SC/55/E10

# International Whaling Commission – Southern Ocean GLOBEC/CCAMLR collaboration

# Cruise report 2002 – 2003

DEBORAH THIELE, SUE MOORE, JOHN HILDEBRAND, ANA SIROVIC, ARI FRIEDLAENDER, DEBRA GLASGOW, RUSSELL LEAPER, KOEN VAN WAEREBEEK, MARK MCDONALD, SEAN WIGGINS, REBECCA PIRZL, FRANCISCO VIDDI, EILEEN HOFMANN

ABSTRACT

Collaboration between the International Whaling Commission, and national programs conducting multidisciplinary ecosystem research in the Antarctic under Southern Ocean Global Ecosystem Dynamics (SO GLOBEC) program and the Commission for the Convention on Antarctic Marine Living Resources (CCAMLR) occurred during five research cruises between April 2002 and April 2003. Visual survey, passive acoustic and tissue biopsy work was conducted by IWC observers and collaborating passive acoustics scientists. Reported here are the preliminary results from these cruises: mapped distribution patterns of cetaceans from visual survey sighting data; individual photo identification records; species identification and positions of animals recorded on sonobuoys; and descriptions of environmental conditions observed or recorded as part of the multidisciplinary effort.

## BACKGROUND

The International Whaling Commission (IWC) commenced collaborative research with CCAMLR in the Southern Ocean during the 1999/2000 austral summer (Reilly *et al.* 2000; Hedley *et al* 2001). The IWC then developed collaboration with the Southern Ocean Global Ecosystem Dynamics Program (SO GLOBEC) with a series of multi-season and multi-year collaborative research cruises. The SO GLOBEC program provides a focussed framework for multidisciplinary ecosystem studies and involves the participation of many national programs.

## NATIONAL SO GLOBEC CRUISES

Cruises under the United States (US) SO GLOBEC program were multidisciplinary and comprised standard mooring cruises, line transect surveys over a constant grid, and process studies at selected locations, all within the Western Antarctic Peninsula (WAP) study region around Marguerite Bay (Figure 1.). These began in March 2001 and were completed in March 2003. A total of eleven cruises were conducted under US SO GLOBEC, and the IWC participated in eight of these.

The initial German SO GLOBEC effort comprised one cruise in April/May 2001 to the WAP study area, and an ice covered area to the south. The IWC participated in this cruise. The major German SO GLOBEC effort will commence in March 2004 with the first in a series of three cruises to a study area in the Weddell Sea. The IWC is participating in these cruises.

The United Kingdom (UK) British Antarctic Survey (BAS) contribution to SO GLOBEC comprised joint SO GLOBEC/CCAMLR objectives in a survey in the Scotia Sea (Figure 2.) in early 2003. The IWC participated in this cruise.

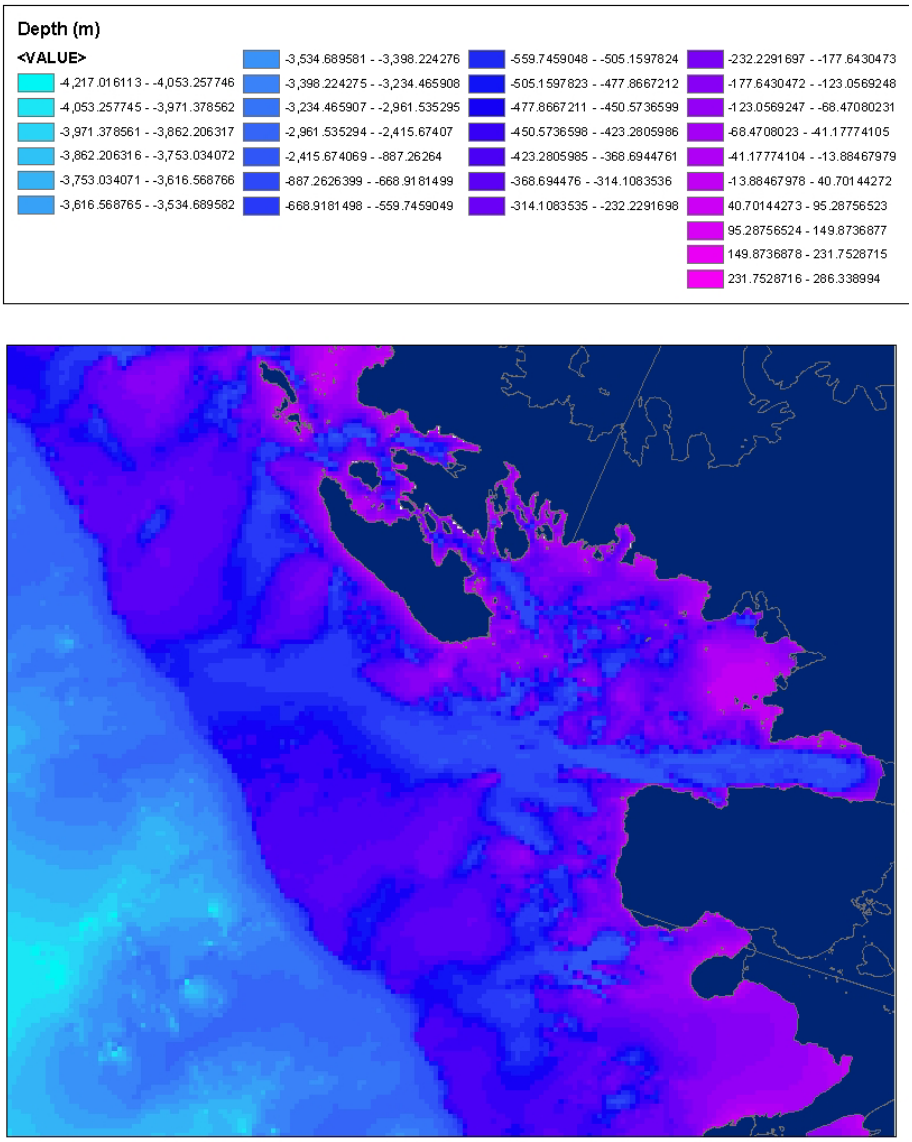
Two SO GLOBEC cruises were conducted by Australia in the East Antarctic study area. One cruise took place in January 2001 and the second took place in the same area in January 2002 (see SC/55/E17). The IWC did not participate in these cruises, however the long-term cetacean research program run by Thiele (SOCEP) did participate (see SC/55/E17).

## REPORTS TO IWC

Reports for the 2001 and early 2002 cruises (US and German programs) have been provided to the IWC SC previously (Thiele *et al.* 2001, Thiele *et al* 2002). Full cruise reports, web diaries and images from all of the cruises can also be found at: http://www.ccpo.odu.edu:80/Research/globec/iwc_collab/menu.htmlor use the link through the IWC website under Recent Additions.

The current report provides a summary of IWC participation in cruises conducted since the 2002 report to IWC (Thiele *et al* 2002). Five research cruises are reported here. Four cruises under the US program and one UK/BAS survey. The collaboration program (ARP's around the Antarctic) that we have developed under the IWC collaboration framework has allowed us to incorporate a significant passive acoustic component to all of these cruises (Thiele and Moore 2003, Thiele 2002). This IWC collaborative project has conducted visual surveys (line transect), tissue biopsy, individual photo identification and passive acoustic projects on all cruises.

Figure 1. US SO GLOBEC Western Antarctic Peninsula (WAP) Marguerite Bay study area BATHYMETRY



**APPENDICES (SC/55/E10 Appendices): THIS DOCUMENT IS AVAILABLE FROM THE SECRETARIAT ON REQUEST AND INCLUDES THE FOLLOWING INFORMATION:**

A. JAMES CLARK ROSS CRUISE JR 82

1. Figures 5 – 11
2. Definitions of data categories entered into Wincruz software
3. Description of structure of database

B. SATELLITE IMAGERY OF SEA ICE CONDITIONS DURING CRUISES

Figure 1 a, b and c

Satellite photos of sea ice extent in Marguerite Bay in a) February 2001; b) February 2002; and c) May 2002

Figure 1 d Satellite photo of sea ice extent in Scotia Sea during JR 82 UK/BAS cruise

C. STUDY AREA MAPS:

A. Figure 1. Survey (A) and proposed process (B) study area US SO GLOBEC Marguerite Bay, Western Antarctic Peninsula.
B. Figure 2. Study area UK/BAS SO GLOBEC - Scotia Sea, Antarctic Peninsula

D.DETAIL OF BIOPSY SAMPLES COLLECTED ON LMG 0203

E. NUMBER OF INDIVIDUAL PHOTO IDENTIFICATON RECORDS FOR ALL US SO GLOBEC CRUISES

**INDIVIDUAL CRUISE REPORT I**

**NATHANIEL B PALMER NBP 0202 - US SO GLOBEC AUSTRAL AUTUMN SURVEY CRUISE**

9 April to 21 May 2002

Visual survey, photo identification, and passive acoustics data were collected on this cruise.

*Visual survey methods*

Standard IWC line transect methodology adapted for multidisciplinary studies is used on SO GLOBEC collaborative cruises. We conduct line transect sighting surveys throughout daylight hours. Sightings were recorded on the laptop based Wincruz Antarctic program which also logs GPS position, course, ship speed, and a prompts the observer to record a suite of other environmental and sightings conditions regularly. Visual observations were made both during the station-transect portion of the trip and during transit to the study area, but not generally whilst on station. When possible, photographic and/or video documentation was made of each sighting for later use in species identification, group size verification, feeding (and other behaviour), individual identification, species confirmation, and/or habitat description. Detailed data on ice conditions were recorded using the ASPeCt (Antarctic Sea Ice Processes and Climate) protocol, whenever the area of sea covered by ice was greater than 5% (see SC/55/E8). If icebergs were present but cover was less than 5% then the number of icebergs in a 180$^{o}$ arc ahead of the vessel were recorded as a comment. We conducted distance and angle testing using radar on fixed targets. There was considerable opportunity for this in the study area due to the proximity of islands and fjord areas.

During this cruise, observations were made from the ice tower of the vessel by a single observer. The ice tower on the NB Palmer is situated above the main bridge and has 360˚ viewing. Most observations were made from the inside of the ice tower, but when weather/sea conditions permitted, the catwalk immediately outside the ice tower was used. The inside main bridge platform was also used for visual survey, usually when visibility was poor from the ice tower. Search effort was focused 45° either side of the trackline while also scanning the full 180° ahead of the vessel. In ice the search method was adjusted to include searching behind so that cetaceans and seals hidden by ice would be detected more readily. The observer used a combination of eye and binocular (7x50 Fujinon) searching. Survey effort commenced when the ship was steaming, and when an appropriate combination of the following conditions provided the necessary visibility: appropriate daylight, winds less than 20 knots or Beaufort sea state less than 5-6, visibility greater than 1 nautical mile (measured by the distance a minke whale blow could be seen with the naked eye as judged by the observer). An informal (but recorded) watch was kept in most borderline conditions or in variable visibility such as fog and snow squalls. Subjective weather data were recorded regularly (e.g. Beaufort sea state, cloud cover, glare, ice cover, sightability etc).

*Visual survey results*

Generally, sighting conditions were poor, particularly during the first half of the cruise. Visual survey was conducted for 184 hours, 16 minutes during the entire cruise. A total of 54 cetacean sightings of 112 animals were made (Table 1**,** Fig. 1). Individual identification records (photo and/or video) were obtained from at least six groups of humpbacks (WOS#10,13,19,20,50,52). Regular digital images of habitat, sea and ice conditions were also collected. On 17$^{th}$ May as we steamed through Gerlache Strait, some ship time was made available to close on humpback whales to obtain photo-identification data. On 17 April 2002 a 'like' blue whale body was sighted underwater to port, swimming away from the vessel. A sonobuoy was deployed by the passive acoustics team member (Ana Sirovic). Blue whale calls were recorded on that sonobuoy. Sightings data from this cruise show mainly humpback, minke, and killer whales present in the study region in the austral fall and beginning of this winter. Humpback sightings were particularly numerous along the mid shelf area just outside Marguerite Bay, along the continental shelf and near the frontal boundary formed as the coastal current exits the bay. There was also a group of humpbacks near the ice edge off Alexander Island associated with a patch of krill recorded by the Biomapper team. Minke sightings were more widespread but seemed to be associated closer to the ice edge and to the coastal frontal boundaries. Killer whales were seen within the ice edge on both occasions in areas where large numbers of seals were recorded.

*Photo identification results*

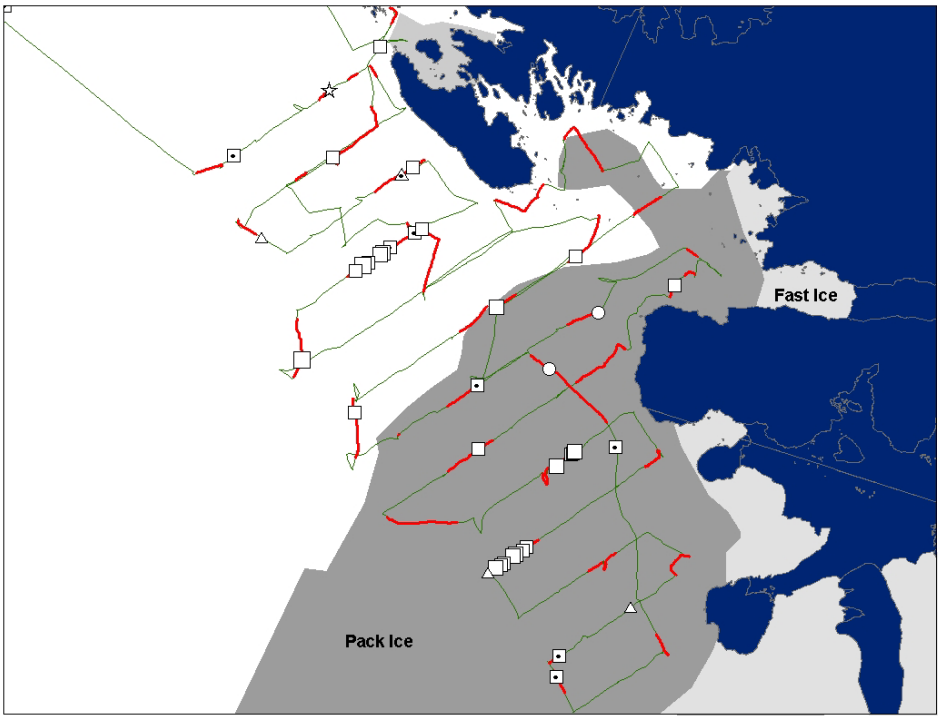
Nine individual humpbacks were photo identified on NBP 0202.

Table 1. NBP 0202 Total cetacean sightings and number of animals NBP02-02 9th April – 21 May 2002

| Cetacean species | No. Sightings | No. Animals |
|---|---|---|
| minke whale | 5 | 7 |
| like minke whale | 3 | 3 |
| like blue whale | 1 | 1 |
| like sei whale | 1 | 3 |
| humpback whale | 21 | 49 |
| like humpback whale | 10 | 25 |
| killer whale | 2 | 7 |
| Commerson's dolphin | 1 | 1 |
| unidentified dolphin | 2 | 4 |
| unidentified large whale | 1 | 1 |
| unidentified small cetacean | 2 | 2 |
| unidentified large baleen whale | 1 | 1 |
| unidentified baleen whale | 1 | 3 |
| unidentified whale | 2 | 4 |
| unidentified small whale | 1 | 1 |
| **Total** | 54 | 112 |

Figure 1. NBP 0202 all cetacean sightings with on and off effort along cruise track and generalised ice coverage (light patches = fast ice, dark patches = pack ice)

(OPEN SQUARES = HUMPBACK WHALES, TRIANGLES = MINKE WHALES, CIRCLES = KILLER WHALES, DIAMONDS = SEI WHALES, CROSSES = FIN WHALES, STARS = LIKE BLUE WHALES, AND CIRCLES WITH CROSSES = UNIDENTIFIED WHALES)



*Passive acoustic methods*

During this cruise, sonobuoys were deployed opportunistically to supplement the information obtained from the visual observations, as well as the ARP data. Sonobuoys are expendable underwater listening devices. Four main components of a sonobuoy are a float, radio transmitter, saltwater battery, and hydrophone. The hydrophone is an underwater sensor that converts the sound pressure waves into electrical voltages that get amplified and sent up a wire (hydrophone depth can be set to 90, 400, or 1000 feet) to the radio transmitter that is housed in the surface float. The radio signal is picked up by an antenna and a radio receiver on the ship, then reviewed and simultaneously recorded onto a digital audio tape (DAT). Sonobuoy can transmit for a maximum of 8 h before scuttling and sinking. I deployed 2 types of sonobuoys: omnidirectional (57B) and difar (53B). Omnidirectional sonobuoys have hydrophones that can register signals up to 20 kHz, but they cannot determine the location of the sound source. DiFAR (DIrectional Fixing And Ranging) sonobuoys also have an omnidirectional hydrophone for recording sound, but it is limited to frequencies lower than 4.5 kHz. However, DiFARs also have 2 pairs of direction sensors, which along with an internal compass can determine the exact bearing of the sound relative to the sonobuoy. With 3 or more sonobuoys in the water it is thus possible to determine the location of the sound source. The Yagi directional antenna was used primarily during the cruise. The maximum range for the radio transmission during this cruise was 16 nm, but the range seemed highly dependent on weather conditions. The Sinclair omnidirectional antenna was also available throughout the cruise but the maximum range obtained by that antenna was less than 3 nm and it was, therefore, not used very often. The problem with having to use the Yagi all the time was that sonobuoys could be heard only while steaming in a straight line. Once we were at a station and the ship started turning, signal was quickly lost. There were several reasons for sonobuoy deployments. Firstly, they provide recordings that can be compared to the ARP data. This will provide a calibration on content as well as detection ranges. Secondly, they are a means of getting recordings outside of the seafloor array range. Lastly, they are a good complement to the visual observations and can help in positive identification of species when visual cues are not.

