Ecology of mesopelagic fish

RRS James Clark Ross Cruise 100
March 8th-April 5th 2004

Cover picture: *Electrona carlsbergi* caught during the cruise.

1. Introductory Section

Martin Collins

Background

The basic objective of the BAS ASGC DYNAMOE programme is to improve our understanding of the Southern Ocean ecosystem. To date much of the work has focussed on krill and links between krill and upper and lower trophic levels. Whilst krill are undoubtedly the key species in the Scotia Sea/South Georgia there is considerable inter-annual variability in the biomass of krill available in this area. In poor krill years, a range of normally krill dependent species will be forced to seek alternative sources of food. It is therefore important to develop our understanding of alternative, possibly krill independent, trophic paths.

Lanternfish (Family Myctophidae) are the dominant mesopelagic fish of the world's oceans, where they play an important role in oceanic food-webs and in cycling carbon from the surface to deeper waters. They are vertical migrants, typically migrating from deep waters during the day to near the surface at night. In the Southern Ocean myctophids potentially play a key role as predators of zooplankton such as copepods, krill and *Themisto* and as prey of higher predators, particularly king penguins and fur seals. Data from BAS studies of fur seals at Bird Island indicates that myctophids are particularly important in the diet of fur seals late in the summer season, during which time the seals are principally foraging in the area NW of South Georgia and towards Shag Rocks.

The aim of JR 100 was to investigate the role of myctophids in the South Georgia ecosystem. By determining the horizontal and vertical distribution of different myctophid species it is possible to determine where and when different species are available to diving predators. The diet of myctophids is poorly known in the Southern Ocean, and will be linked to the vertical movements of both the fish and their prey.

Objectives

1. Characterise the vertical and horizontal distribution of fish in the area between the Shag Rocks and South Georgia shelves, and relate fish distribution to the physical oceanography of the region and the foraging behaviour of fur seals.
2. Investigate the diet and trophic ecology of myctophids.
3. Investigate enzyme activities, anti-oxidants and pollutants in the tissue of mesopelagic fish.
4. Investigate the visual ecology of mesopelagic fish in relation to habitat depth and foraging behaviour (AFI/CGS Award).
5. Service the Acoustic moorings (AFI)
6. Undertake the end of season Western Core Box Survey
7. Continue time series of Longhurst-Hardy Plankton Recorder deployments at shallow and deep locations to the NW of South Georgia

In addition to the scientific objectives we were asked to drop Simon Berry at Bird Island and Rob Smith at KEP. Towards the end of the cruise the ship was diverted back to BI to collect Simon Berry and Neal Farnell.

Table 1.1 Scientific Party

Name	Organisation	E-mail address
Martin Collins	BSD, BAS	macol@bas.ac.uk
Vsevelod Afanasyev	ETS, BAS	Vaf@bas.ac.uk
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Ryan Saunders	St Andrews University	ras19@st-and.ac.uk
Geraint Tarling	BSD, BAS	gant@bas.ac.uk
Clare Waluda	BSD, BAS	clwa@bas.ac.uk
Elizabeth White	Bristol University	elizabeth.white@bristol.ac.uk
Jose Xavier	BSD, BAS	jccx@bas.ac.uk

Figure 1.1 Photograph of the officers and scientists on JR 100.

Dave Pond, Johnnie Edmonston, Kate Cresswell, Doug Bone, Len Featherstone, Nathan Cunningham, Liz White, Peter Enderlein, Nadine Johnston, Cathy Goss, Ryan Saunders, Martin Collins, Simeon Hill, Lizzie Hawker, Andy Black, Geraint Tarling, Jose Xavier, Claire Waluda, Chuck Cook, Tony North, Dave Gooberman (C/O), Andy Hirst, Jerry Burgen (Captain), Vsevelod Afanasyev.

Summary of Science Activities

Mesopelagic Fish

The mesopelagic fish part of the cruise was in two sections. The first section was a series of east-west acoustic transects between the South Georgia and Shag Rocks shelves (Figures 1.2, 1.3). The acoustic transects were supported by a series of set CTD stations and XBT drops to provide background oceanographic data. At the CTD stations bongo net hauls were made to provide samples for plankton studies and to provide supporting information on the zooplankton community. During the acoustic transects target fishing was undertaken with the RMT25 and the IYGPT (pelagic trawl). This was the first cruise with the new pelagic trawl, and the main objective was to develop a safe method of using the trawl. The pelagic trawl did not have a net monitor, which limited its use in target fishing.

During the cruise data observations were made on the at sea distribution of sea birds and marine mammals, with particular emphasis on the fur seals. In addition, the team at Bird Island had fitted satellite tags and time-depth recorders (TDR's) to fur seals and macaroni penguins. Data from the tagged animals was sent to the ship on a daily basis and the information on the macaroni penguin distribution resulted in the westward extension of Transect 4 & 5. The Bird Island team also collected diet data on returning tagged animals.

In the second section of the fish work we focussed on three areas, and undertook day and night sampling in different depth layers from the surface to 1000 m, to investigate diurnal vertical migration. The first two area were chosen, as they were hotspots of fur seal abundance, whilst the third location was the long term deep LHPR site. The LHPR provided background data on the vertical distribution of zooplankton at each location.

Fish catches also supported work on trophic ecology, vision, pollutants, anti-oxidants and enzyme activity.

Moorings

The moorings are an AFI project, to investigate intra- and inter-annual variability in krill. There are two moorings, each with an upward looking ADCP and with twin acoustic releases. Each mooring was located 200 m below surface, one in 1000 m and the other at around 300 m. Both moorings were successfully recovered and were both redeployed at the shallow site, to avoid the risk of being tangled with long-line fishing gear.

At the shallow mooring site a series of RMT8 hauls was undertaken to investigate the source of vertically migrating layers detected with the ADCP.

Western Core Box

The Western Core Box (WCB) survey (Figure 1.3) is undertaken 3 times per season (early, mid and late) to investigate the variability in krill abundance. The survey consists of a series of acoustic transects, undertaken during daylight, with a series of fixed CTD/bongo net/ RMT8 stations which are carried out at night.

During JR100, we undertook the end of season WCB survey, but were limited at the southern end of the transects by icebergs. Most of the acoustic transects were curtailed before the southern end and two of the southern stations were moved to avoid ice. One day was lost to bad weather in the core box and further time lost to an unscheduled call to BI, that was requested by operations without proper consultation with the Principal Scientist.

Figure 1.2. Transect arrangement for JR 100. The E-W transects were the mesopelagic fish section. The NNW-SSE transects are the Western Core Box.

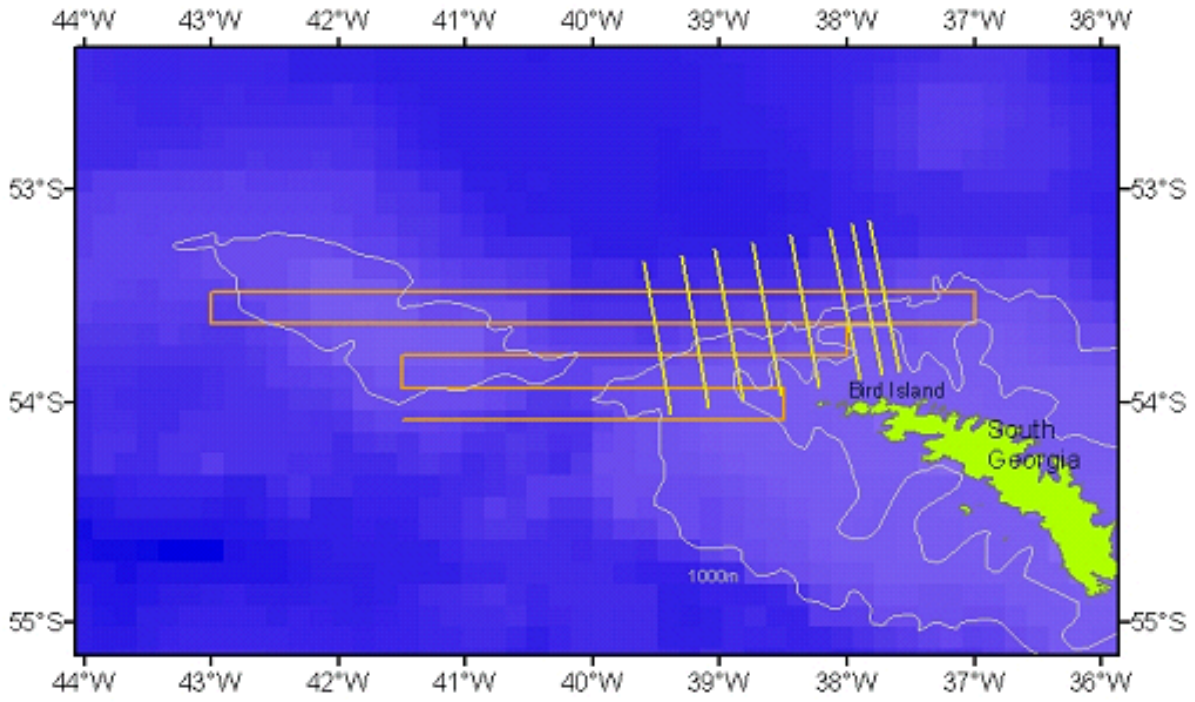

Figure 1.3. Actual cruise track of JR 100

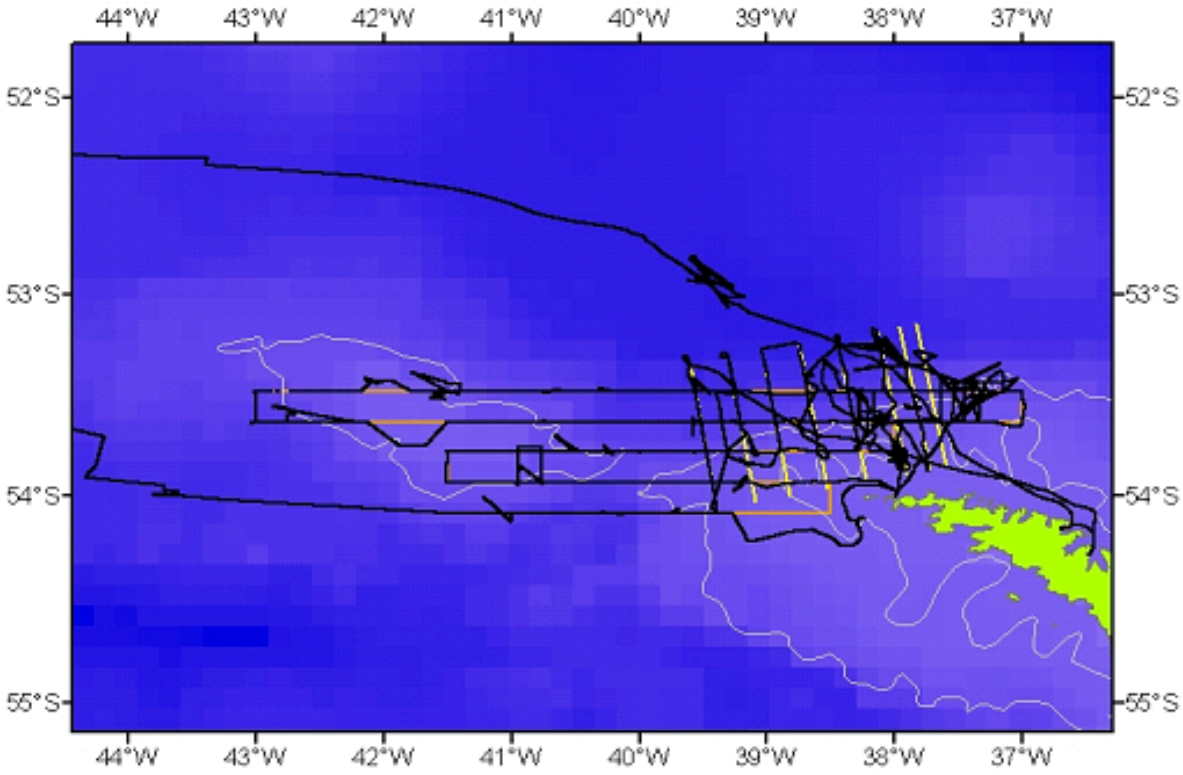

Table 1.2 Summary Timetable

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
1	2	3	4	5	6 JCR at FIPASS Containers unloaded	7 Nets and equipment assembled
8 Labs prepared. Main scientific party arrived	9 Departed Stanley at 0800. Boat drill in Port William.	10 Passage to Shag Rocks.	11 Passage to Shag Rocks. Pelagic Trawl Test.	12 Started first transect (T1). Stations T1-A and T1-B.	13 Called at BI to drop Simon Berry. Started T2. Station T2-B	14 Transect T2. Stations T2-A and T3-A.
15 Transect T3. Stations T3-B, and T3-C.	16 Finished T3. Started T4. Station T4-B	17 Transect T4. Stations T4-A and T4-Z.	18 Completed T4-Z. Started transect T5 Station T5-Z.	19 Transect T5. Station T5-A, T5-B.	20 Transect T5. Station T5-C.	21 Transect T5. Station T5-D. Shallow LHPR (midday).
22 Shallow LHPR (midnight). RMT25's in Box 1.	23 RMT25's in Box 2.	24 LHPR in Box 2. Deep mooring recovery. Calibration in Stromness Bay.	25 Call to KEP to drop Rob Smith. Shallow mooring recovery.	26 RMTs and LHPR at shallow mooring site. Deployment of moorings.	27 Western Core Box (W1.1, 1.2).	28 Western Core Box (W2.1, 2.2).
29 Western Core Box (W3.1, 3.2).	30 Hove-to in gale force winds.	31 Called at Bird Island to collect Simon Berry and Neal Farnell WCB 4.1	1 RMT25's at deep LHPR site. Deep LHPR.	2 Gale force winds end science prematurely. Depart for Stanley.	3 Passage to Stanley	4 Passage to Stanley
5 Arrived at Stanley at 1100. Ship unloaded.	6 Unloading completed.					

Table 1.3 Station List

Event	Date	Time	Latitude	Longitude	Depth	Gear	Station	Comment
1	10/3/2004	17:20	-53.9432	-43.7912	1016	CTD	Test	Test of CTD
2	11/3/2004	13:00	-53.8107	-44.2341	Uncertain	Pelagic Trawl	Test	Doors wrapped around each other
3	11/3/2004	17:00	-53.9358	-43.9123	Uncertain	Pelagic Trawl	Test	Test trawl with 400 m warp
4	11/3/2004	20:30	-53.9901	-43.7677		XBT	001 (Test)	
5	12/3/2004	4:10	-54.0823	-41.4995	0-200	Bongo	T1A	
6	12/3/2004	4:30	-54.0823	-41.4995	0-200	Bongo	T1A	
7	12/3/2004	5:00	-54.0823	-41.4995	0-200	Small bongo	T1A	
8	12/3/2004	5:45	-54.0823	-41.4995	1015	CTD	T1A	
9	12/3/2004	8:40	-54.0837	-41.0449		XBT	T1	
10	12/3/2004	9:05	-54.115	-40.9995	Uncertain	Pelagic Trawl	Test	Doors wrapped around each other
11	12/3/2004	15:06	-54.0834	-40.6676		XBT	T1	
12	12/3/2004	16:43	-54.0827	-40.2261		XBT	T1	
13	12/3/2004	17:15	-54.0876	-40.1499	Uncertain	Pelagic Trawl	Target/Test	Not much on the sounder; no fish caught
14	12/3/2004	21:33	-54.0834	-40.0001	1016	CTD	T1-B	
15	12/3/2004	22:36	-54.0835	-40.0001	0-200	Bongo	T1-B	
16	12/3/2004	22:49	-54.0811	-39.9997	0-200	Bongo	T1-B	
17	12/3/2004	23:13	-54.0811	-39.9997	0-200	Small bongo	T1-B	
18	13/3/2004	1:19	-54.0833	-39.7647		XBT	T1	
19	13/3/2004	5:57	-54.0833	-39.3485		XBT	T1	
20	13/3/2004	17:02	-53.9311	-38.5023				Start of Transect 2
21	13/3/2004	17:05	-53.9313	-38.5434		XBT	T2	Shallow <150m
22	13/3/2004	18:32	-53.9451	-38.9172		XBT	T2	Shallow <200m
23	13/3/2004	19:39	-53.9193	-39.1905	260-270-200	RMT25	close to T2B	
24	13/3/2004	22:55	-53.9335	-39.2501	0-200	Small bongo	T2-B	Previous Bongo failed (x2)
25	14/3/2004	0:13	-53.9333	-39.2832	277	CTD	T2-B	baby CTD (just going for a dip)
26	14/3/2004	0:30	-53.9345	-40.1284		XBT	T2	
27	14/3/2004	2:00	-53.9345	-40.1311		XBT	T2	
28	14/3/2004	3:42	-53.9339	-40.1978		XBT	T2	
29	14/3/2004	8:52	-53.9431	-40.9512	570-577-170	RMT25		
30	14/3/2004	12:07	-53.9334	-40.7503	1014	CTD	T2-A	
31	14/3/2004	13:10	-53.9334	-40.7504	0-200	Small bongo	T2-A	

