in the EEZ of Indonesia.

The ship entered Benoa Harbour, Bali at 09:00 hours on 26 February. The vessel departed Benoa Harbour on 1 March at 13:00 hours.

The report of the cruise was finalized aboard the vessel.

SUMMARY OF MODIFICATIONS TO THE PROCEDURES, VESSELS AND EQUIPMENT

Data Entry

Effort, weather and sightings data records were entered into computer files using the Moon Joyce DataForm00 program. The sightings data entry section of this program has no facility to record newly implemented survey modes such as SS-II and BT-Option II. Sightings recorded during SS-II and BT-Option II modes were entered into the computer files as NSC and IO modes respectively. (The choice of these modes for the data entry process was only to facilitate data summary using the program).

Equipment

The IWC purchased new equipment prior to this cruise including two digital still cameras to record angle estimation and observers search patterns. The ships crew constructed a mounting above the Top barrel for the cameras.

Cruisetrack design

The cruisetrack design (a series of zigzags, evenly spaced longitudinally and spanning the north-south width of the research area, interspersed with segments parallel to the ice edge) was developed specifically for this cruise. The cruisetrack design was easily implemented although differences between the satellite ice edge predictions and the true ice edge was problematic at times. One aim of the increased survey intensity of the line-transect survey near the ice edge compared to normal SOWER tracklines was to increase the chance of the encountering minke whales and thus facilitate the collection of individual identification data – photo-identification and biopsy samples for biopsy/mark-recapture studies. While opportunities for biopsy sampling and photo-identification studies of minke whales was restricted on this cruise, due to low sighting rates, based on our experience with this cruise strategy, we feel it would be worthy of further testing in a study area with a higher sighting rate and larger group sizes of minke whales.

Schedule of the cruise

The overall duration of this cruise (52 days) was shorter compared to recent SOWER cruises (60 days) due to the prevailing high international costs. This, combined with the longer-than-normal homeport transits, resulted in less available research time than on recent cruises. To maximize the research time, the research area had been selected to be as close to Japan as feasible (in Area IV), and as well the homeport visit pre-cruise had been reduced from two days to one day for this cruise.

While the outcome of the minke whale research on this cruise was influenced by many factors including minimal southward recession of the pack ice, low sighting rates for minke whales, and the inaccessible polynyas and leads south of the main ice edge, the reduced time available for research also impacted on the achievements, in particular regarding the amount of survey coverage. A further consequence was a reduction in the amount of research time (compared to recent cruises) allocated during planning to the other SOWER priority species (blue whales, fin whales, southern right whales and humpback whales). As a corollary there was severely restricted time available for incidental studies of other species.

RECOMMENDATIONS

The researchers and captain make the following recommendations based on their experience of this cruise (note that recommendations do not appear in any order of priority).

Acoustics: During planning for this cruise it was agreed to defer action on the acoustics recommendations from last years cruise (the 2007-2008 cruise) due to the restricted time allocation to blue whale research as a result of the overall shortened duration of the cruise. The 2007-2008 recommendations are reiterated:

1. It is strongly recommended to purchase the necessary software for the SOWER cruises, specifically Greenridge Inc DiFAR demultiplexing software, and MATLAB to be used with Ishmael. It is recommended that Greenridge be asked to load the software directly for correct setup.
2. The Dell Inspiron computer used this cruise for acoustic recording is installed with a Sigma Tel C – Major Audio sound card. This sound card may not be adequate to control sound input and it is recommended that use of an alternate sound card be investigated and possibly in combination with a 'Mackie mixer'. This may increase input volume control resulting in improved DiFAR signal acquisition.
3. Currently, simultaneous recording of two sonobuoys had to be done on separate computers. The proper cords necessary for interfacing two receivers into one computer were not available and are recommended for future cruises.
4. During a cruise with more acoustic effort, a larger external hard drive dedicated to acoustics would be necessary for data storage.

Biopsy/photo-Identification

1. Higher capacity Compact Flash (image storage) cards for the Photo-ID cameras would facilitate the collection of photo-identification images. We recommend the IWC purchase two 8 GB cards since it would reduce the frequent changing of cards during sightings. Currently, 5 1GB memory cards are available for the two IWC owned cameras.
2. The batteries currently available for the Photo-ID cameras have diminished power and are unreliable in the cold. We recommend the purchase of three new batteries (BP-511A) and battery grips for 20D cameras.

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ACKNOWLEDGEMENTS

We thank the crew of the *Shonan Maru No. 2* for their hard work and dedication, which led to the successful execution of this study. We acknowledge the Secretariat of the IWC and the staff of The Institute of Cetacean Research (Tokyo) and the ship owners, Kyodo Senpaku Kaisha Ltd for their assistance in arrangements and support for the cruise. The National Research Institute of Far Seas Fisheries (Yokohama) loaned equipment for the cruise, including ammunition for the Larsen biopsy gun, acoustic receivers, AF preamps, video camera, items for biopsy processing and storage. The ship's computer, ship's hard disk, receivers, high-quality headphones were also used for acoustic research. We thank Nick Gales and Jason Gedamke of Australian Antarctic Division (AAD), Kingston, Tasmania, Australia for providing sonobuoys. Natalie Kelly of AAD sent satellite ice images to the ship on a daily basis. Second Officier T. Koyanagi and Quartermasters K. Kurisu and M. Takeuchi assisted with collection of biopsy samples. We thank Chief Radio Officer Y. Tsuda who volunteered to assist with acoustic recording in addition to his normal duties (he is a co-author of this report).

Table 1. Summary of search effort (time and distance) conducted during the cruise in each effort mode.

Area	Start Date Time	End Date Time	NSP Time-Distance (hours-n.miles)		SS-II Abeam closure from NSP Time-Distance (hours-n.miles)		BT-Option II Time-Distance (hours-n.miles)	
Benoa to boundary of Indonesian EEZ	6 Jan 16:50	7 Jan 10:12	0.00	0.0	0.00	0.0	0.00	0.0
Transit from Indonesian EEZ to intercept of Australian EEZ	7 Jan 10:12	8 Jan 09:34	8.32	97.3	0.00	0.0	0.00	0.0
Transit in Australian EEZ	8 Jan 09:34	11Jan 13:55	11.72	134.5	0.00	0.0	0.00	0.0
Transit from Australian EEZ to intercept of Latitude 60°S	11 Jan 13:55	18 Jan 18:38	9.03	106.4	0.00	0.0	0.00	0.0
Transit from intercept of 60°S to start of Minke Whale survey	18 Jan 18:38	19 Jan 15:34	3.94	42.7	0.00	0.0	0.00	0.0
First survey (095°E to 082°E)	19 Jan 15:34	26 Jan 18:00	0.00	0.0	23.35	262.6	31.70	363.7
Second survey (082°E to 092°E)	27 Jan 06:00	3 Feb 09:43	0.00	0.0	13.65	155.0	27.03	308.3
Third survey (092°E to 087°E)	3 Feb 09:43	6 Feb 18:00	0.00	0.0	8.95	95.6	8.78	93.6
Fourth survey (087°E to 092°E)	7 Feb 06:00	12 Feb 18:00	0.00	0.0	8.60	98.2	5.64	63.5

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Table 1 continued. Summary of search effort (time and distance) conducted during the cruise in each effort mode.

Transit from end of Minke Whale survey to intercept of 60°S	12 Feb 18:00	13 Feb 16:14	0.00	0.0	0.00	0.0	0.00	0.0
Transit from Latitude 60°S to intercept of Australian EEZ	13 Feb 16:14	20 Feb 16:47	12.92	148.4	0.00	0.0	0.00	0.0
Transit Australian EEZ	20 Feb 16:47	23 Feb 22:04	32.27	358.9	0.00	0.0	0.00	0.0
Transit from Australian EEZ to intercept of Indonesian EEZ	23 Feb 22:04	25 Feb 01:20	7.53	87.0	0.00	0.0	0.00	0.0
Boundary of Indonesian EEZ to Benoa	25 Feb 01:20	26 Feb	0.00	0.0	0.00	0.0	0.00	0.0
Total			85.73	975.2	54.54	611.4	73.15	829.1

Table 2. Summary of experimental time (hours) during 2008-09.

Area	**Start** Date Time	**End** Date Time	**Photo-ID, Biopsy** Time (hours)	**Minke whale Telemetry trial approach** Time (hours)	**Estimated angle and distance training** Time (hours)	**Estimated angle and distance experiment** Time (hours)
Benoa to boundary of Indonesian EEZ	6 Jan 16:50	7 Jan 10:12	0.00	0.00	0.00	0.00
Transit from Indonesian EEZ to intercept of Australian EEZ	7 Jan 10:12	8 Jan 09:34	0.00	0.00	0.00	0.00
Transit in Australian EEZ	8 Jan 09:34	11Jan 13:55	0.00	0.00	0.00	0.00
Transit from Australian EEZ to intercept of Latitude 60°S	11 Jan 13:55	18 Jan 18:38	0.00	0.00	0.00	0.00
Transit from intercept of 60°S to start of Minke Whale survey	18 Jan 18:38	19 Jan 15:34	0.00	0.00	2.50	0.00
First survey (095°E to 082°E)	19 Jan 15:34	26 Jan 18:00	2.34	0.00	0.00	0.00
Second survey (082°E to 092°E)	27 Jan 06:00	3 Feb 09:43	1.88	0.00	0.00	0.00
Third survey (092°E to 087°E)	3 Feb 09:43	6 Feb 18:00	4.37	0.00	0.00	0.00
Fourth survey (087°E to 092°E)	7 Feb 06:00	12 Feb 18:00	15.85	0.55	0.00	6.07

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Table 2 Continued. Summary of experimental time (hours) during 2008-09.

Area	**Start** Date Time	**End** Date Time	**Photo-ID, Biopsy** Time (hours)	**Minke whale Telemetry trial approach** Time (hours)	**Estimated angle and distance training** Time (hours)	**Estimated angle and distance experiment** Time (hours)
Transit from end of Minke Whale survey to intercept of latitude 60°S	12 Feb 18:00	13 Feb 16:14	0.00	0.00	0.00	0.00
Transit from Latitude 60°S to intercept of Australian EEZ	13 Feb 16:14	20 Feb 16:47	0.48	0.00	0.00	0.00
Transit Australian EEZ	20 Feb 16:47	23 Feb 22:04	0.00	0.00	0.00	0.00
Transit from Australian EEZ to intercept of Indonesian EEZ	23 Feb 22:04	25 Feb 01:20	0.00	0.00	0.00	0.00
Boundary of Indonesian EEZ to Benoa	25 Feb 01:20	26 Feb 09:00	0.00	0.00	0.00	0.00
Total	-	-	24.92	0.55	2.50	6.07

Table 3a. Number of sightings for all species (Groups/Animals) observed during the First survey (095°E - 082°E) of the Minke Whale Research Area in each effort mode. (Excludes sightings observed south of 60°S during transit from Benoa to start of minke whale research).

Species	SS-II (Abeam closure from NSP)		BT-Option II		OE		Total	
	G	A	G	A	G	A	G	A
Minke (Antarctic)	11	11	8	8	-	-	19	19
Minke (undetermined)	-	-	2	2	-	-	2	2
Like minke	-	-	3	4	-	-	3	4
Fin	2	12	1	2	-	-	3	14
Humpback	45	88	58	103	7	12	110	203
Like humpback	1	2	2	3	1	1	4	6
Sperm	19	20	17	18	2	2	38	40
Like sperm whale	1	1	-	-	-	-	1	1
Killer (type A)	-	-	2	12	1*	16*	3	28
Killer (type B)	-	-	-	-	1*	2*	1	2
Killer (type C)	-	-	1	30	-	-	1	30
Killer (type unclassified)	1	1	3	34	-	-	4	50
Southern bottlenose whale	7	17	11	33	-	-	18	50
Like so. bottlenose whale	1	3	2	6	-	-	3	9
Pilot whale	-	-	1	60	-	-	1	60
Hourglass dolphin	-	-	1	4	-	-	1	4
Ziphiid	3	6	7	11	-	-	10	17
Mesoplodon sp	-	-	2	7	-	-	2	7
Unid. large baleen	10	25	2	2	-	-	12	27
Unid. small whale	-	-	2	2	-	-	2	2

* One group comprising two types

Table 3b. Number of sightings for all species (Groups/Animals) observed during the Second survey (082°E - 092°E) of the Minke Whale Research Area in each effort mode.