*Passive acoustic results*

Sonobuoys were deployed both when whales were visually detected and randomly throughout the cruise. A total of 62 sonobuoys were deployed: 57 omnidirectional and 5 DiFARs. Only 4 omni sonobuoys failed upon deployment, which is a satisfactory performance. Locations of all the deployments as well as a preliminary summary of the sonobuoys on which calls were heard can be seen in the complete (Fig. 2) and close-up (Fig. 3) maps of the study area. Further analysis of the recordings is needed to double check for calls that were possibly not detected during the preliminary review.

Species heard on the highest number of sonobuoys were blue whales. All 19 buoys that blues were heard on, however, were deployed in the northern part of the grid, either on the outer shelf or off the shelf break (where the loudest recording was obtained). No blues were heard on any of the sonobuoys deployed while steaming under ice or in Marguerite Bay. Blue whales were also heard on a couple of the sonobuoys deployed while steaming towards the grid stations.

Humpbacks were the second most commonly heard species; their calls were heard on 17 sonobuoys. Most of the calls resembled the song phrases that were recorded last year during GLOBEC I. The distribution of calling humpbacks, however, was quite different from the one observed during the last fall's cruise. They were heard on sonobuoys deployed while steaming along transect lines 4 and 5 on and off the shelf, and again in the same area as we were steaming north after the end of grid work. No humpbacks were heard in Laubeuf fjord, though, where a lot of them were recorded last year. Also, instead of being concentrated around northern tip of Alexander Island like they were last year, this year the humpbacks were more spread out along the shelf due west from the northern edge of Alexander. I heard humpbacks on one sonobuoy deployed in Crystal Sound and on both of the sonobuoys deployed in the Gerlache Strait during the steam back north.

A possible fin whale was heard on the northernmost deployed sonobuoy in the Drake Passage. No minke whale calls were heard in the preliminary analysis. Unidentified odontocete whistles were recorded twice, and clicks preceded those whistles on one occasion. Both of the recordings were obtained while ice was present. An unidentified seal was also heard on a sonobuoy deployed while we were steaming north from the end of the grid.

Figure 2. NBP 0202 Sonobuoy deployment locations with species heard on the sonobuoy marked. Calling whales can be heard at large distances from the sonobuoy so a detected call does not necessarily indicate immediate vicinity of whales.

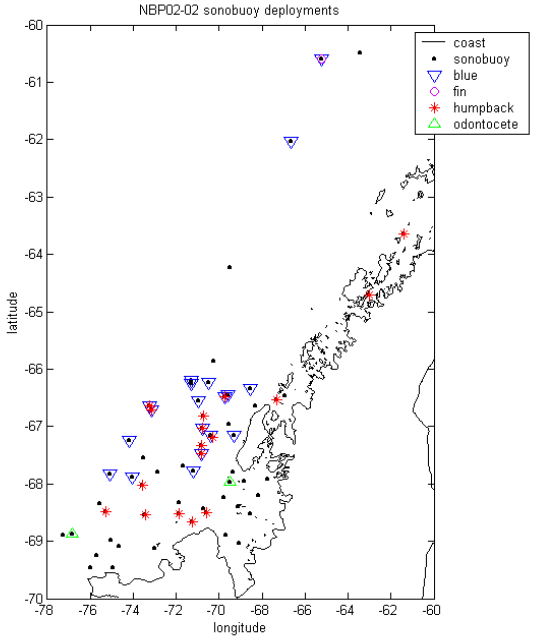
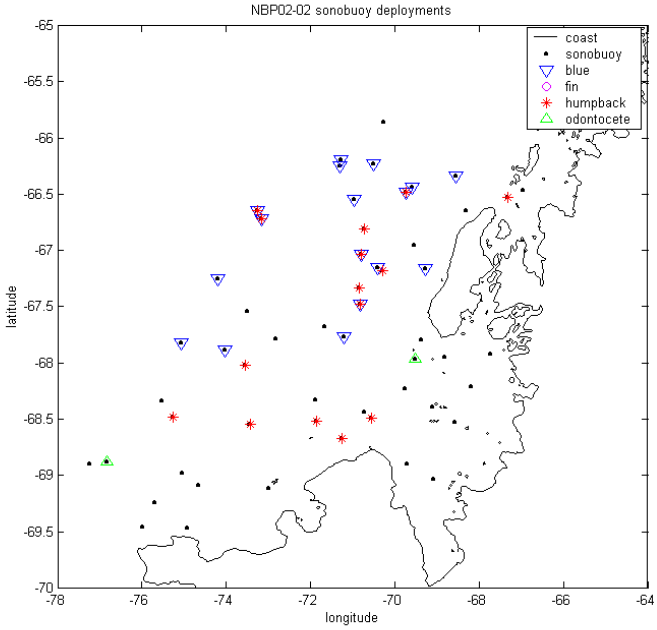



Figure 3. NBP 0202 Close-up of the study area with the sonobuoy deployment locations marked. If any calls were heard on the sonobuoy, it is marked with the appropriate symbol.



**INDIVIDUAL CRUISE REPORT II**

**LAURENCE M GOULD LMG 0203 - US SO GLOBEC AUSTRAL AUTUMN PROCESS CRUISE**

7 April to 20 May 2002

Visual survey, photo identification and biopsy data were collected on this cruise.

*Visual survey methods*

As for NBP 0202 – AND the L M Gould has a wrap around outside bridge viewing area which is generally ideal for visual survey. During this cruise, observations were made from the bridge level by a single observer (AF). When conditions permitted, the observer was located outside along the bridge wings, otherwise, observations were made from inside the bridge.

*Visual survey results*

Generally, sighting conditions were very good during the cruise. Fine visibility and sighting conditions prevailed throughout much of the work at or between inshore stations. The only bout of poor weather came during work at the offshore station. Seventy three (73) hours were spent on full survey effort during this cruise.

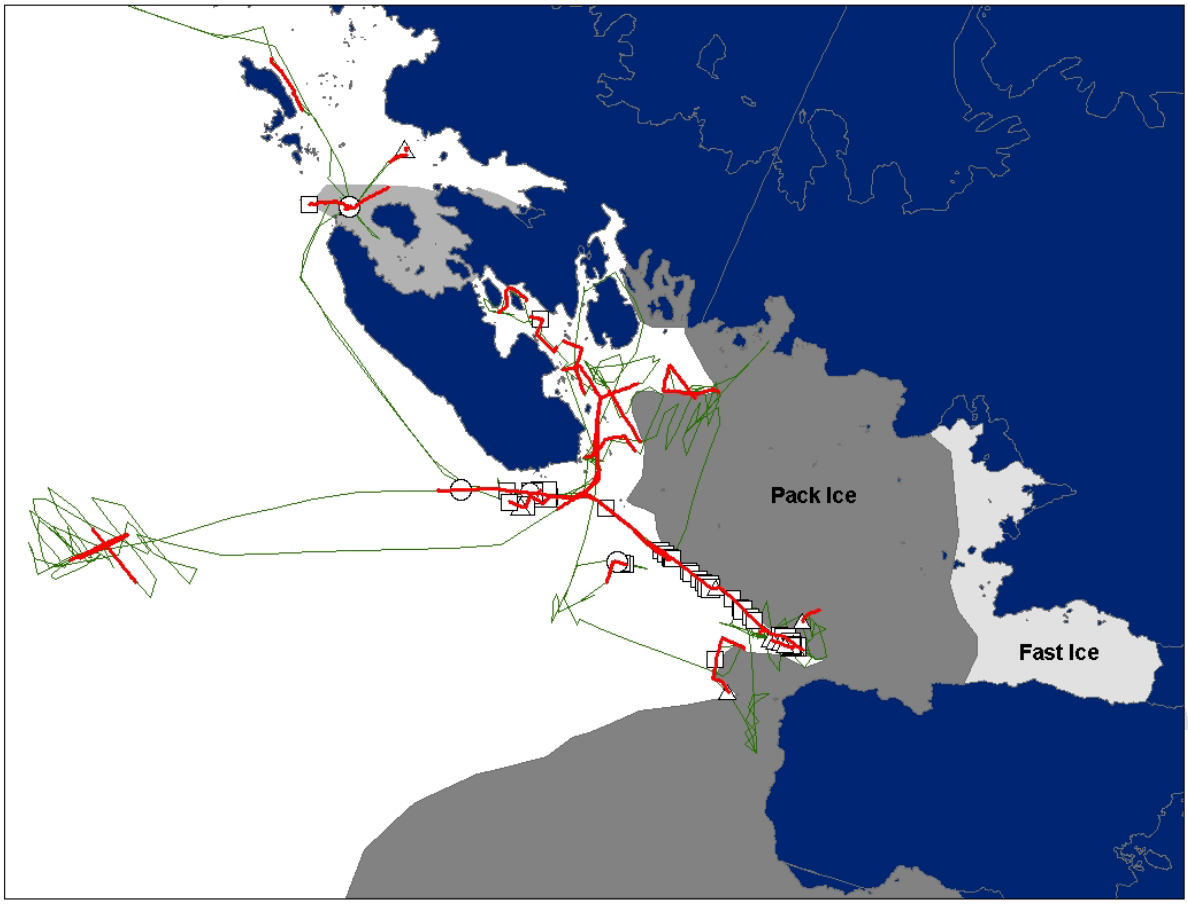
In Antarctic waters (south of 60°S), 93 sightings of 248 cetaceans were made. These included 15 sightings of 34 minke whales, 5 sightings of 44 orcas, 71 sightings of 168 humpback whales, and 2 sightings of 2 unidentified large cetaceans (Figure 1). With respect to humpback whales, the sightings were generally clustered in open water or near ice edges where large aggregations of krill were observed on the ACDP (Figures 3) (see M. Zhou et al. report). These areas were around Alexander Island, the western edge of the canyon bisecting Margeurity Bay (figures 4,5), Johnston Passage southwest of Adelaide Island, and the French Passage/Argentine Islands (see Zhou et al for details on krill distribution in these areas), and to a lesser extent the Bransfield Strait and Neumayer Channel between Port Lockroy and Anvers Island. Environmental conditions in and around Margeurite Bay were somewhat different than those encountered last year. Ice had already begun to form in the south and in the southern portion of the Bay, and by the end of the trip nearly all of Margeurite Bay had begun to freeze over with new ice. It is difficult to judge the true distribution within the study area from the data obtained from this cruise. The line transect grid survey data collected on the N.B. Palmer by D. Glasgow will be used in further spatial analysis. The data from this cruise, however, are a good indication of the relative distribution of baleen whales in nearshore waters and around 'hot spots' of prey distribution (krill) during the Austral fall and early winter.

Humpback whales were sighted with relative frequency from the Bransfield Straits at the northern reaches of the Peninsula to Alexander Island. High densities of humpback whales were seen in several areas where increased acoustic backscatter, associated with krill swarms, was observed. When the LMG was in transit south from Avian Island towards Alexander Island, over 50 humpback whales were seen in open water, clustered along the western edge of the deep canyon bisecting Margeurite Bay. Similarly, at the ice edge off Alexander Island over 2 dozen humpback whales were sighted. As the ice advanced in the following week, and the ship moved north, another aggregation of at least 25 humpback whales was seen at the southern portion of the Johnston Passage on the southwest coast of Adelaide Island. This area showed, along with the Alexander Island site, showed high densities of krill (Zhou et al. LMG 0203 cruise report).

Table 1. LMG 0203 All sightings

| CETACEAN SPECIES | NO. SIGHTINGS | NO. ANIMALS |
|---|---|---|
| minke whale | 15 | 34 |
| humpback whale | 71 | 168 |
| killer whale | 5 | 44 |
| unid whale | 2 | 2 |
| **Total** | 93 | 248 |

Figure 1. LMG 0203 All cetacean sightings with on and off effort along cruise track and generalised ice coverage. (open squares = humpback whales, triangles = minke whales, circles = killer whales, diamonds = sei whales, crosses = fin whales, stars = like blue whales, and circles with crosses = unidentified whales)




*Biopsy methods*

A second component to the marine mammal work is biopsy sampling from small boats. On the occasion that weather conditions, daylight, timing, and whales were present, biopsy sampling was attempted from Zodiacs. Samples were obtained with a Barnett Wildcat Crossbow equipped with custom made floating bolts, and screw-on hollow point biopsy plugs. The bolts are designed to penetrate the skin and blubber (depending on the size of the plug; either 1inch or 0.5 inches) to the end of the plug, where the float begins, and bounce out of the whale, securing a sample with three small barbs inside the plug. Skin samples are preserved in dimethyl sulfoxide solution and will be send to the National Marine Fisheries Service, Southwest Fisheries Science Center for genetic analysis. Blubber samples will be frozen for later use in contaminant, pesticide, heavy metal, etc. analysis.

*Biopsy and photo id results*

A total of 20 biopsy samples were collected during this cruise. All of the samples came from humpback whales. All 20 samples collected contained skin, while 19 also contained blubber samples. Biopsy samples were collected on three separate days during the cruise. The first 4 samples were collected on 11 April 2002 in the Bransfield Straits in open water (63 57S, 61 41W). The next 8 samples were collected on 1 May 2002 north and east of Alexander Island near an ice edge (68 44S, 69 52W). The last 8 samples were collected near the French Passage in the Argentine Islands in open water on 13 May 2002 (65 10S, 64 08W). Dorsal fin photos were taken for all but the final four whales that were biopsied. Blowing snow and difficult working conditions precluded using photo or video cameras during this final trip. Digital video was taken of all biopsy samples taken on 11 April and 1 May, and for the first 4 animals sampled on 13 May.

Three individual humpback whales were photo identified on LMG 0203.

**INDIVIDUAL CRUISE REPORT III**

**NATHANIEL B PALMER NBP 0204 - US SO GLOBEC AUSTRAL WINTER SURVEY CRUISE**

31 July to 18 September 2002

Visual survey data was collected on this cruise.

*Visual survey methods*

As for NBP 0202

During this cruise, observations were made from the ice tower of the vessel by a single observer (Francisco Viddi). The ice tower on the NB Palmer is situated above the main bridge and has 360˚ viewing. Most observations were made from the inside of the ice tower, but when weather/sea conditions permitted, the catwalk immediately outside the ice tower was used. The inside main bridge platform was also used for visual survey, usually when visibility was poor from the ice tower

*Visual survey results*

In total 319.72 hours of observation and 152.02 hours of sighting "on effort" ("Effective effort") (47.55% effectiveness) were made during the entire cruise NBP02-04. This effort was not evenly distributed over the survey grid sections, sea ice coverage being the main variable affecting observation time 136h within the study area. The total hours of incidental observations were 167.72 hours. The observation time spent within the study area totaled 264.65 hours from which 113.0 corresponded to "effective effort" (42.7 %). The average of observation hours per day was 7.61 (1.31 Standard Deviation - SD) and the average of effective effort hours per day was 3.62 (2.44 SD). Sighting conditions (viewing conditions) were variable during the cruise. The appropriate combination of environmental and ship conditions did not lend to long transit times for surveys "on effort". Nevertheless, the observation and effort values accomplished in this cruise are greater than the last winter cruise (NBP01-04), which made almost 110 hours of effort, but less than the last cruise (NBP02-02) during which 183.57 effort hours were achieved. A total of 39 cetacean sightings of 64 animals were made during the cruise (Table 1). In Antarctic waters (south of 60ºS), 38 cetacean sightings of 60 animals were made. These include 31 sightings of 54 minke whales, one sighting of 2 "like" humpback whales, one sighting of 1 killer whale, three sightings of 4 unidentified whales, one sighting of 1 unidentified whale/dolphin and one sighting of an unidentified ziphiid. All of the sightings south of 60ºS, except the "like" humpback whales and the unidentified ziphiid, were from within the study area as defined by the survey grid.

