JAMES CLARK ROSS SCIENCE CRUISE JR54

Introduction by Mark Belchier

Every year British Antarctic Survey scientists undertake a survey to estimate the biomass of Antarctic krill (*Euphausia superba* Dana) in the waters around South Georgia. This survey usually takes place in the middle of the austral summer (December - January). Since 1996 the survey has been conducted within two well defined 80 x 100 km areas or 'boxes' which span the continental shelf-break to the north-east and north-west of South Georgia. Acoustic surveys which use sensitive echo-sounders are the favoured means for assessing krill abundance, as they allow detailed sampling of large areas over a short period of time. BAS scientists currently use the a SIMRAD EK500 scientific echo-sounder to conduct acoustic surveys of krill.
During the week beginning , when the rough weather moderated sufficiently, an acoustic survey was undertaken along four predetermined transects of the 'western box' area to the north-west of South Georgia. Data from this 'early season' survey, which covers a region that will be surveyed again in December - January, will provide a measure of the seasonal changes in krill abundance around South Georgia. In addition to the acoustic survey, CTD deployments, measuring salinity and temperature, were made at four stations within the survey area. Nets are usually deployed to fish for krill during a survey to provide information on the characteristics of the krill that are observed on the echo-sounder. Unfortunately, bad weather prevented the use of the net, but it is hoped that these data can be obtained from the current studies on krill in the diet of predators at Bird Island.

METHODS by Cathy Goss

Survey design
The plan for the survey was prepared in a QuattroPro spreadsheet with an approximate start date and time, reproduced as Appendix 1. The start time in this table was chosen to be well into daylight, but could be shifted either way if necessary, as long as all the acoustic transects were completed in the light. The survey start time can be shifted to suit other activities as long as all the acoustic transects are completed well after dawn and well before dusk. The optimum is probably to put the middle of the acoustic runs at local midday. After dark, the plan called for relocation to a CTD station, foredeck nets (FNETS) and finally a second CTD station, before relocation to start the second day. Details for the CTDs are described in a file called saline.wpd. The actual survey had to be spread out over 5 days because of bad weather. Details are presented in Table 1, and the layout is shown in the plan in Figure 1.

Acoustics
The pc and Simrad EK500 clocks were set so that they matched the master clock.. The logging pc is run using an uninterruptible power supply unit. The software to run the system is in three parts: EchoConfig, EchoConfig and EchoView, icons for each appear on the pc desktop.

EchoConfig was used to send files of settings (.txt) to the EK500, and also read files of settings in order to record a daily dump of settings. To write menu settings to the echosounder using a previously saved file, a file of all menu settings is loaded. When

EchoConfig starts the ‘write’ button remains greyed out until a file is loaded. A file called postCP4ca2.txt was stored at the end of a previous core programme, and a copy of this was made: preCP6.txt, and opened in EchoConfig, then written to the EK500. EK500 settings may be examined directly on the EK500 to confirm that they are the same as the text fileto confirm that they have been loaded correctly. A record was made of settings at the end of the survey in a file called postCP6.txt by reading from the EK500, *NB A full file of all menus and sub-menus needs to be open in EchoConfig when the ‘read’ button is activated to ensure that all settings are copied across*. Other settings dumps are only necessary when there is any reason to believe that any settings have been changed.

EchoLog, the logging module, is self contained and robust, and was used to log telegrams from the EK500 into files on the pc with the start date and time for the name and the extension .ek5. This module automatically opens new files at regular intervals, so, once started, needed no attention, other than to check disk space. EchoLog is started by clicking on the icon, and it begins to log, showing the file name that it is writing to, and the size and data acquisition rate. It will start a new file automatically at pre-set intervals. It is possible to manually trigger the start of a new file, and it helps with processing to start a new one at the moment a transect starts, however this is not essential. The waypoints in the plan should be the position where the usable transect starts, i.e. the ship should be travelling at 10 knots and in the direction of the rest of the transect when the waypoint is reached. It is useful to keep a paper log, noting when anything exceptional happens, e.g. a deviation from the track, a change in ship’s speed, and anything at all that might affect the results.

EchoView displays groups of .ek5 files, but without modifying them, so that any changes could be made but the raw data are protected. The licence hardware device was not on board so EchoView was only available in demonstration mode (it runs for 30 minutes and then closes down in this mode, but could be restarted as many times as needed). After a day of logging, .ek5 files were backed up onto CD.