32	14/3/2004	13:31	-53.9335	-40.7505	0-200	Bongo	T2-A	
33	14/3/2004	13:47	-53.9335	-40.7505	0-200	Bongo	T2-A	
34	14/3/2004	15:27	-53.9324	-41.0402		XBT		
35	14/3/2004	17:11	-53.9332	-41.4986		XBT	T2 (end of transect)	
36	14/3/2004	18:17	-53.7831	-41.5005	178	CTD	T3-A	
37	14/3/2004	18:54	-53.7831	-41.5005	0-170	Bongo	T3-A	
38	14/3/2004	19:10	-53.7831	-41.5005	0-170	Bongo	T3-A	
39	14/3/2004	19:26	-53.7831	-41.5004	0-170	Small bongo	T3-A	
40	14/3/2004	21:40	-53.7835	-41.0629		XBT	T3	
41	14/3/2004	23:30	-53.7047	-40.6524		XBT	T3	
42	15/3/2004	1:05	-53.7093	-40.6446	Uncertain	Pelagic Trawl	Target on T3	TDR on net; winch wire length monitored
43	15/3/2004	5:30	-53.7833	-40.0003		XBT	T3	
44	15/3/2004	5:35	-53.7902	-40.2214	100-20	RMT25	Target on T3	
45	15/3/2004	8:24	-53.7833	-40.0003	1014	CTD	T3-B	
46	15/3/2004	9:19	-53.7833	-40.0003	0-200	Bongo	T3-B	
47	15/3/2004	9:35	-53.7833	-40.0003	0-200	Bongo	T3-B	
48	15/3/2004	9:55	-53.7833	-40.0003	0-200	Small bongo	T3-B	
49	15/3/2004	11:05	-53.783	-39.8122		XBT	T3	On transect
50	15/3/2004	12:39	-53.7832	-39.3913		XBT	T3	
51	15/3/2004	14:05	-53.7874	-39.0673	170-150-177	RMT25	Target on T3	
52	15/3/2004	16:31	-53.7802	-39.0926		Pelagic Trawl	Target on T3	TDR on headline; 3 kts; 180 P. choriodon
53	15/3/2004	19:00	-53.7884	-38.9689		XBT	T3	Off transect due to ice; bird caught wire
54	15/3/2004	22:41	-53.7709	-38.2768	0-120	Bongo	T3-C	of station due to ice
55	15/3/2004	22:51	-53.7709	-38.2768	0-120	Bongo	T3-C	of station due to ice
56	15/3/2004	23:06	-53.7709	-38.2768	0-120	Small bongo	T3-C	off station due to ice
57	16/3/2004	4:46	-53.366	-38.4883	570-510;277-270	RMT25	Target near T3	on fishing search
58	16/3/2004	7:17	-53.3722	-38.4735	248-238;234-228	RMT25	Target near T3	
59	16/3/2004	14:17	-53.7829	-38.1285		XBT		
60	16/3/2004	15:56	-53.6328	-37.9993		XBT	start of transect 4	
61	16/3/2004	17:14	-53.6413	-38.3068	Uncertain	Pelagic Trawl	Target near T4	Strong marks on shelf break. Touched the bottom,; crabs and rocks!
62	16/3/2004	20:28	-53.6328	-38.423		XBT	T4	birds caught in wire
63	16/3/2004	22:03	-53.6292	-38.8315		XBT	T4	
64	17/3/2004	0:25	-53.633	-39.2714	0-200	Bongo	T4-B	south of station due to ice

65	17/3/2004	0:40	-53.633	-39.2714	0-200	Bongo	T4-B	south of station due to ice
66	17/3/2004	1:01	-53.633	-39.2714	0-200	Small bongo	T4-B	south of station due to ice
67	17/3/2004	1:26	-53.6348	-39.2662	1016	CTD	T4-B	
68	17/3/2004	5:06	-53.7004	-39.5794	320-480;250-210	RMT25	Target on T4	
69	17/3/2004	8:00	-53.6967	-39.5763		XBT	T4	
70	17/3/2004	9:40	-53.6328	-40.1424		XBT	T4	
71	17/3/2004	11:20	-53.6335	-40.5193		XBT	T4	
72	17/3/2004	12:40	-53.6332	-40.7489	376	CTD	T4-A	
73	17/3/2004	13:24	-53.6332	-40.7495	0-200	Bongo	T4-A	
74	17/3/2004	13:42	-53.633	-40.7497	0-200	Bongo	T4-A	
75	17/3/2004	14:04	-53.633	-40.7489	0-200	Small bongo	T4-A	
76	17/3/2004	16:53	-53.6344	-41.3627		XBT	T4	
77	17/3/2004	21:05	-53.6331	-42.2502	0-180	Bongo	T4-Z	
78	17/3/2004	21:19	-53.6331	-42.2499	0-180	Bongo	T4-Z	
79	17/3/2004	21:40	-53.6332	-42.2494	0-180	Small bongo	T4-Z	
80	17/3/2004	23:50	-53.6337	-42.5782		XBT	T4	
81	18/3/2004	1:24	-53.5891	-42.7054	Uncertain	Pelagic Trawl	Target on T4	en route back to T4-Z to redo failed CTD.
82	18/3/2004	5:55	-53.6332	-42.2519	182	CTD	T4Z	returned to do CTD
83	18/3/2004	6:20	-53.6335	-43.0316		XBT	T4	
84	18/3/2004	9:24	-53.6335	-43.0325	1016	CTD	T5-Z	
85	18/3/2004	11:57	-53.4834	-43.0002	0-200	Bongo	T5-Z	
86	18/3/2004	12:13	-53.4834	-43.0003	0-200	Bongo	T5-Z	
87	18/3/2004	12:34	-53.4835	-43.0003	0-200	Small bongo	T5-Z	
88	18/3/2004	14:45	-53.4837	-42.5679		XBT	T5-A	Failed; should try harder
89	18/3/2004	14:46	-53.4837	-42.5647		XBT	T5-A	No GPS data
90	18/3/2004	17:30	-53.4402	-42.03	170; 170-175	RMT25	Targets on T5	Marks at ~25m; 120 > 38KHz
91	18/3/2004	19:11	-53.44	-42.0644	125-140;143-130	RMT25	Targets on T5	good targets above bottom at around 140m
92	19/3/2004	0:40	-53.4264	-41.5793	Uncertain	Pelagic Trawl	Targets on T5	
93	19/3/2004	4:34	-53.494	-41.4198	500-530; 100-75	RMT25	near T5A	
94	19/3/2004	7:49	-53.5012	-41.5762	40-90; 60-65	RMT25	Targets on T5	
95	19/3/2004	10:20	-53.5114	-41.5516	806	CTD	T5-A	
96	19/3/2004	11:18	-53.4834	-41.5003	0-200	Bongo	T5-A	
97	19/3/2004	11:33	-53.4833	-41.5003	0-200	Bongo	T5-A	
98	19/3/2004	11:55	-53.7521	-38.5661	0-200	Small bongo	T5-A	

99	19/3/2004	14:16	-53.483	-41.0782		XBT	T5	
100	19/3/2004	16:40	-53.4832	-40.6805		XBT	T5	
101	19/3/2004	17:10	-53.4758	-40.6346	Uncertain	Pelagic Trawl	Targets on T5	
102	19/3/2004	21:22	-53.4837	-40.2414		XBT	T5	
103	19/3/2004	22:16	-53.4848	-40.1654	Uncertain	Pelagic Trawl	Targets on T5	
104	20/3/2004	1:40	-53.4835	-39.9994	0-200	Bongo	T5-B	
105	20/3/2004	1:59	-53.4834	-39.9997	0-200	Bongo	T5-B	
106	20/3/2004	2:20	-53.4835	-39.9993	0-200	Small bongo	T5-B	
107	20/3/2004	2:42	-53.4825	-39.6678	1016	CTD	T5 B	
108	20/3/2004	4:45	-53.4825	-39.6617		XBT	T5	
109	20/3/2004	7:30	-53.4941	-39.449	215-290;290-210	RMT25	Targets on T5	
110	20/3/2004	10:30	-53.4833	-39.3644		XBT	T5	
111	20/3/2004	12:14	-53.4959	-38.9436		XBT	T5	Failed
112	20/3/2004	12:20	-53.4958	-38.9377		XBT	T5	
113	20/3/2004	13:52	-53.4837	-38.5514		XBT	T5	
114	20/3/2004	14:29	-53.4872	-38.4999	1016	CTD	T5-C	
115	20/3/2004	15:33	-53.4872	-38.4999	0-200	Bongo	T5-C	
116	20/3/2004	15:53	-53.4873	-38.4999	0-200	Bongo	T5-C	
117	20/3/2004	16:14	-53.4872	-38.4999	0-200	Bongo small	T5-C	
118	20/3/2004	18:38	-53.5414	-38.2191	uncertain	Pelagic Trawl	Target on T5	
119	20/3/2004	21:56	-53.5282	-38.2316	260-275;205-270	RMT25	Target on T5	Between T5C and T5D
120	20/3/2004	23:50	-53.4835	-38.1543		XBT	T5	
121	21/3/2004	1:10	-53.482	-37.8504		XBT	T5	
122	21/3/2004	3:09	-53.477	-37.4103		XBT	T5	
123	21/3/2004	4:58	-53.4835	-37.0166	714	CTD	T5-D	
124	21/3/2004	5:45	-53.4835	-37.0166	0-200	Bongo	T5-D	
125	21/3/2004	6:00	-53.4835	-37.0167	0-200	Bongo	T5-D	
126	21/3/2004	6:20	-53.4835	-37.0166	0-200	Small bongo	T5-D	
127	21/3/2004	8:08	-53.6335	-37.2983		XBT	T5	
128	21/3/2004	9:55	-53.6335	-37.3003		XBT	T5	
129	21/3/2004	15:09	-53.619	-38.1472		LHPR	Shallow LHPR	not on original spot due to ice
130	21/3/2004	22:06	-53.5429	-38.2815	250-245;240-235	RMT25	Target	Near shallow LHPR
131	22/3/2004	2:35	-53.6071	-38.037		LHPR	Shallow LHPR	site approximate due to ice
132	22/3/2004	13:06	-53.5631	-37.387	200-100-0	RMT25	Box 1	Day

133	22/3/2004	15:43	-53.5133	-37.303	600-400-200	RMT25	Box 1	day
134	22/3/2004	20:02	-53.3879	-37.1839	1000-800-600	RMT25	Box 1	Dusk
135	22/3/2004	23:44	-53.5294	-37.3819	200-100-0	RMT25	Box 1	Night
136	23/3/2004	3:50	-53.2909	-37.7752	600-400-00	RMT25	Box 1	Night
137	23/3/2004	10:00	-53.3156	-37.9507	~250	Pelagic Trawl	Targets in Box 1	
138	23/3/2004	13:08	-53.3167	-37.9495	1000-0	RMT25	Box 2	Day
139	23/3/2004	17:59	-53.3092	-37.9831	800-600-400	RMT25	Box 2	day
140	24/3/2004	21:49	-53.3398	-37.9661	1000-700-400	RMT25	Box 2	night
141	24/3/2004	1:18	-53.3047	-38.0116	400-200-0	RMT25	Box 2	Night
142	24/3/2004	5:00	-53.25	-38.139	1000-0	LHPR	Box 2	Night
143	24/3/2004	10:29	-53.5132	-37.8559	204	CTD	Deep Mooring	
144	24/3/2004	13:21	-53.5077	-37.8573		Recovery	Deep Mooring	time on deck as recorded by bridge
145	24/3/2004	20:56	-54.1589	-36.6949	51	CTD	Stromness	Calibration
146	25/3/2004	16:54	-53.7949	-37.9432	203	CTD	Shallow Mooring	
147	25/3/2004	19:00	-53.8004	-37.9347		Recovery	Shallow Mooring	time on deck as recorded by bridge
148	25/3/2004	22:02	-53.7691	-37.9211	100-50-0	RMT8	Shallow Mooring	100-50/ 50-0
149	26/3/2004	0:02	-53.7892	-37.9345	300-200-100	RMT8	Shallow mooring	Net 1 only; Net2 damaged
150	26/3/2004	2:36	-53.8074	-37.9789	170-0	LHPR	Shallow Mooring	170 m max
151	26/3/2004	4:26	-53.7907	-37.9241	Surface	Neuston	Shallow Mooring	
152	26/3/2004	4:50	-53.801	-37.9554	Surface	Neuston	Shallow Mooring	
153	26/3/2004	5:10	-53.8083	-37.978	Surface	Neuston	Shallow Mooring	
154	26/3/2004	11:20	-53.8141	-37.936	100-50-0	RMT8	Shallow Mooring	
155	26/3/2004	13:25	-53.8066	-37.914	200-150-100	RMT8	Shallow Mooring	
156	26/3/2004	15:51	-53.8066	-37.914	250-0	LHPR	Shallow Mooring	
157	26/3/2004	18:16	-53.7949	-37.9433		Mooring A	Shallow Mooring	Approx. Time
158	26/3/2004	19:11	-53.7951	-37.9391		Mooring B	Shallow Mooring	Precise time!
159	26/3/2004	21:06	-53.7818	-37.9002	100-50-0	RMT8	Shallow Mooring	
160	26/3/2004	21:43	-53.7867	-37.9431	275-200-100	RMT8	Shallow Mooring	
161	27/3/2004	9:23	-53.3339	-39.6287		UOR	W1.1N	
162	27/3/2004	16:55	-53.7112	-39.1861		UOR	Transect W-1.2	UOR Redeployed after repair on deck
163	27/3/2004	21:43	-53.4929	-39.2511	0-200	Bongo	1 (W1.2N)	(at the end of WCB 1.2)
164	27/3/2004	22:00	-53.4929	-39.251	0-200	Bongo	1 (W1.2N)	
165	27/3/2004	22:20	-53.4929	-39.2511	0-200	Bongo	1 (W1.2N)	
166	27/3/2004	22:42	-53.4929	-39.251	1014	CTD	1 (W1.2N)	

167	27/3/2004	23:10	-53.4929	-39.2511		XBT	1 (W1.2N)	deployed whilst CTD at ~1000m
168	28/3/2004	0:02	-53.4939	-39.265	0-250-0	RMT8	1 (W1.2N)	0-250 metres
169	28/3/2004	0:11	-53.4947	-39.2794	Surface	Neuston	1 (W1.2N)	
170	28/3/2004	0:33	-53.4946	-39.3143	Surface	Neuston	1 (W1.2N)	
171	28/3/2004	4:37	-53.8445	-39.1384	0-250-0	RMT8	2 (W2.1S)	
172	28/3/2004	4:45	-53.8419	-39.1463	Surface	Neuston	2 (W2.1S)	Brash ice so did not do a 2nd Neuston
173	28/3/2004	6:26	-53.8457	-39.1438	247	CTD	2 (W2.1S)	
174	28/3/2004	6:54	-53.8463	-39.1435	0-200	Bongo	2 (W2.1S)	
175	28/3/2004	7:11	-53.8463	-39.1435	0-200	Bongo	2 (W2.1S)	
176	28/3/2004	7:32	-53.8463	-39.1435	0-200	Bongo	2 (W2.1S)	
177	28/3/2004	9:17	-53.2606	-38.7378		UOR	W2.2S	Relocated due to ice
178	28/3/2004	20:03	-53.4656	-38.6028	135-150;172	RMT8	Target fishing	
179	28/3/2004	21:10	-53.7586	-38.5937	0-200	Bongo	3 (W2.2S)	Relocated due to ice
180	28/3/2004	21:29	-53.7585	-38.5936	0-200	Bongo	3 (W2.2S)	
181	28/3/2004	21:44	-53.7585	-38.5937	0-200	Bongo	3 (W2.2S)	
182	28/3/2004	22:07	-53.7585	-38.5937	199	CTD	3 (W2.2S)	
183	28/3/2004	22:54	-53.7442	-38.5956	0-250-0	RMT8	3 (W.2.2S)	
184	28/3/2004	23:08	-53.7388	-38.6137	Surface	Neuston	3 (W2.2S)	
185	28/3/2004	23:28	-53.7306	-38.6383	Surface	Neuston	3 (W2.2S)	
186	29/3/2004	2:49	-53.4568	-38.6199	0-250-0	RMT8	4 (W2.2N)	
187	29/3/2004	2:53	-53.4552	-38.6253	Surface	Neuston	4 (W2.2N)	
188	29/3/2004	3:13	-53.4474	-38.6509	Surface	Neuston	4 (W2.2N)	
189	29/3/2004	4:08	-53.4317	-38.6954	1017	CTD	4 (W2.2N)	
190	29/3/2004	4:30	-53.4317	-38.6955		XBT	4 (W2.2N)	
191	29/3/2004	5:08	-53.4317	-38.6955	0-200	Bongo	4 (W2.2N)	
192	29/3/2004	5:24	-53.4317	-38.6954	0-200	Bongo	4 (W2.2N)	
193	29/3/2004	5:41	-53.4317	-38.6955	0-200	Small bongo	4 (W2.2N)	
194	29/3/2004	6:46	-53.4076	-38.644	100-50-20	RMT8	Target haul	
195	29/3/2004	9:17	-53.2089	-38.4296		UOR	W3.1N	Deployed - brought out before 3.1S (ice)
196	29/3/2004	15:01	-53.5525	-37.9891		UOR	W3.2S	new position (ice) (half way up transect)
197	29/3/2004	18:40	-53.3611	-38.0819	1013	CTD	5 (W3.2N)	
198	29/3/2004	19:06	-53.3611	-38.0827		XBT	5 (W3.2N)	
199	29/3/2004	22:17	-53.3609	-38.0928	0-250-0	RMT8	5 (W3.2N)	Bongos cancelled due to high winds
200	31/3/2004	12:51	-53.6504	-38.1002	128	CTD	6 (W3.2S)	