*Discussion*

As stated earlier, a primary research objective of the cetacean studies within SO GLOBEC is to determine the winter distribution and foraging ecology of baleen whales in relation to the characteristics of the environment and the distribution of their prey. In the first week of the cruise, only two sightings were made. In Drake Passage while steaming south, a small whale was sighted but not identified. The second sighting was made in the southern region of Gerlache Strait. Two 'like' humpback whales were observed very close to shore. This sighting remained as 'like' humpback as there was no opportunity to confirm species. Surface swimming and blow patterns of these whales were like those produced by humpback whales. This becomes a very interesting sighting (if those whales were really humpbacks) due to the season (winter) of the observation. The area where these whales were seen was also an area of high concentrations of other marine mammals (Antarctic fur seals, elephant seals and crabeater seals, and seabirds). These observations were correlated with the vertical temperature distribution, which showed the intrusion of Circumpolar Deep Water from Drake Passage through Boyd Strait and into Bransfield Strait (CTD data). Only three days after the "like" humpback observation, the first minke whale *(Balaenoptera acutorostrat*a) was sighted (after this almost all sightings made during the cruise were minke whales). This observation was made while work was ongoing at several stations in Crystal Sound just before entering the SO GLOBEC grid. Vertical temperature distribution in this area indicated that the trough that extends into Crystal Sound from the continental shelf was filled with Circumpolar Deep Water modified by mixing with the overlying Antarctic Surface Water. This whale was seen in a very narrow lead of open water where the sea ice was consistently around 9/10 coverage. Also present was an abundant quantity of krill (mainly *Thysanoessa* sp*p.* in all stages) and ctenophores at depths of 200-300 m. The first Minke whale observed within the study area (SO GLOBEC grid) was at the limit of the northern and central sector of the grid. The animal was seen surfacing in a narrow lead of open water and once again, this observation could be

correlated with the presence of Circumpolar Deep Water extending from 300 m to 500 m along the northern side of the Marguerite Trough. The best days for Minke whale sightings were 11 and 14 August. Seven different sightings were made totaling 18 whales. These observations were made at the southern sector of the grid . The vertical hydrography in the area showed a homogenous layer (Winter Water) and the presence of Modified Circumpolar Deep Water. The presence of this water mass indicated that no intrusions of Circumpolar Deep Water were present. The sightingson 11 August were correlated with a dense patch of "something" (probably krill) was present in the water early that morning as detected by the ADCP. These dense concentrations of potential food could explain in part the presence of whales and their high activity in the area. The BIOMAPER-II also detected an important patch of high amplitude backscatter between the surface and 150 m. In fact, one of the whales, which was spy-hopping through very small cracks in the ice pack, had its mouth full of water, evidence of feeding behavior. Finally, it is important to mention that the sea ice coverage and thickness observed that day were not a constrainton the whales activity. On both 11 and 14 August, while the *N.B. Palmer* was stationary (at station or assisting the *Gould* to set up for their process station) whales were observed blowing and spy-hopping for more than three hours. Between the second and third Minke whale sighting, an orca was observed spy-hopping not far from the baleen whales.

Four sightings of Minke whales were made during 15 and 16 August, totaling seven whales. These observations were made on transect 10 in the southern sector of the grid. The vertical physical properties along this transect showed the presence of the southern boundary of the ACC. One of the sightings made on 16 August was correlated with a high number of crabeater seals (120) along the edge of a lead of open water. During these two days, and during a BIOMAPER-II tow, very dense patches between the surface and 100 m (on 15 August) and between 100 and 150 m (on 16 August) were detected (this last one, one of the densest patches of backscatter seen on all four SO GLOBEC cruises). Two minke whales and one unidentified whale were sighted during 17 and 18 August. During 17 August, backscattering data collected with BIOMAPER-II varied from being low throughout most of the water column to having dense krill-like patches between 50 and 100 m.

Cetacean sightings were particularly numerous in the southern and south-central sector of the SO GLOBEC grid. A correlation was observed between cetacean sightings and the presence (detection) of dense krill patches. Cetacean observations were also correlated with other predator occurrence, such a crabeater seals and penguins.The data collected during the second year of the U.S. SO GLOBEC study demonstrates that whales can be found in the Marguerite Bay area throughout the winter (as stated in the last winter cruise). Understanding the changes that occurred from the first winter cruise to the second will greatly enhance our understanding of the environmental conditions that are critical to cetacean habitat during austral winter in Marguerite Bay. Continued analyses and collection of cetacean sightings data in conjunction with concurrent prey and hydrographic distributions will allow determination of the causal relationships underlying austral winter cetacean distributions in the Antarctic Peninsula region.

Figure 1.NBP 0204 All cetacean sightings with on and off effort along cruise track and generalised ice coverage (open squares = humpback whales, triangles = minke whales, circles = killer whales, diamonds = sei whales, crosses = fin whales, stars = like blue whales, and circles with crosses = unidentified whales)

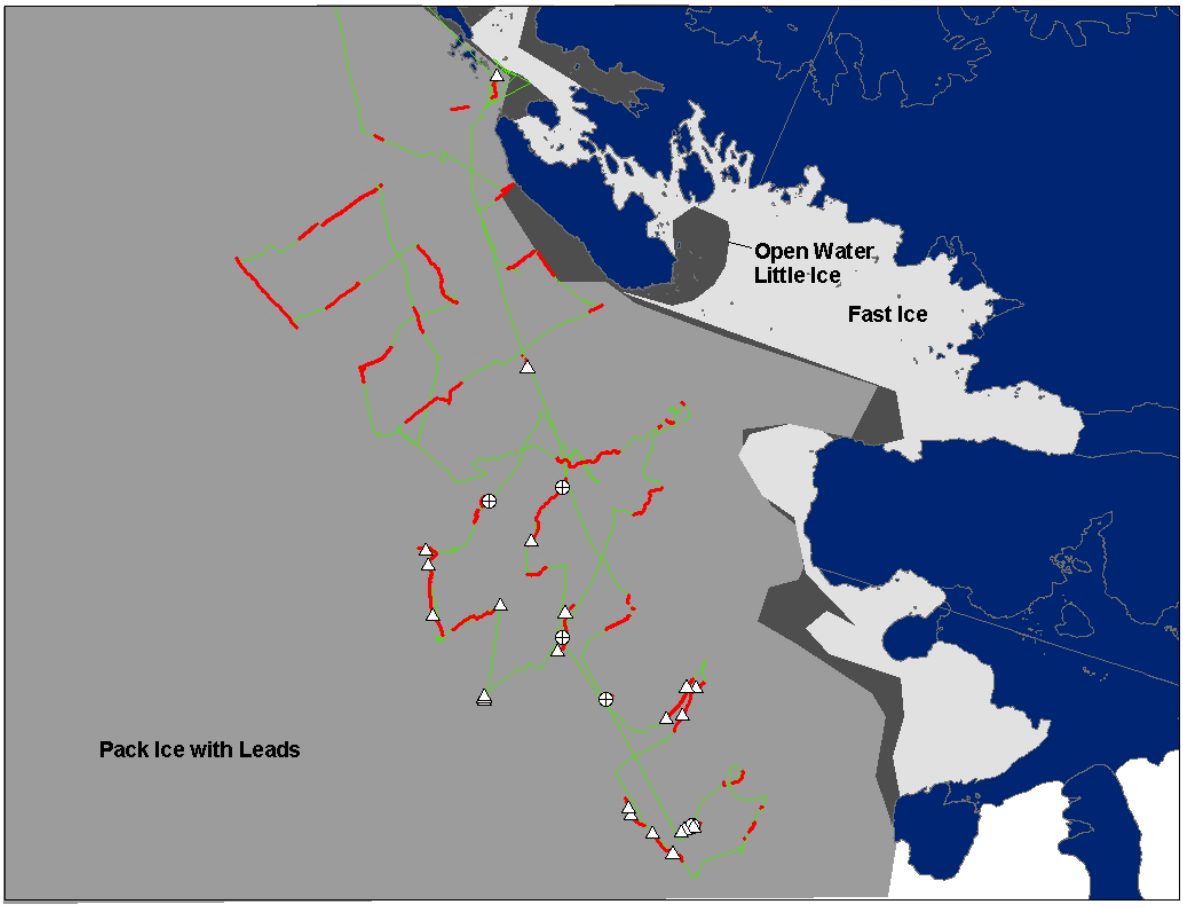



Table 1.NBP 0204 All cetacean sightings made south of 60°S

| | Sightings | Number of animals |
|---|---|---|
| minke whale | 31 | 54 |
| "Like" humpback whale | 1 | 2 |
| Killer whale | 1 | 1 |
| Unidentified ziphiid | 1 | 1 |
| Unidentified Whale/Dolphin | 1 | 1 |
| Unidentified Whale | 3 | 4 |
| Total | 38 | 63 |

**INDIVIDUAL CRUISE REPORT IV**

**LAURENCE M GOULD LMG 0302 - US SO GLOBEC LATE AUSTRAL SUMMER MOORING CRUISE**

**13 February to 7 March 2003**

Visual survey, photo identification, biopsy and passive acoustics data were collected on this cruise.

*Visual survey methods*

As for NBP 0202

The L M Gould has a wrap around outside bridge viewing area which is generally ideal for visual survey. During this cruise, observations were made from the bridge level by two or more observers (DT and DG). When conditions permitted, the observers were located outside along the bridge wings, otherwise, observations were made from inside the bridge.

Visual survey results

Visual survey was conducted in daylight hours throughout the cruise, when visibility and weather conditions permitted. Over 200 hours of visual survey effort was conducted. Humpback whales made up the majority of sightings (Table 1.). The main objectives of the cruise were to recover SIO and WHOI moorings and redeploy one SIO mooring on the northern LTER transect line. In addition, ship time was allocated to the visual survey, photo identification and biopsy program. The objectives of this program were to: conduct visual survey throughout the SO GLOBEC study area in the Western Antarctic Peninsula; focus ship time effort on geographical areas and/or at physically defined features (ie. the ice edge, Matha Strait, southern Adelaide Island, waters over deep troughs, NE end of Alexander Island) where whales had been found in concentrations and/or feeding during the previous spring, autumn and winter SO GLOBEC cruises; to obtain photo identification records and tissue biopsies from whales in these areas.

Humpbacks were numerous, as usual in the Bransfield and Gerlache Strait, and around Palmer Station. After leaving Palmer Station the ship worked offshore, just over the shelf break to recover moorings. Sighting conditions were not good throughout this part of the cruise due to sea and wind conditions, and hardly any sightings were made. One notable exception occurred during the recovery of the SIO ARP (acoustic recording package) #2. More than 20 sei whales in 5 groups were observed in the area, very active at the surface and feeding (side lungeing observed). Sonobuoys were deployed, and the ship remained stationary and declutched to reduce interference. A wide range of calls were recorded over the next two hours (see acoustics report). These high quality recordings are exceptional because acoustic detections from this species have rarely been made, and this species is generally believed to be infrequent callers.

The next part of the cruise was conducted within Marguerite Bay (northern end). WHOI and SIO moorings were retrieved, detected or dragged for over a number of days. During transits around the Faure Shallows (22 February) many humpbacks and minkes were detected visually (see maps). Most humpbacks sighted here were in the region of the shallows that abuts the eastern end of the deep trough that runs in to the bay around the southern end of Adelaide Island. Feeding behaviour was frequently observed here.

On the 24$^{th}$ February we surveyed what was left of the sea ice by following the outer 'ice edge' from well NE of the tip of Alexander Island in a SW direction, crossing the major trough which bisects Marguerite Bay and George VI Sound. Killer whales, humpbacks and minke whales were recorded here, with humpbacks dominating. Individual photo identification records and tissue biopsy samples were collected from humpback and minke whales along the ice edge during the day. The ship then transited back to the northern end of Marguerite Bay for drifter and mooring work.

Ship time was again made available to the marine mammal survey program on 26$^{th}$ February. We chose to head for Matha Strait – an area of consistently high whale and krill concentrations throughout the 2001 – 2002 SO GLOBEC surveys. As the ship broke through ridge and rafted sea ice into the southern end of Laird Island, humpbacks were again found in abundance. The ice edge here provided a rich feeding area for over 50 humpbacks and a small number of minke and killer whales. Zodiac work (photo id, biopsy, feeding behaviour observations and photo records) was carried out throughout the afternoon.

Humpback groups were also concentrated outside Deception Island on 1 March, and on the transit from the island to Palmer Station through the Straits that afternoon and evening. This species were also abundant as we crossed Dallman Bay, headed for the Drake Passage on the 3$^{rd}$ March. At the northern end of the bay we

observed three humpbacks (including a calf) surrounded by a very large, but also very spread out, group of killer whales. A few of the killer whales were closely shadowing the humpbacks, but did not appear to be seriously intending to attack. Some of the killer whale group were observed tail slapping in unison for some time. This group appeared to be the small 'fish eating' type, rather than the mammal eating type of killer whale. Excellent survey condition were experienced on the first day of transit back across the Drake Passage and an entire afternoon of constant fin whale sightings kept everyone busy as we sailed across uncharted shoals and ridges. Many fin and a couple of blue whales were recorded on sonobuoys here.

*Photo identification results*

Sixty nine individual whales were photo identified on LMG 0203 (3 sei, 5 minke, 4 killer whales, 2 fin, 55 humpbacks).

Table 1. LMG 0302. Cetacean sightings/no. of animals

| Species – common name | sightings | animals |
|---|---|---|
| Fin whale, like fin whale | 23 | 65 |
| Sei whale | 5 | 22 |
| Minke, like minke | 17 | 36 |
| Killer whale | 3 | 38 |
| Unidentified cetaceans | 13 | 26 |
| Hourglass dolphin | 3 | 13 |
| Humpback, like humpback | 116 | 320 |
| TOTAL | 180 | 520 |

Figure 1. LMG 0302 All cetacean sightings with on and off effort along cruise track and generalised ice coverage. (open squares = humpback whales, triangles = minke whales, circles = killer whales, diamonds = sei whales, crosses = fin whales, stars = like blue whales, and circles with crosses = unidentified whales). Ice (LIGHT PATCHES = FAST ICE, DARK PATCHES = PACK ICE)