The Simrad EK500 suffers from noise levels at 120 and 200 kHz that are noticeably worse than those on comparable ships; comparisons were made during the data analysis workshop following JR47 between the James Clark Ross, the Atlantida, Yuzhmorgeologia and the Kaiyo Maru. Vsevelod Afanasyev tested parts of the system and concluded that the deck unit (systems box) was not the source of the noise. This leaves two elements that need to be examined separately: the cabling and the transducers. It is believed that the noise worsened following the move away from the ship’s wiring to a dedicated cable, some years earlier, and the cabling is thought to be the most likely noise source. The cables need to be disconnected at the transducers, and this can only be carried out while the ship is in dry dock

Nets

The weather prevented deployment of foredeck nets (FNETS), but notes on their deployment follow for reference on future early/late season surveys. FNETs are fished at the surface for anything between 5 and 20 minutes, depending on what plankton is in the water. Their catch would supplement the acoustic data, and could be frozen for subsequent analysis. The choice between the two sizes of cod end liners for the FNET is really dependent upon local conditions, in most situations, it is probably best to choose the coarser mesh, as we wish to catch a sample of the krill that are likely to be recorded acoustically, and there were no privisions made for the analysis of smaller plankters. The smaller mesh could become

clogged if there are any long-chain algae blooming etc. Securing the FNET to the frame is by lacing it in place through the eyelets and rope loops. A loop is pulled through the nearest eyelet, and the loop that projects is just long enough to reach to the next eyelet so that a second loop can be pulled through the next eyelet and the first loop and so on. A piece of line is needed to complete the lacing, with the strongest knot that can be devised.

CTDs

General

Four CTD drops were required over the course of two days, two on shelf and two off shelf. The first was planned to be on shelf, in shallow water, in the evening of the first day and the second around 3.5 hours later off shelf, in deep water, dropped to 1000m. Exact times were to be confirmed when the start time of the whole survey was known. The third was planned to be at a similar time to the first in the evening of the second day, but with the deep drop first, a 3.5 hour interval and finally a fourth, shallow deployment.

Salinities

Salinity measurements from the CTD require calibration using water samples collected during each drop. Instructions for collecting these were as follows:

- wash salinity bottles
- close air valve and spigot when niskin bottles are cocked
- fire bottles at a) shallow:
  - close to bottom as possible
  - 150
  - 125
  - 100
  - 90
  - 80
  - 70
  - 60
  - 50
  - 40
  - 30
  - 20

  b) deep:
  - 1000
  - 800
  - 600
  - 400
  - 200
  - 100
  - 80
  - 60
  - 40 * 2
  - 20 * 2

make sure all bottles are fired before surface is reached

- water should be drawn off the niskin soon after collection
- rinse bottles twice, and lid inserts with the seawater to be sampled
- fill bottles three-quarters full
- cover neck and lid with parafilm if no white inserts
- store bottles in one crate per day, label crate, log bottle numbers
- leave in salinometer lab for 24h at least

Salinity bottles (medical flats), were located next to the Autosal. They are usually used with black screw-on lids, but the critical thing for storage are the small white inserts which create a good seal. Unfortunately, these could not be found, so the bottles were sealed with plastic film. After the survey full salinity bottles were left in labelled crates in the rack the autosal room, ready for later analysis, they do not need refrigeration.

SURVEY AND RESULTS

Sampling narrative by Mark Belchier

28 October 2000
We steamed to station 1 for an early (0900 GMT) start on Saturday morning. The wind from the South was increasing all through the transect (which passed uneventfully) reaching 50 knots + by station 2. This meant it was impossible to get to station 3 (across the wind) so the decision was taken to call off the science for the day and tack to station 3 for an early morning Sunday start.

29 October 2000
We left station 3 to start the transect at 11.00 GMT this morning (Sunday) and completed this just after the allotted time after a little manoeuvring for Bergy Bits, Growlers etc. However, the SW wind had been freshening all day to over 40 knots, which meant that deployment of the CTD and F-nets was not possible. We have taken the decision to move over night to station 7 to start Transect 3 in the morning and weather permitting should do all the stations as planned. If this is achieved it will still leave stations 5, 5.5 and 6 to do.

30 October 2000
We managed to complete the second set of transects today in a large swell and have tried, so far unsuccessfully, to deploy the Rosette sampler and F-nets. The wind has increased with waves breaching the fo'c'sle making the F-netting impossible. The CTD made it to 30m depth before the brake system jammed (a computer problem). Although we managed to get the CTD onboard again we have so far have not been able to deploy again.