201	31/3/2004	13:17	-53.6498	-38.1	0-130	Bongo	6 (W3.2S)	
202	31/3/2004	13:19	-53.6497	-38.1	0-130	Bongo	6 (W3.2S)	
203	31/3/2004	13:42	-53.6497	-38.1	0-130	Small bongo	6 (W3.2S)	
204	31/3/2004	17:50	-53.5549	-37.8325	295-270	RMT25	Target on 4.1	Winch problems during recovery
205	1/4/2004	3:57	-53.0482	-39.2614	200-100-0	RMT25	deep LHPR	
206	1/4/2004	5:35	-53.0482	-39.2614	600-400-200	RMT25	deep LHPR	600-200m
207	1/4/2004	7:57	-53.0152	-39.1788	600-400-200	RMT25	deep LHPR	600-200m
208	1/4/2004	10:06	-52.9712	-39.2887	1000-0	RMT25	deep LHPR	Net 1 open all the way
209	1/4/2004	15:26	-52.9393	-39.5083	200-100-0	RMT25	deep LHPR	daylight
210	1/4/2004	18:08	-52.9494	-39.2885	600-400-200	RMT25	deep LHPR	daylight
211	1/4/2004	21:24	-52.9288	-39.3468	1000-800-600	RMT25	deep LHPR	Deep RMT 600 - 800/ 800 - 1000 m
212	2/4/2004	1:24	-52.8593	-39.5283	100-50-0	RMT25	deep LHPR	shallow - to 100m
213	2/4/2004	3:32	-52.9036	-39.4845	1000-0	LHPR	deep LHPR	
214	2/4/2004	6:31	-52.8208	-39.6034	1016	CTD	deep LHPR	to 1000m
215	2/4/2004	7:03	-52.8211	-39.6052		XBT	deep LHPR	during deep CTD

Cruise Narrative

Tuesday March 9th 2004

Safety brief at 0800 in the bar. Set off from centre berth at FIPASS at 0900, and anchored in Port William for boat drills and to secure equipment in the labs. Raised the anchor at around 11:30 and headed SE towards Shag Rocks. Wind F6 from SW, putting reasonable swell on the beam and causing discomfort for some.

Wednesday March 10th

Wind still blowing steady 30 knots from the SW, but turned head to wind at 08:00 to check possibility of testing the pelagic trawl. Conditions not suitable, so continued passage towards Shag Rocks.

Tested CTD at 14:00, down to 1000 m (Event 1). Completed by 15:30 and continued on passage.

Thursday March 11th

Weather moderated sufficiently to test the pelagic trawl (IYGPT). Trawl prepared after breakfast and shot step by step (Event 2) to enable the crew and scientists involved to learn the procedure. Some problems encountered with the winch in automatic mode. Net veered to 400 m of wire, then hauled back. The trawl doors had crossed, probably during the shooting process. Brought both doors up to the port block and disconnected the net from the port door to bring it on board. With the net on board the deck winch and crane were used to disentangle the doors. Gear eventually sorted by 13:00. Continued along the track towards the start of the first transect.

Prepared the trawl and shot again at 15:45 (Event 3). Acoustics not working due to computer network problem, so just shot and hauled. One of the doors had rotated, but the net came on board OK. XBT tested at 19:30 (Event 4).

Friday March 12th

Arrived at the transect start and began with the first CTD/Bongo station (T1-A) at 01:00. Large bongos (Events 5 & 6), small bongos (Event 7) and CTD (Event 8) completed. Acoustic transect commenced at around 03:30. XBT drop at 05:45 (Event 9). Marks detected on the sounder just before the XBT location, so IYGPT prepared for shooting. Trawl shot away around 06:30 (Event 10), and appeared to be OK. Paid out 530 m of wire, to get the net to approximately 250 m.

Hauled the net back on board, but the doors had crossed again. Disentangled the doors in the same way as previous time. Once the doors were secured, rejoined the transect.

XBTs dropped (Events 11 and 12) during the transect. Trawl prepared for another fishing attempt. Few marks on the sounder, but net shot and 250 m of warp paid out, to fish at around 100 m (Event 13). Problems with winch system prevented hauling for a while. Eventually winch problem partially solved, with power only available to either the net drum or the winches. The net hauled on board with a catch of *Themisto* and little else.

Proceeded along acoustic transect, and completed station T1-B (Events 14-17) and XBT drop (Event 18). RMT 25 prepared for night trawl. RMT 25 all set to be launched, but an initial problem with the gantry winch resulted in a loss of power to both gantries, so the RMT haul was cancelled.

Saturday March 13th

Continued along the acoustic track overnight with XBT drop (Event 19), but icebergs caused a diversion from the track and the CTD/Bongo station to be moved. However, the winch was still not working, so the station could not be done.

Headed for Bird Island to drop off Simon Berry (scaffolder). Attempted to reach BI from the south-west, but too much ice in the area, so headed around the Willis Islands to Elsahul. Arrived around 1100 and two ribs were deployed to take Simon and a small amount of cargo ashore. Tow TDR's collected from BI to monitor the depth of the pelagic trawl. Boats returned around 12:45.

Departed BI, heading for the start of Transect 2. Started transect at around 1400, with an XBT (Event 21). Continued along transect with some deviations to avoid icebergs. Another XBT dropped on the transect (Event 22). Deployed the RMT 25 (Event 23) for the first time at 1640 (local), with a small catch. Continued transect to Station T2-B. Attempted the large bongos first, but abandoned when a wire was caught, which destroyed the depth compensator when it was released. Small bongos (Event 24) and CTD (Event 25) completed successfully. Continued along transect 2, with three XBT drops overnight (Events 26-28).

Sunday March 14th

Weather continues calm, but foggy. Very few marks detected during the target fishing period in the night, but RMT 25 eventually shot at 05:50 (local), down to 550 m. Catch dominated by salps, but

diverse catch of fish. Rejoined transect, arriving at station T2-A (09:15 local) and did CTD (Event 30) and bongos (31-33), but large bongos now without depth compensation. Completed the last leg of transect 2, with XBT drops (Events 34, 35).

Headed north to start point of transect T3 at Station T3-A, arriving at 15:45 (local). CTD (Event 36), large (37, 38) and small (39) bongos completed in shallow (~200 m) depth on the Shag Rocks shelf. Station completed at 1640 (local). Started transect T3, with XBT drops at 15 nautical mile intervals (Events 40, 41).

Started to look for targets for the pelagic trawl at 1800 (local), but no fishable marks. Decided to shoot the trawl at 21:30 (Event 42), with a TDR fitted to log depth. Large target appeared on the sounder as net was shot, which was targeted, but wasn't caught! Net paid out in stages to try to calibrate the wire to depth ratio at a towing speed of 3.5 knots. 800 m of wire paid out, which took net to a maximum of 200 m. Caught myctophids, but they were in poor condition.

Monday March 15th

Switched to the RMT 25 and continued on transect, with a further XBT drop (Event 43). RMT 25 shot on marks in the top 100 m (Event 44), but release mechanism failed on second net, so it was brought back on board, with small myctophid catch. Continued on transect to Station T3-B, arriving at 0520 (local) with CTD (Event 45), large (46, 47) and small (48) bongos.

Continued on T3, with XBT drops (Events 49, 50). Early in the afternoon fish marks were detected at ~200 m and decided to trawl them with both the RMT (Event 51) and IYGPT (Event 52). IYGPT yielded good catch of *P. choriodon*. Continued on transect, with another XBT prior to station T3-C.

Station T3-C moved due to ice, and on arrival at new station (1940 local) the CTD failed to work. Bongo net hauls undertaken (Events 54-56). Lots of icebergs on the shelf to the north and west of Bird Island, prevented both the planned LHPR at the shallow station and pelagic trawling. Decided to do a series N-S transects, 4 miles apart between T4 and T5, to search for fish on the shelf edge and do some target fishing with the RMT 25.

Tuesday March 16th

RMT 25 net shot at 01:45 (Event 57) and brought on board at 03:20 (local), with diverse fish catch. Continued on N-S transects and did second haul with the RMT 25. Second haul (Event 58) on board at 06:20 and then headed back to the position where we had left T3 the previous evening. CTD was not repairable, and the spare on board was also not working, so contacted HQ to see what could be done. Fortunately it turned out that we had a new CTD unit on board. Rejoined T3 and completed the transect with an XBT drop (Event 59) at 1115 (local).

Headed north to the eastern end of T4 and started transect with an XBT drop (Event 60). Continued along transect, looking for targets for the pelagic trawl. Strong fish-like marks spotted at 200 m depth on the shelf break (water depth 250-300 m). Shot the pelagic trawl (Event 61) and fished through the location of the marks, but uncertain of the precise depth of the net. Net recovered and had been, at least briefly, in contact with the bottom. Catch included crabs (*P. spinosissima*), basket stars, demersal notothenioid fish and a few rocks. Fortunately the net was undamaged, and the large catch of *G. nicholsi* indicated that these were the acoustic marks.

Rejoined transect and continued to the next station, with XBT drops (Events 62, 63) along the way. Reached station T4-B at 21:25 (local) and did the bongo hauls (Events 64-66) before the CTD (Event 67).

Wednesday March 17th

Continued on transect T4, looking for targets to fish with the RMT 25. RMT 25 shot at 02:00, targeting layers at 400 m and 225 m (Event 68). Net on board at 03:52, with diverse fish catch. Rejoined transect, continuing to look for fishable targets and dropping XBT's (Events 69-71) ahead of Stations T4-A.

Reached Station T4-A at 09:40 (local), with CTD (Event 72) and then bongo hauls (Events 73-75). Rejoined transect, which has been extended west beyond Shag Rocks, to cover an area where macaroni penguins were foraging. Took a detour south to avoid the Black Rock area, with an XBT drop east of the Shag Rocks shelf (Event 76).

Reached Station T4-Z at 1800 (local), but once again the CTD wasn't working, so just did the bongo nets (Events 77-79), intending to return when the CTD was fixed. Recommenced the transect and prepared to target fish with the pelagic trawl. Little life on the sounder, so just beyond

an XBT drop (Event 80), turned back towards T4-Z. Shot the trawl (Event 81) at 22:25 (local), with little sign of life in the water. Net on board shortly before midnight, with a small catch, but some fish from the previous haul were still in the net and had been washed down to the cod-end.

Thursday March 18th

Returned to do the CTD at station T4-Z (Event 82: 0300 local), then returned to the transect with the RMT 25 rigged to target fish. No good targets identified, so continued to the end of T4, where an XBT was dropped (Event 83) and then headed north to station T5-Z and the start of T5.

Arrived at T5-Z at 0630 (local), with clear skies and light winds. CTD (Event 84) and bongo hauls (Events 85-87) completed successfully. Started T5, looking out for targets to fish with the pelagic trawl before we reached the Shag Rocks shelf. XBT dropped on the transect (Events 88-89).

After lunch some acoustic layers were detected at 30-50 m, with water depth 150 m on the shelf. Marks were stronger on the 120 than the 38 Khz, but with fur seals and macaroni penguins in the area were worth fishing. RMT 25 shot and towed through the marks (Event 90), and during the tow more marks, also stronger on the higher frequency, were identified close to the sea-floor at 150 m depth. The first pair of nets was hauled with a catch of *Themisto* and the net was shot away to catch the deeper marks (Event 91). Second set of nets yielded a good catch of *Patagonotothen guntheri*.

Continued along the transect towards the next station, but stopped to fish with the pelagic trawl to a depth of 275 m (Event 92) at the shelf edge. Small catch of *P. gracilis* and myctophids.

Friday March 19th

Two RMT hauls in the early hours, the first fishing layers on the shelf edge (Event 93) and the second over the Shag Rocks shelf (Event 94) in search of fish larvae. Small catches in both.

Continued along the transect, reaching station T5-A at 0720 local, with CTD (Event 95) and bongos (96-98). Continued on transect T5, with two XBT drops (99, 100), before targeting fish-like marks with the pelagic trawl (Event 101), which produced a small catch of myctophids. Continued along the transect, with an XBT drop (Event 102). A broad scattering layer was

detected at 1850 local, and was fished with the pelagic trawl (Event 103), yielding a good catch of myctophids.

Continued along the transect to station T5-B, where the bongo nets (Events 104-106) and CTD (107) were deployed.

Saturday March 20th

Continued transect T5 after completion of station T5-B, dropping an XBT (Event 108), then target fishing with the RMT (Event 109). Minor problems with the RMT monitor and bars slightly delayed the trawl, but a good catch of fish was taken.

Rejoined transect towards Station T5-C, with XBTs (Events 110-113) en route. Arrived at Station T5-C at 1130 (local), and did the CTD (Event 114) and bongos (Event 115-117). Started the transect towards T5-D, and quickly saw fish-like marks at 280-320 m, which were fished with the pelagic trawl (Event 118) and the RMT 25 (Event 119). Pelagic trawl caught 20 kgs of krill, probably taken at the surface on the way down and some myctophids dominated by *Electrona carlsbergi*. RMT 25 was towed through two different acoustic marks at 300 m, but the catch of both nets was dominated by *Electrona carlsbergi*.

Rejoined transect towards Station T5-D with XBT drops (Events 120-122).

Sunday March 21st

Reached Station T5-D at 02:00 (Local) with CTD first (Event 123) and then bongos (Events 124-126). Headed south to complete the end of T4, with XBT drops along the way (Events 127-128).

With transects completed headed for the shallow LHPR site. Brief scientific meeting at 1000 (local).

Shallow LHPR site still littered with icebergs, so found an alternative location to the NE. LHPR deployed (Event 129) at 1210 (local), back on board at 12:40. Hove to for an hour to repair an oil leak in the gantry. Headed north to the shelf edge to look for targets to fish, found reasonable targets at 260-300 m. Shot the RMT at 1900 (Event 130). Good catch, again dominated by *Electrona carlsbergi*.

Proceeded back to LHPR site for midnight deployment. Unable to return to noon site, but found location close by. LHPR deployed at 2330 (Event 131).

Monday March 22nd

Ran a series of acoustic transects N-S in the first box for RMT25 fishing. Wind increased quickly in the morning to 30-35 knots, which delayed the first RMT25 station. RMT25 deployed at 1000 with nets fished 200-100 m and 100-0 m (132), but caught few fish. Second nets deployed and fished 400-600 and 200-400 m (133), with good fish catch. Third set extended beyond dusk, fishing 1000-800 and 800-600 m (Event 134), on board at 2030 (local).

Started the night nets with 200-100 and 100-surface (Event 135; 2045 local).

Tuesday March 23rd

Turned the RMT around for the night 200-400 and 400-600 depth trawls (Event 136). Switched to pelagic trawl (Event 137) for target fishing at 300 m.

Moved to the off-shelf RMT25 site and started the daylight RMT25's at 0930 (local), with the net intended to fish 1000-800 and 800-600, but net problems resulted in 1000-surface, fished mostly in the 800-1000 m zone (Event 138). Second set fished 800-600, plus 600-400 (Event 139). Second net up at 1700 local, so no time for the daylight shallow haul. Moved back to start point and started with the deep haul (1000-700 and 700-400; Event 140) and then did a second haul (Event 141; 400-200 and 200-surface).

Wednesday March 24th

Finished the RMT series at 00:30 and headed for the LHPR start. LHPR (Event 142) deployed at 0200, down to 1000 m and back on deck at 04:10. Headed for the deep mooring location. At 07:30 a CTD (Event 143) was done at the mooring location, then the vessel sat on position for an hour to cross check moorings with EK60.

Moorings releases fired at 0840 (local), but it didn't appear on the surface. Fired again at 0925 and the mooring surfaced just ahead on the port bow. Mooring recovered (Event 144) by 1030 (local). Headed for Stromness Bay.

Arrived in Stromness Bay at 1530 (local), and everyone had a quick trip ashore before acoustic calibration started at 1800 (local). Calibration completed at 2330.

Thursday March 25th

Departed Stromness Bay at 0600 and headed around the coast to KEP. Arrived just outside King Edward Cove at 0800, dropped off Rob Smith and some cargo and headed back out to sea. Reached the shallow mooring location at 1330 and did a CTD (Event 146). Mooring released at 16:00 (local) and recovered (Event 147).

After dark two RMT hauls (0-50; 50-100 and 100-200; 200-300) were made over the mooring location (Events 148, 149). The first two nets had large catches of krill (70 kg in the 0-50 net), whilst the net broke for the shallow haul in the second deployment. The LHPR was deployed (170-surface) over the mooring site (Event 150).