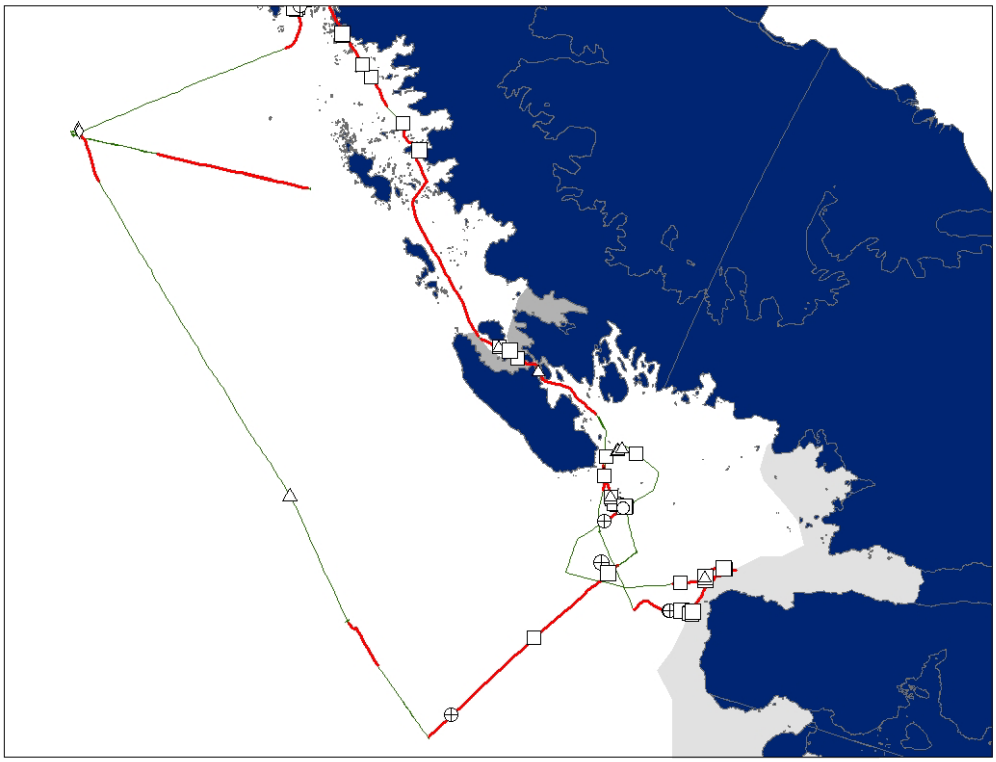
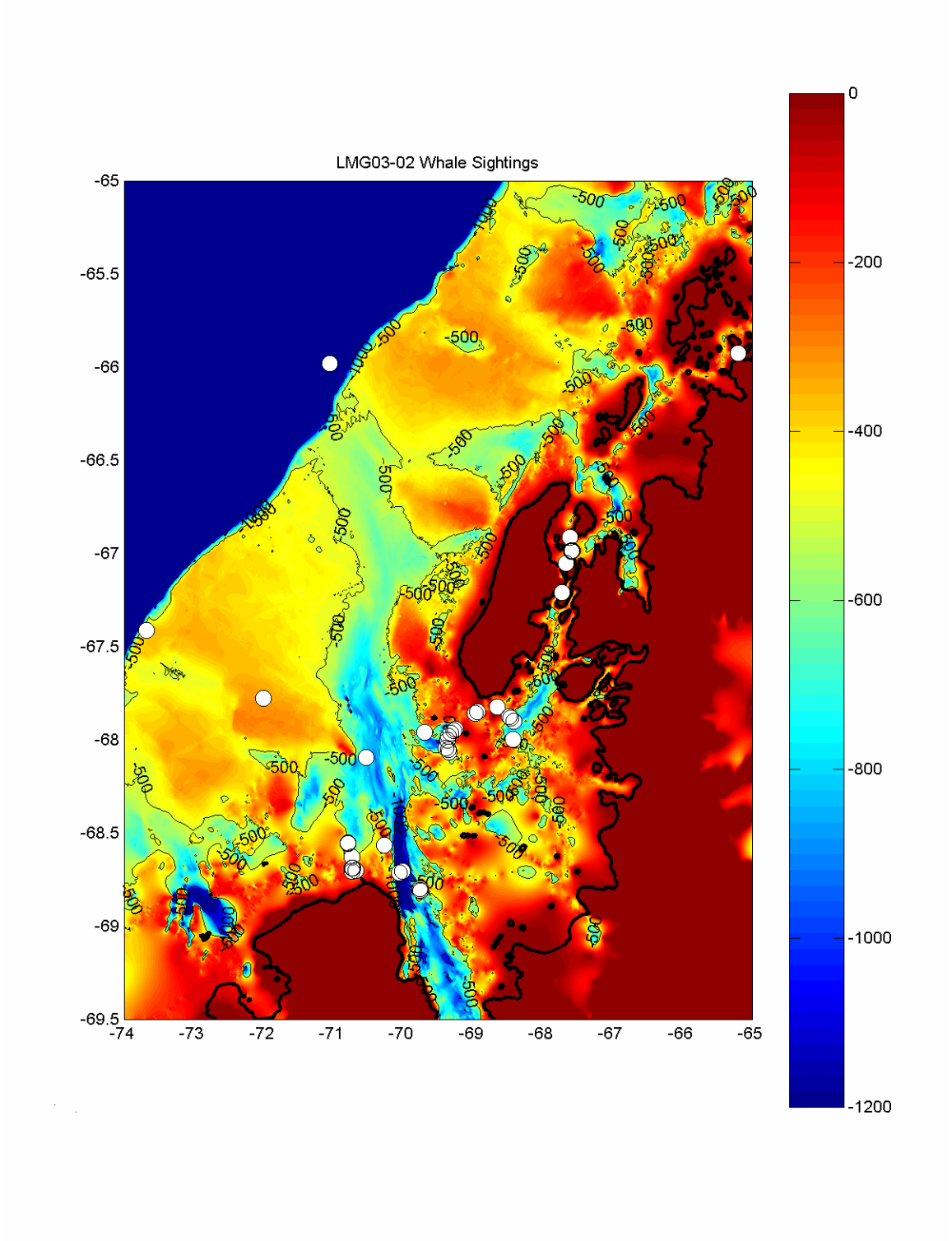


Figure 2. LMG 0302. Bathymetry of the study area with LMG 0302 sightings plotted. (all species open circles)




*Passive acoustics report*

The primary goal of this project is to determine the minimum population estimates, distribution and seasonality of mysticete whales within the West Antarctic Peninsula region. These data will be integrated with the SO GLOBEC environmental data set to improve understanding of baleen whale distribution and seasonal abundance in the area. The species of interest are blue: (*Balaenoptera musculus*), fin (*B. physalus*), humpback (*Megaptera novaeangliae*) and minke (*B. bonaerensis*) whales, southern right whale (*Eubalaena australis*), sperm whale

(*Physeter macrocephalus*), killer whale (*orcinus orca),* as well as Southern Ocean seals such as crabeater (*Lobodon carcinophaga)*, Weddell seal (*Leptonychotes weddellii*) and leopard seal (*Hydrurga leptonyx*).

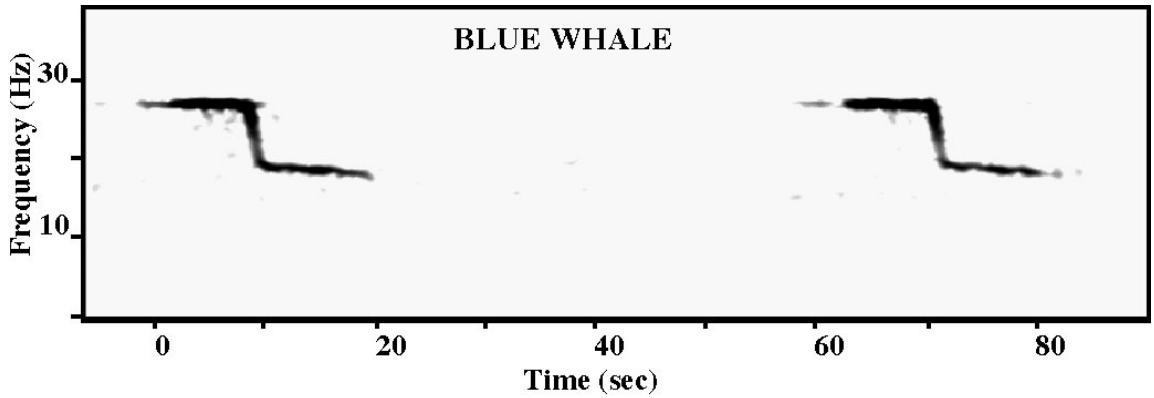



Figure 2. LMG 0302 Antarctic blue whale calls recorded on the ARPs. The call is a 28 Hz tone of 10 s duration, followed by a 1 s down-sweep (28-19 Hz) and a 10 s slightly down-swept tone (19-18 Hz).

A key task for the LMG0302 cruise was to recover 7 bottom-mounted acoustic recording packages (ARPs) and to redeploy one ARP at site 1, co-located with an LTER station . The ARPs consist of a data logging system with two 18-GB hard disks, an acoustic release, and a hydrophone component floating 10 m above the mooring. They sample acoustic data continuously at 500 samples/s over the 12 months of the deployment. Also during this cruise, sonobuoys were deployed opportunistically to supplement the information obtained from the visual observations, as well as the ARP data. Sonobuoys are expendable underwater listening devices. Sonobuoys detect underwater sounds, which get transmitted to the underway ship using radio waves. These sounds can be reviewed for whale calls in real-time and simultaneously recorded onto a digital audio tape (DAT). We deployed two types of sonobuoys: 57B omni-directional sonobuoys that record broadband (20Hz – 20 KHz) acoustic data, and 53B DiFAR (Directional Fixing And Ranging) sonobuoys that can be used to determine the exact bearing of the sound.

All seven ARPs deployed last year were successfully recovered during this cruise, and all instruments came back in good condition (see Figure 1 for ARP locations). There was evidence of slight corrosion on the shallow water instruments (S7 and S9). Six instruments (S1A, S2A, S5A, S6A, S7A, and S9) yielded complete, high quality acoustic data sets. One instrument (S4A) had low gain on its hydrophone, resulting in only partial data return. One instrument was serviced, batteries and disks were replaced, and then deployed at site 1B, co-located with an LTER station.

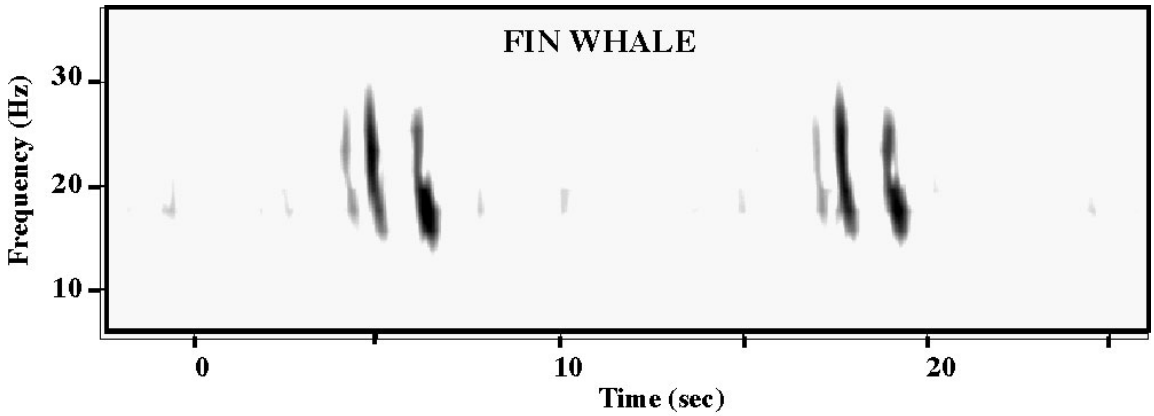



Figure 3. LMG 0302. Antarctic fin whale calls recorded on the ARPs. The call produced by the whale is a single down-swept pulse (30-15 Hz). Multipath propagation produced 2 additional pulses.

Preliminary analysis of the ARP data show high numbers of calls on all instruments. Blue whale calls are present in large numbers, and there is evidence of calling blue whales year round. Blue whale calls are more frequently detected along the shelf break (S1A, S2A, S5A, S6A) than on the shallow water instruments (S7A, S9). Fin whales are present seasonally, with stronger fin whale calls heard on the instruments from the shelf break. Minke whale calls are seen most frequently in the shallow water instruments, as were seal calls, mostly likely crabeater seals. An unidentified call (Figure 15) was heard frequently again this year on all instruments, showing higher call presence during the ice-covered periods. The source of these sounds is still not known, but they are suggestive of minke whale song. During winter time these calls are so abundant that they create a band of high ambient noise near 150 Hz.

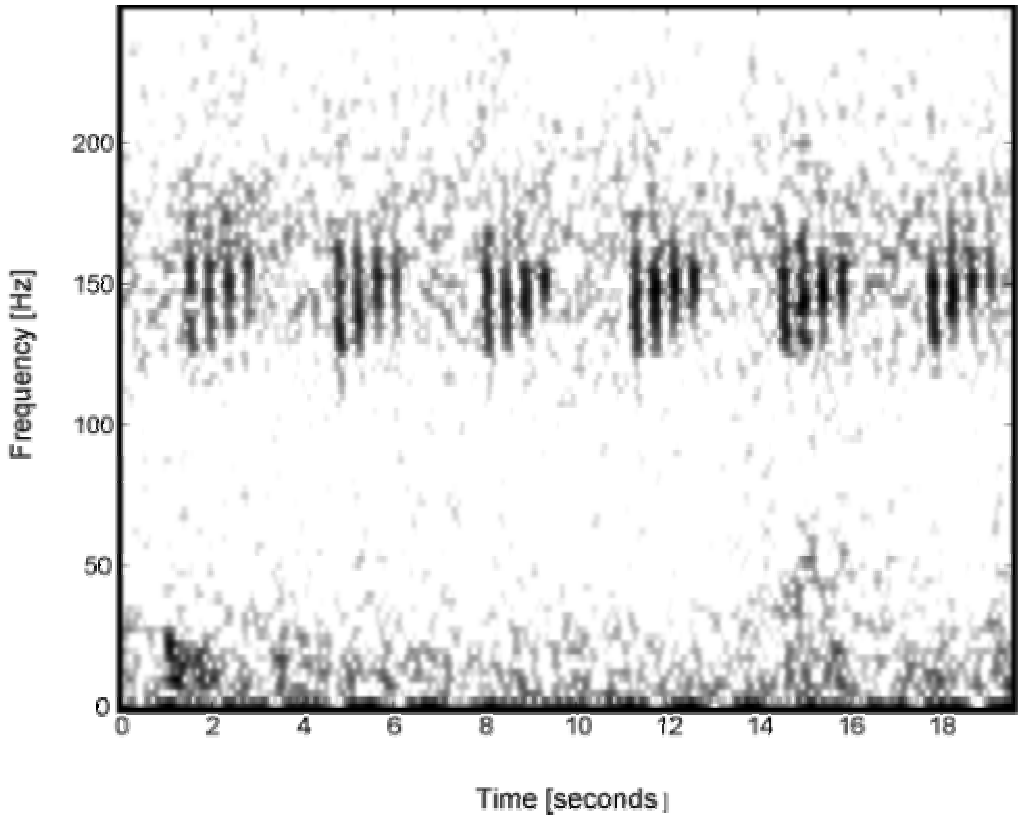



Figure 4. LMG 0302. Unidentified calls recorded on the ARP S-6, day 247, 1813 GMT. A quadruplet pulse near 150Hz repeats on a 3 second interval. High ambient noise at 150 Hz is from the production of many of these "songs" in the nearby region.

Sonobuoys were deployed both when marine mammals were visually detected and randomly throughout the cruise (Figure 16). A total of 33 sonobuoys were deployed – 26 omnidirectionals (type 57B) and 7 DiFARs (type 53B). The locations of all the deployments are shown in Figure 16 and given in the cruise event log (Appendix 2). Whale species heard and the number of sonobuoys which detected them are: blue (3), fin (5), humpback (5), minke (2), sei (2), right (1) and sperm (1) (Figure 17). The detection of sei whale by sonobuoys was a significant event. This is the first time that low frequency acoustic signals have been recorded from sei whales anywhere. The characteristics of these signals will be useful to help located sei whales in the ARPs, and therefore determine sei whale seasonality in the West Antarctic Peninsular region. In recognition of this we will devote attention to these data in the present cruise report. See also the visual sighting description of this event in the next section of the cruise report.

On February 19, 2003, at about 1310 GMT, blows were sighted which were later recognized as sei whales near ARP S2, which was floating on the surface while the ship searched for it. Upon realizing sei whales were present, a type 53D sonobuoy was deployed at 1400 and a type 57B at 1405. At 1413 the ship's 3.5 kHz sonar was secured and we began to receive clear whale calls on both sonobuoys. The ship stopped at 1421 to maintain good radio contact with the sonobuoys and yet keep ship noise distant from the sonobuoys while the whales remained near the sonobuoys. At 1555 the ship continued on its way and sonobuoy contact was lost about 1700.

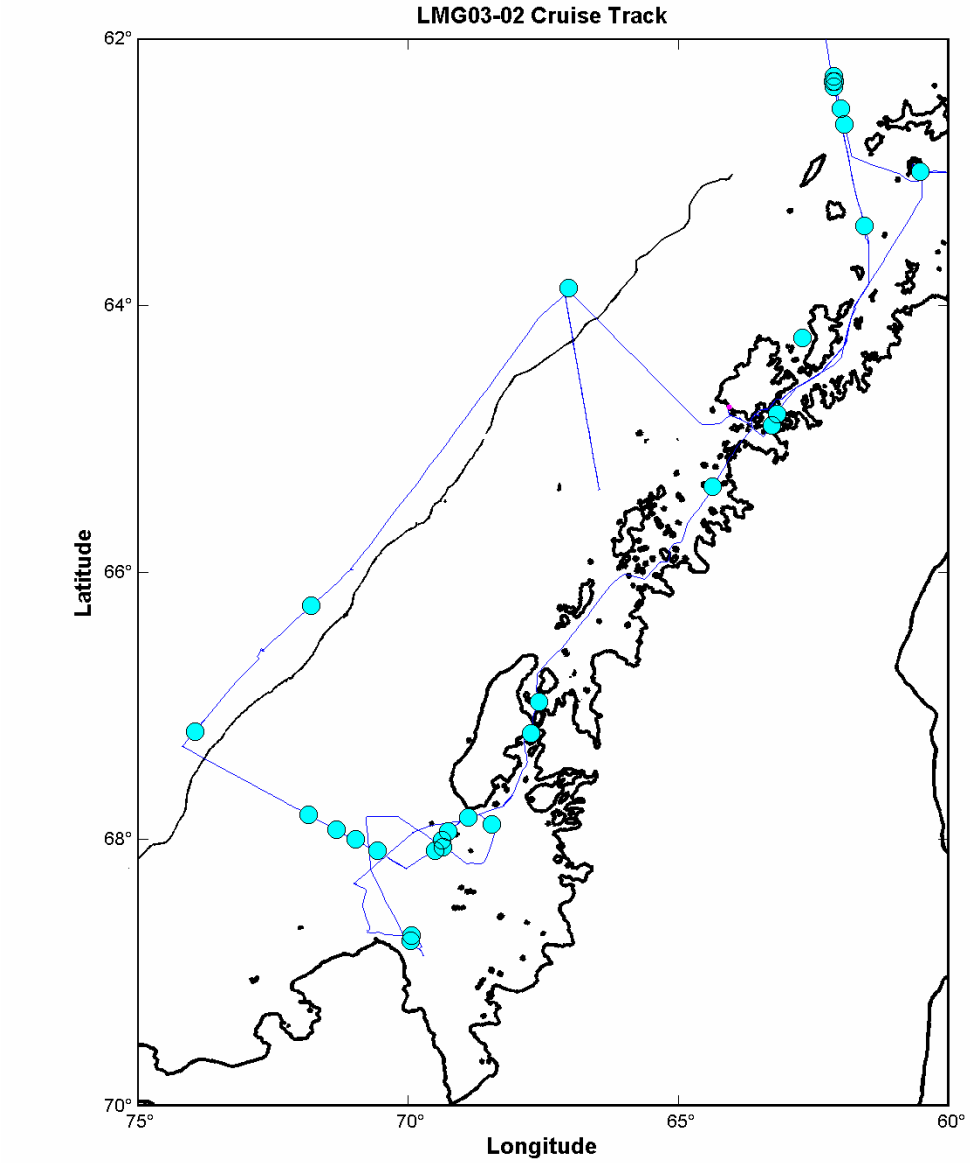



Figure 5. LMG 0302. Locations of sonobuoys deployed during LMG0302 south of 62° S. Sonobuoys were also deployed north of 62° S but not shown here.