31 October 2000 - 1 November 2000
We have managed to get most of the survey work done. We finished the CTD stations over night following completion of the acoustic transects. Weather has meant that we have been unable to deploy the Fnets

Analysis of Acoustic Data

Acoustic data were analysed using Echoview version 2.00.107. Table 2 sets out the names of the logged .ek5 files that were grouped in echoview to cover the four acoustic transect. Table 2 also records some notes on the conditions prevailing during each transect, apparent from

examination of the files in Echoview. The two most significant features visible on the charts which might affect the quality of the results were the presence of a thick bubble layer caused by adverse weather conditions, and the occurrence of periods of missed echoes at 38 kHz. The latter phenomenon is probably also caused by the presence of bubbles near the surface which blanket out returning echoes, giving the chart a striped appearance, called 'dropout' (Figure 2). The presence of near-surface targets in transect 3 (Figure 3), where the bubble layer had thinned, highlight the possible significance of the loss of data from a deep surface layer in transects 1 and 2. Biomass was calculated for each transect and for the total area as on previous South Georgia Core Programme surveys - see Table 3.

Conclusions and recommendations

- Poor weather reduced the value of this survey, preventing netting, obscuring part of the acoustic record and the CTDs would not have been carried out at all without extra time. Future short surveys could benefit from being scheduled within a time window that is as long as possible. For example a time slot could be planned to be either on arrival in an area or on departure, giving a second chance of encountering favourable weather.
- Noise problems continue to compromise the data collected by the EK500, but the testing carried out on this cruise brings us a step nearer to overcoming them. ***Action*** is necessary to ensure that the programme of testing is continued at the earliest possible moment when the James Clark Ross is dry-docked.

Figure 1 Survey Layout

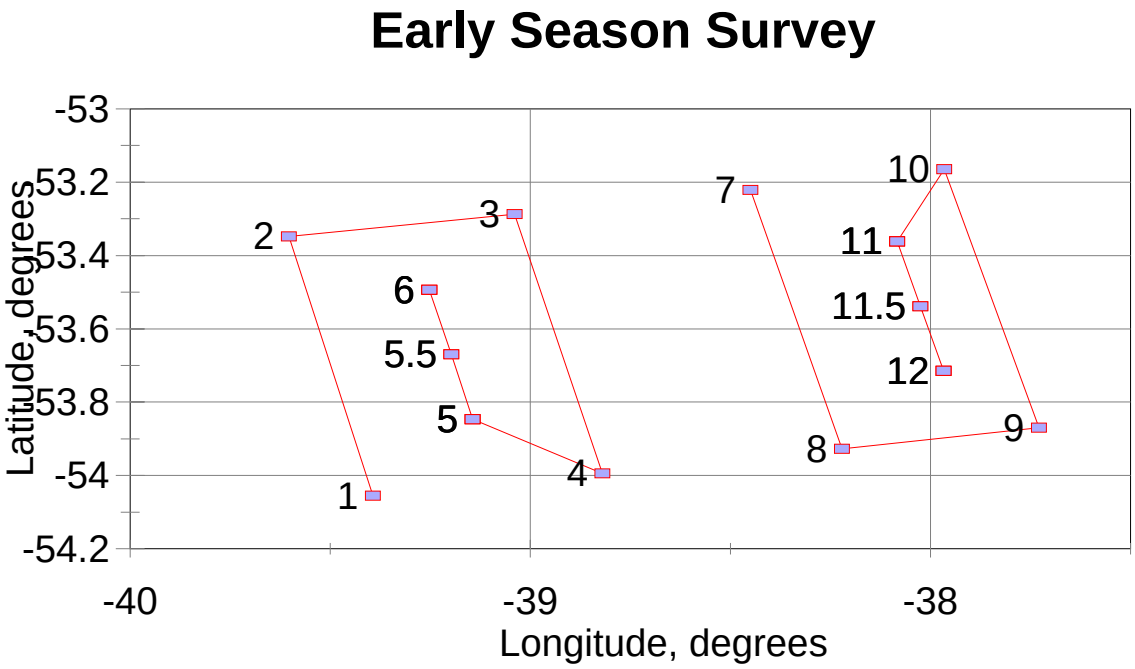

Figure 2 Echograms from Transect 3, 38 kHz top 120 kHz bottom showing ‘dropout’ (missed pings) at 38 kHz