Species	SS-II (Abeam closure from NSP)		BT-Option II		OE		Total	
	G	A	G	A	G	A	G	A
Minke (Antarctic)	2	2	4	5	1	1	7	8
Minke (undetermined)	-	-	1	1	-	-	1	1
Like minke	-	-	1	1	-	-	1	1
Blue (Antarctic)	1	2	-	-	1	4	2	6
Fin	-	-	-	-	1	7	1	7
Humpback	36	60	93	167	4	8	133	235
Like humpback	2	5	5	9	-	-	7	11
Sperm	7	7	11	11	-	-	18	18
Like sperm			1	1	-	-	1	1
Killer (type unclassified)	1	4	6	90	1	3	8	97
Southern bottlenose whale	3	8	9	15	-	-	12	23
Pilot whale	-	-	2	60	-	-	2	60
Ziphiid	2	4	7	18	-	-	9	22
Mesoplodon sp.			1	1	-	-	1	1
Unid. large baleen	3	3	3	5	-	-	6	8
Unid. large whale	1	1	-	-	-	-	1	1
Unid. small whale	1	2	1	1	-	-	2	3

Table 3c. Number of sightings for all species (Groups/Animals) observed during the Third survey (092°E - 087°E) of the Minke Whale Research Area in each effort mode.

Species	SS-II (Abeam closure from NSP)		BT-Option II		OE		Total	
	G	A	G	A	G	A	G	A
Minke (Antarctic)	3	3	7	9	2	3	12	15
Minke (undetermined)	1	1	-	-	-	-	1	1
Like minke	-	-	2	2	-	-	2	2
Blue (Antarctic)	-	-	3	4	-	-	3	4
Humpback	18	28	24	55	5	10	47	93
Like humpback	3	3	1	1	-	-	4	4
Killer (type unclassified)	-	-	1	12	-	-	1	12

Table 3d. Number of sightings for all species (Groups/Animals) observed during the Fourth survey (087°E - 092°E) of the Minke Whale Research Area in each effort mode.

Species	SS-II (Abeam closure from NSP)		BT-Option II		OE		Total	
	G	A	G	A	G	A	G	A
Minke (Antarctic)	5	7	1	2	1	1	7	10
Blue (Antarctic)	-	-	1	3	1	4	2	7
Fin	-	-	1	2	-	-	1	2
Humpback	49	91	22	39	12	21	83	151
Like humpback	1	1	1	1	-	-	2	2
Sperm	-	-	3	3	-	-	3	3
Killer (type C)	-	-	3	36	-	-	3	26
Killer (type unclassified)	-	-	1	15	-	-	1	15
Southern bottlenose whale	5	10	1	2	-	-	6	12
Like so. bottlenose whale	-	-	1	2	-	-	1	2
Ziphiid	1	2	-	-	-	-	1	2
Unid. large baleen	1	1	1	1	1	1	3	3

Table 4. Number of sightings for all species (Groups/Animals) observed within the entire Minke Whale Research Area (Initial survey and three re-surveys combined) in each effort mode. (Excludes sightings observed south of 60°S during transits between Benoa and the minke whale research).

Species	SS-II (Abeam closure from NSP)		BT-Option II		OE		Total	
	G	A	G	A	G	A	G	A
Minke (Antarctic)	21	23	20	24	4	5	45	52
Minke (undetermined)	1	1	3	3	-	-	4	4
Like minke	-	-	6	7	-	-	6	7
Blue (Antarctic)	1	2	4	7	2	8	7	17
Fin	2	12	2	4	1	7	5	23
Humpback	148	267	197	364	28	51	373	682
Like humpback	7	11	9	14	1	1	17	26
Sperm	26	27	31	32	2	2	59	61
Like sperm	1	1	1	1	-		2	2
Killer (type A)								
Killer (type B)								
Killer (type unclassified)	2	5	17	229	2	21	21	255
Southern bottlenose whale	15	35	21	50	-	-	36	85
Like so. bottlenose whale	1	3	3	8	-	-	4	11
Pilot whale	-	-	3	120	-	-	3	120
Hourglass dolphin	-	-	1	4	-	-	1	4
Mesoplodon sp.	-	-	3	8	-	-	3	8
Ziphiid	6	12	14	29	-	-	20	41
Unid. large baleen	14	29	6	8	1	1	21	38
Unid. large whale	1	1			-	-	1	1
Unid. small whale	1	2	3	3	-	-	4	5

Table 5. Number of sightings for all species (Groups/Animals) observed during the transits between Benoa and the Minke Whale Research, in each effort mode. (Includes sightings observed south of 60°S during transit).

Species	NSP		OE		Total	
	G	A	G	A	G	A
Minke (Antarctic)	1	2	-		1	2
Like minke	2	3	-	-	2	3
Fin	-	-	2	4	2	4
Humpback	18	41	6	16	24	57
Bryde's whale	1	1	-	-	1	1
Sperm	6	15	1	3	7	18
Southern bottlenose whale	4	9	-	-	4	9
'Like southern bottlenose whale'	1	1	-	-	1	1
Long-finned pilot whale	1	45	-	-	1	45
Pilot whale	2	101	1	170	3	271
Killer	4	68	-	-	4	68
Risso's dolphin	1	50	-	-	1	50
Hourglass dolphin	-	-	2	9	2	9
Striped dolphin	1	55	1	30	2	85
Spotted dolphin	6	225	-	-	6	225
Spinner dolphin	3	27	-	-	3	27
Dwarf/pygmy sperm whale	5	7	-	-	5	7
Pygmy killer whale	2	75	-	-	2	75
Mesoplodon sp.	7	24	-	-	7	24
Ziphiid	8	17	2	7	10	24
Unidentified large baleen whale	2	3	-	-	2	3
Unidentified large whale	1	1	-	-	1	1
Unidentified dolphin	6	30	1	2	7	32
Unidentified small whale	2	2	1	2	3	4
Unidentified small cetacean	2	3	-	-	2	3

Table 6. Number of sightings for all species (Groups/Animals) observed in the EEZ of Australia during the transits between Benoa and the Minke Whale research Area, in each effort mode.

Species	NSP		OE		Total	
	G	A	G	A	G	A
Bryde's whale	1	1	-	-	1	1
Sperm whale	3	12	-		3	12
Southern bottlenose whale	2	4	-		2	4
'Like southern bottlenose whale'	1	1	-		1	1
Dwarf/pygmy sperm whale	5	7	-		5	7
Striped dolphin	1	55	-		1	55
Spotted dolphin	1	50	-		1	50
Pygmy killer whale	2	75	-		2	75
Mesoplodon sp.	1	4	-		1	4
Ziphiid	5	9	1	1	6	10
Unidentified dolphin	3	11	-	-	3	11
Unidentified small whale	1	1	1	2	2	3
Unidentified small cetacean	2	3	-	-	2	3

Table 7 Number of sightings for all species (Groups/Animals) observed during the transits between the boundaries of the EEZ's of Australia, and Indonesia in each effort mode.

Species	NSP		OE		Total	
	G	A	G	A	G	A
Killer whale (type unclassified)	1	6	-	-	1	6
Pilot whale	-	-	1	170	1	170
Risso's dolphin	1	50	-	-	1	50
Spotted dolphin	5	175	-	-	5	175
Spinner dolphin	3	27	-	-	3	27
Ziphiid	1	1	1	6	2	7
Unidentified large baleen whale	1	1	-	-	1	1
Unidentified large whale	1	1	-	-	1	1
Unidentified dolphin	3	19	1	2	4	21

Table 8. Number of sightings for all species (Groups/Animals) observed during the transits between the Minke Whale Research Area to the intercept of the EEZ of Australia, in each effort mode.

Species	NSP		OE		Total	
	G	A	G	A	G	A
Minke (Antarctic)	1	2	-	-	1	2
Like minke	2	3	-	-	2	3
Fin	-	-	2	4	2	4
Humpback	18	41	6	16	24	57
Sperm	3	3	1	3	4	6
Killer whale (type C)	2	60	-	-	2	60
Killer whale (type unclassified)	1	2	-	-	1	2
Southern bottlenose	2	5	-	-	2	5
Long-finned pilot whale	1	45	-	-	1	45
Pilot whale	1	81	-	-	1	81
Striped dolphin	-	-	1	30	1	30
Hourglass dolphin	-	-	2	9	2	9
Mesoplodon sp.	6	20	-	-	6	20
Ziphiid	2	7	-	-	2	7
Unidentified large baleen whale	1	2	-	-	1	2
Unidentified small whale	1	1	-	-	1	1

Table 9. Summary of all sightings (Groups/Animals) observed during the entire cruise.

Species	Total	
	G	A
Minke (Antarctic)	46	54
Minke (undetermined)	4	4
Like minke	8	10
Blue (Antarctic)	7	17
Fin	7	27
Humpback	397	739
Like humpback	17	26
Bryde's whale	1	1
Sperm	66	79
Like sperm	2	2
Killer (type A)	2	12
Killer (type C)	7	171
Killer (type unclassified)	17	185
Southern bottlenose whale	40	94
Like so. bottlenose whale	5	12
Long-finned pilot whale	1	45
Pilot whale	6	391
Risso's dolphin	1	50
Hourglass dolphin	3	13
Striped dolphin	2	85
Spotted dolphin	6	225
Spinner dolphin	3	27
Dwarf/pygmy sperm whale	5	7
Pygmy killer whale	2	75
Mesoplodon sp.	10	32
Ziphiid	30	65
Unid. large baleen	23	41
Unid. large whale	2	2
Unid. small whale	7	9
Unid. dolphin	7	32
Unid small cetacean	2	3

Table 10. Results of biopsy sampling during SOWER 2008-09. All samples were collected with the Larsen system. Note that there is no sample #019.

Species & date	Sight no.	Group size	Individual whale number	Sample number	Blubber	Comments
Minke						
26 January	054	001	01	09041001	Yes	
26 January	058	001	01	09041002	Yes	double hit: 2 skin samples, 1 blubber sample
26 January	062	001	01	09041003	Yes	double hit: 2 skin samples, 1 blubber sample
09 February	042	001	01	09041025	No	small sample
Total no. of whales sampled			**4**			
Blue						
30 January	123	002	01	09011004	No	
05 February	022	001	01	09011005	Yes	double hit: 2 skin samples, 2 blubber samples
05 February	024	002	01	09011006	Yes	double hit: 2 skin samples, 2 blubber samples
07 February	027	004	01	09011015,09011017	Yes	2 skin samples, 1 blubber sample (#017)
07 February	027	004	02	09011016	No	
07 February	027	004	03	09011018	Yes	
Total no. of whales sampled			**6**			
Humpback						
06 February	028	004	01	09071007	Yes	
06 February	028	004	02	09071008	No	double hit: 2 skin samples
07 February	022	002	01	09071009	Yes	double hit: 2 skin samples, 1 blubber sample
07 February	022	002	02	09071010	Yes	
07 February	024	001	01	09071011	Yes	
07 February	025	001	01	09071012	No	
07 February	026	003	01	09071013	Yes	
07 February	026	003	02	09071014	No	
07 February	046	002	01	09071020	No	
07 February	047	001	01	09071021	Yes	double hit: 2 skin samples, 2 blubber samples
08 February	001	003	01	09071022	No	
08 February	001	003	02	09071023	No	
11 February	003	001	01	09071026	Yes	
11 February	004	001	01	09071027	No	

Continued next page

Table 10 continued. Results of biopsy sampling during SOWER 2008-09.

Species & Date	Sight No.	School Size	Individual whale number	Sample Number	Blubber	Comments
Humpback continued						
11 February	005	001	01	09071028	Yes	
12 February	001	002	01	09071029	Yes	
12 February	001	002	02	09071030	Yes	double hit: 2 skin samples, 2 blubber samples
12 February	007	002	01	09071031	Yes	
12 February	007	002	02	09071032	Yes	
12 February	019	005	01	09071033	No	
12 February	019	005	02	09071034	No	
12 February	019	005	03	09071035	Yes	
12 February	019	005	04	09071036	No	
Total no. of whales sampled			**23**			
Killer whale						
09 February	036	015	01	09101024	No	Type C
Total no. of whales sampled			**1**			

Table 11. Summary of the photo-ID images of individual whales collected in 2008-09. For humpback whales, fluke photographs of fair to excellent quality are noted in the Comments column.

Species & Date	Sight no.	Group size	No. of whales photographed	Biopsy sample no.'s	Comments
Minke					
21 January	002	01	01		
22 January	001	01	01		
24 January	001	01	01		
24 January	058	01	01		
25 January	029	01	01		
26 January	054	01	01	09041001	
26 January	058	01	01	09041002	
26 January	062	01	01	09041003	
05 February	007	01	01		
06 February	001	01	01		
09 February	036	01	01		multispecies aggregation with fin, humpback, killer whales
09 February	042	01	01	09041025	
09 February	049	03	03		
Total			**15**		
Blue					
30 January	123	02	02	09041004	
05 February	022	01	01	09041005	
05 February	023	01	01		
05 February	024	02	02	09041006	
07 February	027	04	04	09011015,09011016, 09011017,09011018	biopsy samples from 3 whales
09 February	061	03	02		
Total			**12**		
Humpback					
18 January	004	02	01		
18 January	005	03	02		
18 January	017	02	01		
18 January	027	03	03		
24 January	015	02	01		fluke
24 January	021	02	01		
24 January	033	02	02		
25 January	*	02	02		
26 January	019	02	01		fluke
26 January	049	01	01		
29 January	013	03	02		fluke 1 whale
30 January	035	04	03		flukes 2 whales
30 January	102	02	02		
30 January	103	01	01		fluke
30 January	115	02	02		
02 February	038	01	01		

*No sighting number recorded during off-effort time. (Time and position recorded.)