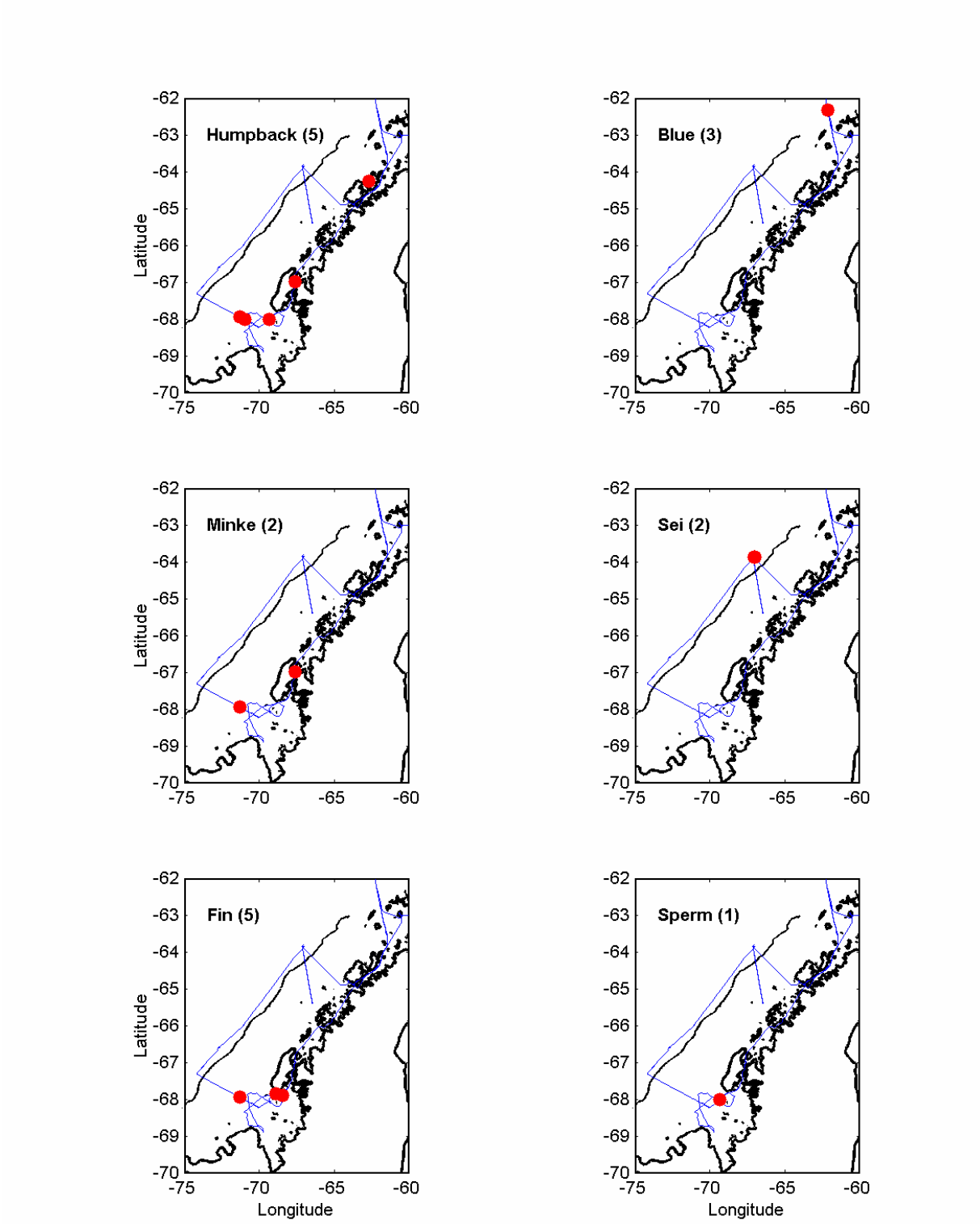



Figure 6. LMG 0302. Locations of whales captured by sonobuoys deployed during LMG0302 south of 62° S.

During the nearly three hours of recordings from the two sonobuoys, whale calls were observed at a rate of about one per minute for a total of nearly 200 whale calls from this group of about 15 sei whales. Using the directional information from the DIFAR buoy and time differences between the two buoys many of the calls can be located geographically and source levels can be computed. Sei whales have only rarely been recorded and never so well

as in this instance, none of the previous reports having been published in any detail. The few reported recordings of sei whales sound nothing like the calls recorded in this instance. These recordings will result in a technically complete and detailed publication on the sounds of sei whales in the Antarctic. The sounds were a series of tones and sweeps generally in the 200 to 600 Hz range with durations of one to three seconds. There were also a number of sounds which can be described as whooshes or growls, which are more difficult to quantify. The unique quality of the sei whale sounds which distinguishes these recordings from those of any other whale is the manner in which the tones and sweeps suddenly step up or step down in frequency during the call. Often but not always these steps occur at harmonic frequencies.

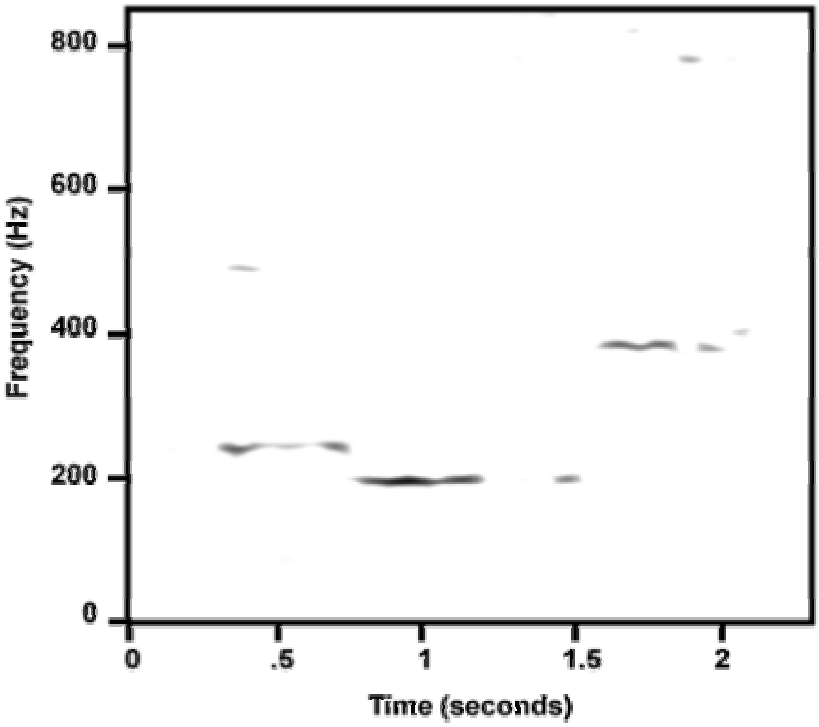



Figure 7. LMG 0302. A spectrogram of one call from a sei whale. The distinctive and unique character of the sei whale calls recorded in this encounter is the frequency stepping in the tonal and swept frequency calls which often occur at harmonic frequencies.

**INDIVIDUAL CRUISE REPORT V**

**RRS JAMES CLARK ROSS JR82 - UK/BAS SO GLOBEC AUSTRAL SUMMER SURVEY CRUISE**

**7 January to 23 February 2003**

*Survey area and general methods*

The survey design followed a pattern of north-south zig-zag transects conducted from west to east across the Scotia Sea with more detailed transects around the island of South Georgia. The area covered was similar to that of the IWC-CCAMLR survey in 2000 but did not extend as far west. All effort was in passing mode. This involved two crossings of the Polar Front (formerly referred to as the Antarctic Convergence) and eight crossings of the Southern Antarctic Circumpolar Current Front (SACCF). The southern end of each transect was determined by the northern limit of the pack ice. Sampling stations were spaced at 60 mile intervals along each transect. At each sampling station the vessel was stopped and CTD (Conductivity Temperature Depth) casts and plankton samples were collected. In addition, target fishing for krill was conducted at stations to sample swarms indicated by a Simrad EK60 multiple frequency echo-sounder. Cetacean observations were conducted whenever weather conditions allowed while the vessel was underway on transect. The usual transect speed was $5ms^{-1}$ (10 knots) and a number of underway data were collected including measurements of krill abundance from the EK60 and CTD profiles from an Undulating Oceanographic Recorder (UOR).

Visual survey, photo identification and passive acoustics data were collected on this cruise.

*Visual survey methods*

Observations were conducted according to the protocol used for single platform observations during the IWC-CCAMLR survey in 2000 (Reilly *et al.,* 2000). Two observers searched a $180^{o}$ sector ahead of the vessel with 7x50 binoculars. Observations were made from the roof of the bridge (Monkey Island) behind a wind deflecting screen on the roof of the bridge at an eye height of 18.3m. If rain made observations from the Monkey Island difficult then observations were made from inside the bridge from an eye height of 16m. Sightings and environmental data were entered directly into a computer running the Wincruz software. Data from the vessels underway monitoring system were also recorded including wind speed, sea temperature and salinity. A full description of the database structure, field data codes, and definition of data categories is given in Appendix I. Range to each sighting was measured from the angle of dip from the horizon to the whale using Fujinon 7x50 reticle binoculars. Bearings to sightings were recorded by lining up reference marks at $10^{o}$ intervals in a semicircular pattern of around 1m radius from the observer on the deck, with equivalent $10^{o}$ marks on the windshield (see photo). In addition, one observer used a photogrammetric system for measuring range and bearing (Leaper and Gordon, 2001). It had been hoped that both observers would be able to use the system but one set of equipment was lost by airline baggage handlers. To ensure consistency between observers and other surveys, priority was given to recording distance and angle using the reticle binoculars and angle reference marks. Higher magnification, Nikon 10x50, binoculars were also used to assist species identification and group size estimation. In addition to the cetacean sightings, data on pinniped and penguin sightings were also recorded. Whenever possible, range and bearing was recorded to all pinniped sightings. However, in areas of high fur seal density, only fur seals within 150m either side of the vessel were recorded. Other seabirds were only noted if any unusual behaviours were observed that might relate to the presence of prey species.

Detailed data on ice conditions were recorded using the ASPeCt (Antarctic Sea Ice Processes and Climate) protocol, whenever the area of sea covered by ice was greater than 5%. If icebergs were present but cover was less than 5% then the number of icebergs in a $180^{o}$ arc ahead of the vessel were recorded as a comment. It was not possible to conduct distance and angle experiments using radar on fixed targets. However, the photogrammetric measures of range and bearing allowed comparison between visual estimates and measured values to actual sightings. In addition, some measurements were made to fixed targets to allow comparison with angle and distance experiments conducted on other surveys.

*Visual survey results*

Survey effort

The cetacean survey effort is shown in figures 1-4. Total effort was 220 hours. Most of the survey effort was conducted in deep water with only 7% in depths of less than 200m. Distribution of effort by depth is shown in table 1. Sea surface temperatures ranged from –1.6 to $8.8^{o}C$ with the distribution of effort by sea surface

temperature shown in table 2. A total of 95 n.miles of effort were conducted in estimated ice cover of greater than 5%, this amounted to 4% of the total effort. Environmental variables that could be related to sighting probability included visual estimates of sea state, overall 'sightability' and minke whale visibility. In addition, wind speed and solar radiation were measured by the ship's instrumentation system. Restricting analysis to effort in sightability 'moderate to excellent' and wind speeds of less than $12ms^{-1}$ results in 1672nm of effort compared to a total effort of 2237nm. This would include 203 out of 214 sightings and only exclude 2 sightings identified to species level.

Cetacean sightings

Table 3 lists the number of on-effort sightings and total number of individuals by species. The locations of some of these are also shown on figures 1 - 4. In addition, two species, Commerson's dolphin (*Cephalorhynchus commersonii*) and Gray's beaked whale (*Mesoplodon grayi*) were also sighted off-effort (table 4). The locations of all sightings relative to the vessel are shown in figure 5 Some degree of rounding in radial distances is evident corresponding to a division of 0.1 reticles (the Wincruz software rounded all reticle readings to the nearest 0.1 reticles). Analysis of the ranges and bearings measured photogrammetrically provide additional data with a measured level of accuracy, for comparison. A preliminary comparison of estimated distances against measured (figure 6) indicates no substantial bias in distance estimation and moderate variance. Analysis of bearing estimates suggested a root mean square error of around $5^{o}$. Further analysis of these data is planned. Distribution of perpendicular distances to species with similar strength and type of visual cue are shown in figures 7-10. Fin whales were generally observed north of the SACCF (Southern Antarctic Circumpolar Current Front) whereas minke whales were predominantly observed to the south of this and towards the southern ends of the transects. Sei whales were also observed to the north of the SACCF and sometimes associated with right whales, but not in the same areas as fin whales. Of 16 sightings in greater than 5% ice cover, 2 were right whale, 1 was killer whale and 13 were minke whale.

Pinniped sightings

Table 5 lists sightings of pinnipeds with the proportion of sightings of animals hauled out on ice. Fur seals were the most frequently encountered pinniped, often at great distances from ice or land. Almost all the sightings of crabeater and leopard seals were on or close to ice.

Discussion

The generally good weather conditions during the survey allowed a greater amount of survey effort than had been expected. The amount of effort was around 50% greater than that achieved from the James Clark Ross during the CCAMLR synoptic survey in 2000. The area covered by both surveys was broadly similar and the two data sets should prove comparable due to similar survey protocols and the fact that both observers on this study were also involved in the CCAMLR survey.

The use of photogrammetric methods proved an effective way of measuring radial distance and bearing to sightings. In addition, these methods provided the equivalent of distance testing experiments for estimating the variance of distances based on reticle readings and estimated angles. This is especially important for multi-disciplinary cruises where dedicated ship time is not available for distance experiments.

One encounter of particular interest to the SOWER 2000 objectives was on 4th February 2003. Observation conditions were ideal and a mixed group of 16 humpback, 3 right whales and 1 minke whale were seen in the vicinity of a large, dense swarm of krill about 0.5nm by 0.3nm and around 60m deep. Apart from this single swarm, acoustic measurements indicated low krill densities in the area. The ship passed through the swarm three times and locations of the whales were measured relative to the ship using the video tracking methods. This should allow analysis of the locations of the whales and movements in relation to the swarm together with behavioural observations over a period of several hours.

The detections of six individuals in two groups of sperm whales are unlikely to be sufficient for strip width estimation. This number of sightings is consistent with previous visual and acoustic surveys in the Scotia Sea and around South Georgia from RRS James Clark Ross. In the detailed surveys around South Georgia, sperm whales were encountered in the same localised area as these previous surveys (Leaper *et al*., 2000). Observations of Gray's beaked whale were also of particular interest. The long-held view on the occurrence of Gray's beaked whale is that it covers a circumglobal distribution in temperate or cold temperate waters of the southern hemisphere between 30º and 45º (e.g. Marcuzzi and Pilleri, 1971; Ross, 1979; Rice, 1998; Pitman, 2002). For a detailed review of documented specimen and sighting localities see Mead (1989). Goodall and Galeazzi (1985) first referred to some 53 stranding observations or specimens of *M. grayi* recorded from the tips of the southern continents, the southernmost being Tierra del Fuego at ca. 54ºS. Mead (1989), repeated by Ohsumi *et al*. (1994), discusses a particular specimen in the National Museum of New Zealand (nmnz 612) which he says was collected from an unknown locality in the Antarctic; Mead adds 'it is difficult to attach much importance to this

record because *M. grayi* has been known to stray before' (referring to the only record from the northern hemisphere, in The Netherlands). However, the origin of this specimen should be of interest. Anton van Helden, curator of marine mammals at Te Papa museum (*in litt*. to KVW, 8 April 2003) disputes Mead's (1989) conclusion and believes the specimen is from the Chatham islands[1]. While Pitman (2002) cites for the distribution of *M. grayi* 'circumglobal in temperate waters of the southern hemisphere', in the same paper an excellent photo by Richard A. Rowlett 'taken in Antarctic waters' is printed. Ohsumi *et al*. (1994) indicate a single sighting of Gray's beaked whale in the Antarctic based on the IDCR/SOWER survey programme since 1987/88, at about 62º30'S, 150ºE (estimated from map) in the Australian Antarctic basin. So far we are aware, there exist no other similar, published records. These observations of Gray's beaked whale sighting from the Scotia Sea, south of the Polar Front widens the possibility that the subantarctic and Antarctic oceans may be part of the normal distribution area for *M. grayi* like it is now becoming increasingly recognized for *M. layardii* (e.g. Pitman, 2002). The issue should become clearer still in the future with an increasing percentage of the hitherto lumped 'ziphiids' sightings identified to species.