Figure 3 Echocharts from a small section of transect 3, 120 kHz on the left 38 kHz on the right

Table 1 RRS James Clark Ross, cruise JR54 Early Season Survey

Acoustic Transects

Station #	Core box position	Date	time (GMT)	Longitude	Latitude	Notes
1	Waypoint_W.1.1.S	28-Oct-00	09:00	-39.3919	-54.0553	Wind S 45 Knots (Gusting 60) Very Rough
2	Waypoint_W.1.1.N	28-Oct-00	13:16	-39.6023	-53.3472	
3	Waypoint_W.2.1.N	29-Oct-00	11:00	-39.0382	-53.2870	Wind Westerly 33 Knots
4	Waypoint_W.2.1.S	29-Oct-00	15:32	-38.8190	-53.9940	(Move off track at 13:59 Iceberg, return 14:47)
7	Waypoint_W.3.1.N	30-Oct-00	11:34	-38.4490	-53.2209	Wind 24 knots V. large swell across beam.
8	Waypoint_W.3.1.S	30-Oct-00	15:39	-38.2203	-53.9269	
9	Waypoint_W.4.1.S	30-Oct-00	17:12	-37.7279	-53.8692	Note change from BST to GMT
10	Waypoint_W.4.1.N	30-Oct-00	21:14	-37.9643	-53.1642	and possible computer errors

CTD Stations

Station #					
11	Station_W.3.2.N	31-Oct-00	18:39	-38.0825	-53.3614
6	Station_W.1.2.N	01-Nov-00	00:40	-39.2511	-53.4926
5	Station_W.1.2.S	01-Nov-00	08:00	-39.1435	-53.8464
12	Station_W.3.2.S	01-Nov-00	12:00	-37.9658	-53.7141

Station #		Event	Depth (m)	Max Sample depth	Sample Crate	Bottle Numbers
11	Station_W.3.2.N	1	2660	1000	Blue 5	+1-12
6	Station_W.1.2.N	2	3142	1000	Blue 5	+13-24
5	Station_W.1.2.S	3	285	277	Red 2	+1-12
12	Station_W.3.2.S	4	132	123	Red 2	+13-22

Table 2 RRS James Clark Ross, cruise JR54 Early Season Survey

Acoustic Data

Station #	Date	time (GMT)	EV file	EK5 file start	EK5 file end	Notes
1	28-Oct-00	09:00	transct1	085348	124348	Very bad bubble layer reached 50m deep, but a number of targets evident with krill ΔSv
2	28-Oct-00	13:16				
3	29-Oct-00	11:00	transct2	100034	142843	Bubble layer improved but still significant dropout at 38kHz; krill and zooplankton targets, bubble layer worsens along transect
4	29-Oct-00	15:32				
7	30-Oct-00	11:34	transct3	095515	141724	Bubble layer much less, still significant dropout
8	30-Oct-00	15:39				Small targets with small krill ΔSv and zooplankton layer. At 1407h ΔSv +9 marks. Weaker, +14 ΔSv marks appeared on shelf
9	30-Oct-00	17:12	transct4	160850	195529	Much better bubble layer. Near-bottom +12
10	30-Oct-00	21:14				ΔSv aggregation at 1828h. Bubble layer worsens along transect

Note EK500 time (used for data records) appears to correspond to ship time, but the logging pc time (i.e. ek5 file names) was one hour slow except for at the start of transect 1.

Table 3 RRS James Clark Ross, cruise JR54 Early Season Survey Results

Survey box	mean krill length, mm	TS, dB kg^{-1}
west early	46.6	-38.55

Transect	Date	Length	Density
W1.1	28 Dec	80.547	2.52
W2.1	29 Dec	81.490	0.69
W3.1	30 Dec	76.264	10.47
W4.1	30 Dec	81.499	0.61

Survey	Box	Dimensions, km	Mean Density, g m^{-2}	Variance	Biomass, tonnes
Early	West	133.33 x 80	3.46	5.17	36,936

JR54 Personnel

Mark Belchier, Science Manager South Georgia - field co-ordinator
Vsevolod Afanasyev - ETS
Jeremy Robst - ITS
Cathy Goss - planning and support - not on ship
Andy Brierley - Project Leader - not on ship
Mike Meredith - Oceanography support - not on ship

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