Friday March 26th

Overnight the neuston net was prepared and three hauls made (Events 151-153) and then some acoustic runs were made along one of the core box transects. At first light the damaged RMT net was replaced and two daylight RMT hauls were made at the moorings site (100-50 m; 50-0 m Event 154 and 200-150 m; 150-100 m; Event 155). The LHPR was deployed at 12:50 (local) over the moorings site (Event 156).

Both moorings were prepared on deck, ready for shallow deployments approximately 300 m apart. The first mooring was deployed at 15:16 (local; Event 157) and the second at 16:10 (local; Event 158).

After dark the RMT was prepared and shot, to repeat the night time hauls close to the moorings. The first net (100-50 and 50-surface) was shot at 18:06 (Event 159) and the second (275-200; 200-100) at 18:43 (Event 160).

Departed the moorings site and headed for the NW start point of the core box.

Saturday March 27th

Reached Core Box start at 0620, deployed the UOR (Event 161) and started the transect at 07:00.

Unable to complete the first leg (W1.1) due to ice. UOR modem wasn't functioning correctly during the first leg and so UOR was recovered at the end. UOR re-deployed (Event 162) at the start of the second leg (W1.2) and now working fine.

Transect W1.2 completed at 16:30 (local) and we headed back to the first station. Slight delay getting on station due to problems with the stern thrusters. On station the bongo nets were deployed first (Events 163-165), followed by the CTD (Event 166). An XBT was dropped while the CTD was at 1000 m (Event 167). Once the CTD was on board the RMT 8 was shot (Event 168) and towed into wind, away from station (0-250; 250-0). Whilst the RMT 8 was in the water, two neuston net hauls were made (Events 169-170).

Sunday March 28th

Headed south to Station 2 (W1.2S), and shot the RMT 8 first (Event 171), in a light NW breeze (0-250; 250-0). The neuston net was just deployed once (Event 172), as there was a lot of ice around. The RMT8 was recovered, with a good catch of Themisto in the second net. Returned to the station for the CTD (300 m; Event 173) and bongos (Events 174-176).

Having completed Station 2 we headed to the start point for transect W1.3, but the south end of the transect was blocked with ice, so the transect start point was shifted 15 miles north. UOR deployed at the start of the transect (Event 177).

Completed the transect and started transect W1.4, heading back south in a freshening SW wind. Unable to complete the transect due to ice. After breaking off the transect, the RMT 8 was shot on some weak targets at 160 m (Event 178; 1700, local), but did not catch much.

Returned to Station 3 (W2.2S) for the bongos (Events 179-181), CTD (182) and RMT (183). Two deployments of the neuston net (Events 184, 185) made whilst the RMT 8 was in the water.

Completed Station 3 and headed to Station 4 (W2.2N). RMT shot away from 3 miles down wind of Station 4 (Event 186). Two neuston hauls completed (Events 187, 188) while the RMT 8 was in the water.

Monday March 29th

Following the RMT 8 haul, the CTD was deployed (Event 189), with an XBT dropped (Event 190) while the CTD was at 1000 m. After the CTD the bongos net hauls were undertaken (Events 191-193). After completing the bongos, time allowed some target fishing with the RMT 8. Marks were seen close to Station 4 and were fished (Event 194), but a small catch resulted.

The UOR was deployed (Event 195; 06:15) at the start of Transect 3.1, but the transect was cut short due to ice and the UOR recovered (10:10 local). In deteriorating weather, the next transect leg (W3.2) was started north of the start point due to ice at the southern end. The UOR was redeployed (Event 196).

The end of transect W3.2 was reached at 14:30 (local) and the UOR recovered. Headed back south along the transect to Station 6 (W3.2 N), where winds of 25-30 knots caused the bongo hauls to be deferred and the CTD was done first (Event 197), with a simultaneous XBT (Event 198). Following the CTD, the wind had not moderated sufficiently for the bongos, so the RMT 8 was shot after dark (Event 199). Following the RMT 8 haul, the swell was still too great for the bongos, so the vessel began to relocate towards Station 6. However Station 6 was inaccessible due to ice, so selected a location on the shelf as close as possible. Wind speed increased to 40 knots, so Station 6 postponed.

Tuesday March 30th

Hove-to in 35-40 knot winds and big seas. Not able to work all day. Received a message via the captain from operations that we have to do a call at BI tomorrow- Principal Scientist was not consulted on this.

Wednesday March 31st

Arrived off Elsahul at 0630 and put the two Humbers in the water to pick up Simon Berry and Neal Farnell from BI. All on board by 0800, and we head north to do Station 6 (W3.2 S). Arrived at the station at 0930 and do the CTD first (Event 200), followed by the bongos (Events 201-203). During the station the RMT 8 is dismantled, as it would not be valid to do the RMT 8 in daylight. RMT 25 set up for later.

After completing the station we headed for the southern end of transect W4.1. Transect started at 1300, without the UOR so that we are able to target fish. Some weak targets detected just after

1400 and the RMT 25 shot (Event 204), but the mark had moved, so only net 1 was opened. Winch problems delayed recovery of the net by an hour and the catch was small. The transect was continued, but with insufficient time to complete it before dark.

Thursday April 1st

Arrived near the deep LHPR station at 00:30 and shot the RMT 25 (Event 205). Net 1 fished from 200-100 m, but net 2 did not appear to open properly, so the trawl brought in early. Shot away again to target 400-600 and 400-200 m zones (Event 206), but the net wasn't performing correctly, so recovered early (03:30). Release mechanisms reset and shot away again at 04:15 and brought back at 07:00, with decent fish catch in both nets (Event 207). Shot away again at 08:00 to target 600-800 and 800-1000 m layers (Event 208). Net 1 opened successfully, but did not appear to close when commanded. Net 1 stayed open from 1000 m to the surface, and was eventually closed at the surfaced and net 2 was opened and closed.

RMT 25 checked out on deck and some cables replaced. Shot away again at 12:30 (local) to do the daytime 200-100 and 100-surface tows (Event 209). Net worked fine, but very few fish caught. Net reset to do the daytime 600-400 and 400-200 tows (Event 210), again some problems getting the nets to open and close, but eventually worked and produced good catch of *Electrona carlsbergi* in the 400-200 m net.

The night deep tow (1000-800; 800-600) was shot at 18:30 (Event 211) and back on board by 21:30, with a decent catch, and leaving time to repeat the dark 100m-surface tow that had failed on the previous evening (Event 212).

Friday April 2nd

With the wind gradually increasing the LHPR was deployed close to the deep site at 0030 (local) (Event 213) and was back on board by 0230. During the LHPR the weather had deteriorated, preventing the bongo nets, but the CTD was lowered (Event 214) and an XBT dropped (215).

Stayed on station until 0900, but the weather further deteriorated, preventing any further scientific activities and the JCR set off for Stanley. Initial progress very slow in 40 knot winds and a big sea.

Cruise quiz in the evening.

Saturday April 3rd

Weather moderated slightly, but still making slow progress towards Stanley. Lab packing and cleaning and cruise report writing continues.

End of cruise dinner.

Sunday April 4th

Weather moderated further, allowing better progress towards Stanley, though it looks likely that we'll arrive back late Monday afternoon. Weather continued to moderate through the day.

Monday April 5th

Excellent progress overnight in calm conditions. Arrived alongside FIPASS at midday. First container on board shortly after lunch and packed with cases and boxes. First container moved to quay and second on board to pack nets, LHPR and UOR. Packing mostly finished by 1630, with just the deck workshop left to pack.

2. Physical Oceanography

Elizabeth Hawker

Conductivity-Temperature-Depth (CTD) Operations

A Conductivity-Temperature-Depth (CTD) unit was used on JR100 to vertically profile the temperature and salinity of the water column on 25 CTD stations (Figure 2.1). Six stations were occupied in the Western Core Box region to the northwest of South Georgia. These were fixed locations including 3 deep off-shelf and 3 shallow on-shelf stations, currently surveyed three times a year as part of the BAS Biosciences Programme. Fourteen stations were occupied on the transects of the Fish Survey with locations chosen so as to enable as broad an oceanographic coverage of the survey region as possible. Four additional stations were occupied; one test station on passage between the Falkland Islands and South Georgia, two stations at two mooring sites for calibration purposes, and one station in Stromness Harbour for the acoustic calibration. The method of acquisition and calibration of the data are described here.

CTD unit and deployment

The CTD unit was a Sea-Bird 911 plus with dual temperature and conductivity sensors, an altimeter, dual SBE 43 oxygen sensors and a par sensor. Part way through the cruise (between stations 009 and 010) the second oxygen sensor was replaced with a fluorometer. For some stations (between 011 and 018) the deck unit was successfully configured (by Nathan Cunningham) to incorporate NMEA gps data.

The CTD unit was connected to an SBE 32, 12 position carousel water sampler (S/N 3215759-0173) carrying 12 10 litre bottles and also to an SBE 35 Reference Temperature Sensor (S/N 0315759-0005). The CTD data were logged via an SBE 11 plus deck unit to a 1.4GHz P4 PC, running Seasave Win32 version 5.28e (Sea-Bird Electronics Inc.). This new software is a great advance on the DOS version, allowing numerical data to be listed to the screen in real time, together with several graphs of various parameters. The data rate of recorded data for the CTD was 24 Hz.

The CTD package was deployed from the mid-ships gantry and A-frame, on a single conductor torque balanced cable connected to the CTD through the BAS conducting swivel. This CTD cable was made by Rochester Cables and was hauled on the 10T traction winch. The general procedure was to start data logging, deploy, and then to stop the CTD at 10 db pressure. After a minimum 2

minute soak, the package was raised to just below the surface and then continuously lowered to the target depth (1000m for deep stations, and approximately 20m off the bottom for shallow stations), with the Niskin bottles being closed during the upcast. The final CTD product was formed from the calibrated downcast data averaged to 2db intervals.

A summary of all CTD deployments is given in Table 2.1. The CTD configurations used during the cruise are detailed in Table 2.2, together with the serial numbers of the relevant sensors. The corresponding calibration coefficients are given in appendix A.

During the cruise there were no problems in the deployment of the CTD package and no re-terminations were required. Some problems were, however, encountered with the CTD and deck units and are briefly summarised here. After station 007 it was noticed that the deck unit had been switched off. When switched back on communication between the CTD and the deck unit could not be established. After trying to ascertain the cause of the problem the CTD unit was replaced and all sensors (except pressure) switched from the old to new unit. The CTD worked well during the next two stations (stations 008 and 009), but a further failure in communication between the deck and CTD units was traced to a fuse in the deck unit. Both CTD and deck units performed well until after station 018 when a problem with the primary pump caused it to turn on while the CTD was on deck in the bottle annex. On further inspection the pump was found to be very worn. It is likely therefore, that some seawater remained in the pump after the last CTD cast and that with the ship's movement the pumps were triggered to switch on. To stop the pumps the deck unit was switched off. However, when switched back on there was a complete failure of the deck unit to communicate to the CTD, and it was replaced with the spare. A new (primary) pump was also installed in the CTD, and the least worn of the remaining spare pumps installed as the secondary pump.

Data Aquisition

1. At the end of each CTD cast, four files were created by the Seasave Win32 version 5.28e module:

100ctd[num].dat	a binary data file
100ctd[num].con	an ascii configuration file containing calibration information
100ctd[num].con	an ascii header file containing the sensor information
100ctd[num].bl	a file containing the data cycle numbers at which a bottle was closed on the rosette

These files were saved on the D:\ drive of the CTD PC with a separate folder for each CTD.

2. The CTD data was converted to ascii and calibrated by running the Sea-Bird Electronics Inc. Data Processing software version 5.28f *Data Conversion* module. This program was used only to convert the data from binary, although it can be used to derive variables. This output an ascii file *100ctd[num].cnv*.

The sensors were calibrated following:

Pressure Sensor:

$$P = C\left(1-\frac{T_0^2}{T^2}\right)\left(1-D\left(1-\frac{T_0^2}{T^2}\right)\right)$$

where P is the pressure, T is the pressure period in μS, U is the temperature in degrees Centigrade, and $D = D_1 + D_2U$

$C = C_1 + C_2U + C_3U^2$

$T_0 = T_1 + T_2U + T_3U^2 + T_4U_3 + T_5U_4$.

Conductivity Sensor:

$$cond = \frac{\left(g + h\,f^2 + i\,f^3 + j\,f^4\right)}{10\left(1 + \delta t + \varepsilon p\right)}$$

where the coefficients are given in Appendix A, p is pressure, t is temperature, and $\delta = CTcorr$ and $\varepsilon = Cpcorr$.

Temperature Sensor:

$$Temp\,(ITS-90) = \left\{\frac{1}{g = h(\ln(f_0/f) + i(\ln^2(f_0/f) + j(\ln^3(f_0/f))}\right\} - 273.15$$

where the coefficients are given in Appendix A, and f is the frequency output by the sensor.

3. The Sea-Bird Electronics Inc. Data Processing software version 5.28f *Cell Thermal Mass* module was then used to remove the conductivity cell thermal mass effects from the measured conductivity. This takes the output from the data conversion program and re-derives the pressure and conductivity to take into account the temperature of the pressure sensor and the action of pressure on the conductivity cell. The output file is of the form *100ctd[num]tm.cnv*. This correction followed the algorithm

Corrected Conductivity = c + ctm

where *ctm = (-1.0 * b * previous ctm) + (a * dcdt * dt)*
dt = (temperature - previous temperature)
*dcdt = 0.1 * (1 + 0.006 * (temperature - 20)*
*a = 2 * alpha / (sample interval * beta + 2)*
*b = 1 - (2 * a / alpha)*
with *alpha = 0.03* and *beta = 7.0*.

All files were transferred from the CTD PC to the Unix system using samba and placed in the directory *~/pstar/data/ctd/ascii_files/100ctd[nnn]/* where *nnn* was the station number of the cast.

SBE35 High Precision Thermometer

Each time a water sample was taken using the rosette, the SBE 35 recorded a temperature in EEPROM. This temperature was the mean of 10 * 1.1 seconds recording cycles (therefore 11 seconds) data. The thermometer has the facility to record 157 measurements but the data was downloaded approximately every few casts and then transferred to the Unix system using samba. To process the data, communication was established between the CTD PC and the SBE35 by switching on the deck unit. The *Seabird terminal programme* was used to process the data. This is a simple terminal emulator set up to talk to the SBE35. Once you open the program the prompt is ">". The SBE35 will respond to the command '*ds*' (display status) by telling you the date and time of the internal clock, and how many data cycles it currently holds in memory. A suitable file name can be entered via the 'capture' toolbar button, and the data downloaded using the command '*dd*' (dump data). The data currently held in the memory is listed to the screen. This can be slow due to the low data transfer rate. Once the download is completed the 'capture' button should be clicked to close the open file, and the memory of the SBE 35 cleared using the command *"samplenum=0"*. To check the memory is clear the command '*ds*' should again be entered before shutting down the system. The SBE35 data files were divided into separate files for each station with 12 records (one level for each bottle) called *100sbe[nnn]*. These were transferred to Unix via samba and placed in the directory *~/pstar/data/ctd/ascii_files/sbe35/.*

The data were converted to temperature using the Sea Bird calibration routines:

$$Temp\,(ITS-90)=\left\{\frac{1}{a_0+a_1\ln(n)+a_2\ln^2(n)+a_3\ln^3(n)+a_4\ln^4(n)}\right\}-273.15$$

and $t_{90}=slope\times t_{90}+offset$

where *n* is the output from the SBE 35 and the other constants are listed in appendix A.

Salinity Samples

At each CTD station, between seven and twelve Niskin bottles were closed and sampled for salinity analysis. The primary purpose of this is to calibrate the salinity measurements made by the CTD sensors. Samples were taken in 200 ml medicine bottles. Each bottle was rinsed three times and then filled to just below the neck, to allow expansion of the (cold) samples, and to allow effective mixing upon shaking of the samples prior to analysis. The rim of each bottle was wiped with a tissue to prevent salt crystals forming upon evaporation, a plastic seal was inserted into the bottle neck to prevent loss of sample and the screw cap was replaced. The bottle crates were colour coded and numbered for reference. The salinity samples were placed close to the salinometer (sited in the chemistry lab) and left for at least 24 hours before measurement. This allowed the sample temperatures to equalise with the salinometer.

The samples were then analysed on the BAS Guildline Autosal model 8400B, S/N 63360 against Ocean Scientific standard seawater (batch P143). One vial of OSIL standard seawater was run through the salinometer at the beginning, and at the end of each crate of samples enabling a calibration offset to be derived and to check the stability of the salinometer. Once analysed the conductivity ratios were entered by hand into an EXCEL spreadsheet, converted to salinities and transferred to the Unix system using samba. They were then read into a pstar data file and used in the further CTD data processing.

CTD data processing

Further processing of the CTD data using pstar scripts (in Unix) required both the salinity data from the bottle samples and the SBE35 temperature data. The pstar execs check for the required input files, assuming that they have been placed in the correct directories.

100seactd0

This exec converted data from the Seabird ascii format to pstar. The output files were *100ctd[nnn].raw* and *100ctd[nnn]*. These were moved to the directories *~/ctd/raw/* and *~/ctd/rough/* respectively.