Table 1. JR 82 Distribution of effort (in nautical miles) by depth of water (metres)

| 0-999m | 1000-1999m | 2000-2999m | 3000-3999m | 4000-4999m | No depth reading | Total |
|---|---|---|---|---|---|---|
| 484 | 212 | 433 | 845 | 240 | 23 | 2237 |

Table 2.JR 82 Distribution of effort (in nautical miles) by sea surface temperature (°C)

| -2 to 0 | 0 to 2 | 2 to 4 | 4 to 6 | 6 to 8 | 8 to 10 | No temp reading | Total |
|---|---|---|---|---|---|---|---|
| 239 | 664 | 865 | 276 | 94 | 76 | 23 | 2237 |

[1] *M.grayi* specimen nmnz 612 was donated to the Museum [National Museum of New Zealand, Wellington] by Lady Kinsey. The next specimen in the register, a mandible of *T. shepherdi*, listed as coming from the Chatham islands, is from the same donor. The previous record is a southern right whale earbone that is listed as 'Antarctic ?'. A ditto mark is below this associated with the *M. grayi* specimen, however this has been crossed out (probably a product of the transfer of information from the old register). Anton van Helden concludes that in his opinion 'the most likely origin of the *M. grayi* specimen is the Chatham islands'.

Table 3. JR 82 On-effort cetacean sightings

| Species | Number of sightings | Total individuals |
|---|---|---|
| Fin whale (*Balaenoptera physalus*) | 15 | 36 |
| Sei whale (*Balaenoptera borealis*) | 4 | 8 |
| Antarctic minke whale (*Balaenoptera bonaerensis*) | 10 | 24 |
| Undetermined minke whale (*Balaenoptera bonaerensis/acutorostrata*) | 30 | 48 |
| Sperm whale (*Physeter macrocephalus*) | 6 | 6 |
| Humpback whale (*Megaptera novaeangliae*) | 12 | 38 |
| Right whale (*Eubalaena australis*) | 20 | 33 |
| Southern bottlenose whale (*Hyperoodon planifrons*) | 15 | 31 |
| Undetermined beaked whale of genus Mesoplodon (*Mesoplodon sp*.) | 4 | 13 |
| Undetermined beaked whale (*Ziphiidae*) | 9 | 24 |
| Killer whale (*Orcinus orca*) | 4 | 33 |
| Pilot whale (*Globicephala sp*.) | 2 | 85 |
| Hourglass dolphin (*Lagenorhynchus cruciger*) | 9 | 58 |
| Peale's dolphin (*Lagenorhynchus australis*) | 2 | 5 |

Table 4. JR 82 Observations of Gray's beaked whale

| ***Identification*** | ***Date*** | ***Location*** | ***Group size*** | ***Depth SST (ºC)*** | ***Comments*** |
|---|---|---|---|---|---|
| ***M. grayi*** | 4 Feb. 2003 | 61.39º S<br>031.19º W | 6 (5-7) | 3,956m<br>1.16 ºC | long, white rostra sticking out above water surface; no teeth seen. |
| **like – *M.grayi*** | 8 Feb 2003 | 56.85º S<br>031.60º W | 4 (4-5) | 3,608m<br>2.64 ºC | in 1 individual: long rostrum seen before whitish head surfaces; body grey-brown, no scars seen on 3.5-5m body |

Table 5. JR 82 Pinniped sightings on effort.

| Species | Number of sightings | Total individuals | Proportion on ice |
|---|---|---|---|
| Fur seal (*Arctocephalus sp*.) | 390 | 1019 | 0.14 |
| Crabeater seal (*Lobodon carcinophagus*) | 15 | 27 | 0.93 |
| Leopard seal (*Hydrurga leptonyx*) | 12 | 13 | 0.83 |
| Weddell seal (*Leptonychotes weddellii*) | 5 | 5 | 1.00 |
| Unidentified Phocid | 18 | 25 | 0.72 |

Figure 1. JR 82 On effort sightings of fin whales (upward pointing triangles), sei whales (downward pointing triangles), and minke whales (open circles)

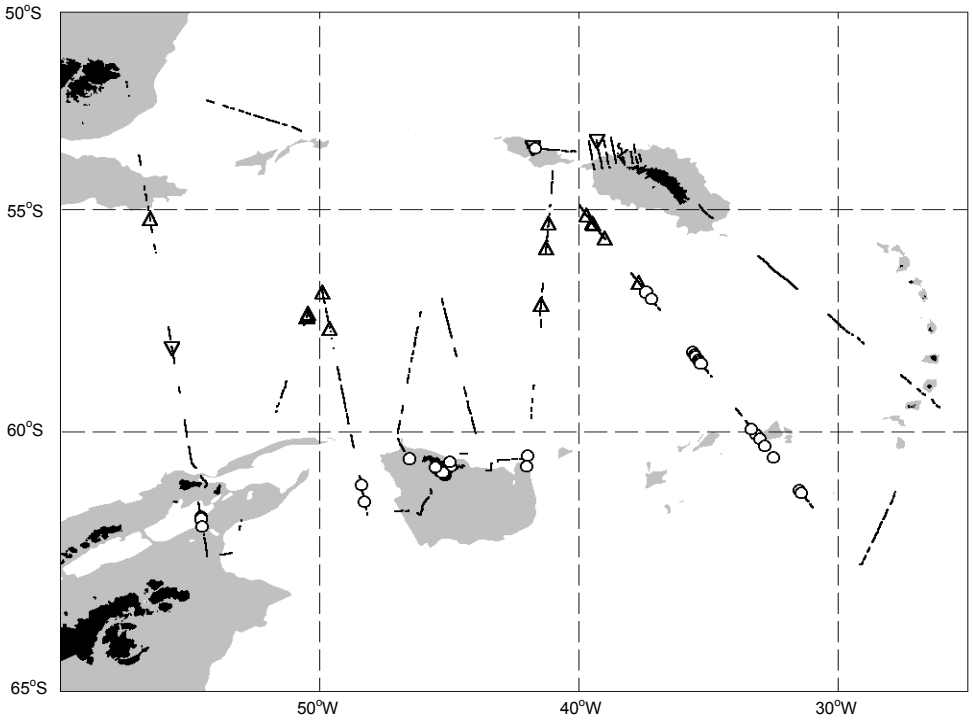



Figure 2. JR 82 On effort sightings of humpback whales (open circles)

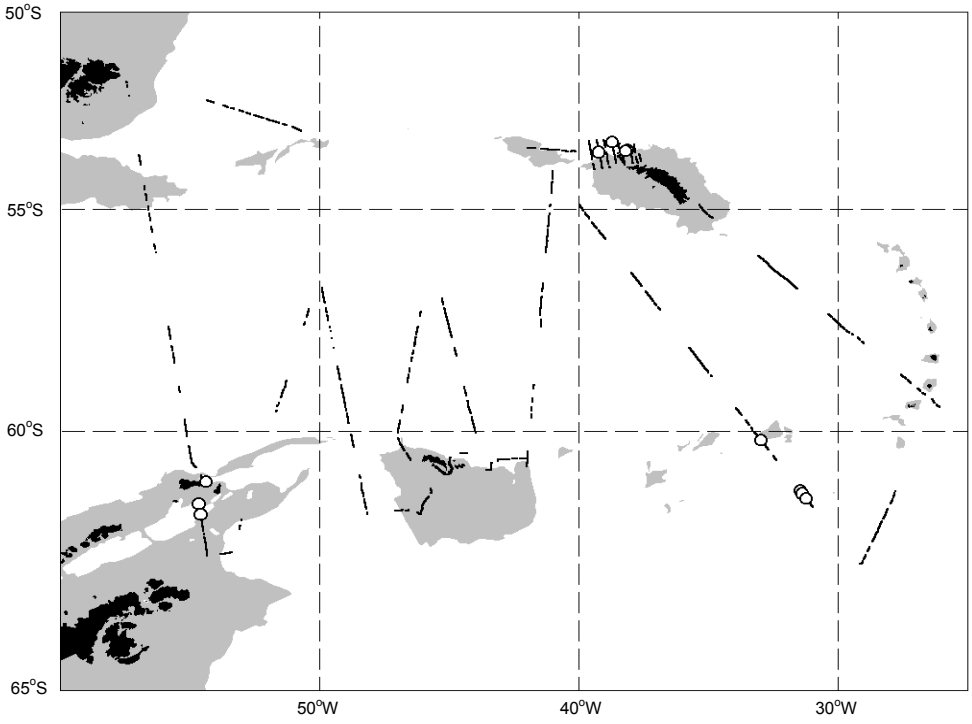


Figure 3. JR 82 On effort sightings of right whales (open circles)

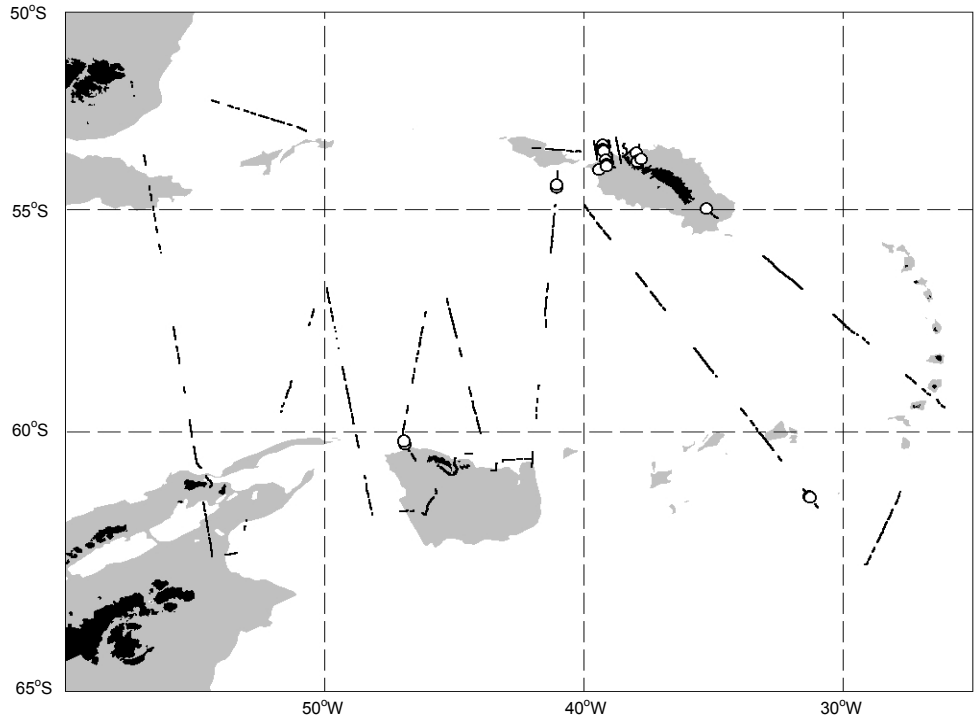
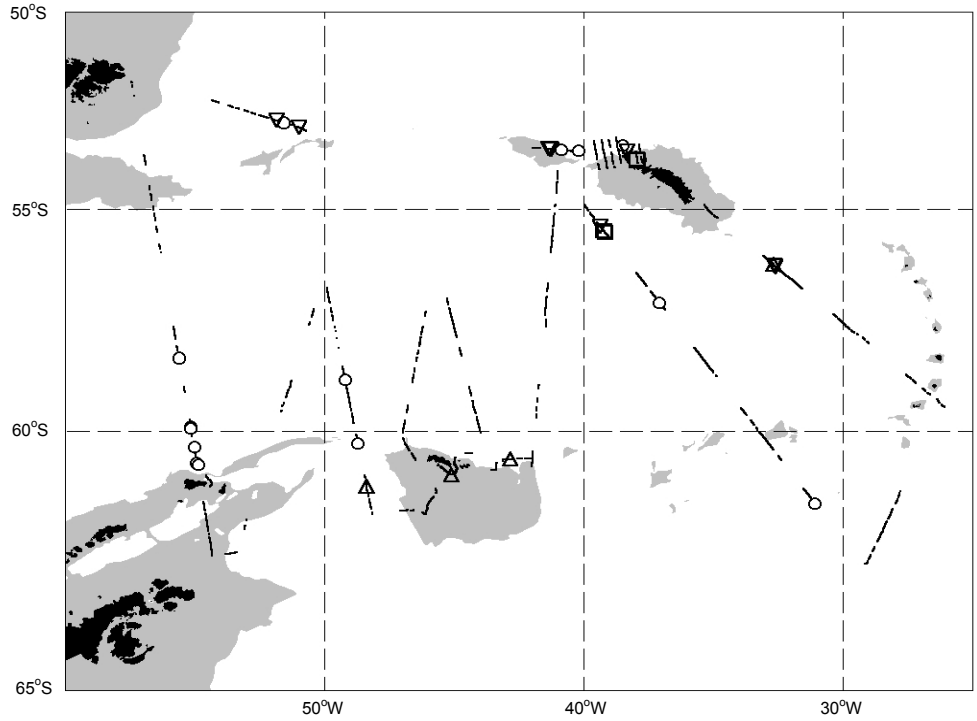



Figure 4. JR 82 On effort sightings of sperm whales, killer whales and southern bottlenose whales



*Passive acoustics report*

The acoustic team had two goals during this cruise. The first goal was the deployment of an Acoustic Recording Package (ARP). Data from the ARP can be used to determine distribution and seasonality of mysticete whales within the range of the recordings. The second goal was obtaining acoustic recordings of various species of whales by making opportunistic deployment of sonobuoys from an underway ship. These recordings are helpful in analysis of ARP data, but also enable data acquisition outside of the range of the ARP and provide some insight into spatial distribution of various species of cetaceans.

The acoustic recording packages (ARP) that was deployed during this cruise is a bottom-mounted instrument with a hydrophone component floating 10 m above the mooring. The ARP also consists of a data logging and acoustic release systems, batteries, and flotation. It will record continuously at 1000 samples per second for 500 days and the data will be stored on two 18 Gb hard disks. The low frequency calls of blue and fin whales can be recorded from as far as 50 km radius, but somewhat higher frequency minke, humpback, southern right and possibly sperm whale calls should also be detectable.

During the JR82 cruise, sonobuoys were deployed opportunistically in order to supplement the information that will be gathered from the seafloor recorder. Sonobuoys are expendable underwater listening devices. The sonobuoy has 4 main components – a float, a radio transmitter, a saltwater battery, and a hydrophone. The hydrophone is an underwater sensor that converts the pressure waves from underwater sounds into electrical voltages that get amplified and sent up a wire (length of released wire can be set to 90, 400, or 1000 feet) to the radio transmitter that is housed in the surface float. The radio signal is picked up by an aerial and a radio receiver on the ship, then reviewed and simultaneously recorded onto a digital audiotape. Sonobuoy can transmit for a maximum of 8 h before scuttling and sinking.

There are 2 types of sonobuoys. Omnidirectional sonobuoys have hydrophones that can register signals up to 20 kHz, but they cannot determine the location of the sound source. DiFAR (DIrectional Fixing And Ranging) sonobuoys also have an omnidirectional hydrophone for recording sound, but it is limited to frequencies lower than 3.5 kHz. However, DiFARs also have 2 pairs of direction sensors, which along with an internal compass can determine the exact bearing of the sound relative to the sonobuoy. This can then be correlated to visual observations of the species of marine mammal in that location.

The aerial used during the cruise was a 160 MHz omnidirectional Ringo Ranger. The maximum range for the radio transmission during this cruise was approximately 8 nm, but was variable dependant on weather conditions. We used software controlled ICOM's IC-PCR1000 receiver for reception of sonobuoy signal. Data were recorded on digital audiotapes using Sony PCM-M1 digital audio recorder and reviewed using SpectraPlus software package.

The noise levels from the RRS James C Ross were very low and they did not affect the quality of recordings greatly, except when we were at a station and the bow thrusters were being used.