Continued next page

Table 11 continued. Summary of the photo-ID images of individual whales collected in 2008-09. For humpback whales, fluke photographs of fair to excellent quality are noted in the Comments column.

Species & Date	Sight no.	Group size	No. of whales photographed	Biopsy sample no.'s	Comments
Humpback continued					
03 February	035	06	04		fluke 1 whale
05 February	026	02	02		fluke 1 whale
06 February	016	02	01		fluke
06 February	028	04	04	09071007, 09071008	
06 February	*	01	01		fluke
07 February	018	02	02		fluke 1 whale
07 February	022	02	02	09071009, 09071010	fluke 1 whale
07 February	024	01	01	09071011	fluke
07 February	025	01	01	09071012	
07 February	024-026	05	05	09071013,09071014	flukes 3 whales
07 February	046	02	02	09071020	
07 February	047	01	01	09071021	fluke
08 February	001	03	03	09071022,09071023	fluke 1 whale
08 February	*	02	02		fluke 1 whale
11 February	003	01	01	09071026	fluke
11 February	004	01	01	09071027	
11 February	005	01	01	09071028	
12 February	001	02	02	09071029,09071030	
12 February	002	03	02		flukes 2 whales
12 February	*	01	01		
12 February	007	02	02	09071031,09071032	fluke 1 whale
12 February	016	02	02		flukes 2 whales
12 February	019	05	05	09071033,09071034, 09071035,09071036	flukes 2 whales
Total			**74**		
Killer whale					
07 January	001	06	06		in tropical waters during transit
18 January	016	02	01		male, unclassified type
19 January	010	15	08		Type C
19 January	011	45	10		Type C
20 January	014	10	04		Type B
21 January	001	18	18		feeding in slick; Types A & B
25 January	025	02	02		Type A, eyepatches seen through binoculars
26 January	033	30	10		distant photos; unclassified type
09 February	036	15	15	09101024	Type C; in multispecies aggregation with fin, minke, humpback

*No sighting number recorded during off-effort time. (Time and position recorded.)

Continued next page

Table 11 continued. Summary of the photo-ID images of individual whales collected in 2008-09.

Species & Date	Sight no.	Group size	No. of whales photographed	Biopsy sample no.'s	Comments
Killer whale continued 09 February	038	08	08		Type C; in aggregation with sighting #036
Total			**82**		

Table 12. Summary of video recording of blue whale sightings during 2008-2009.

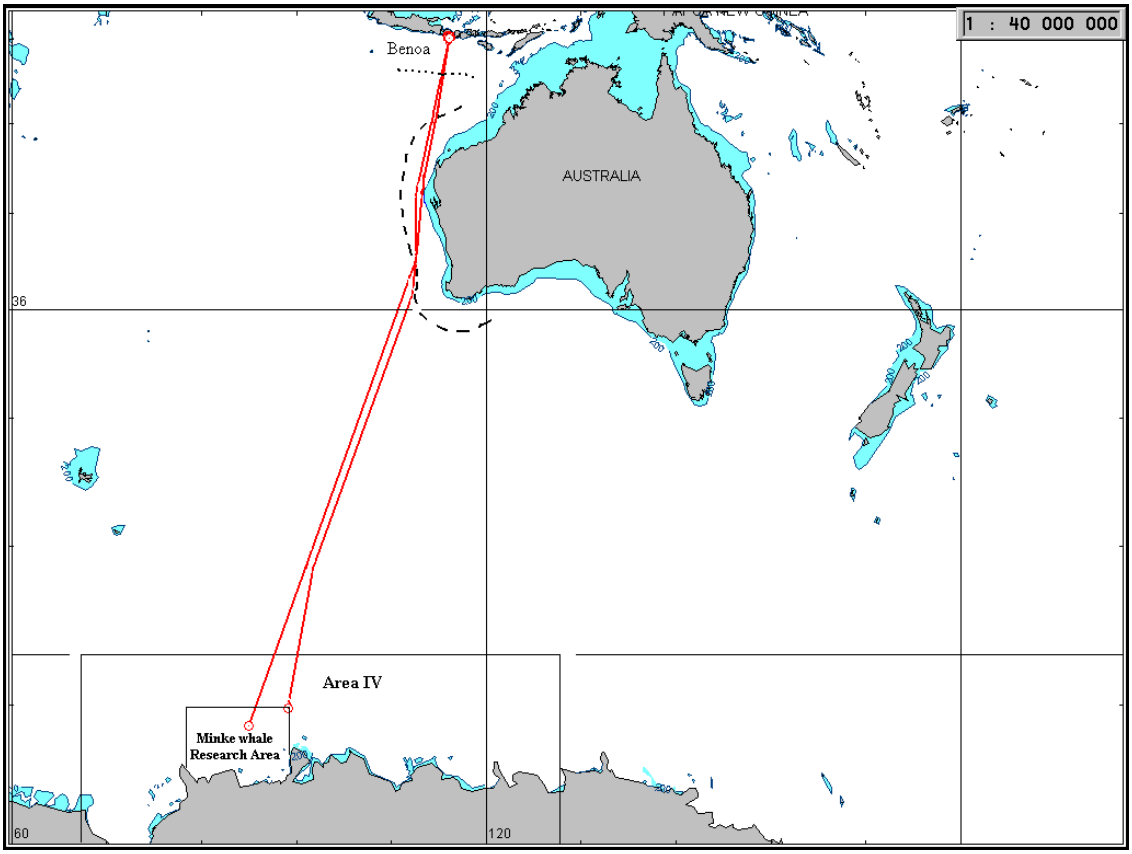
Date	Sighting number	Group size	Number of whales recorded	Taped time (hour:min:sec)	Tape number
30 January	123	02	02	0:04:30	001
30 January	123	02	02	0:04:41	001
30 January	123	02	02	0:25:31	001
05 February	022	01	01	0:04:15	002
05 February	023	01	01	0:01:03	002
05 February	023	01	01	0:01:32	002
05 February	024	02	02	0:00:16	002
05 February	024	02	02	0:00:19	002
05 February	024	02	02	0:01:14	002
05 February	024	02	02	0:00:16	002
07 February	027	04	02	0:02:13	003
07 February	027	04	?	0:03:35	003
07 February	027	04	02	0:04:16	003
07 February	027	04	02	0:00:38	003
07 February	027	04	01	0:02:56	003
07 February	027	04	01	0:02:36	003
07 February	027	04	01	0:01:53	003
07 February	027	04	0	0:00:26	003
09 February	061	03	02	0:00:50	004
09 February	061	03	02	0:01:56	004
09 February	061	03	02	0:01:13	004
09 February	061	03	02	0:02:10	004
09 February	061	03	02	0:01:31	004
Total time				**01:09:50**	

Table 13. Summary of Acoustic Recording during 2008-2009.

Date	Station	Activity		Position Latitude (S)	Longitude (E)	Time recorded (HH:MM:SS)	Bio-Sounds Heard
21 January	01		E	63°57.90	092°01.08	0:10:00	Nil
21 January	02		E	63°56.68	092°05.90	1:40:00	Nil
22 January	03	Blue whale biopsy attempt	E	64°14.30	090°45.02	2:00:00	Fin - strong
24 January	04		E	63°33.33	086°35.47	2:00:00	Sperm
26 January	05		E	64°59.02	082°06.04	1:45:00	Sperm, unknown
27 January	06		E	64°16.67	083°33.23	0:13:00	Nil
28 January	07		D	64°10.25	083°57.06	2:00:00	Sperm
29 January	08		E	64°08.20	086°58.20	2:05:00	Sperm
30 January	09	Blue whale biopsy attempt	D	64°00.96	088°51.81	0:20:0	Sperm
30 January	10	Blue whale biopsy attempt	D	64°03.60	088°49.58	1:00:00	Sperm
30 January	11	Blue whale biopsy attempt	D	64°09.03	088°49.88	0:35:00	Fin - strong, Sperm
30 January	12	Blue whale biopsy attempt	D	64°11.28	088°50.20	0:05:00	Nil
30 January	13	Blue whale biopsy attempt	D	64°10.33	088°50.52	1:15:00	Sperm
1 February	14		E	64°44.14	089°11.62	2:00:00	Blue - faint downsweeps and 28HZ, Sperm
2 February	15		E	63°31.58	090°49.38	1:20:00	Blue – very faint 28HZ, Sperm,
3 February	16		E	63°37.36	090°12.96	2:25:00	Blue - very faint downsweeps
4 February	17		E	64°35.21	088°58.55	1:10:00	Blue - very faint 28HZ
5 February	18	Blue whale biopsy attempt	D	64°42.81	088°06.63	5:20:00	Blue - very strong downsweeps and 28HZ, Sperm
6 February	19		E	64°01.90	087°27.08	1:35:00	Blue - downsweeps and 28HZ
7 February	20	Blue whale biopsy attempt	D	63°53.35	087°20.12	4:00:00	Blue – very strong, long duration downsweeps, Sperm
8 February	21		E	64°05.90	088°04.68	1:40:00	Sperm
9 February	22	Killer whale/fin whale biopsy attempt	D	64°18.10	088°55.91	1:00:00	Sperm
9 February	23	Blue whale biopsy attempt	D	64°53.06	090°10.27	0:10:00	Sperm
9 February	24	Blue whale biopsy attempt	D	64°53.10	090°12.00	No Audio	Nil
9 February	25	Blue whale biopsy attempt	D	64°53.85	090°19.65	7:35:00	Blue – downsweeps and 28HZ, Sperm

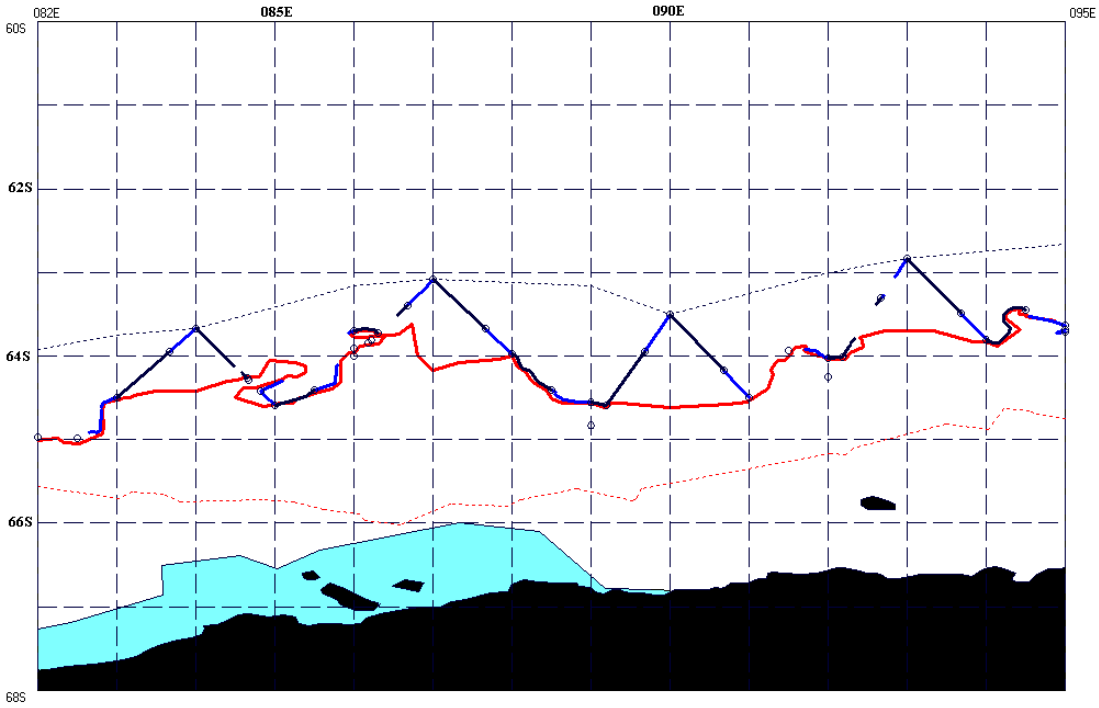
E = Evening station, D = Station during research hours

Figures 1a-e. Details of the cruisetracks.