100seactd1

This exec required the SBE35 data and salinity bottle data for the relevant station. The output files were:

100ctd[nnn].bottle - containing the CTD data at the bottle firing positions

100ctd[nnn].samp - containing the **.bottle* file with the addition of the bottle salinity and SBE35 data

100sam[nn].dif - containing residuals from the **.samp* file

100sam[nnn].bot - containing salinity data from the spreadsheet

The exec used the *100ctd[nnn].samp* file to derive the conductivity of the salinity samples. The pstar program *mlist* was used to produce a quick and dirty plot of *botcond v deltaC* to the screen and to the printer. The cast number was written on the hardcopy since it was just a rough plot. The output file was *100sam[nnn].cond* containing the conductivity variable *deltaC*. After running the exec the files were moved to the directories *~/ctd/samples/bottle/*, *~/ctd/samples/samp/*, *~/ctd/samples/dif/* and *~/ctd/samples/salts/* respectively.

100seactd2

This exec plotted the salinity profiles of the CTD stations and overlay the bottles on top of the profiles such that obvious bad salinity samples were rapidly picked out. The plot was again produced both to the screen and printer and the cast number immediately written on the hardcopy (rough plot).

ctdoff

This program required the file *100ctd[nnn].cond* and produced the mean and standard deviation of the conductivity residual. These numbers were written on the plot produced by *100seactd2* for further reference.

On the basis of the results of *100seactd1*, *100seactd2* and *ctdoff* for each station it was decided whether some bottles should be rejected and the conductivity residual recalculated. For example, the cruise protocol required bottles to be fired at depths where the salinity gradient was very steep

so that some bottle samples were unsuitable to use in calibration. The **.cond* file was moved to the directory *~/ctd/samples/cond*.

100seactd3

This exec required the conductivity residual (the output of *ctdoff*). This offset was added to the rough version of the CTD file (the output of *100seactd0* - *100ctd[nnn*]), and the salinity was re-derived with the new conductivity. The output file of this exec was *100ctd[nnn].cal* which was moved to the directory *~/ctd/cal*.

100seactd4

This exec used the pstar program *mlist* to select the downcast (N.B. the CTD was lowered to 10 db and then brought to the surface before starting the true downcast). The output files were *100ctd[nnn].24hz* and *100ctd[nnn].2db*. These were moved to the directories *~/ctd/24hz*/ and *~/ctd/2db/* respectively.

100seactd5

This exec is similar to *100seactd1*, but used the updated values of salinity rather than the raw data. At this stage of the processing the second conductivity and temperature variables were dropped (while useful for difficult stations, in general they give no more information than the primary sensors). The output files were *100ctd[nnn].cbottle*, *100ctd[nnn].csamp* and *100ctd[nnn].cdif* and were moved to the directories *~/ctd/samples*, *~/ctd/samples/csamp/* and *~/ctd/amples/cdif/* respectively.

Quality of the CTD Calibration

The conductivity offsets used for the CTD calibration are listed in Table 2.1 and were applied to the primary conductivity cell. For stations 011 to 015 and 019 to 025 this offset was calculated as described above. For stations 001 to 010 (and also those at the mooring and calibration sites; stations 016 to 018) the mean conductivity offset derived for stations 011 to 015 was used. After the conductivity offset was applied, the samples were merged with the corrected CTD data, and new corrected sample files derived.

A total of 189 salinity samples were used in the calibration. The mean difference in the 22 duplicate samples was 0.000018. Following analysis some of the bottle samples were excluded

from the derivation of the calibration offsets because they were clearly sited in a poor calibration region (ie strong vertical gradient of salinity) or because of clear contamination.

On brief inspection, the mean offsets between the SBE35 thermometer and the primary and secondary CTD thermometer sensors were 0.0039°C and 00053°C, respectively. In each case the SBE35 thermometer recorded the lower temperature.

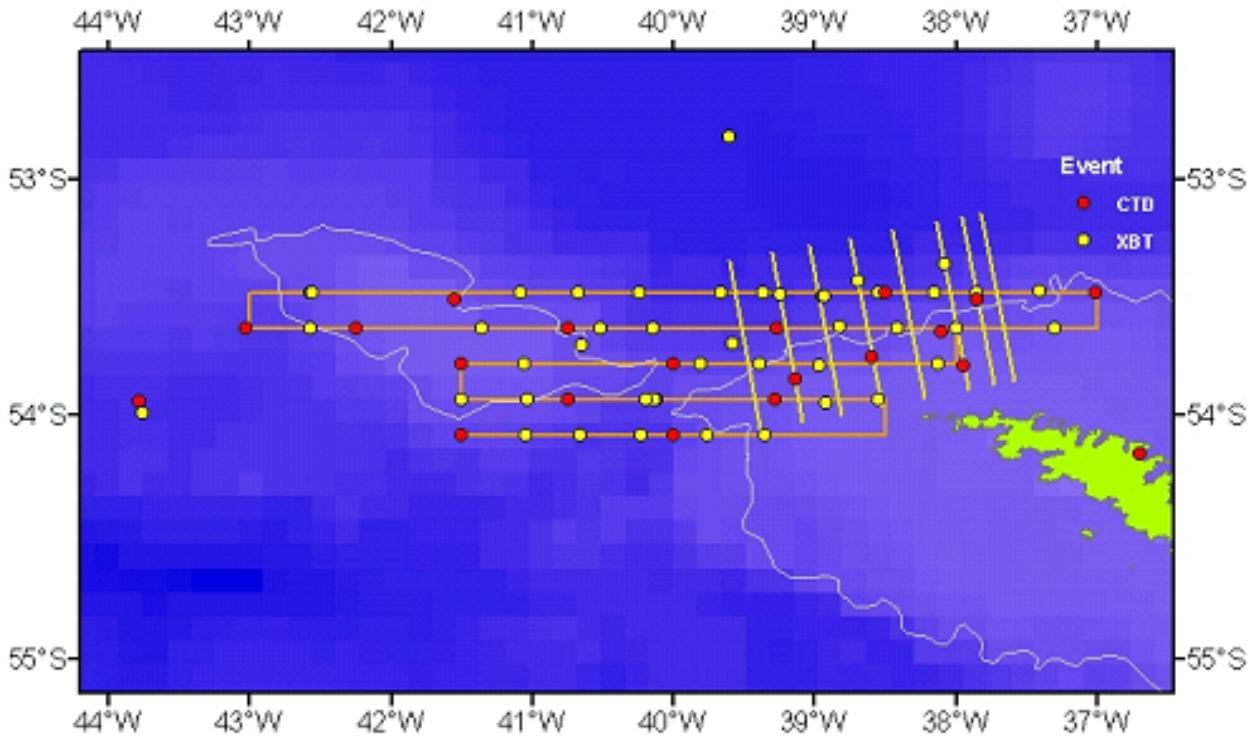

Figure 2.1. Locations of CTD and XBT drops during JR100.

Table 2.1: Summary of CTD deployments on JR100

STATION	Event	Calendar date	Day of Year	Time at bottom (GMT)	Longitude	Latitude	Water depth	Ctd Max pressure	Comment	Conductivity offset (used in calibration)
100ctd001	001	10/03/2004	070	17:45	-43.79	-53.94	3680	1016	test station	0.00138
100ctd002	008	11/03/2004	071	06:06	-41.50	-54.08	1641	1015	T1-A	0.00138
100ctd003	014	12/03/2004	072	21:57	-40.00	-54.08	2746	1016	T1-B	0.00138
100ctd004	025	13/03/2004	073	23:32	-39.28	-53.93	314	277	T2-B	0.00138
100ctd005	030	14/03/2004	074	12:30	-40.75	-53.93	1870	1014	T2-A	0.00138
100ctd006	036	14/03/2004	074	18:30	-41.50	-53.78	207	178	T3-A	0.00138
100ctd007	045	15/03/2004	075	08:45	-40.00	-53.78	1337	1014	T3-B	0.00138
100ctd008	067	17/03/2004	077	01:46	-39.27	-53.63	2077	1016	T4-B	0.00138
100ctd009	072	17/03/2004	077	12:50	-40.75	-53.63	400	376	T4-A	0.00138
100ctd010	082	18/03/2004	078	06:00	-42.25	-53.63	214	182	T4-Z	0.00138
100ctd011	084	18/03/2004	078	11:12	-43.03	-53.63	1365	1016	T5-Z	0.00120
100ctd012	095	19/03/2004	079	10:40	-41.55	-53.51	848	806	T5-A	0.00125
100ctd013	107	20/03/2004	080	03:04	-39.67	-53.48	3696	1016	T5-B	0.00030
100ctd014	114	20/03/2004	080	14:54	-38.50	-53.49	3556	1016	T5-C	0.00096
100ctd015	123	21/03/2004	081	05:15	-37.02	-53.48	771	714	T5-D	0.00320
100ctd016	143	24/03/2004	084	10:38	-37.86	-53.51	1355	204	deep mooring	0.00138
100ctd017	145	24/03/2004	084	21:01	-36.69	-54.16	75	51	Acoustic calibration	0.00138
100ctd018	146	25/03/2004	085	17:00	-37.94	-53.79	322	203	shallow mooring	0.00138
100ctd019	166	27/03/2004	087	23:05	-39.25	-53.49	3156	1014	W1.2-N	-0.00013
100ctd020	173	28/03/2004	088	06:34	-39.14	-53.85	293	247	W1.2-S	-0.00276
100ctd021	182	28/03/2004	088	22:16	-38.59	-53.79	244	199	W2.2-S	0.00416
100ctd022	189	29/03/2004	089	04:30	-38.70	-53.43	3506	1017	W2.2-N	0.00229
100ctd023	197	29/03/2004	089	19:05	-38.08	-53.36	2668	1013	W3.2-N	0.00137
100ctd024	200	31/03/2004	091	12:59	-38.10	-53.65	170	128	W3.2-S	-0.00074
100ctd025	214	02/04/2004	093	06:51	-39.60	-52.82	3719	1016	deep LHPR site	-0.00344

Table 2.2a: CTD configuration for Stations 001 to 007

CTD sensor	Serial Number	date last calibrated
Sea-Bird 911 plus	09P15759-0480	24-Jul-03
Series 410K-105 Digiquartz pressure transducer	67241	24-Jul-03
Primary SBE 4C conductivity sensor	042255	14-May-03
Primary SBE 3 plus temperature sensor	032679	13-May-03
Primary pump SBE 5 T submersible pump	2395	
Secondary SBE 4C conductivity sensor	042813	22-Nov-02
Secondary SBE 3 plus temperature sensor	034235	04-Dec-02
Secondary SBE 5 T submersible pump.	2400	
Tritech PA200/20-5 Altimeter	2130.27001	28-Jan-00
Primary Seabird SBE 43 Oxygen sensor	0245	27-Aug-02
Secondary Seabird SBE 43 Oxygen sensor	0242	07-Jul-03
Biospherical Instruments Par Sensor	7235	22-Aug-03

Table 2.2b: CTD configuration for Stations 008 and 009

CTD sensor	Serial Number	date last calibrated
Sea-Bird 911 plus	09P15759-0480	24-Jul-03
Series 410K-105 Digiquartz pressure transducer	89973	10-Jul-02
Primary SBE 4C conductivity sensor	042255	14-May-03
Primary SBE 3 plus temperature sensor	032679	13-May-03
Primary pump SBE 5 T submersible pump	2395	
Secondary SBE 4C conductivity sensor	042813	22-Nov-02
Secondary SBE 3 plus temperature sensor	034235	04-Dec-02
Secondary SBE 5 T submersible pump.	2400	
Tritech PA200/20-5 Altimeter	2130.27001	28-Jan-00
Primary Seabird SBE 43 Oxygen sensor	0245	27-Aug-02
Secondary Seabird SBE 43 Oxygen sensor	0242	07-Jul-03
Biospherical Instruments Par Sensor	7235	22-Aug-03

Table 2.2c: CTD configuration for Stations 010 to 018

CTD sensor	Serial Number	date last calibrated
Sea-Bird 911 plus	09P15759-0480	24-Jul-03
Series 410K-105 Digiquartz pressure transducer	89973	10-Jul-02
Primary SBE 4C conductivity sensor	042255	14-May-03
Primary SBE 3 plus temperature sensor	032679	13-May-03
Primary pump SBE 5 T submersible pump	054315	
Secondary SBE 4C conductivity sensor	042813	22-Nov-02
Secondary SBE 3 plus temperature sensor	034235	04-Dec-02
Secondary SBE 5 T submersible pump.	052400	
Tritech PA200/20-5 Altimeter	2130.27001	28-Jan-00
Primary Seabird SBE 43 Oxygen sensor	0242	07-Jul-03
Fluorometer, Chelsea Aqua 3	088249	03-Dec-01
Biospherical Instruments Par Sensor	7235	22-Aug-03

Vessel-Mounted Acoustic Doppler Current Profiler (VM-ADCP)

This section describes the method of acquisition of ADCP data on JR100. The system was operated in two modes: water-track mode, when water depths were greater than ~500m and bottom-track mode in shallower waters. In general, the ADCP worked very well with water-track velocity information generally obtained to ~350m depth and bottom-track velocity information to ~550m.

Instrument Configuration

The RRS *James Clark Ross* is fitted with an RD Instrument's 153.6 kHz hull-mounted Acoustic Doppler Current Profiler (ADCP). Unlike other NERC research ships, the orientation of the transducer head on the JCR is offset by approximately 45° to the fore-aft direction in hope that the instrument will give a better response in the main direction of motion (i.e. fore-aft). To provide protection from ice, the transducer is mounted in a sea-chest recessed into the hull of the ship, which is again, different from the design of other British research ships. The contents of the sea-chest are isolated from the surrounding sea water by a 33mm thick window of Low Density PolyEthylene (LDPE). Within the sea-chest, the transducers are surrounded by a liquid composed of 90% de-ionised water and 10% ethylene glycol.

The ADCP system used version 17.07 firmware and version 2.48 RDI Data Acquisition Software (DAS) run on a Pentium 2 266Mhz (in DOS). For JR100, the ADCP was configured to record data in 64 x 8m bins and in ensembles of 2 minute duration. The 'blank beyond transmit' was 4m, this together with a 6m transducer depth, resulted in the centre of the first bin depth at 14m. In contrast to other underway scientific instruments on the RRS James Clark Ross the ADCP does not log to the SCS system. Instead, the 2 minute ensembles of data are fed directly into the ship's Level C system. In the event of a problem with the ship's Level C system, the data has to be recovered from the PC files. This appeared to happen on jday 074 - so the PC files were saved to the Unix system for further investigation.

During JR100, data were collected in either bottom-track mode in water depths of less than 500m or water track mode where the water depth was sufficiently great to

preclude useful bottom tracking. The bottom-track mode was configured through the Direct Command menu of the DAS software using the command FH0004. This sets the instrument to one bottom-track ping for every four water-track pings.

Standard method of processing

The steps involved in processing the data are detailed below and summarised in the flowchart in Figure 2.2. The data for 24 hour periods were read from the Level C system into pstar files. Pstar software and data from several navigation streams were then used to process the ADCP data.

Step 1. *Reading data*

The data were read in and saved in 24 hour periods (00:00 to 23:59) using the Unix script *100adpexec0*. This processing produces two output files: one containing the water-track data and one containing the bottom-track data. When the ADCP was set to record only water-track information, the bottom-track file contained only engineering data and zero's for the bottom velocity.

The output files were *100adp[jday]d* and *100bot[jday]d*.

Step 2. *Water velocity / temperature correction*

The presence of the de-ionised water / ethylene glycol mix within the sea-chest requires a correction to be made to the water and bottom-track velocity data. This correction was derived by Mike Meredith (BAS) and Brian King (SOC). The following text is Dr Meredith's description of the steps involved:

"The ADCP DAS software assumes that the fluid surrounding the transducers is ambient seawater and derives a speed of sound through measured temperature at the transducer head and an assumed salinity of 35. However, a correction is clearly needed to account for the fluid being the 90% de-ionised water / 10% ethylene glycol mixture instead of seawater.

From point measurements obtained from RDI, we previously derived the following equation for the speed of sound through the mixture as a function of temperature:-

$C = 1484 + 3.6095t - 0.0352t^2$

The individual velocity measurements from which this equation was derived to an accuracy of 0.01%, with the environmental conditions being known to within ± 35kPa pressure and ± 0.5°C temperature was used to derive a correction term to adjust the

speed of sound assumed by the DAS to one appropriate for the mixture in the sea-chest. The correction term was:-

$(1484 + 3.6095t – 0.0352t^2) / (1449.2 + 4.6t – 0.055t^2 0.00029t^2)$

*A further correction for temperature is applied, due to the temperature-dependency of the velocity scaling correction A (see later). This correction was the value derived on JR55, i.e. (1-0.00152*temp).”*

This correction was applied to both the raw water and bottom tracked velocities using the Unix script *100adpexec0.1*.

The output files were *100adp[jday]d.t* and *100bot[jday]d.t*

Step 3. *Time correction*

The DAS software time stamps the ADCP data. This time stamp comes from the Pentium 2, which drifts at a rate approximately one second per hour. To correct this to the ship’s master clock, the two clock times were read several times a day and the difference calculated. The Julian date (jday), ADCP clock reading and calculated time differences were entered using the Unix script *100adpexec1* and from this calculated time drift, a correction was derived and applied to the ADCP data time.