Sonobuoys were deployed when marine mammals were visually detected and randomly throughout the cruise, but attempting to provide maximum reception from a single sonobuoy. A total of 107 sonobuoys were deployed: 80 omnidirectional and 27 DiFAR. Four DiFAR and 12 omnidirectional sonobuoys failed (15% failure rate for each type). This relatively high failure rate is probably due to the age of the sonobuoys, which are only given for research after their shelf life in the Navy has passed.

Locations of all the deployments as well as a preliminary summary of the buoys on which calls were heard can be seen in the complete and close-up (Western Core Box detail) maps of the study area. Further analysis of the recordings is needed to double check for calls that were possibly not detected during the preliminary review. Other data noted for each deployment were date and time of deployment, the reason for the deployment, comments on sonobuoy range and reception, and comments on any unusual things heard.

Preliminary results:

The Acoustic Recording Package was successfully deployed at 60°00' S latitude and 51°54' W longitude.

Several species of baleen whales, as well as odontocetes were recorded from the deployed sonobuoys. Further analyses of the recordings are needed.

**ACKNOWLEDGEMENTS**

Enormous thanks must go to the US National Science Foundation, Eileen Hofmann, the Raytheon marine support teams, British Antarctic Survey, Eugene Murphy, Angus Atkinson, and the Captains and crew of all of the vessels involved in this collaboration. We also thank Dan Costa and the members of the Scientific Steering Committee of US SO GLOBEC for providing an observer for NBP 0204 – the winter survey cruise, and to Francisco Viddi who carried out the observations for us on this cruise and put in such a remarkable effort. Ari Friedlaender provided all of the sighting maps for the US SO GLOBEC cruises. IWC research on the LM Gould (LMG 0302) and the James Clark Ross (JR82) was greatly facilitated by the loan of many items of equipment and we thank all of the individuals, programs and organisations who assisted in this way: National Science Foundation and Raytheon for supplying some IWC participants with Antarctic clothing on the JCR; CEPEC for the loan of a pair of 10 x 50 binoculars for the JCR; IFAW for the loan of a laptop computer and video equipment; SOCEP/D Thiele for the loan of two laptops, and a digital slr camera for the LMG; Ari Friedlaender for the loan of a laptop, and Deb Glasgow for the loan of her Nikon camera and lenses.

REFERENCES

Brierley, A. S., Fernandes, P. G., Brandon, M. A., Armstrong, F., Millard, N. W., McPhail, S. D., Stevenson, P., Pebody, M., Perrett, J., Squires, M., Bone, D. G., Griffiths, G. 2002. Antarctic krill under sea ice: elevated abundance in a narrow band just south of ice edge. Science 295: 1890 – 1892.
Goodall, R.N.P. and Galeazzi, A.R. 1985. A review of the food habits of the small cetaceans of the Antarctic and Sub-antarctic. pp. 566-72. *In*: W.R. Siegfried, P.R. Condy & R.M. Laws (eds.). *Antarctic Nutrient Cycles and Food Web*.
Hedley, S., Reilly, S., Borberg, J., Holland, R., Hewitt, R., Watkins, J., Naganobu, M., Sushin, V. 2001. Modelling whale distribution: a preliminary analysis of data collected on the CCAMLR-IWC Krill synoptic survey, 2000**.** Unpublished paper submitted to the International Whaling Commission Scientific Committee July 2001, London, SC/53/E9.
Hofmann E., J. Klinck, C. Lascara, and D. Smith. 1996. Water mass distribution and circulation west of the Antarctic Peninsula and including Bransfield Strait. *Foundation for Ecological Research West of the Antarctic Peninsul*a, R. Ross, E. Hofmann, and L. Quetin, eds., American Geophysical Union, Antarctic Research Series, 70, 61-80.
Leaper, R., Gillespie, D. and Papastavrou, V. (2000). Results of passive acoustic surveys for odontocetes in the Southern Ocean. J. Cetacean Res. Manage. **2**(3): 187-196
Leaper, R. and Gordon, J. (2001). Application of photogrammetric methods for locating and tracking cetacean movements at sea J. Cetacean Res. Manage. **3**(2):
Marcuzzi, G. and Pilleri, G. 1971. On the zoogeography of cetacea. *Investigations on Cetacea* 3(1): 101-170.
Reilly, S., Hedley, S., Hewitt, R., Leaper, R., Thiele, D., Pitman, R. L., Naganobu, M., Watkins, J., Holland, R. 2000. SOWER 2000: initial results from the IWC-CCAMLR program to study whales and krill in the Southern Ocean. Unpublished paper submitted to IWC SC 52.International Whaling Commission Scientific Committee June 2000, Adelaide, SC/52/E21.
Širovic, A., Hildebrand, J., Wiggins, S., Moore, S., McDonald, M., Thiele, D. 2003 A note on automatic detection of blue whale calls recorded in the Antarctic. Unpublished paper presented to the International Whaling Commission Scientific Committee May 2003, Berlin SC/55/E11
Širovic, A., Hildebrand, J., Wiggins, S., Moore, S., McDonald, M., Thiele, D. 2002. Seasonality of blue (*Balaenoptera musculus*) and fin (*Balaenoptera physalus*) whales west of the Antarctic Peninsula. Submitted to Deep Sea Research Nov 2002. Unpublished paper presented to the International Whaling Commission Scientific Committee May 2003, Berlin, SC/55/For Information 5.
Thiele, D., Hofmann, E., Friedlaender, A., Moore, S., McDonald, M. 2001. Preliminary report on IWC-SO GLOBEC collaborative research in the Western Antarctic Peninsula study area March – June 2001. Unpublished paper submitted to the International Whaling Commission Scientific Committee July 2001, London, SC/53/E8.
Thiele, D., Moore, S., Hildebrand, J., Friedlaender, A., Širovic, A., Pirzl, R., McDonald, M., Wiggins, S., Hofmann, E., Klinck, J. 2002. Second annual report on IWC collaborative research in the SO GLOBEC Western Antarctic Peninsula study area. Unpublished paper submitted to the International Whaling Commission Scientific Committee June 2002, Shimonoseki, SC/54/E12.
Thiele, D., Chester, E., Moore, S., Friedlaender, A., Širovic, A., Hildebrand, J.2003. Exploring the impacts of physical variability in the Antarctic marine environment on baleen whale distribution: IWC-SO GLOBEC collaboration 2001-2002. Submitted to Deep Sea Research Nov 2002. Unpublished paper presented to the International Whaling Commission Scientific Committee May 2003, Berlin, SC/55/For Information 6.
Thiele, D. and Moore, S. 2003a. (in press). IWC-SO GLOBEC collaboration. Annex J. Report of the Scientific Committee, International Whaling Commission 54th Annual Meeting, Japan 2002. Journal of Cetacean Research and Management (Suppl.).
Thiele, D, Chester, E., Nicol, S., Peddemors, V., Friedlaender, A. 2003 Australian research for Southern Ocean GLOBEC – 2000/01 and 2002/03. Unpublished paper presented to the International Whaling Commission Scientific Committee May 2003, Berlin, SC/55/E17.
THIELE, D. AND MOORE, S. 2003B REPORT OF THE SO GLOBEC WORKING GROUP. UNPUBLISHED PAPER PRESENTED TO THE INTERNATIONAL WHALING COMMISSION SCIENTIFIC COMMITTEE MAY 2003, BERLIN SC/55/E9.

**Web site address for IWC cetacean summaries by cruise, cruise reports, and technical US SO GLOBEC reports:**

http://www.ccpo.odu.edu:80/Research/globec/iwc_collab/menu.html

or use the link through the IWC website under Recent Additions.

# APPENDICES SC/55/E10

(AVAILABLE FROM IWC SECRETARIAT ON REQUEST)

# Appendices to the cruise report of cetacean survey in the Scotia Sea from British Antarctic Survey vessel *RRS James Clark Ross*, 7 January to 23 February 2003

Figure 5. Location of all cetacean sightings relative to the vessel

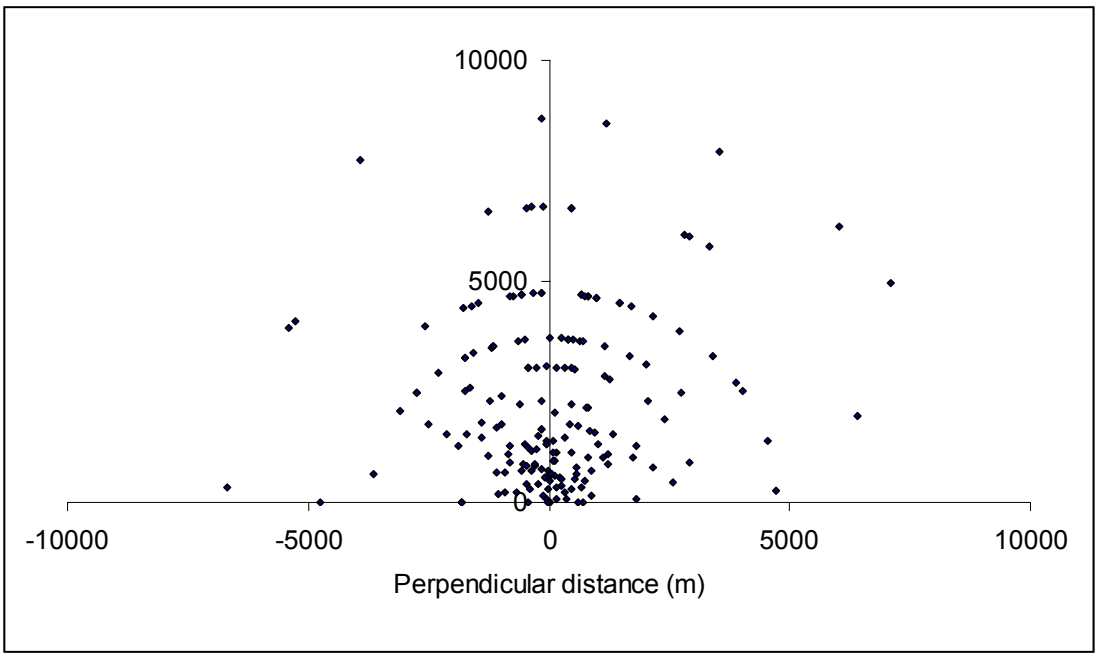



Figure 6. Comparison of estimated and measured radial distances to sightings

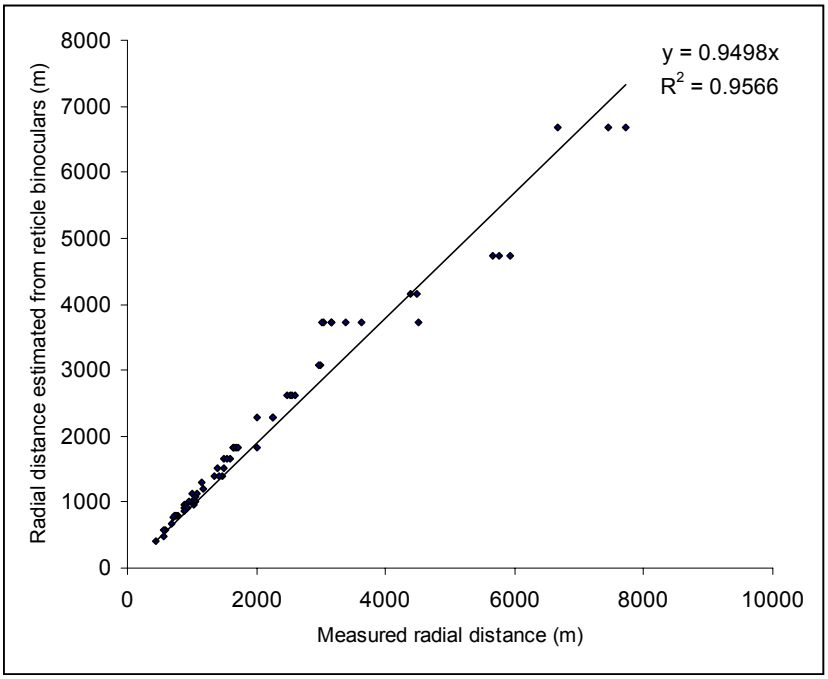


Figure 7. Perpendicular distances to fin and sei whale sightings combined (distances are shown as the mid-point of 250m wide bins).

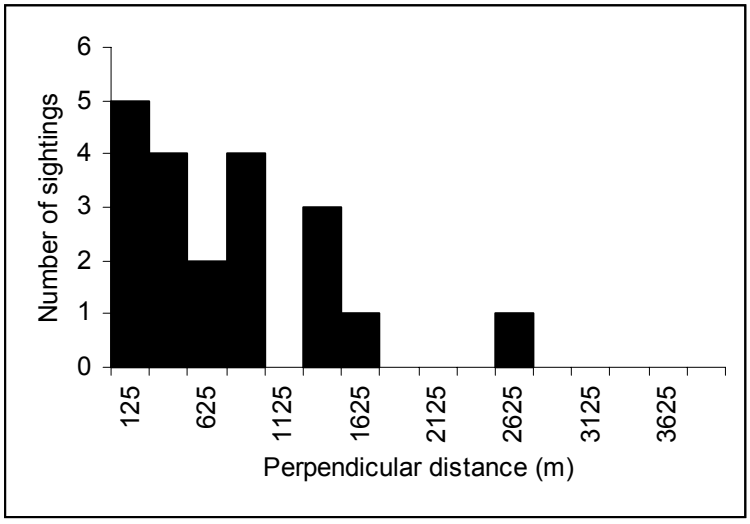



Figure 8. Perpendicular distances to minke whale sightings (distances are shown as the mid-point of 250m wide bins).

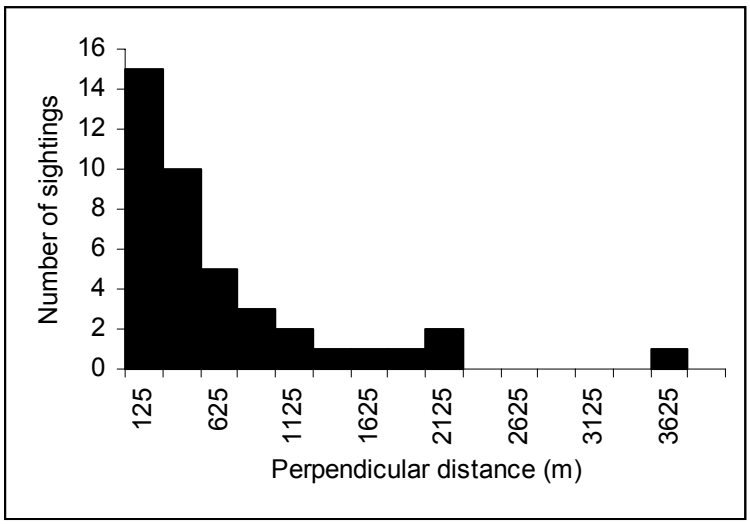



Figure 9. Perpendicular distances to humpback and right whale sightings combined (distances are shown as the mid-point of 250m wide bins).

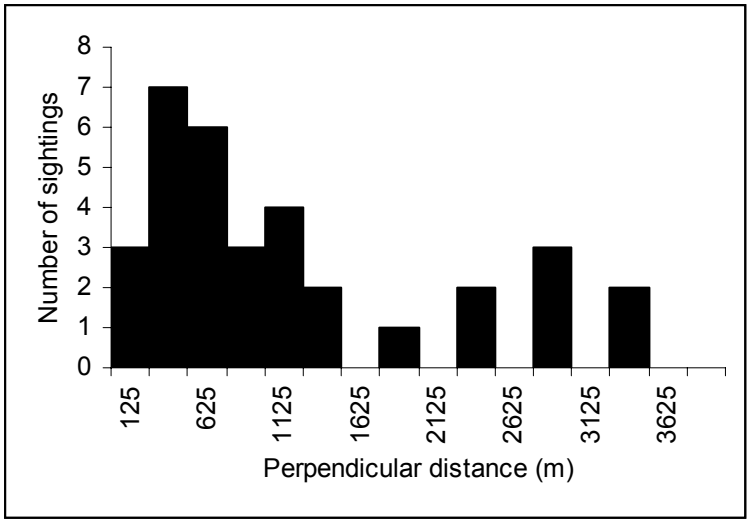



Figure 10. Perpendicular distances to all baleen whale sightings combined (distances are shown as the mid-point of 250m wide bins).