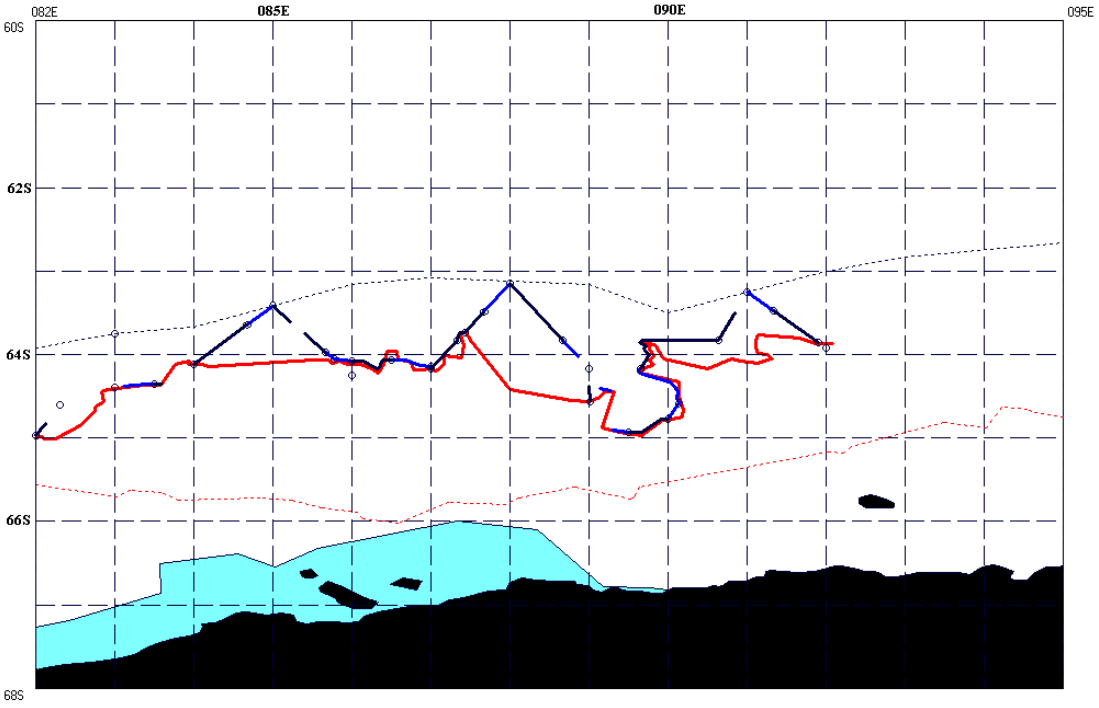


1a. The entire survey, including the transits to and from the Minke Whale Research Area.
The Australian 200 n.mile EEZ is indicated by the dashed line. The Indonesian 200 n.mile EEZ is indicated by the dotted line.

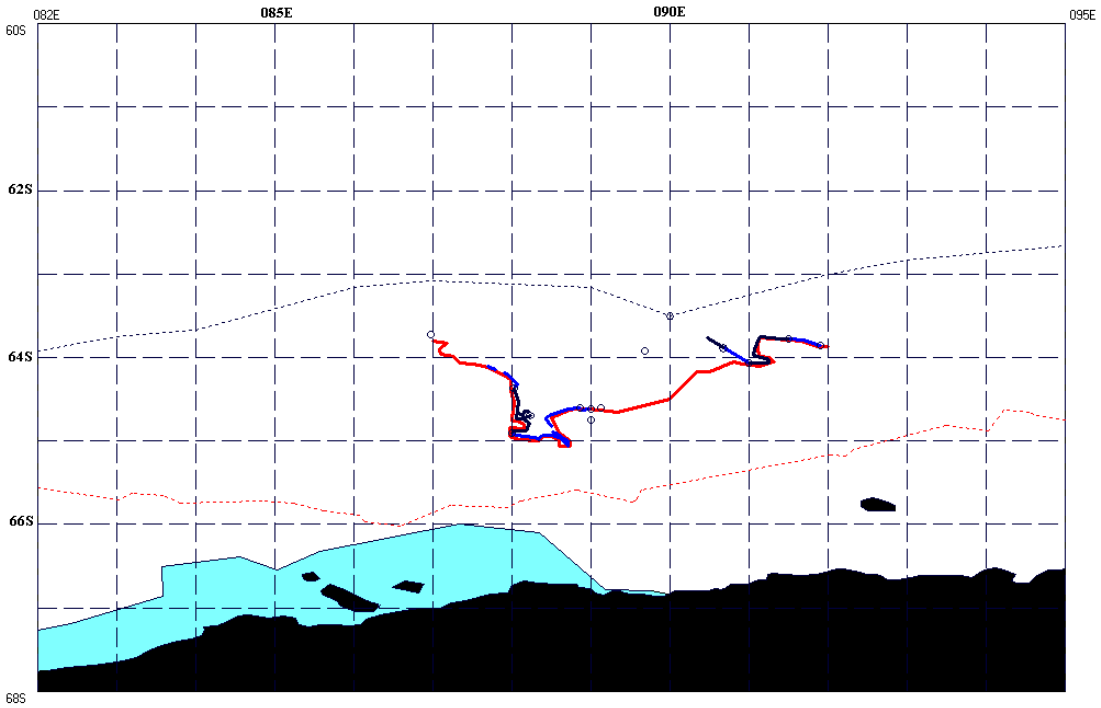
In Figures **1b-e** and **2a-h** the black area represents land, the light blue shaded area represents the extent of the West Ice Shelf and the red dotted line represents the 1000m isobath. The black dotted line represents the Northern Boundary of the Research Area. In Figures **1b-e** the open circles are waypoints.



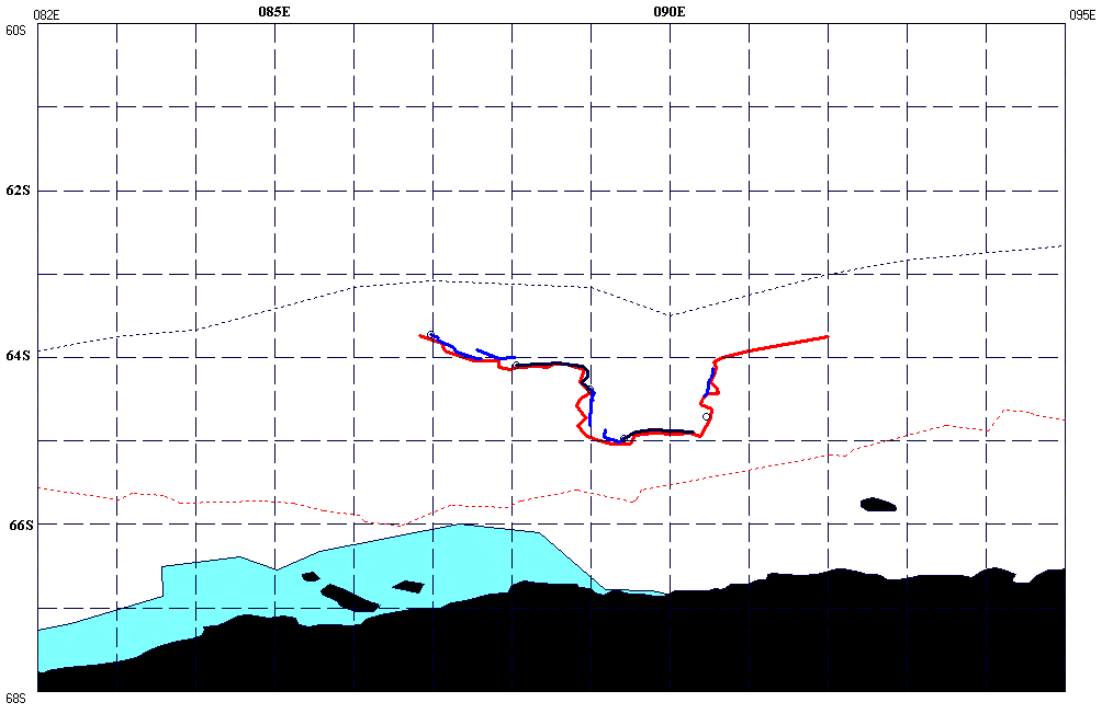
1b. Sections of the cruisetrack during the First survey of the Research Area covered on search effort. The red line represents the best estimate of the ice edge observed during the First survey. The blue line represents survey in SS-II mode. The black line represents survey in BT-Option II mode.



1c. Sections of the cruisetrack during the Second survey of the Research Area covered on search effort. The red line represents the best estimate of the ice edge observed during the Second survey. The blue line represents survey in SS-II mode. The black line represents survey in BT-Option II mode.

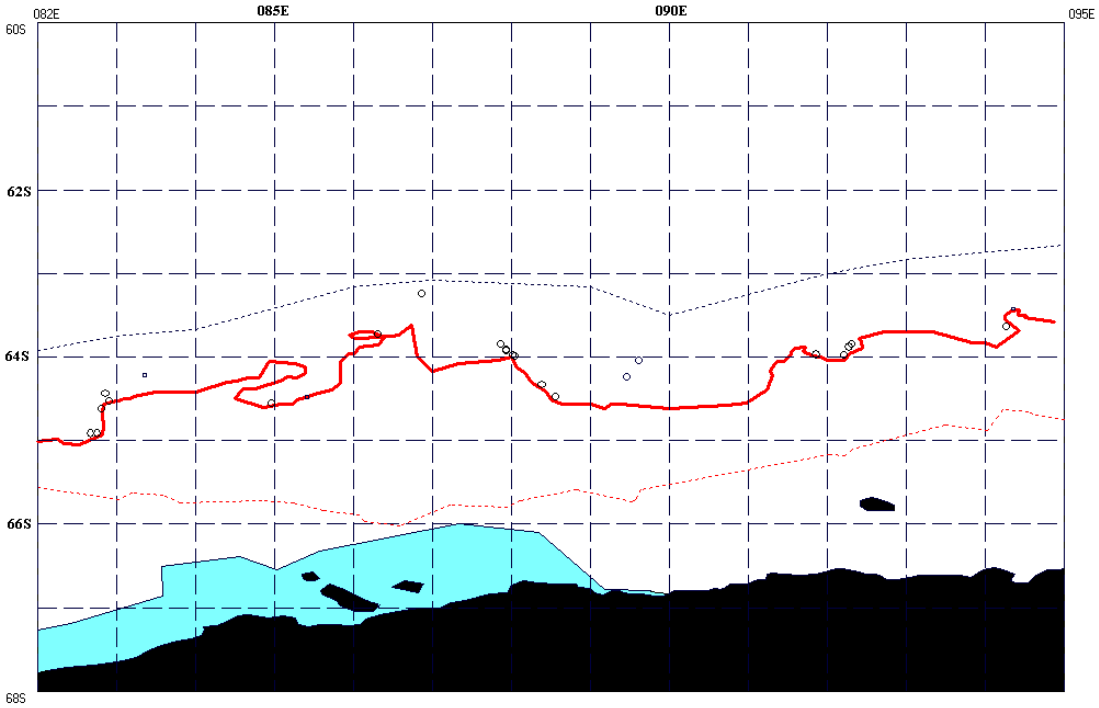


1d. Sections of the cruisetrack during the Third survey of the Research Area covered on search effort. The red line represents the best estimate of the ice edge observed during the Third survey. The blue line represents survey in SS-II mode. The black line represents survey in BT-Option II mode.

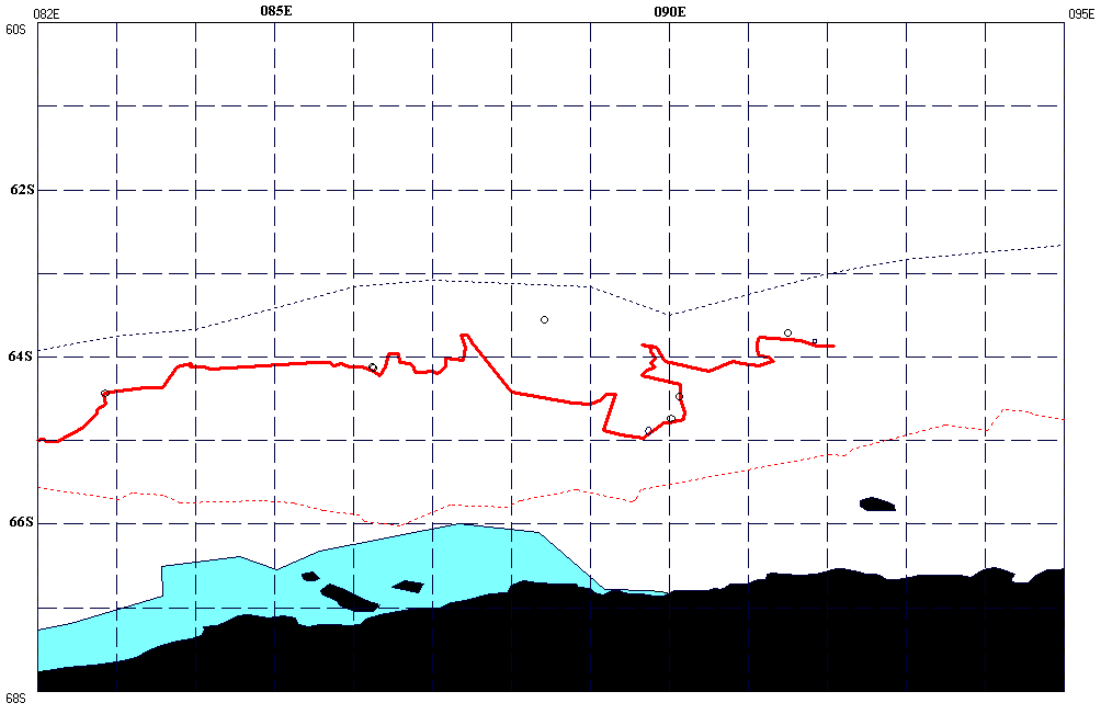


1e. Sections of the cruisetrack during the Fourth survey of the Research Area covered on search effort. The red line represents the best estimate of the ice edge observed during the Fourth survey. The blue line represents survey in SS-II mode. The black line represents survey in BT-Option II mode.