NB: *100adpexec1* was run 24 hours in arrears to allow for the corrected time falling outside of the 24 hour input file period, which will causes the program to fall over.

The output files were *100adp[jday]d.corr* and *100bot[jday]d.corr*.

Step 4. *Gyrocompass error correction*

The ADCP measures water velocity relative to the ship. To calculate east and north water velocities from ADCP data, information is required on the ship’s heading and velocity over the ground. This is partially fulfilled with input from the ship’s gyrocompass (described in the ship’s navigation report). However, it is well known that in addition to having an inherent error, gyrocompasses can oscillate for several minutes after a turn, before steadying on a new course. There is also an additional deviation of the gyrocompass that varies with latitude. To overcome these difficulties, the ADCP is ‘corrected’ with data from the Ashtec ADU-2 (see navigation section). The Ashtec cannot be used instead of the gyrocompass because Ashtec coverage is not continuous, but the data can be corrected on an ensemble by ensemble basis. As a result of the ‘standard processing’ as detailed in the navigation report, the edited Ashtec data is held within a file as data of 2 minute averages. This data still contains large ‘spikes’, which are removed using an interactive editor. Any gaps created by this editing or previously existing in the data, are then linearly interpolated. The

gyrocompass correction file (*100ash01.int*) is then applied to the ADCP data through the Unix script *84adpexec2*. The east velocity (*velew*) and north velocity (*velns*) from the ADCP are converted to speed and direction and the heading correction (as calculated from the gyrocompass correction file) applied to both the gridded water-track data and non-gridded bottom-track data. The program then converts the data back to east and north velocities ready for the *A* and ∅ calibrations performed in the next processing step. Should there be no Ashtec correction to be made, this exec can be replaced by one that adds a dummy (zero value) correction variable (*a-ghdg*) or subsequent processing steps can be modified to omit this variable.

The input files were *100adp[jday]d.corr*, *100bot[jday]d.corr* and *100ash01.int.*

The output files were *100adp[jday]d.true* and *100bot[jday]d.true*.

Step 5. *Calibration of the ADCP data*

A final correction is then required to correct for the misalignment between direction as defined by the Ashtec ADU-2 antenna array and the actual direction of the ADCP transducers. This correction is called the heading misalignment, ∅. There is also an inherent scaling factor, *A* associated with the ADCP, by which the water velocities must be multiplied to scale them correctly. The method of calculating *A* and ∅ is described in Box 1. These calculated corrections were then applied to both water-track and bottom-track velocity data through the Unix script *100adpexec3*.

The input files were *100adp[jday]d.true* and *100bot[jday]d.true*.

The output files were *100adp[jday]d.cal* and *100bot[jday]d.cal*.

The calibration values used during JR100 were: *A = 1.0299* and *∅ = -1.6095*.

Step 6.

The data, at this stage, contained calibrated water velocity relative to the ship. To derive absolute velocity, the files are merged with position from the 'bestnav' navigation file (see navigation report) and the ship velocity between ensembles is derived. This velocity is then removed from the water velocity data to give absolute water velocity. This is performed using the Unix script *100adpexec4*.

The input files were *100adp[jday]d.cal* and *100bot[jday]d.cal*.

The output files were *100adp[jday]d.abs* and *100bot[jday]d.abs*

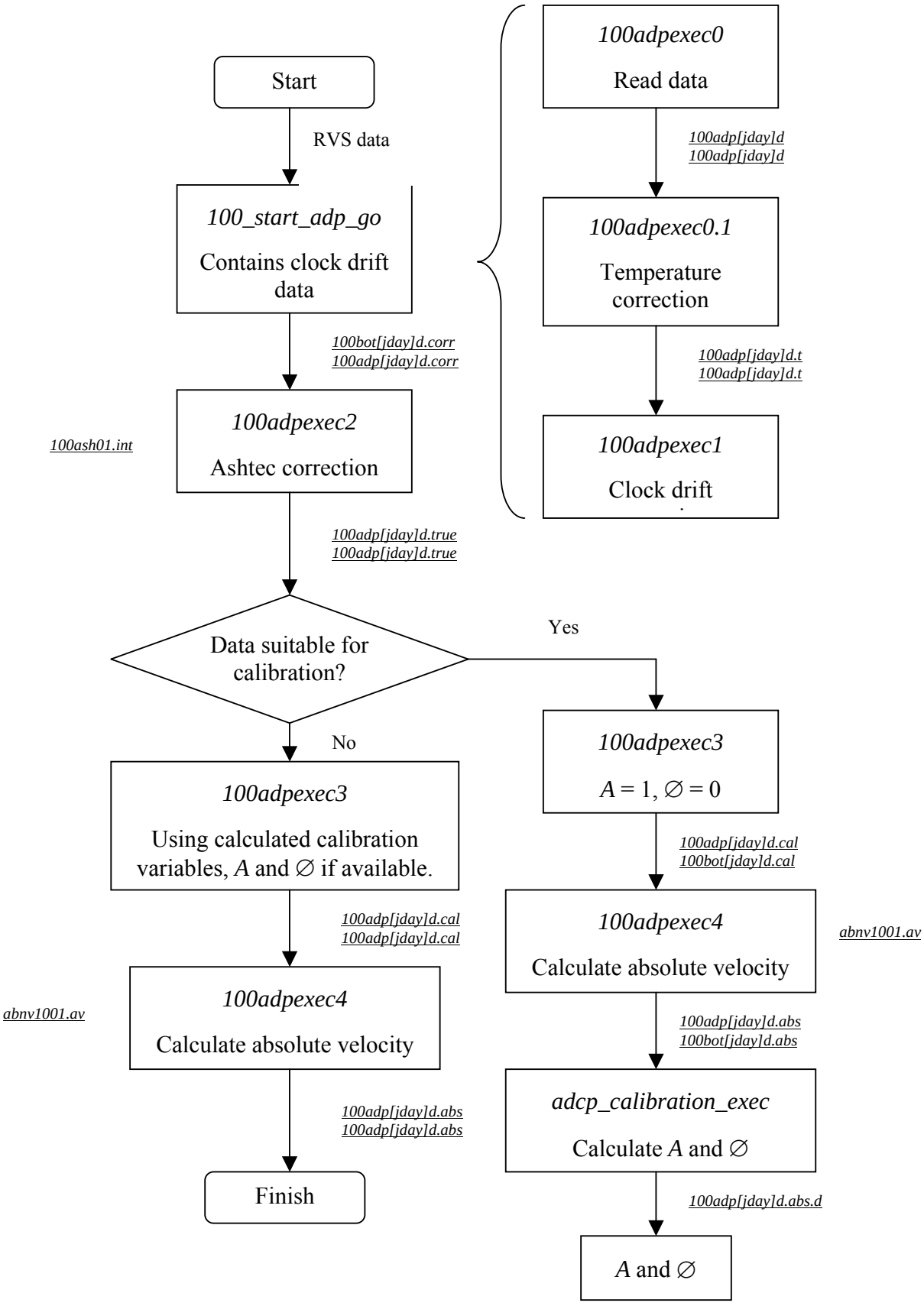

Figure 2.2. ***ADCP Processing Flow-Chart***

BOX 1: Derivation of the calibration coefficients A and ∅

1. Periods when the ADCP gave bottom-track velocities (i.e. when the ship was working in water depths generally less than 500m) were identified.

2. The files with bottom-track velocities were then calibrated with a nominal scaling in *100adpexec3* by setting the scaling factor, *A*, to one and the misalignment angle, ∅, to zero.

3. The two minute ensembles of ADCP data were then merged with 'bestnav' position fixes. From these 'bestnav' fixes, the ship's east and north velocity over ground were calculated. Time periods within each data file were then identified where the ship's heading and velocity did not deviate greatly over a period of at least 6 minutes.

4. The ADCP bottom-track velocities were then multiplied by –1 as the velocity of the ship given by the 'bestnav' fixes is in the opposite sense to the velocity of the bottom as derived by the ADCP.

5. Values for *A* and ∅ for each time period were then derived using vector mathematics and the following formulas:

   $$A = U_{GPS} / U_{ADCP}$$

   Where U_{ADCP} is the bottom-track ADCP derived ship speed and U_{GPS} is the GPS position fix derived ship speed (that is, ship speed over ground)

   $$\varnothing = \varnothing_{GPS} - \varnothing_{ADCP}$$

   Where $\varnothing_{GPS}$ is the direction of motion of derived from the GPS navigational

Identification of CTD 'on-station' ADCP data

To identify the ADCP data for a particular CTD station the corresponding Julian date was identified from the CTD deck log. From the corresponding *100adp[jday].abs* file, the *ve* and *vn* variables (ship velocity averaged over 2-minute periods in the east and north direction respectively) were plotted. From this plot, approximate start and stop times of the period when the ship was stationary during the CTD deployment, were noted.

Using the same *100adp[jday].abs* file, every 64th data cycle (i.e. start of every 2-minute time-averaged ensemble) was listed using *mlis*t and displaying the variables; *time* (JDAY), *bindepth*, *absve*, *absvn*, *ve* and *vn*. From this list, those data cycles closest to the times noted previously from the ship's velocity plot, were identified. The data cycle closest to the start of the stationary period with *ve* and *vn* both nearing 0 cm/s was noted. For the end of the stationary period, the data cycle listed that clearly showed the ship to be moving off-station was located and the data cycle immediately preceding this was noted as this represented the last data cycle of the last 2–minute ADCP ensemble of the stationary period of the ship.

This block of data cycles was then copied to a new file using *pcopya* for further processing using *allav*, which averaged the data cycles over one ensemble (i.e. 2 minutes and 64 data cycles). The resulting file was then viewed on an arrow graph to provide a time averaged view of the on-station ADCP data.

Oceanlogger (Underway Measurements)

Throughout JR100, underway measurements were made with the ship's oceanlogger. The oceanlogger system is comprised of a thermosalinograph and fluorometer connected to the ship's non-toxic pumped seawater supply, plus meteorological sensors measuring duplicate air pressure, duplicate air temperature, duplicate humidity, duplicate total incident radiation (TIR) and duplicate photosynthetically available radiation (PAR). Within the oceanlogger system a total of 18 sensors were logged. The meteorological data set was completed by merging in the windspeed and direction from the anemometer. Data were time-stamped using the ship's master clock. The current calibration certificates for all sensors were provided by Vsevalod Afanasyev (*ETS*).

Oceanlogger data were processed in 12 hour segments using three Unix scripts calling PSTAR software routines (*100oclexec0* and *100oclexec1* were both called from *jr100_ocean*):

100oclexec0

This exec read the oceanlogger data streams into pstar format and merged in relative wind speed and direction from the anemometer data stream. Output files were *100ocl[jday][a/p].raw* and *ocl100[a/p].* The former of these is the 12-hour data segment for morning (*a*) or afternoon (*p*) of Julian day (*jday*). The latter was the master file to which successive 12-hour sections were appended.

100oclexec1

This exec divided the data into ocean data and meteorological data files, writing meteorological data to a separate file. The output file was *100met[jday][a/p].raw* (containing the meteorological data).

twvelexec

This exec merged the met data file with gyrocompass and navigation data streams in order to calculate ship motion and true wind velocity. The output file was *100met[jday][a/p].true*.

Discrete samples for salinity analysis were taken approximately twice in each 24 hr period from the outflow of the thermosalinograph in the prep. lab. These were taken in 200 ml medicine bottles, sealed with plastic inserts, and stored for 24 hrs to allow their temperature to equalise with the laboratory temperature. Subsequently, they were analysed following an identical procedure to samples taken for CTD calibration (see CTD section). For JR100, a total of 34 discrete samples were taken. The measured salinities were recorded so that calibration of the oceanlogger salinity could be undertaken if required.

Navigation Data

There were six navigational instruments for scientific use on the RRR *James Clark Ross* (listed in Table 2.3 below). Three of these streams were used regularly in processing other oceanographic datasets. Although the five instruments appear in some cases to be similar, they are all unique. As well as the three GPS systems listed in Table 2.3, there are additional GPS systems on board the JCR for the ship's use. These are a Leica MX400 and two Ashtec G12 receivers which form part of the dynamic positioning system. In addition, there is a Racal Satcom, which receives GPS SV range correction data via INMARSAT B. This data is passed to the Trimble, Leica and G12 receivers allowing them to operate in Differential mode (DGPS). During JR100 the DGPS reference station at Stanley was used.

The collection and use of all navigation data are linked. The instruments are currently logged to the SCS system and then transferred to the old RVS Level C system where they are currently read. During cruise JR100, the data for all six instruments and the standard editing procedures were done in one Unix script called *jr96_nav_go*. This script required the Julian day and am or pm selection as input and then executed a further 8 C shell scripts to read in 12 hours of data and edit where necessary. The time periods were either from 00:00 hrs to 11:59 hrs or 12:00 hrs to 23:59 hrs.

Table 2.3: Scientific Navigation instruments on JR100

Instrument	Type	Code	Use
Trimble 4000	GPS receiver	gps	Primary positional information
Ashtec GG24	GLONASS / GPS receiver	glo	Positional information
Ashtec ADU-2	GPS receiver	ash	Attitude information
Seatex	GPS Receiver	swn	For EM120
Gyrocompass	Sperry Mk 37 model D	gyr	Heading information
Electromagnetic Log	Chernikeeff log Aquaprobe Mk V	eml	Velocity information

Trimble 4000

The Trimble 4000 receiver in differential mode, was the primary source of positional information for the scientific work on JR100. The data were logged at 1 second intervals to the SCS derived Level C stream.

gpsexec0: reads Trimble data into pstar format

datapup - transfers the data from RVS binary files to pstar binary files

pcopya - resets the raw data flag on the binary file

pheadr - sets up the header and data name of the file

datpik - removes data with a dilution of precision (hdop) greater than 5

output files: *100gps[jday][a/p].raw* (just before editing stage)

100gps[jday] (following *datpick*)

100gps01 (master file to which processed data were appended)

Gyrocompass

The gyrocompass is a fundamental data stream which constitutes the most continuous information available on ship's heading. It is involved in processing data from meteorological instrumentation (so as to derive information on true wind velocity), and in processing the Acoustic Doppler Current Profiler (ADCP). It is also drawn into the bestnav stream to derive positional information by dead reckoning during periods of no GPS data coverage.

gyroexec0: reads in the gyrocompass data and removes the inevitable bad data

datapup - transfers the data from RVS binary files to pstar binary files

pcopya - resets the raw data flag on the binary file

pheadr - sets up the header and data name of the file

datpik - forces all the data from the gyro to be between 0^o and 360^o

Output files: *96gyr[jday][a/p].raw*

96gyr01 (master file to which jday files are appended)

Ashtec ADU-2

The ship's gyrocompass is subject to an inherent error and can oscillate for several minutes after a turn. Consequently, the Ashtec ADU-2 is used to correct errors in the gyrocompass heading prior to input of the data to the ADCP processing. The configuration of the receiver is complex, made more so by the fact that the receiver can only be configured with the use of a laptop running a terminal emulation program. Configuration data for the Ashtec aerial configuration is shown in Table 2.4. The port-aft antenna is designated number 1, port-fwd is number 2, stbd-fwd is number 3 and stbd-aft is number 4. The XYZ vectors have been adjusted so that heading is defined by the direction normal to the 1-4 baseline (i.e. that baseline has Y = 0)

Table 2.4 Ashtec configuration

Vector	X(R)	Y(F)	Z(U)
1-2	2.938	4.748	0.027
1-3	1.478	4.749	0.011
1-4	13.210	-0.0000	-0.036
offset	0(H)	0(P)	0(R)
Max cycle	0.2 cyc	smoothing	N
Max mag	0.08	Max angle	10

The complex data processing path is designed such that the Ashtec can be used to correct the gyrocompass.

ashexec0: Reads in data from the GPS3DF into pstar format

datapup - transfers the data from RVS binary files to pstar binary files

pcopya - resets the raw data flag on the binary file

pheadr - sets up the header and data name of the file

output files: *100ash[jday][a/p].raw*

ashexec1: Merges Ashtec data to master gyro file from *gyroexec0*

pmerg2 - merges the Ashtec file with the master gyro file

parith - calculates the difference in the Ashtec and gyro headings (delta heading)

output files: *100ash.[jday][a/p].mrg*

ashexec2: Complicated exec editing the merged data file

datapik2 - rejects all data outside the following limits:

heading outside 0^o and 360^o

pitch outside -5^o and 5^o

roll outside -7^o and 7^o

attf outside -0.5^o and 0.5^o

mrms outside 0.00001^o and 0.1^o

brms outside 0.00001^o and 0.1^o

delta heading outside -5^o and 5^o

pmdian - removes flyers in delta heading of greater than 1^o from a 5 point mean

pavrge - sets the data file to be on a 2 minute time basis

phisto - calculates the pitch limits

datpik - further selection of bad data outside the following limits:

pitch outside the limits created

mrms outside the range 0 to 0.004

pavrge - again, sets the data file to be on a 2 minute time base

pmerge - merges the heading data back in from the master gyro file

pcopya - changes the order of the variables

Output files: *100ash[jday][a/p].edit*

100ash[jday][a/p].ave

ashedit.exec: a manual editing procedure (using the pstar *plxyed* editor) to manually remove obvious outliers from a-ghdg and interpolate any gaps in the data

output files: *100ash[jday][a/p].ave.dspk*

Ashtec GLONASS (GG24)