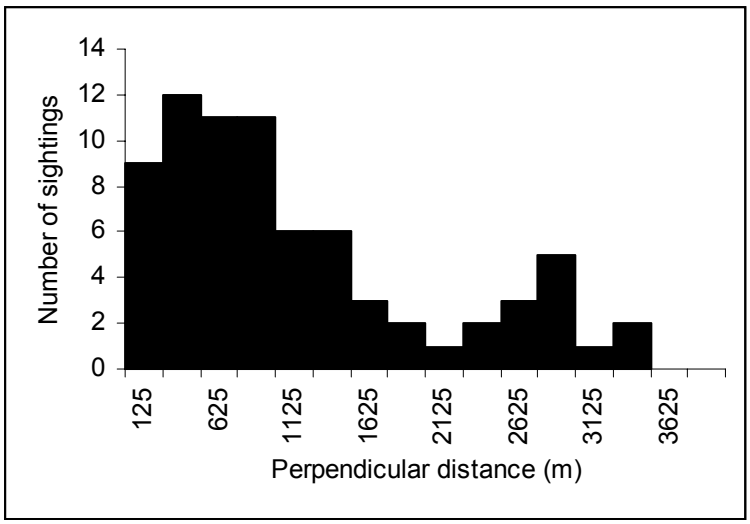
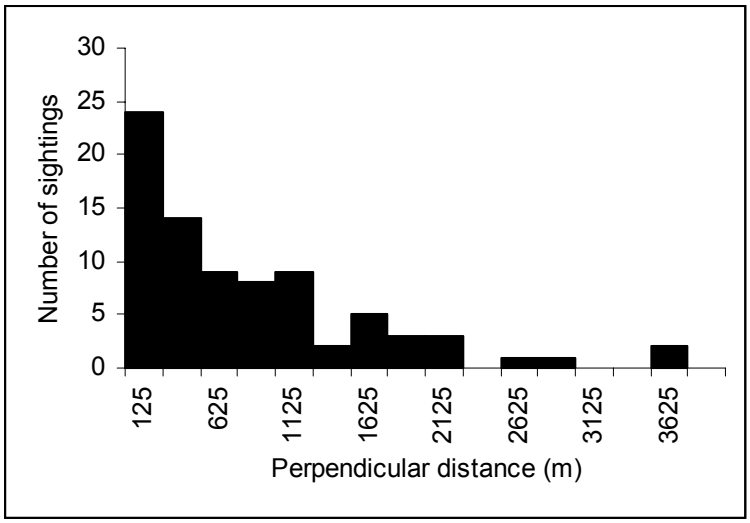



Figure 11. Perpendicular distances to all small whale sightings combined (distances are shown as the mid-point of 250m wide bins).



## *JR 82*

## *Definitions of data categories entered into Wincruz software*

**1. Viewing conditions**

**1.1 Swell code**

When entering swell codes, swell was defined to be waves generated by wind elsewhere. Thus any waves generated by the wind that was currently being experienced were not considered as swell.

**1.2 Sightability**

Sightability category was a subjective judgement of overall conditions related to detecting a blow from a large baleen whale. This was a combination of sea conditions and meteorological visibility with more emphasis on meteorological visibility than for the minke whale visibility distance. If it was not possible to discern the horizon at all then sightability was classed as 'Poor=2' or 'Too poor to survey=1" if visibility was less than 1 n.mile. If the horizon was visible and allowed reticle readings but had poor contrast for detecting blows then sightability was classed as 'Moderate=3'. 'Good=4' sightability required a clear horizon with enough contrast to allow a blow to be detected at the horizon. 'Excellent=5' was limited to near perfect conditions.

**1.3 Beaufort**

The Beaufort scale was designed as a way of estimating wind speed from the appearance of the sea. In this context however, Beaufort is used as a proxy for sea state. Sea state was categorised as Beaufort N if it was judged to affect viewing conditions similarly to the sea conditions generated by a wind of Beaufort force N blowing across the open sea for some hours. Thus for example, the sea state from an increasing wind which had not yet had time to build up the waves or areas sheltered by ice, would be given lower Beaufort categories than the corresponding wind speed.

**2. Weather Conditions**

**2.1 Visibility**

Visibility is defined in Wincruz as an estimate of the maximum distance (in nautical miles) that a blow from a minke whale could be detected. Most of the minke whales encountered during the survey did not produce a strong blow but visibility was defined assuming a strong blow. In conditions that were judged to be optimum, visibility was recorded as 2.5 n.mile.

2.2 Ice cover was rounded to the nearest 10% by the software. If total cover was less than 5%, which was frequently the case in areas of scattered ice bergs, then the number of bergs in sight in a $180^{o}$ arc ahead of the vessel was entered as a comment. When ice cover was greater than 5%, detailed ice records were made using the Aspect (Antarctic Sea Ice Processes and Climate) recording procedures.

**3. Sighting data**

**3.1 Species codes**

The species codes and definitions of 'like' sightings were the same as for the CCAMLR survey.

**3.2 Group size**

For sightings surveys where a variety of species from small odontocetes to large mysticetes are likely to be encountered, it is not possible to have a single, consistent, biologically meaningful definition of 'group'. Instead, group needs to be defined in relation to the sighting process and spatial resolution of the data that can be collected. For line transect surveys, based on perpendicular distances, the main considerations are the way in which groups of animals affect their probability of detection and assigning an appropriate perpendicular distance to clusters of animals when these are considered as a single group. For the purposes of this survey we classified clusters of whales as a group if

(i) The whales were close enough to each other and with some degree of behavioural synchronisation such that the presence of more than one whale increased the probability of detection of an individual. In this case, the recorded sighting location was that of the first sighting location of the group.

(ii) Whales were not necessarily showing any degree of behavioural synchronisation but aggregations were sufficiently dense that it was not possible to distinguish sightings of new individuals from resightings of whales that had already been seen. In this case, the recorded sighting location in Wincruz was to the first animal to be detected, but video scans were performed to allow an estimate of the location of the 'centre' of the group.

**Appendix II**

**Structure of database**

Cetacean Sightings (on effort)

Cetacean Sightings (off effort - these were sightings made while Wincruz was running but not on effort)

Non-Wincruz off effort cetaceans (these were off-effort sightings which were not entered into Wincruz)
Pinniped sightings (on effort)
All visual data (every entry in Wincruz with corresponding ship data)
Ice Photos

Data fields from Excel file

**Observer codes**

RL - Russell Leaper
KVW - Koen Van Waerebeek
DS - Debbie Salmon
AS - Ana Sirovic
OBS - any of ship's crew or other scientists

**Pinniped sightings**

Species code 25 was added as 'Unidentified phocid seal'

**Effort code**

This is MI for normal observations from the Monkey Island. If watching from the bridge due to rain then this code is set to 'BR'. Note reticle readings should be calculated using the height of eye on the bridge (16m).

# Appendices to the IWC-SO GLOBEC cruise report

**SATELLITE IMAGERY OF SEA ICE CONDITIONS DURING CRUISES**

Figure 1 a, b and c

Satellite photos of sea ice extent in Marguerite Bay in a) February 2001; b) February 2002; and c) May 2002

Figure 1a

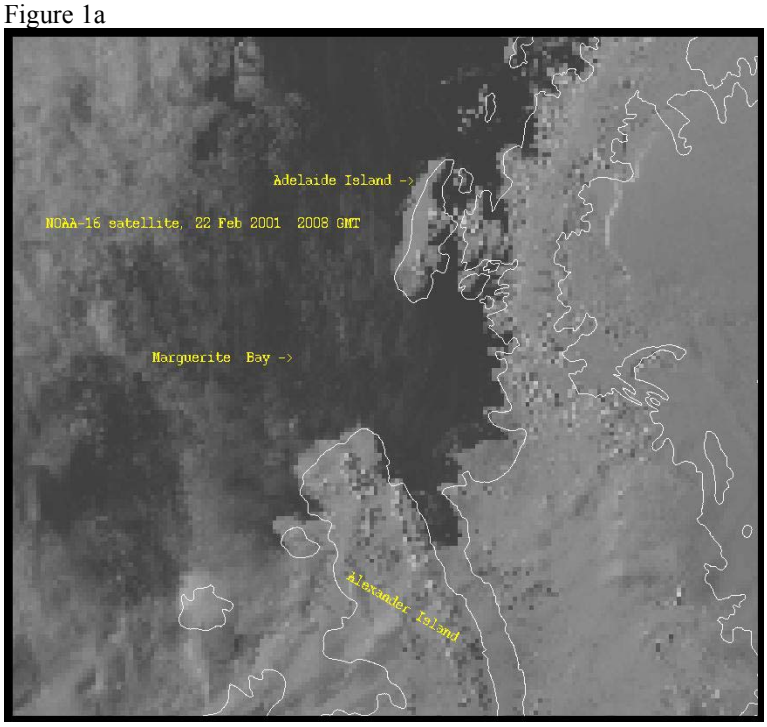



Figure1b

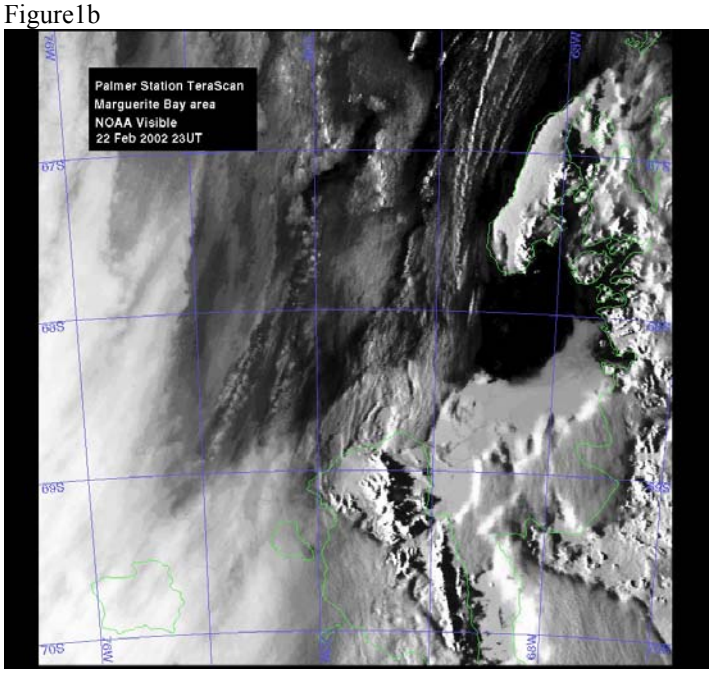
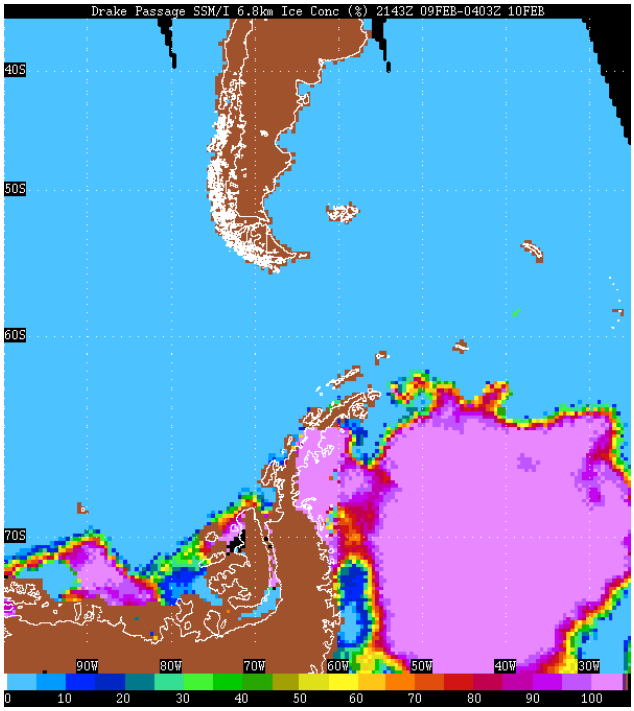


Figure 1 c


Figure 1 d Satellite photo of sea ice extent in Scotia Sea during JR 82 UK/BAS cruise



# Appendices to the IWC-SO GLOBEC cruise report

C. STUDY AREA MAPS:

A. Figure 1. Survey (A) and proposed process (B) study area US SO GLOBEC Marguerite Bay, Western Antarctic Peninsula.

B. Figure 2. Study area UK/BAS SO GLOBEC - Scotia Sea, Antarctic Peninsula

Figure 1. Survey (A) and proposed process (B) study area US SO GLOBEC Marguerite Bay, Western Antarctic Peninsula.

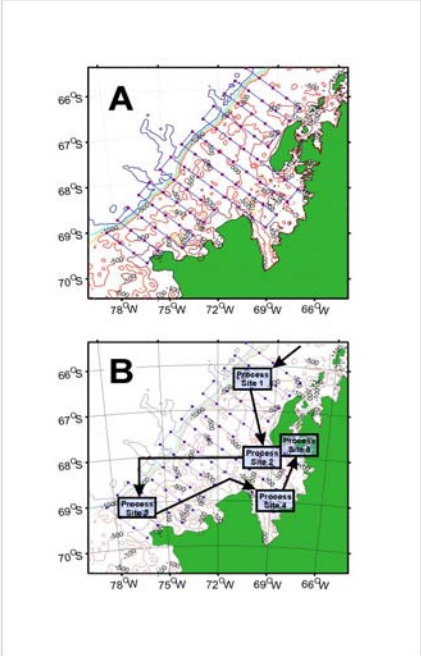
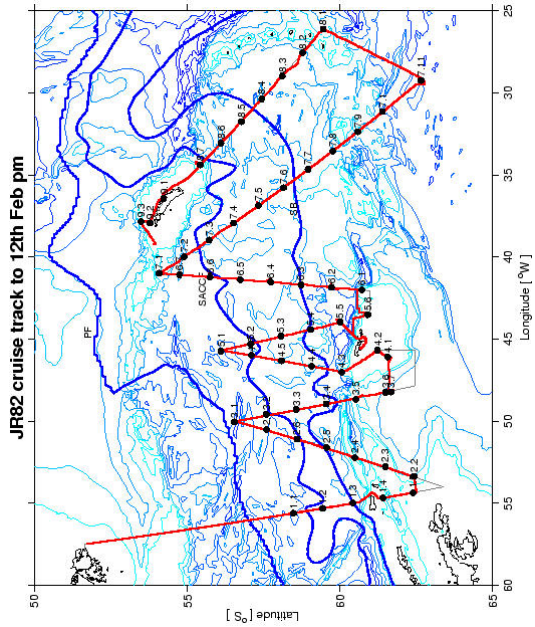



Figure 2. Study area UK/BAS SO GLOBEC - Scotia Sea, Antarctic Peninsula



# Appendices to the IWC-SO GLOBEC cruise report

D. DETAIL OF BIOPSY SAMPLES COLLECTED ON LMG 0203

Table 2. Biopsy samples collected during LMG0203

| Date | Sample # | WOS# | Species | Skin | Blubber |
|---|---|---|---|---|---|
| 4//11 | 1 | 6 | M.n.* | Y | Y |
| 4/11 | 2 | 7 | M.n. | Y | Y |
| 4/11 | 3 | 9A | M.n. | Y | Y |
| 4/11 | 4 | 9B | M.n. | Y | Y |
| 5/1 | 5 | 53A | M.n. | Y | Y |
| 5/1 | 6 | 53B | M.n. | Y | Y |
| 5/1 | 7 | 53C | M.n. | Y | Y |
| 5/1 | 8 | 54A | M.n. | Y | Y |
| 5/1 | 9 | 54B | M.n. | Y | Y |
| 5/1 | 10 | 56A | M.n. | Y | N |
| 5/1 | 11 | 56B | M.n. | Y | Y |
| 5/1 | 12 | 56C | M.n. | Y | Y |
| 5/13 | 13 | 76A | M.n. | Y | Y |
| 5/13 | 14 | 76B | M.n. | Y | Y |
| 5/13 | 15 | 77A | M.n. | Y | Y |
| 5/13 | 16 | 77B | M.n. | Y | Y |
| 5/13 | 17 | 78A | M.n. | Y | Y |
| 5/13 | 18 | 78B | M.n. | Y | Y |
| 5/13 | 19 | 78C | M.n. | Y | Y |
| 5/13 | 20 | 79A | M.n. | Y | Y |
| **TOTAL** | | | | 20 | 19 |

- *Megaptera novaeangliae* (humpback whale)

# Appendices to the IWC-SO GLOBEC cruise report

## E. INDIVIDUAL PHOTO IDENTIFICATON RECORDS FOR ALL US SO GLOBEC CRUISES

The total number of recognisable photo identification images obtained on US SO GLOBEC cruises was 242. These figures are a minimum and will be revised as photo id matching is done. A breakdown of images per cruise and by species and individuals follows:

Total individuals all species = 113

By species
Total Humpbacks = 95 individuals
Total minkes = 8 individuals
Total killer whales = 5 individuals
Total sei whales = 3 individuals
Total fin whales = 2 individuals

By cruise
LMG 0103 = 20 individuals (3 minke, 1 killer whale, 16 humpback)
LMG 0201A = 5 individuals (all humpbacks)
LMG 0203 = 3 individuals (all humpbacks)
NBP 0103 = 4 individuals (all humpbacks)
NBP 0202 = 9 individuals (all humpbacks)
Polarstern = 3 individuals (all humpbacks)
LMG 0302 = 69 individuals (3 sei, 5 minke, 4 killer whales, 2 fin whales, 55 humpbacks)