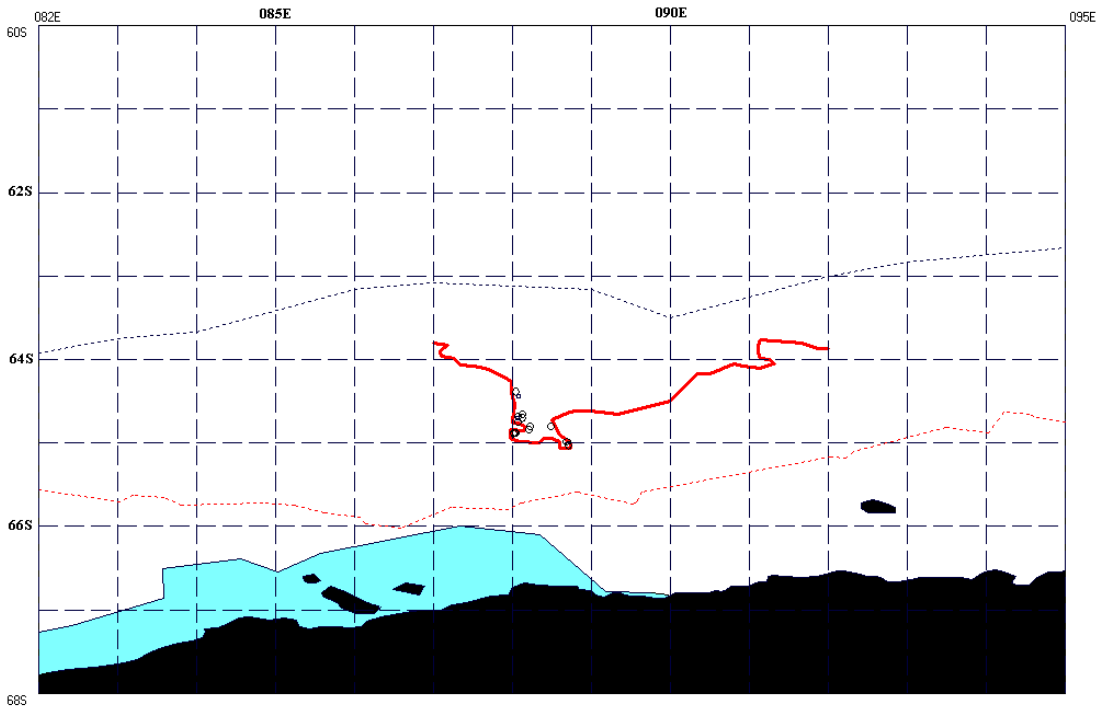
Figures 2a-p. Positions of whale sightings in the Minke Whale Research Area.



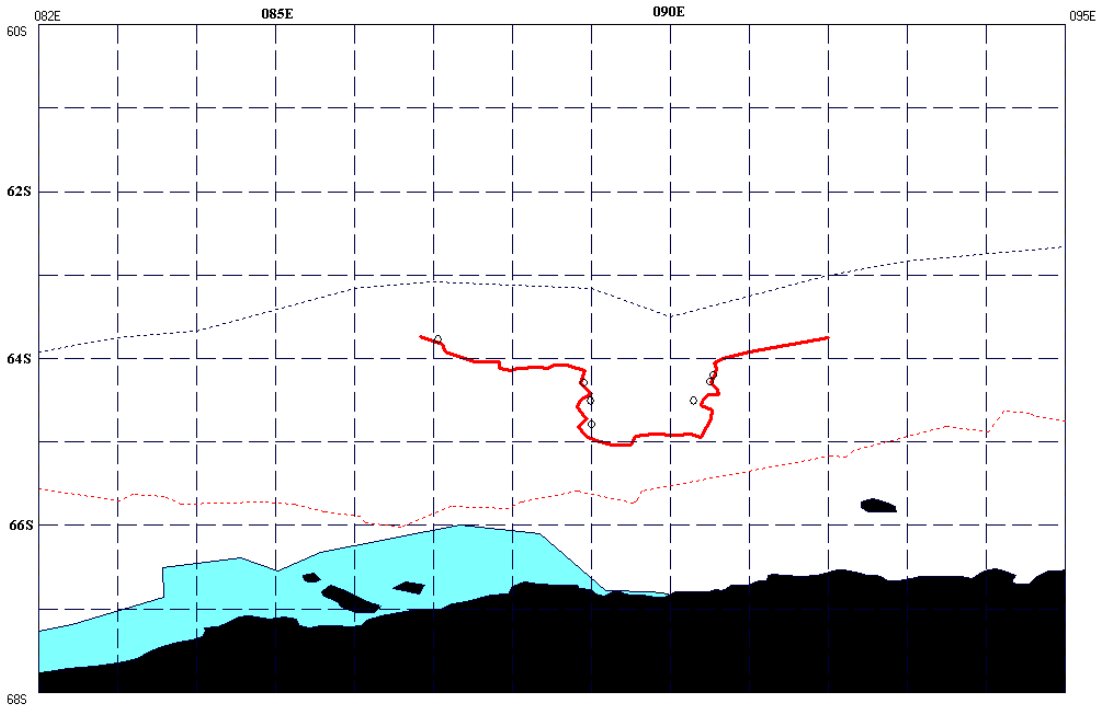
2a. Positions of minke whale (O) and 'like minke whale' (□) observed during the First survey of the Research Area. The red line represents the best estimate of the ice edge observed during the First survey.



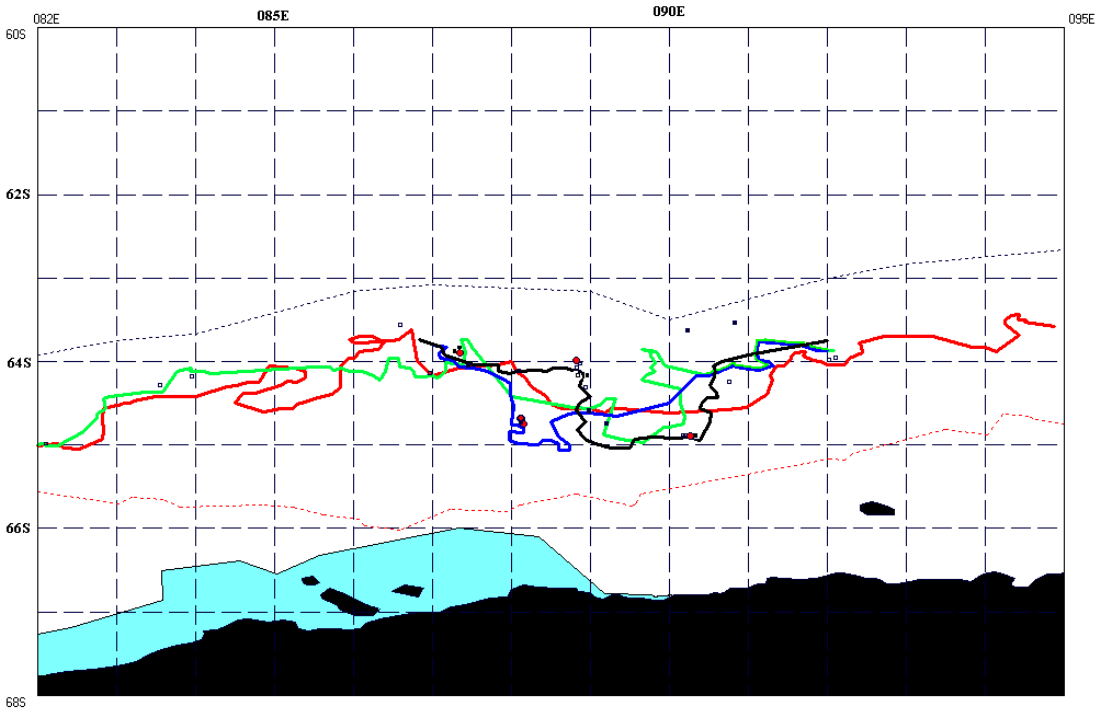
2b. Positions of minke whale (O) and 'like minke whale' (□) observed during the Second survey of the Research Area. The red line represents the best estimate of the ice edge observed during the Second survey.



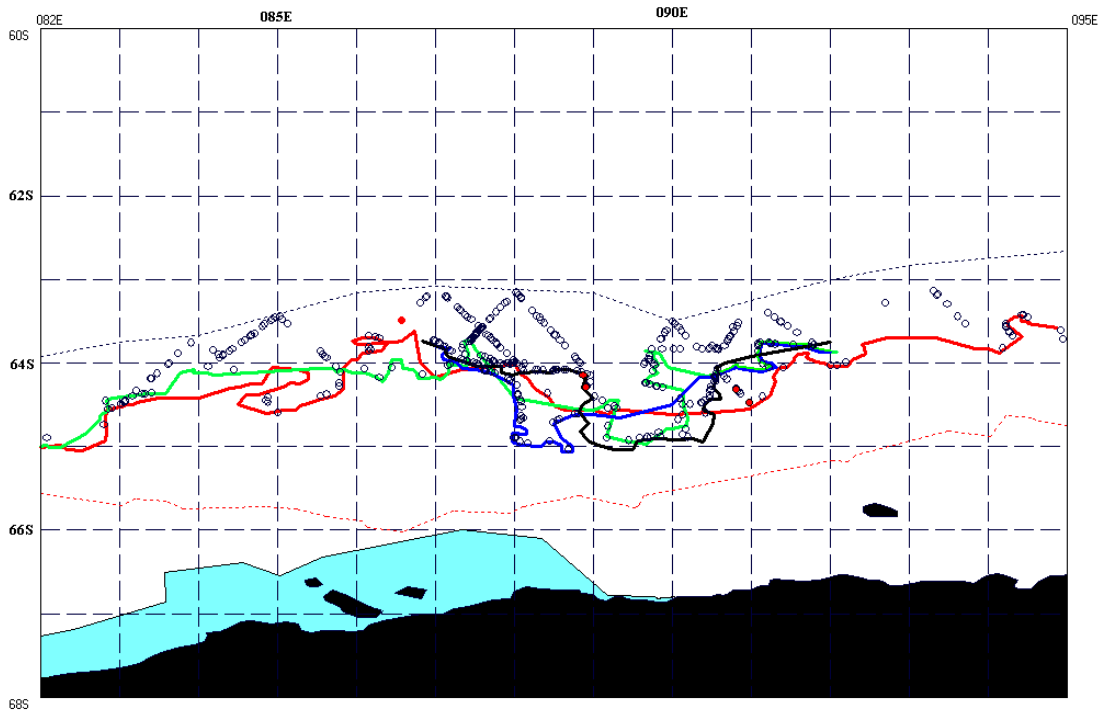
2c. Positions of minke whale (O) and 'like minke whale' (□) observed during the Third survey of the Research Area. The red line represents the best estimate of the ice edge observed during the Third survey.



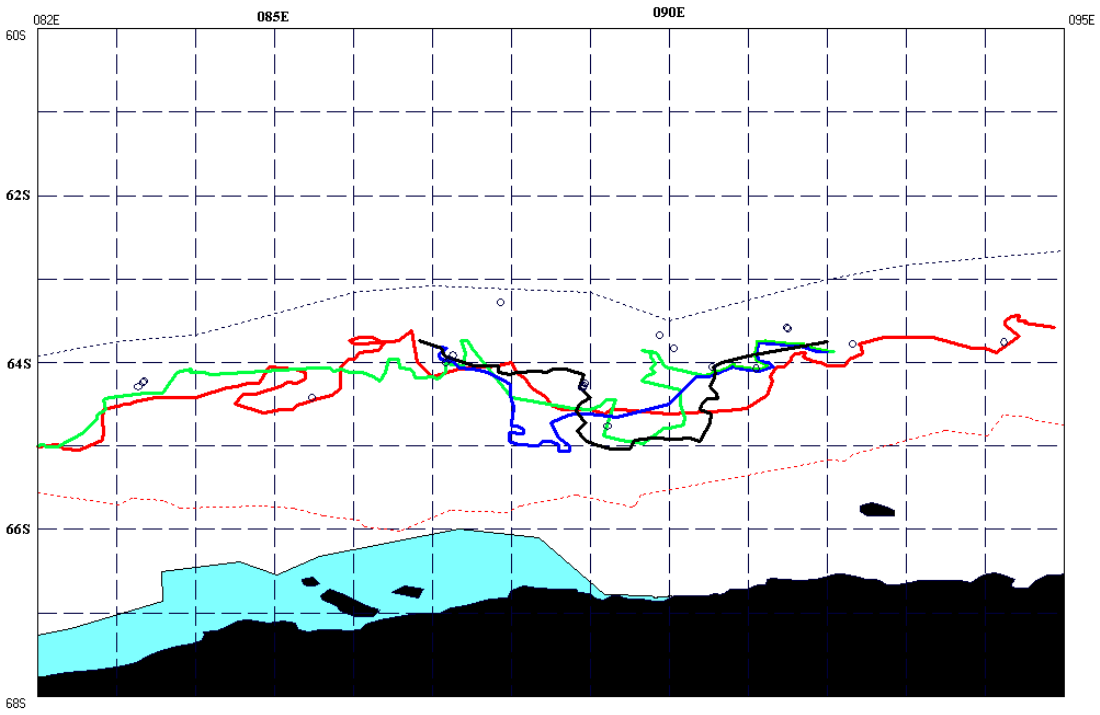
2d. Positions of minke whale (O) and 'like minke whale' (□) observed during the Fourth survey of the Research Area. The red line represents the best estimate of the ice edge observed during the Fourth survey.