The Ashtec GG24 works by accepting data from both American GPS and the Russian GLONASS satellites. This increases accessibility to satellite fixes, and hence should provide more accurate navigation data than standard GPS coverage allows. However, experiments on previous cruises have suggested that the accuracy is significantly lower than the differential GPS. Data were logged routinely, but were not used in the processing of other data streams.

ggexec0: Reads Ashtec (GLONASS GG24)data into pstar format

outputfiles: *100glo[jday][a/p].raw*

100glo[jday][a/p] (following basic quality control

Electromagnetic Log

The Electromagnetic Log gives water velocity relative to the ship in both the fore-aft and port-starboard direction. This data was read in 12 hour time periods using a simple exec *emlexec0*.

emlexec0: Reads in data from the Electromagnetic Log into pstar format

datapup - transfers the data from RVS binary files to pstar binary files

pcopya - resets the raw data flag on the binary file

pheadr - sets up the header and data name of the file

Output files: *96eml[jday][a/p].raw*

Doppler Log

The Doppler Log gives water velocity relative to the ship in both the fore-aft and port-starboard direction. This data was read in 12 hour time periods using *dopexec0*.

dopexec0: Reads in data from the Doppler Log into pstar format

datapup - transfers the data from RVS binary files to pstar binary files

pcopya - resets the raw data flag on the binary file

pheadr - sets up the header and data name of the file

Bestnav

Bestnav is a processed data stream, which contains 30 second interval position data. It uses the best available data source: GPS when available, dead reckoning from the ship's gyrocompass and speed otherwise.

navexec0 - Reads in data from the bestnav stream into pstar format

datapik2 - transfers the data from RVS binary files to pstar binary files

pcopya - resets the raw data flag on the binary file

pheadr - sets up the header and data name of the file

posspd - calculation of the east and north velocities from position and time

papend - output file is added to the master file

pdist - recalculates the 'distance run' variable

pcopya - takes out the RVS calculated 'distance run'

Ouput files: *abnv1001* (master file used for all pstar scripts requiring navigation information e.g. ADCP processing)

navexec1 - Averages and filters navigation data

pcopya - copies master file (*abnv1001*) and changes data name

pmdian - removes spikes in velocity data

pintrp - interprets and replaces missing velocity data

pfiltr - data smoothed using top hat

Output files: *abnv1001.av*

Expendable Bathythermographs (XBT's)

A sequence of XBT drops were performed from RRS *James Clark Ross* during JR100. These were performed at 15 nm intervals during the Fish Survey transects and on the deep stations for the Western Core Box. The details of the XBT drops are listed in Table 7.5 and illustrated in Figure 2.1.

Sippican T5 probes were used and launched using a hand held launcher from the rear of the aft deck. The ship decreased its speed to 6 knots for deploying the probes. Data were logged by a Viglen IBM-type 486 PC running the Sippican WinMk12 software. Once a successful drop had been performed, data were transferred via samba to the central Unix system (jruf) for further processing.

Step 1. The pstar script *xbtexec0* was used to read in data from ascii to pstar format, set up header information, and extract navigation and water depth from the RVS data streams for the time of the XBT drop.
Step 2. A second script *xbtexec.edit* was used to run a median despiking routine on the data, and launche the pstar program "*plxyed*", which enables interactive editing of the XBT profile. This was used to remove any remaining spurious spikes, and also to remove the noise recorded after the probe had reached its terminal depth.

In general the XBT deployments were very successful, with just a few bad drops where excessive spiking or clearly unrealistic values were logged. These were generally identified mid-drop, with the drop aborted and restarted with a new probe.

Acknowledgements

Thanks to Nathan Cunningham (*Data Manger*) and Vsephalod Afanasyev (*ETS*) for CTD and XBT operations and to Mark Brandon (*OU*) for advice before and during JR100.

Table 2.5. JR100 XBT deployments

Cruise Event	XBT event	PC file name	Julian Day	Time (GMT)	Latitude	Longitude	Water Depth	Comment
004	001	100xbt031.edt	071	2235	-54.0244	-43.0680	1501	
009	002	100xbt009.edt	072	0829	-54.0836	-41.0761	2969	
011	003	100xbt010.edt	072	1512	-54.0832	-40.6511	2298	
012	004	100xbt011.edt	072	1642	-54.0827	-40.2291	2803	
018	005	100xbt019.edt	073	0119	-54.0837	-39.7936	3244	
019	006	100xbt020.edt	073	0552	-54.0829	-39.3653	382	
021	007	100xbt021.edt	073	1708	-53.9313	-38.5252		
022	008	100xbt022.edt	073	1832	-53.9450	-38.9169	210	
026	009	100xbt027.edt	074	0032	-53.9326	-39.3538	447	
027	010	100xbt028.edt	074	0206	-53.9333	-39.7720	664	
028	011	100xbt029.edt	074	0342	-53.9339	-40.1963	1694	
034	012	100xbt030.edt	074	0527	-53.9328	-41.6172	1247	
035	013	100xbt033.edt	074	1710	-53.9331	-41.4954	338	
040	014	100xbt034.edt	074	2139	-53.7833	-41.0791	148	
041	015	100xbt035.edt	074	2340	-53.7834	-40.6532	792	
043	016	100xbt 036.edt	075	0444	-53.7842	-40.2295	168	
049	017	100xbt 037.edt	075	1106	-53.7829	-39.8115	1588	
050	018	100xbt 038.edt	075	1239	-53.7831	-39.3923	788	
053	019	100xbt 039.edt	075	1859	-53.7884	-38.9711		
059	020	100xbt 040.edt	076	1418	-53.7828	-38.1279	367	
060	021	100xbt 041.edt	076	1556	-53.6328	-37.9989	146	
062	022	100xbt 042.edt	076	2021	-53.6329	-38.4193	1070	
063	023	100xbt 043.edt	076	2207	-53.6306	-38.8421	1417	
	024	100xbt 044.edt	077	0753	-53.6334	-39.6855	2720	aborted
069	025	100xbt 045.edt	077	0801	53.6331	-39.7005	2726	
070	026	100xbt 046.edt	077	0933	-53.6336	-40.1010	1816	
071	027	100xbt 047.edt	077	1120	-53.6334	-40.5180	1856	
	028	100xbt 048.edt	077	1518	-53.6343	-40.9356	132	Not an event
076	029	100xbt 049.edt	077	1654	-53.6341	-41.3572	132	
080	030	100xbt 050.edt	077	2354	-53.6337	-42.5874		
083	031	100xbt 051.edt	078	0911	-53.6335	-43.0099	1967	
088	032	100xbt 052.edt	078	1440	-53.4836	-42.5823	494	aborted
089	033	100xbt 053.edt	078	1444	-53.4836	-42.5722	470	
099	034	100xbt 054.edt	079	1414	-53.4830	-41.0842	1709	
100	035	100xbt 055.edt	079	1646	-53.4830	-40.6648	2182	
102	036	100xbt 056.edt	079	2122	-53.5835	-40.2442	2126	
108	037	100xbt 057.edt	080	0445	-53.4827	-39.8217	3218	
110	038	100xbt 058.edt	080	1035	-53.4828	-39.3968	3048	
111	039	100xbt 059.edt	080	1213	-53.4945	-38.9884	3471	
112	040	100xbt 060.edt	080	1211	-53.4950	-38.9716	2671	
113	041	100xbt 061.edt	080	1351	-53.4837	-38.5704	2853	
120	042	100xbt 062.edt	080	2353	-53.4835	-38.1459	2022	
121	043	100xbt 063.edt	081	0116	-53.4825	-37.8325	1555	
122	044	100xbt 064.edt	081	0309	-53.4770	-37.4114		
127	045	100xbt 065.edt	081	0808	-53.6343	-37.0007	180	
128	046	100xbt 066.edt	081	0955	-53.6332	-37.4210	238	
	047	100xbt 067.edt	081	1131	-53.6333	-37.8388	148	not an event
167	048	100xbt 068.edt	087	2312	-53.4928	-39.2511	3154	
190	049	100xbt 069.edt	089	0432	-53.4316	-38.6954	3497	
198	050	100xbt 070.edt	089	1911	-53.3610	-38.0826	2668	

3. Acoustics

Cathy Goss, Jose Xavier, Ryan Saunders, Peter Enderlein & Geraint Tarling

Introduction

JR100 has been the first major cruise on *James Clark Ross* to concentrate on the fish fauna, requiring different strategies for the operation of the Simrad EK60 echosounder. The fish survey transects were run through day and night. This was followed by a standard survey for krill in the Western Core Box area using established acoustic methods. The EK60 sounder suffered regular crashes, experienced before on JR82, and on JR96. It was noted that the 200 kHz did not appear to perform as well as it had on JR82; this is attributed to the wider beam angle (8 degrees) than the single beam that it replaced.

The core box survey carried out at South Georgia over an area north of Bird Island, was the fourth repeat in a series of combined oceanographic/acoustic surveys in the austral autumn. The objective of the surveys is to provide an acoustic stock assessment of krill at three different seasons for five years. Seven transects were run in the Western Core Box area.

We had an unusually large number of helpers on this cruise:
Cathy Goss, wrote this report and takes responsibility for any errors it contains, also watched the sounder and processed data, Jose Xavier watched the sounder and did the lion's share of data processing, Ryan Saunders watched the sounder and processed data, Peter Enderlein and Geraint Tarling took on the calibration with help from Doug Bone and Tony North.

Aims

1. Collection of acoustic data to accompany all transects, fishing searches and nets during the cruise.
2. Acoustic survey in the Western Core Box at South Georgia.
3. Improvement in acoustic protocols using the EK60.

4. Calibration of the equipment at an appropriate site for the acoustic surveys.
5. Back up and post process acoustic data.

Methods/system specification

Software versions

Simrad EK60 v 1.4.4.66

Although ER60 software had been run successfully on JR96, a warning had been issued by Sonardata that some angle data were not being stored correctly by this package, therefore the decision was made to revert to the EK60 software.

Sonardata Echolog_60 v 3.10.15

Sonardata Echoview v 3.10.129

HASP Dongle BAS1 is licensed for base, bathymetry, analysis export, school detection module, virtual echogram module, and for live viewing.

The Echosounder pc and its accompanying workstation are now integrated into the ship's LAN, and data files are logged to a Sun workstation jruf, which is backed up at regular intervals and supported by hardware backup in the event of a machine failure. This has been a huge benefit, saving time formerly taken up with copying data on to cds, and adding security through increased file space, and more frequent back ups. Formerly files had to be deleted during a cruise in order to make space for new data. See JR96 Cruise Reports for more details.

File locations

Initial settings following JR96 and revised settings after calibration: Eksettings.xls. Full calibration results summary.xls. Raw files that permit a replay of the calibration are also available with the other data files.

Live viewing template: C:\program files\sonardata\echoview31\Live Viewing Templates\EK60-60-EK6.EV on workstation 2.

All transect details during the cruise were recorded on a log located on the ship's intranet, which automatically entered lat and long for each time entered. Fish survey transects were divided up whenever there was a break for a CTD station or for fishing, numbered 1.1, 1.2, to 1.n as needed on transect 1, 2.1, 2.2 et seq on transect 2 and so on. See Appendix B for a full list.

Compression with Echolog

Echolog allows for a variety of data compression strategies. Averaging samples below the sounder detected bottom+ an offset could be disastrous if bottom detection was triggered by something dense in the water column, and although this can be prevented by setting a deep minimum bottom on the EK60, that too can cause problems if the ship moves into shallow water and the deep minimum has not been changed. Since low backscattering may be of interest, the preferred strategy is to rely on removing angle data with echolog. A comparatively shallow maximum depth, 300m, will be set in Echolog, allowing the possibility of looking deeper with the EK60 say 500m, and keeping the data if deep targets are seen. Final compression settings used in Echolog for all frequencies:

power data only (angle data is still available from .raw files which are being saved)

from 0m – 9999m, this could be from 10m to 250m for krill studies since the first 10m is normally deleted at processing stage, and deeper data are not used.

Average samples where both Sv below –100 and TS below 20 i.e. the latter condition is always met and therefore has no effect

Maximum number of samples to average: 50

Ignore bottom detection if range less than 10 metres

The settings are also used by Echozip; this was run post hoc on .raw files, either singly or in batch mode in a DOS window. From the program file directory where echozip is located type: Echozip_60 –z folder, where folder is the location of .raw and .out files to be compressed. EK60 .raw data files are just over 25MB; Echolog as set brings this down to around 9 or 10 MB. This facility was frequently used on JR 100 because the raw files were being saved to a regularly backed–up array, Echolog_60 was not continuously essential and was often switched off because users needed to use Workstation 2 for Echoview processing without being interrupted by the start of automatic live-viewing when Echolog was running.

Settings

EK60 settings are shown in Table 3.1; they are listed for the start of the cruise (derived from JR96 calibration), revised settings following the calibration at Stromness, and further adjustments made after the calibration.

A general list of parameters that need to be recorded in order to reproduce the method used for a particular survey has been prepared:

Vessel/platform
Location
Time
Ship's speed
Echosounder model
Software version
Calibration method and date (sphere type)
Absorption coefficient
Sound speed
Salinity
Temperature
Frequencies. For each:
- Transducer depth
- Beam angle
- Output power
- Sample interval
- Bandwidth
- Pulse length
- Pulse interval

Processing parameters:
- Threshold
- Noise removal
- Integration bin size
- False bottom removal
- Interference removal
- Missed ping removal
- Seabed discrimination algorithm
- Dead zone calculation

Survey Protocol

A protocol has been devised for running the acoustic core box series, this was followed for both the fish survey and the core box, with the difference that the fish survey was also run after dark, and the transect sections were of varying lengths.

Acoustic Core Box protocol:

Two ~43 mile transects completed each day for 4 days.

Box to be completed from west to east

Switch EA to reduced power

All other sounders, acoustic devices of any sort to be switched off

Build up to speed 1 mile before station to launch UOR

Start transect at least 30 minutes after dawn

Pass through waypoint at 10 knots and on course

Speed to be maintained at 10 knots or less where conditions dictate

Pass through transect endpoint at 10 knots and on course

Turn gradually so that UOR does not need to be recovered

Complete link between transects at 10 knots for UOR

Begin gradual turn for start of second transect of the day so that ship will -

Pass through transect start point at 10 knots and on course

Pass through transect endpoint at 10 knots and on course

Data processing in Echoview

For post processing, an ev file was set up with standard virtual variables that were created following the JR82 example. These have been documented in Anon (2000), and are also described in Echoview help ' about virtual variables' (Higginbottom et al, 2000). New methods have been added for removing missed pings that occur during bad weather, (Figure 3.1) and interference spikes that are particularly prevalent at 120 kHz, making use of the schools module. Details of post-processing steps appear in Section 19.

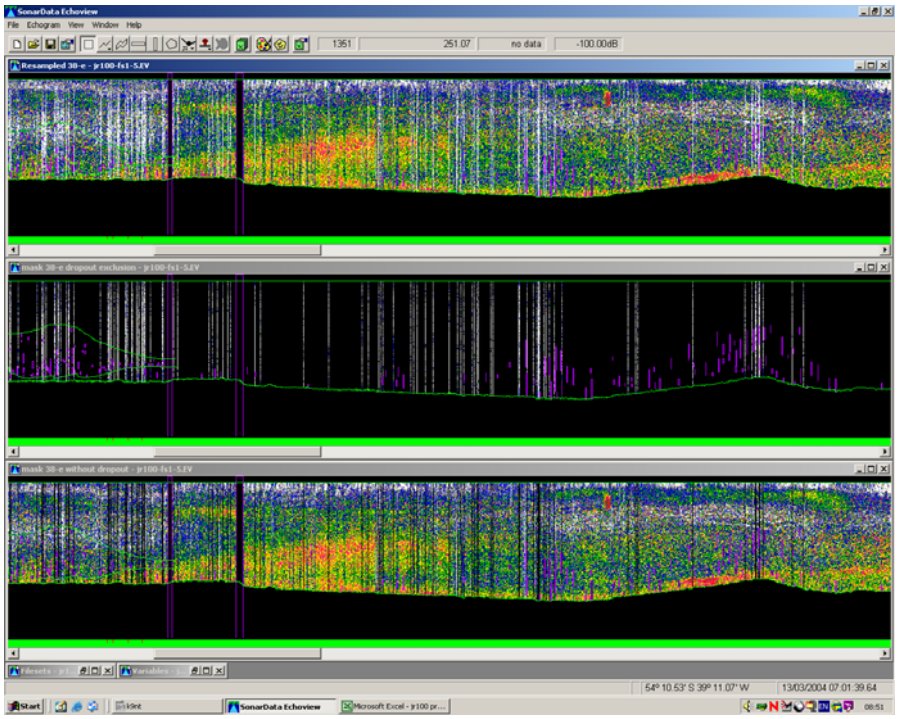

Figure 3.1 Interference spikes on the 120kHz.