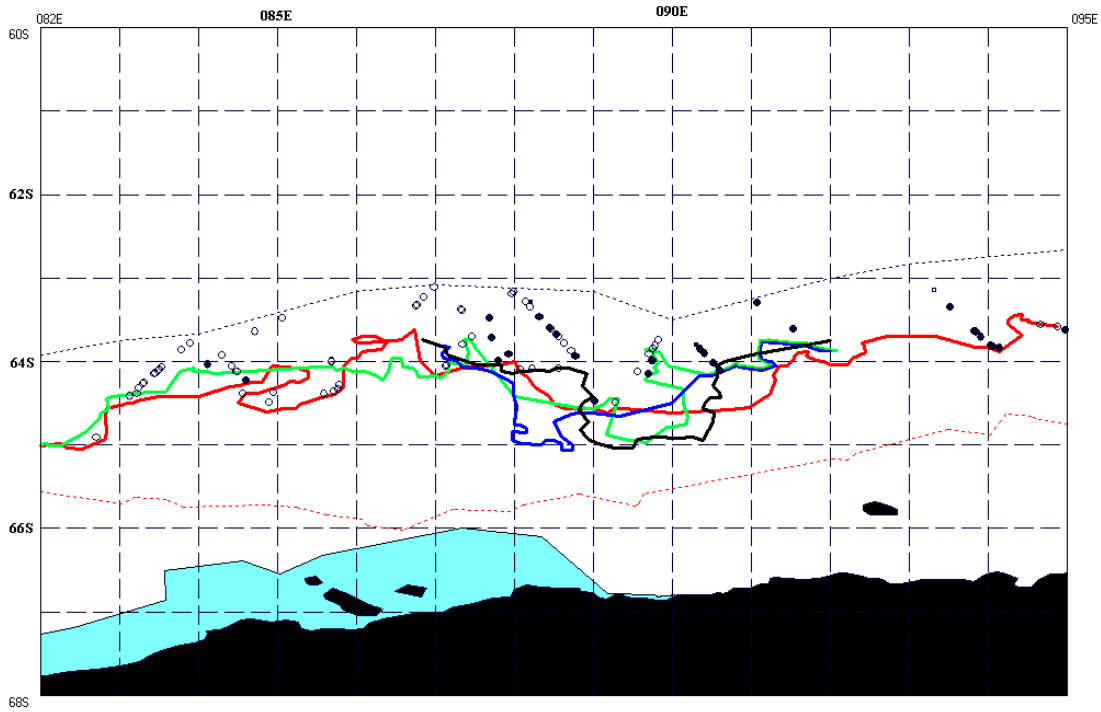
2e. Positions of blue whale (Antarctic) (●) observed during the four surveys of the Research Area. Locations of all acoustic recording stations conducted during the four surveys of the Research Area: stations with blue whale acoustic detections (■) and stations with no blue whale acoustic detections (□). Best estimates of the ice edge are represented by: red line - First survey; green line – Second survey; blue line – Third survey; black line – Fourth survey.



2f. Positions of humpback whale (O) and fin whale (●), observed during the four surveys of the Research Area. Best estimates of the ice edge are represented by: red line - First survey; green line – Second survey; blue line – Third survey; black line – Fourth survey.



2g. Positions of killer whale (O) observed during the four surveys of the Research Area. Best estimates of the ice edge are represented by: red line - First survey; green line – Second survey; blue line – Third survey; black line – Fourth survey.



2h. Positions of sperm whale (O), southern bottlenose whale (●), pilot whale (■) and hourglass dolphin (□), observed during the four surveys of the Research Area. Best estimates of the ice edge are represented by: red line - First survey; green line – Second survey; blue line – Third survey; black line – Fourth survey.

Appendix A: Ship specifications and crew list

Ship specifications:

	Shonan Maru No.2
Call sign	JFCF
Length	64.8 m
Breadth	10.2 m
International Gross tonnage	1015 t
Japan Gross tonnage	712 t
Barrel height	20.0 m
IOP height	14.0 m
Upper Bridge height	11.0 m
Bow height	6.5 m
Engine power (main)	5500 HP
Crew	18

Crew list:

	Shonan Maru No.2
Captain	H. Komiya
Chief Officer	T. Oshima
Second Officer	T. Koyanagi
Chief Engineer	F. Horinaga
First Engineer	H. Yasunaga
Second Engineer	H. Fujimoto
Third Engineer	Y. Sakai
Chief Operator	Y. Tsuda
Boatswain	Z. Suzuki
Quartermaster	N. Nakamura
Quartermaster	K. Kurisu
Sailor	M. Takeuchi
Sailor	K. Matsuguchi
Sailor	Y. Yoshino
No. 1 Oiler	Y. Yoshii
Fireman	T. Nagatomo
Chief Steward	K. Kawasaki
Steward	K. Oki

Appendix B. AMSR-E satellite ice.

Advanced Microwave Scanning Radiometer (AMSR-E) sea ice data were sent daily to the vessel from the Australian Antarctic Division (AAD). The sea ice data were downloaded daily at AAD from the website (http://iup.physik.uni-bremen.de:8084/amsr/amsre.html) and data for the SOWER research area were converted into an interpolated raster image using ArcMap. Sea ice maps were produced from the raster image constructed using sea ice concentration categories (0-3%, 3-20%, 20-30%, 30-90% and 90-100%).

See Figures A-E below for examples of AMSR-E satellite ice predictions at various times of the cruise.

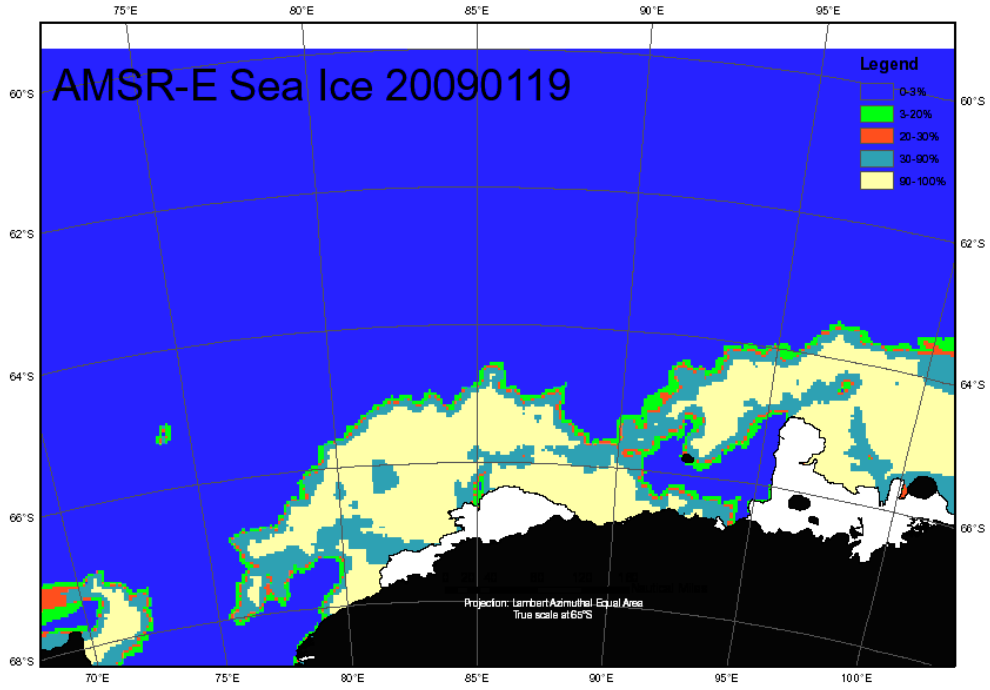


Figure A. First survey of the Research Area commenced at longitude 095°E, on 19 January.

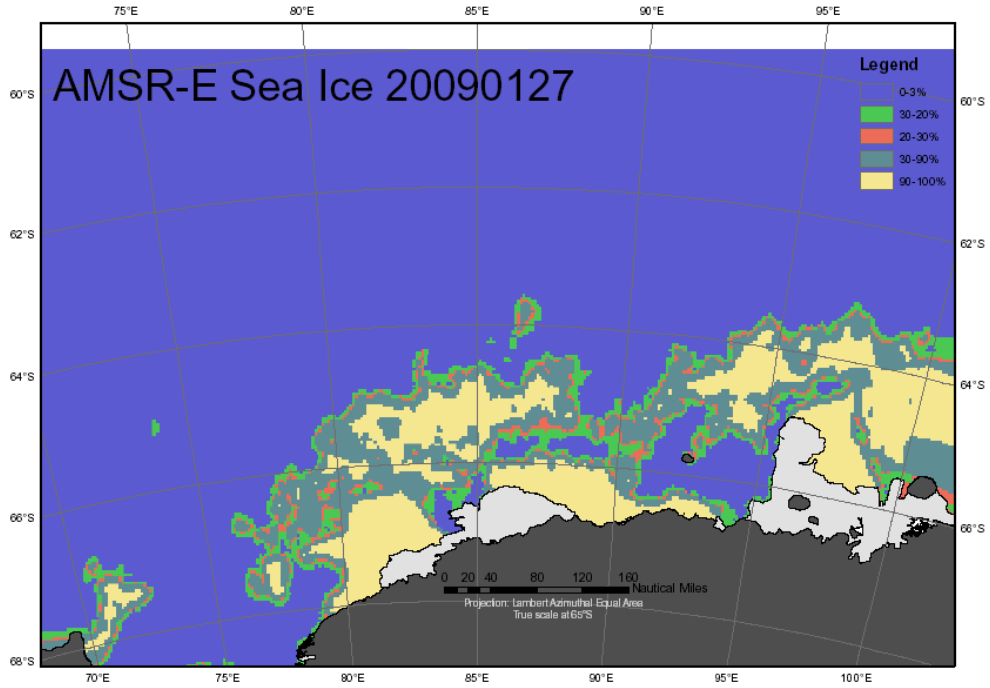


Figure B. Second survey of the Research Area commenced at longitude 082°E, on 27 January.

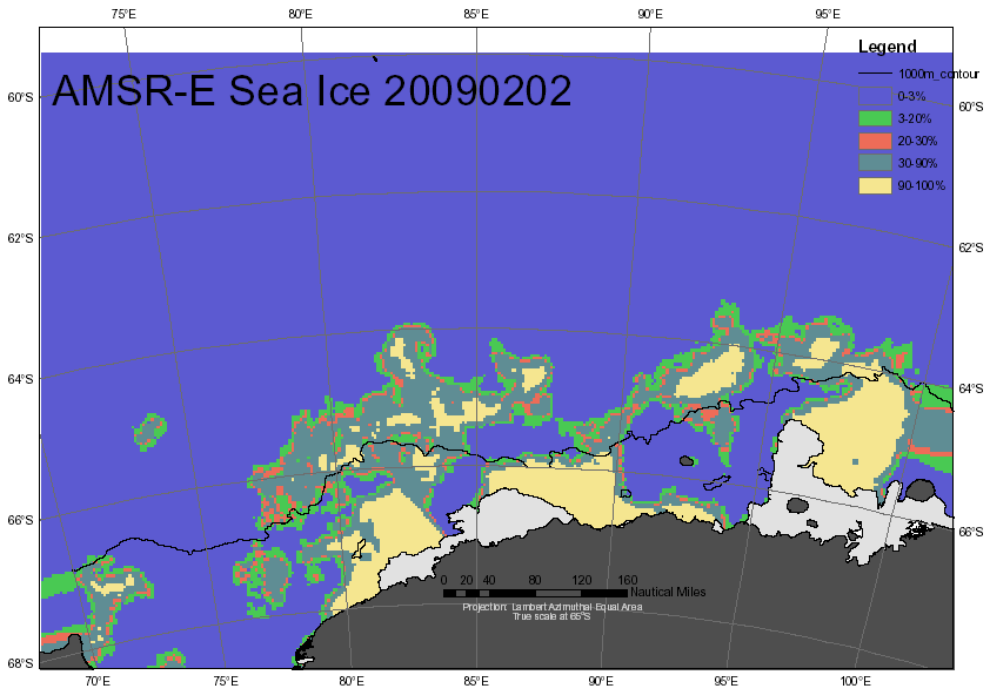


Figure C. Third survey of the Research Area commenced at longitude 092°E, on 3 February. (AMSR-E prediction for 3 February was not available).

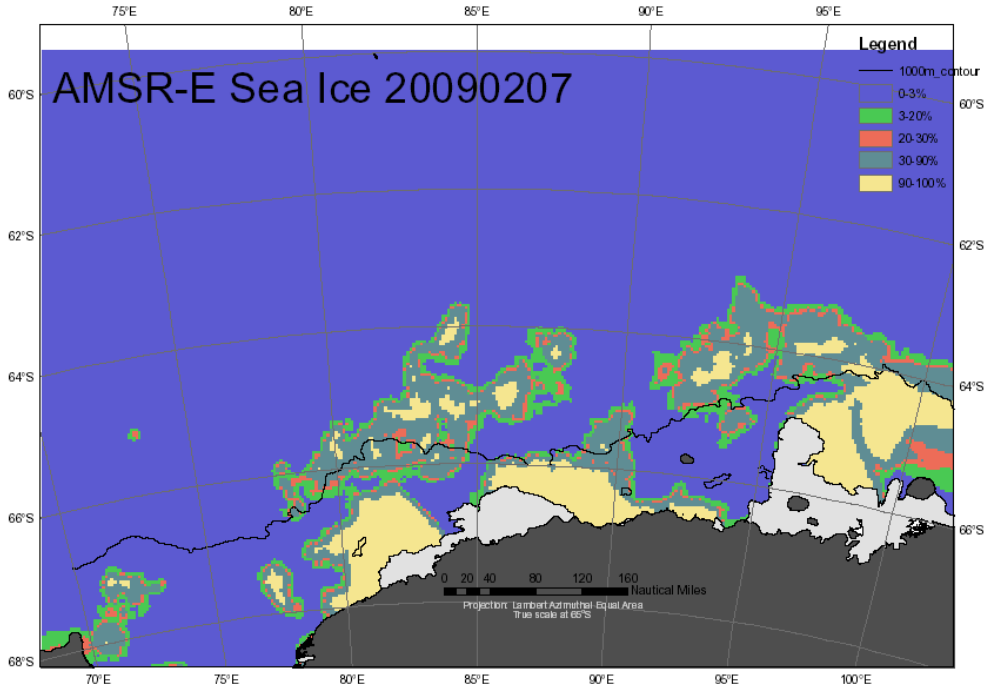


Figure D. Fourth survey of the Research Area commenced at longitude 087°E, on 7 February.

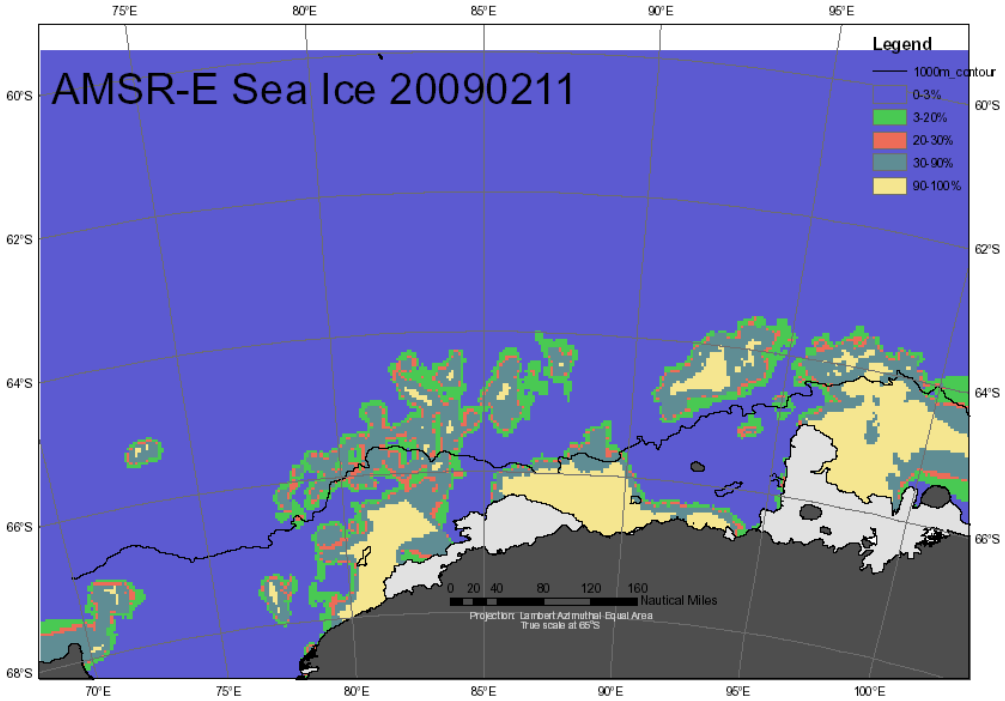


Figure E. End of scheduled research period, 12 February.

Appendix C. Example spectrograms of blue whale sounds recorded during 2008-2009

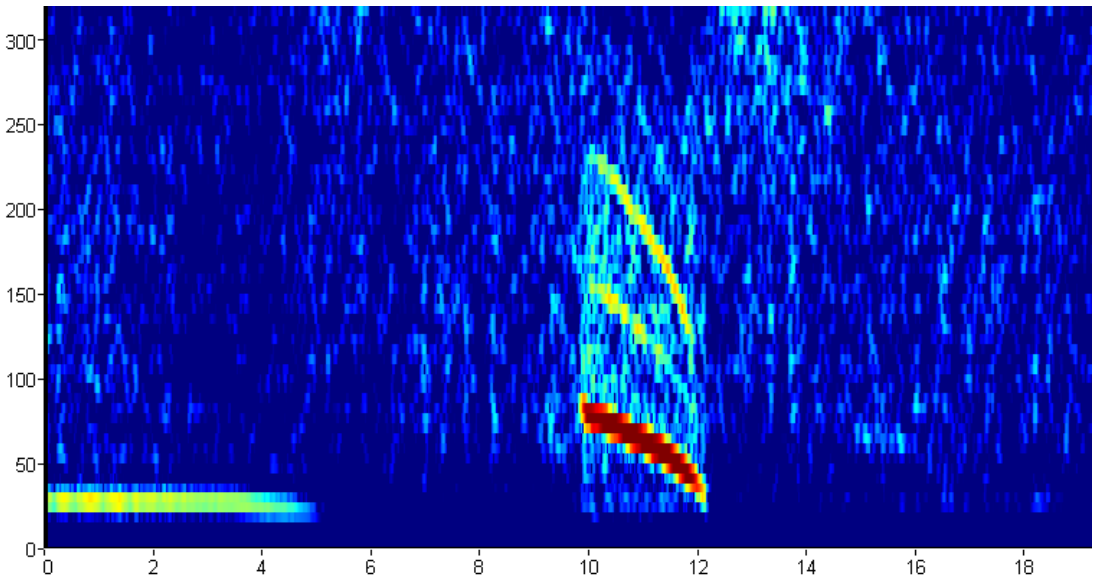


Figure A. Spectrogram of very loud 28 Hz tone and very loud downsweep calls from blue whales. Station # 18, 5 February 2009, position 64°43'S 088°07'E. (FET 16384 pts, 87.5% overlap, Hanning window). x axis represents frequency (HZ), y axis represents time (sec).

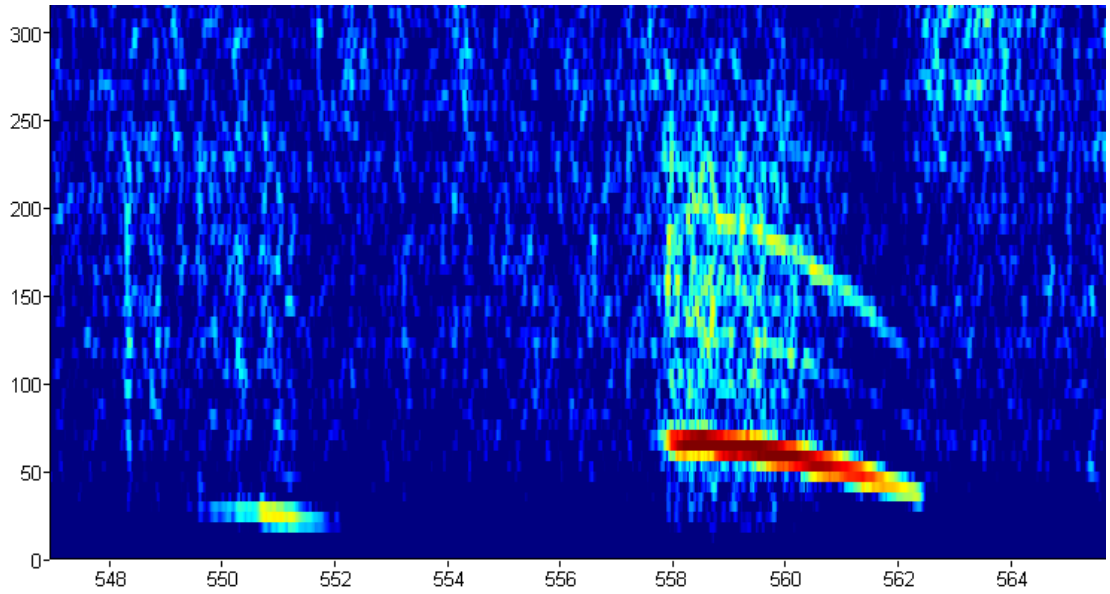


Figure B. Spectrogram of loud 28 Hz tone and long duration downsweep calls from blue whales. Station # 20, 7 February 2009, position 63°53'S 087°20'E. (FET 16384 pts, 87.5% overlap, Hanning window). x axis represents frequency (HZ), y axis represents time (sec).

Appendix D. Observations of cetaceans while in the 200 n.mile Exclusive Economic Zone of Australia.

Introduction

The 2008-2009 International Whaling Commission - Southern Ocean Whale and Ecosystem Research Program (IWC-SOWER) Cruise surveyed in IWC Antarctic Area IV in January and February 2009. The main objectives of the 2008-2009 cruise were to:

1. investigate temporal changes in the spatial distribution of minke whales in relation to recession of the pack ice;
2. continue research on blue whales (including collecting biopsy samples, acoustic data, photographs for identifying individual animals and behavioural data);
3. continue research on fin whales, southern right whales and humpback whales, especially on stock structure (including collecting biopsy samples and individual identification photographs).

The research plan was a series of repeat surveys in the area spanning longitudes 105° and 115°E and up to 60 n.miles north of the pack ice edge Anon (2008a). The research area had been selected to coincide with the area surveyed on the last cruise (the 2007-2008 IWC-SOWER cruise), which had been intended as a collaborative survey with an Australian Antarctic Division aerial survey. However, due to unsuitable pack ice conditions in the area 105° and 115°E, indicated on satellite predictions, the research area was subsequently changed during the transit from Benoa to the Antarctic. The research area was later defined as the area between longitudes 082° and 095°E. Details of the entire cruise are reported in Ensor *et al*. (2009).

The vessel from which the research was conducted (the *Shonan Maru No.2*) used Benoa, Bali as the homeports pre-cruise and post-cruise. The vessel passed through the 200 n.mile Exclusive Economic Zone (EEZ) of Australia on the transits between Benoa and the Antarctic Research Area. Given the time constraints in reaching the Research Area from Benoa, there was no possibility of conducting research other than Passing mode (NSP) operations in the EEZ of Australia. Permission had been granted by the Australian Department of Foreign Affairs and Trade for research in Passing mode the Australian EEZ.

Methods

The ship departed Benoa on 6 January 2009. En route to the Antarctic research area the vessel intersected the Australian EEZ and while in the zone research was to be conducted in Passing mode. A description of the research procedures and data recording methodology is given in Anon (2008b).

Results

The ship departed Benoa on 6 January 2009. The EEZ of Australia was intersected on 8 January at position 16°51'S 113°51'E at 09:34 hours. The vessel departed the Australian EEZ on 11 January at 13:55 hours at position 31°21'S 111°08'E.

On return from the Antarctic the *Shonan Maru No.2* intersected the EEZ of Australia on 20 February at position 31°21'S 111°08'E at 16:47 hours. The vessel departed the Australian EEZ on 23 February at 22:04 hours at position 16°51'S 113°51'E.

During both transits combined, a total of 43.99 hours of research in NSP mode was conducted in the Zone (493.4 n.miles).

During transit from Benoa to the Antarctic a total of 11.72 hours of research in NSP mode was conducted in the Zone (134.5 n.miles). Windy conditions, unsuitable for research, were experienced in the southern part of the Zone. On the return transit to Benoa, in the Australian EEZ, good conditions were experienced and a total of 32.27 hours of research in NSP mode was conducted (358.9 n.miles).

A total of 30 sightings were made within the Australian EEZ (Table A). A notable sighting within the Australian EEZ was of a southern bottlenose whale calf recorded in a group of three whales on 21 February at position 28°21'S 111°20'E during the return transit to Benoa.

References

Anon 2008a. Report of the Planning Meeting for the 2008-2009 IWC-SOWER Cruise. Available from the IWC Secretariat, Cambridge, United Kingdom.

Anon 2008b. 2008-2009 IWC-SOWER Cruise. Information for Researchers. Available from the IWC Secretariat, Cambridge, United Kingdom.

Ensor P., Komiya H., Kumagai S., Kuningas S., Olson P. and Tsuda Y. 2008-2009 IWC-Southern Ocean Whale and Ecosystem Research (IWC-SOWER) Cruise. Available from the IWC Secretariat, Cambridge, United Kingdom.

Table A. Number of sightings for all species observed during transit in the Australian 200 n.mile EEZ in each effort mode.

Species	NSP		OE		Total	
	G	A	G	A	G	A
Bryde's whale	1	1	-	-	1	1
Sperm whale	3	12	-	-	3	12
Southern bottlenose whale	2	4	-	-	2	4
'Like southern bottlenose whale'	1	1	-	-	1	1
Dwarf/pygmy sperm whale	5	7	-	-	5	7
Striped dolphin	1	55	-	-	1	55
Spotted dolphin	1	50	-	-	1	50
Pygmy killer whale	2	75	-	-	2	75
Mesoplodon sp.	1	4	-	-	1	4
Ziphiid	5	9	1	1	6	10
Unidentified dolphin	3	11	-	-	3	11
Unidentified small whale	1	1	1	2	2	3
Unidentified small cetacean	2	3	-	-	2	3

Table B. Cetacean sightings made while in the 200 nmile EEZ of Australia.

Date	Time	Mode	Species	Number	Position	
					Latitude	Longitude
Transit south						
08 January 2009	10:26	NSP	Sperm	5	17°00.81'S	113°47.65'E
08 January 2009	11:33	NSP	Sperm	3	17°13.36'S	113°43.53'E
08 January 2009	11:36	NSP	Sperm	4	17°14.02'S	113°43.31'E
10 January 2009	15:59	OE	Unidentified small whale	2	27°07.11'S	111°07.87'E
11 January 2009	09:24	OE	Ziphiid	1	30°28.04'S	111°07.79'E
11 January 2009	12:35	NSP	Unidentified small whale	1	31°06.35'S	111°08.09'E
11 January 2009	13:23	NSP	Ziphiid	1	31°14.68'S	111°08.09'E
Transit north						
21 February 2009	06:56	NSP	Southern bottlenose whale	1	28°41.27'S	111°27.31'E
21 February 2009	08:47	NSP	Southern bottlenose whale	3	28°21.01'S	111°29.69'E
21 February 2009	11:02	NSP	Unidentified dolphin	3	27°56.30'S	111°32.62'E
21 February 2009	12:21	NSP	'Like southern bottlenose whale'	1	27°41.30'S	111°34.45'E
21 February 2009	15:24	NSP	Ziphiid	1	27°09.43'S	111°37.85'E
21 February 2009	17:15	NSP	Ziphiid	2	26°47.79'S	111°40.55'E
22 February 2009	08:59	NSP	*Mesoplodon sp.*	4	23°53.77'S	112°01.61'E
22 February 2009	09:26	NSP	Pygmy killer whale	10	23°48.86'S	112°02.99'E
22 February 2009	09:46	NSP	Ziphiid	2	23°45.76'S	112°03.66'E
22 February 2009	10:16	NSP	Dwarf/pygmy sperm whale	1	23°40.43'S	112°05.23'E
22 February 2009	11:00	NSP	Dwarf/pygmy sperm whale	1	23°32.50'S	112°07.25'E
22 February 2009	11:03	NSP	Unidentified dolphin	4	23°31.98'S	112°07.40'E
22 February 2009	11:25	NSP	Ziphiid	3	23°28.87'S	112°08.26'E
22 February 2009	12:30	NSP	Spotted dolphin	50	23°16.88'S	112°11.28'E
22 February 2009	12:13	NSP	Dwarf/pygmy sperm whale	1	23°14.04'S	112°12.04'E
22 February 2009	12:49	NSP	Dwarf/pygmy sperm whale	3	23°13.56'S	112°12.17'E
22 February 2009	13:03	NSP	Dwarf/pygmy sperm whale	1	23°11.09'S	112°12.90'E
22 February 2009	13:19	NSP	Unidentified small cetacean	1	23°08.24'S	112°13.76'E
22 February 2009	13:22	NSP	Striped dolphin	55	23°07.59'S	112°13.95'E
22 February 2009	13:57	NSP	Pygmy killer whale	65	23°02.10'S	112°15.33'E
22 February 2009	16:07	NSP	Bryde's whale	1	22°39.92'S	112°21.20'E
22 February 2009	17:24	NSP	Unidentified dolphin	4	22°28.84'S	112°23.85'E
23 February	07:47	NSP	Unidentified small cetacean	2	19°41.33'S	113°07.47'E

Appendix E. Observations of killer whales during SOWER 2008-2009.

Killer whales were sighted frequently (21groups/255animals) in the research area (longitudes 082° - 095°E) during an initial survey and three repeat surveys in the area. The killer whales were most often detected near the pack ice edge in the research area. Additionally, 3 groups (105 animals) were sighted on 19 January just outside the research area, 4-6 n.miles from the ice edge.

In 2003, Pitman and Ensor described 3 morphological forms of killer whales found in Antarctica based on the presence or absence of a dorsal cape and the relative size and orientation of the species' white eyepatch. Type A, similar in form to killer whales that occur worldwide, does not exhibit a dorsal cape and has a medium-sized eyepatch oriented parallel to the body axis; Type B has a dorsal cape and a large eyepatch (described as at least twice as large as Type A) oriented parallel to the body axis; and Type C, has a dorsal cape and a small, forward-slanted eyepatch (at an angle to the body axis).

During SOWER 2008-2009, we attempted to classify to Type every group of killer whales encountered in Antarctic waters. This was difficult in some cases when the survey was in passing mode and the whales did not come close to the ship; most of those groups remain unclassified. We photographed 9 sightings (7 in the research area and 2 just outside), which aided in the determination of Type. In all, we determined 2 groups Type A, 0 groups Type B, 6 groups Type C. We also observed a mixed group of Type A and Type B killer whales (Table 1).

The mixed group was sighted at 05:47hr in the morning of 21 January, at 0.6 n.miles from the ship. We spent 20 minutes observing and photographing this group. There were 18 killer whales feeding in a slick about 40m in diameter, together with 50-60 seabirds. Blood was apparent in the slick but no carcass or animal remains were seen. The size of the slick was suggestive of a marine mammal kill. Sixteen of the killer whales were clearly Type A's (lacking a dorsal cape and with small to moderately-sized eyepatches parallel to the body axis). Two of the whales in the group were clearly Type B's (with a pronounced dorsal cape and large eyepatches parallel to the body axis). To our knowledge, this is the first documentation of a mixed Type group. It seems likely that the killer whales formed a temporary association during a feeding event since mixed Type groups have not been reported in the past. Both Types are known to prey on marine mammals.

On three occasions we encountered groups that exhibited features of both Type C and B whales: 19 January, sighting #010; 26 January, sighting #033; and 09 February, the aggregation of sightings including #036 and #038. All whales had dorsal capes, but the size and shape of the eyepatch varied within the groups, ranging from small to large in size, yet usually forward-slanted. Given the variation between individuals within groups, we felt this represented an intergrade of form rather than the mixing of two clearly defined Types. Details of the sightings follow.

On 26 January (sighting #033), a group of 30 killer whales was sighted at 64°12'S 083°20'E, approximately 13 miles from the ice edge, 90 miles from the continental slope front (1000m contour), and in >3000m of water. The whales were traveling in several subgroups; individuals in the larger subgroups were clustered tightly together. Photographs reveal individuals with dorsal capes, and small to moderate-sized, forward slanted eyepatches. At least two whales had large, Type B eyepatches. Because the majority of the group had forward-slanted eyepatches, we classified this group as Type C. Interestingly, this group was sighted 1.1 n.miles from another group of unclassified killer whales (sighting #036), group size 17, that was later observed to be joined by a pair of whales classified as 'like minke whale'. All the killer whale sightings detected on this afternoon were viewed and photographed in passing mode.

A group of 15 killer whales (sighting #010) photographed on 19 January, just outside the research area, exhibited a similar range in eyepatch shapes and sizes as those described above. Because the majority of the group had forward-slanted eyepatches, this group was also classified as Type C

On 9 February, we encountered a mixed species feeding aggregation (sightings #034-038) that included scattered groups of killer whales (totaling 51 individuals), two minke whales, two fin whales, one humpback and large flocks of seabirds. The sightings were centered at 64°19'S 088°53'E, near the ice edge among scattered belts of ice floes, and approximately 80 n.miles from the slope front in 3000m of water. We spent about an hour observing the aggregation, and approached several groups of killer whales for photographs and biopsy. (One biopsy sample collected.)

10-12 subgroups of killer whales were present, in sizes ranging from 4 – 15 whales. While the subgroups were associated, they remained distinct and there was not an observable exchange of individuals. The morphology varied subtly between subgroups: all exhibited dorsal capes, but some were minimally present while others were quite pronounced. There was a variation in eyepatches, both between and within groups. Most eyepatches were markedly forward-slanted and of a medium size, thus appearing to be an intergrade between C and B Type

eyepatches. There were also some whales with forward-slanted eyepatches of a large size. Due to the pronounced forward-slanted feature of most of the eyepatches we classified the killer whales in all the groups as Type C's. Type C's are commonly reported in large groups; whether the whales in this aggregation comprise a stable aggregation or not is unclear. The variation, however subtle, between groups, suggest that they do not.

All the species appeared to be feeding; and a fin whale rolled on its side at one point and the killer whales were diving and milling. Small groups of killer whales (4-6 whales) were observed following the fin whales, sometimes diving closely by a fin whale's head or tail. Yet the behavior did not seem aggressive and the fin whales did not appear to be agitated by the presence of the killer whales. Similarly, the behaviour of the minke whales and the humpback whale appeared normal.

Based on our observations of the pack ice edge, we speculate during all the repeat surveys, in this vicinity there was consistent and reasonably strong surface convergence feature and this may have concentrated prey (including krill and mesopelagic fish). The pack ice edge extended north-south for about 60 nmiles and there were streams of floes from its northern margin. High sighting rates of humpback whales at the ice edge just north of this location during all repeat surveys lends support to this area containing concentrated prey. Additionally, Antarctic fur seals were quite frequently seen on this part of the pack ice edge, although observations of crabeater seals were infrequent.

While previous accounts of the three killer whale Types have not reported intergrades between Types (Pitman and Ensor 2003), we felt this was evidenced by the three sightings described here. Of the variation in morphology observed between and within groups classified as Type C, the eyepatch size showed the most variation.

Group sizes

Group sizes of all killer whales sighted (including the 3 groups just outside the research area) ranged from 1 to 45, with a mean of 15. Of the groups classified to Type, Type A group sizes ranged 2-16 (mean 6.7, n=3) and Type C ranged 8-45 (mean=21, n=6). The ranges of these group sizes correspond to those found by Pitman and Ensor (2003), but the means are lower. That study reported a Type A mean of 13.6 (n=28) and Type C mean of 46.1 (n=14).

Currently the taxonomic identity of the different morphological forms killer whales in Antarctica, their relationship to one another, and within the Antarctic ecosystem is not completely understood. Continued field observations, photographic and biological sampling, of all forms are needed to clarify their status.

References

Pitman, R.L. and P. Ensor. 2003. Three forms of killer whales (*Orcinus orca*) in Antarctic waters. J. Cetacean Res. Manage. 5:131-139.

Table 1. Killer whale groups classified as Type A, B, or C during SOWER 2008/2009.

Date	Sighting no.	Lat	Long	Group size	Type	Photos	Comments
19 January	010	63°33'S	095°06'E	15	C	Yes	Just outside research area. Eyepatches variable in size.
19 January	011	63°34'S	095°05'E	45	C	Yes	Just outside research area.
20 January	014	63°45'S	094°13'E	10	A	Yes	
21 January	001	63°45'S	092°18'E	18	A & B	Yes	Feeding in slick
25 January	025	64°24'S	085°28'E	02	A	Yes	No photos of eyepatches, but Type A clearly seen through binoculars.
26 January	033	64°12'S	083°20'E	30	C	Yes	Eyepatches variable in size.
09 February	035	64°16'S	088°54'E	13	C	No	In association with humpback whale & sightings #036 & #038
09 February	036	64°19'S	088°53'E	15	C	Yes	In mixed species feeding aggregation. Eyepatches variable in size.
09 February	038	64°18'S	088°53'E	08	C	Yes	In mixed species feeding aggregation. Eyepatches variable in size.