JR100 Calibration Narrative March 24, 2004 Stromness, South Georgia

The vessel arrived in Stromness Bay around 1530h (local). A request to stop all discharges from the ship was made to avoid freshwater contaminating the seawater in the immediate vicinity of the calibration. All sounders apart from the EK60 were switched off.

CTD event 145 was used to obtain temperature, salinity and sound speed for the calibration. The sound speed was calculated from the equation given in MacLennan and Simmonds (1992), and came out at 1456.9 m/s. Another estimate came from the formula given in Fofonoff & Millard 1983 1457.2. However the CTD gave values of 1461 using three different algorithms. The first estimate was used to enter into the EK60 during the calibration. When the calibration was nearly complete it became clear that conductivity rather than salinity had been used to determine the sound velocity entered. When this error was corrected all sound velocity estimates agreed: 1461. The wrong conductivity value had also been entered into the salinity field. The correct values were: potemp = 3.1133, salinity = 33.305 and sndvel = 1461. These were entered into the sounder after the calibration, along with the correct salinity and temperature. A new alpha value was determined by the sounder, which differed from the value calculated in the spreadsheet we have historically used for this purpose.

20:17h end of 38 kHz calibration

23:37h 120 kHz sphere in position -46 at 0.512

Also after the event it was noted that the 30mm sphere had been used for the 120 kHz calibration. Predicted TS for this sphere has been requested from Simrad.

22:30h end of 120 calibration. Pulse length 0.512 not completed owing to lack of time

23:13h 200 kHz calibration had to be restarted because too narrow range entered for TS deviation. The 200 kHz calibration was thwarted by inability to map points very far from the axis. The TS settings had been left on their restricted survey ranges rather than being opened up as required in the calibration protocol. This included maximum gain compensation value of 1dB, which would explain the data points distant from the axis were not being recorded. When data from this calibration were entered it was noted that there was a very extreme beam angle (9 degrees) so this will not be used.

Table 3.1 Sound Velocity and Absorption Coefficients (MacLennan and Simmonds, 1992)

		During calibration	After calibration
Temperature (C)		3.1	3.1
Salinity (ppt)		30.4	33.3
Depth (m)		10.0	10.0
Frequency (kHz)		120	120
pH		8.0	8.0
Sound Velocity ($m.s^{-1}$)		1456.9	1460.7
Absorption coeff ($dB.km^{-1}$)	38 kHz	9.45	10.28
	120 kHz	26.98	28.84
	200 kHz	40.04	42.07

Data coverage

Fish Survey

These transects were run both day and night over a series of east-west, parallel tracks north-west of Bird Island, details may be found in the Transect Log (Appendix B). Dawn and dusk need to be calculated each day for each track and in order to determine which sections will give comparable data. Figure 3.2 shows the transect layout.

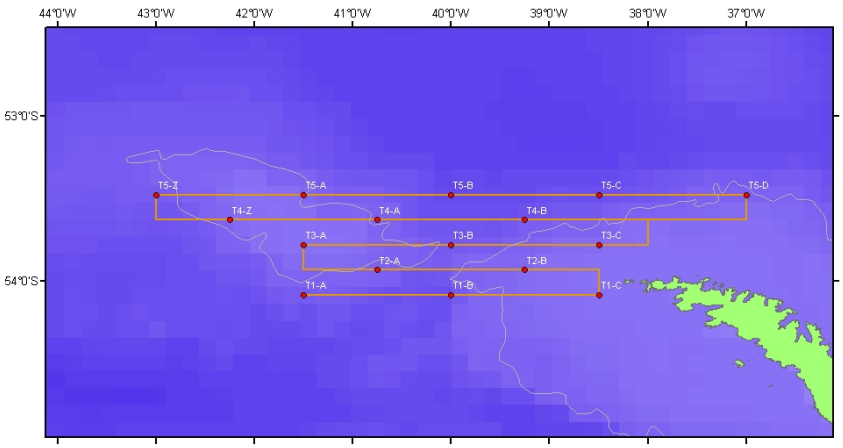

Figure 3.2. Acoustic transects for the fish survey.

Western Core Box at South Georgia

Seven transects were run in the Western Core Box, but several were cut short because of the presence of numerous icebergs in the area. The actual tracks carried out are shown in Figure 3.3, including a diagonal track across the box before the start. (Detailed locations are in Appendix B).

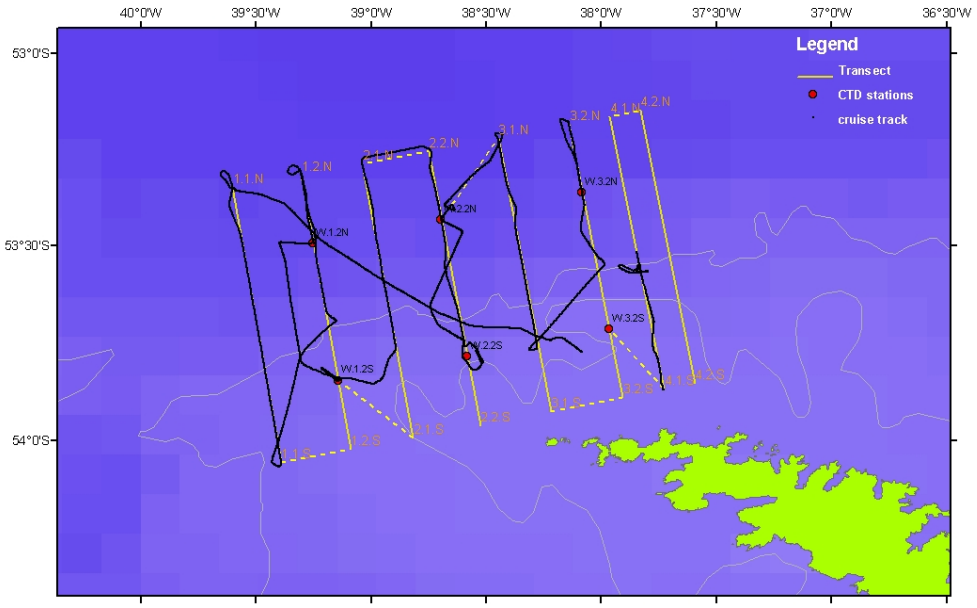

Figure 3.3. Acoustic tracks in the Western Core Box.

Problems encountered

Interference

The 120 and 200 kHz sounders suffered 'ping' type interference noticeably in shallow water, as noted on JR82 and JR96. This did not originate from the ADCP or the EA500 which were both switched off for short periods while the EK60 was run in passive mode.

False bottom marks appeared regularly on the 38 kHz echogram at bottom depths related to ping intervals. If the seabed depth is sufficient for an echo to be recorded shortly after a new ping is transmitted (e.g. with a ping interval of 2 seconds and a sound speed of 1461 metres per second, a seabed depth just greater than 1461 will cause a weak echo to appear at a depth equivalent to the amount by which it exceeds

1461) these echoes are then subject to TVG as if they had originated from the new ping. False bottom marks that were not affected by the EK60 ping interval were probably caused by the EA500, and sometimes these appear 'striped' when the EA ping interval is twice or more that of the EK60.

A new type of interference was noted intermittently on this survey consisting of very short but regular pulses 2-samples long and of very consistent intensity (obviously increased by TVG) visible on the 120 kHz echogram, but best viewed in the graph ping facility as in the following figure. The interference could be removed using the time-varied noise subtraction method generally employed, increasing the noise level by an appropriate amount.

EK60 operation

The periodic crashes of the EK60 encountered on previous cruises continued on JR100. The sounder stops pinging on one frequency (apparently at random) and the number of pings is much reduced on the other two. A soft alarm from EK60 is just audible when this problem happens; switching the GPT link off and on again cures the problem. The use or not of various software on the ek60 pc (APC10) or Workstation-_2 doesn't affect the occurrence of crashes, nor does changing the ping interval. A ping interval of 2 seconds was tested before starting the core box, but the frequency of crashes was becoming a problem, so the interval was increased to 2.5 seconds and the system was stable for almost 24 hours. However, once the core box survey began, a number of crashes occurred, necessitating constant supervision of the sounder.

Echoview operation

Echoview version 3.1 functioned in general without problems for post processing, but live viewing was less satisfactory. Although it appeared that live-viewing templates were recognised, derived variables were not reproduced. If they were imported from another file they were sometimes correct, but more often appeared as multiple and incomplete sets, and after repairing the faults these new versions were not saved correctly either.

Future Plans

Outputs

Biomass or number estimates from Krill 120 mask s-c, fish 38 s-c both for top 250m, and for a 50m depth grid (to provide abundances in top 50 and 100m for predators).

Scrutinise 120 s-c for krill max depth. Below this, treat all backscattering at 38kHz as fish. Seabed discrimination routines and noise removal will need to be extended for this.

Ideas for Analyses

Analyse krill and fish co-occurrence across the surveys

Compare acoustic data from transects with other underway data

References

Anon (2000) Report of the CCAMLR 2000 Synoptic Survey B0 Workshop held at La Jolla, California, July 2000. SC-CCAMLR

Fofonoff , P. & Millard, R.C. Jr. 1983

Algorithms for the computation of fundamental properties of seawater. Unesco Tech. Papers in Marine Science No 44. 53pp

Higginbottom, I.R., Pauly, T.J. and Heatley, D.C. (2000) Virtual echograms for visualisation and post-processing of multi-frequency echosounder data. Proceedings of the Fifth European Conference on Underwater Acoustics, ECUA 2000 (Ed M.E. Zakharia) 1497-1502.

MacLennan, D.N. and Simmonds, E.J., (1992) Fisheries Acoustics. Chapman & Hall, London

Table 3.2. EK60 settings during JR100

Cruise	start JR100	JR100	JR100	JR100	JR100	JR100	JR100
Date	11/3/2003	15/03/2004	15/03/2004	3/24/2004	3/24/2004	3/25/2004	3/26/2004
Software version	1.4.4.66	16:35-18:30	23:30	calibration	calibration	11:00	6:45
							re-installed 200kHz
/OPERATION MENU/Ping Mode	Ext.Trig	Ext.Trig	Ext.Trig	Ext.Trig	Ext.Trig	Ext.Trig	Ext.Trig
/OPERATION MENU/Ping Interval	2 sec (varied)	3 sec (varied)	3 sec (varied)	1 sec	1 sec	2 sec	2 sec
Salinity				30.4	30.4	33.305	33.305
Temperature						3.1133	3.1133
Sound Velocity	1457 m/s	1457 m/s	1457 m/s	1456.9	1456.9	1461	1461
/TRANSCEIVER MENU/Transceiver-1 Menu/Mode	Active	Active	Active	Active	Active	Active	Active
/TRANSCEIVER MENU/Transceiver-1 Menu/Transducer Type	ES38	ES38	ES38	ES38	ES38	ES38	ES38
/TRANSCEIVER MENU/Transceiver-1 Menu/Transducer Depth	0.00 m	6.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m
/TRANSCEIVER MENU/Transceiver-1 Menu/Absorption Coef.	10.05 dBkm	10.05 dBkm	10.05 dBkm	9.16	9.16	9.97*	9.97*
/TRANSCEIVER MENU/Transceiver-1 Menu/Pulse Length	1.024ms	1.024ms	1.024ms	1.024ms	0.512	1.024ms	1.024ms
/TRANSCEIVER MENU/Transceiver-1 Menu/sample interval	0.1865m	0.1865m	0.1865m	0.1865m	0.0932	0.1865m	0.1865m
/TRANSCEIVER MENU/Transceiver-1 Menu/Bandwidth	2425Hz	2425Hz	2425Hz	2425Hz	3275	2425Hz	2425Hz
/TRANSCEIVER MENU/Transceiver-1 Menu/Max. Power	2000 W	1000 W	1000 W	1000 W	1000 W	1000 W	1000 W
/TRANSCEIVER MENU/Transceiver-1 Menu/2-Way Beam Angle	-20.70 dB	-20.70 dB	-20.70 dB	-20.70 dB	-20.70 dB	-20.70 dB	-20.70 dB
/TRANSCEIVER MENU/Transceiver-1 Menu/Sv Transd. Gain	24.19 dB	24.19 dB	24.19 dB	24.16 dB	24.36	24.16 dB	24.16 dB
/TRANSCEIVER MENU/Transceiver-1 Menu/Sa correction	-0.07 dB	-0.07 dB	-0.07 dB	-0.74	-0.84	-0.74	-0.74
/TRANSCEIVER MENU/Transceiver-1 Menu/Angle Sens.Along	22	22	22	22	22	22	22
/TRANSCEIVER MENU/Transceiver-1 Menu/Angle Sens.Athw.	22	22	22	22	22	22	22
/TRANSCEIVER MENU/Transceiver-1 Menu/3 dB Beamw.Along	7.02°	7.02°	7.02°	6.95°	6.95°	6.95°	6.95°
/TRANSCEIVER MENU/Transceiver-1 Menu/3 dB Beamw.Athw.	6.94°	6.94°	6.94°	6.97°	6.97°	6.97°	6.97°
/TRANSCEIVER MENU/Transceiver-1 Menu/Alongship Offset MINOR	0.07°	0.07°	0.07°	0.17°	0.17°	0.17°	0.17°
/TRANSCEIVER MENU/Transceiver-1 Menu/Athw.ship Offset MAJOR	0.03°	0.03°	0.03°	0.0°	0.0°	0.0°	0.0°
/TRANSCEIVER MENU/Transceiver-1 Menu/Frequency	38 kHz	38 kHz	38 kHz	38 kHz	38 kHz	38 kHz	38 kHz
/TRANSCEIVER MENU/Transceiver-2 Menu/Mode	Active	Active	Active	Active	Active	Active	Active
/TRANSCEIVER MENU/Transceiver-2 Menu/Transducer Type	ES120-7	ES120-7	ES120-7	ES120-7	ES120-7	ES120-7	ES120-7
/TRANSCEIVER MENU/Transceiver-2 Menu/Transducer Depth	0.00 m	6.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m

/TRANSCEIVER MENU/Transceiver-2 Menu/Absorption Coef.	27.21 dBkm	27.21 dBkm	27.21 dBkm	26.24 dBkm	26.24 dBkm	28.04*	28.04*
/TRANSCEIVER MENU/Transceiver-2 Menu/Pulse Length	1.024ms	1.024ms	1.024ms	1.024ms	0.512	1.024ms	1.024ms
/TRANSCEIVER MENU/Transceiver-2 Menu/sample interval	0.1865m	0.1865m	0.1865m	0.1865m	0.0932	0.1865m	0.1865m
/TRANSCEIVER MENU/Transceiver-2 Menu/Bandwidth	3026 Hz	3026 Hz	3026 Hz	3026 Hz	5557 Hz	3026 Hz	3026 Hz
/TRANSCEIVER MENU/Transceiver-2 Menu/Max. Power	1000 W	500W	500W	500W	500W	500W	500W
/TRANSCEIVER MENU/Transceiver-2 Menu/2-Way Beam Angle	-20.70 dB	-20.70 dB	-20.70 dB	-20.70 dB	-20.70 dB	-20.70 dB	-20.70 dB
/TRANSCEIVER MENU/Transceiver-2 Menu/Sv Transd. Gain	22.43 dB	22.43 dB	22.43 dB	22.31 dB	25.40 dB	22.31 dB	22.31 dB
/TRANSCEIVER MENU/Transceiver-2 Menu/Sa correction	-0.42 dB	-0.42 dB	-0.42 dB	-0.41 dB	0.0 dB	-0.41 dB	-0.41 dB
/TRANSCEIVER MENU/Transceiver-2 Menu/Angle Sens.Along	21	21	21	21	21	21	21
/TRANSCEIVER MENU/Transceiver-2 Menu/Angle Sens.Athw.	21	21	21	21	21	21	21
/TRANSCEIVER MENU/Transceiver-2 Menu/3 dB Beamw.Along	7.92°	7.92°	7.92°	7.39°	7.39°	7.39°	7.39°
/TRANSCEIVER MENU/Transceiver-2 Menu/3 dB Beamw.Athw.	7.78°	7.78°	7.78°	7.36°	7.36°	7.36°	7.36°
/TRANSCEIVER MENU/Transceiver-2 Menu/Alongship Offset	0.05°	0.05°	0.05°	-0.07°	-0.07°	-0.07°	-0.07°
/TRANSCEIVER MENU/Transceiver-2 Menu/Athw.ship Offset	0.15°	0.15°	0.15°	-0.20°	-0.20°	-0.20°	-0.20°
/TRANSCEIVER MENU/Transceiver-2 Menu/Frequency	120 kHz	120 kHz	120 kHz	120 kHz	120 kHz	120 kHz	120 kHz
/TRANSCEIVER MENU/Transceiver-3 Menu/Mode	Active	Active	Active	Active	Active	Active	Active
/TRANSCEIVER MENU/Transceiver-3 Menu/Transducer Type	ES200-7	ES200-7	ES200-7	ES200-7	ES200-7	ES200-7	ES200-7
/TRANSCEIVER MENU/Transceiver-3 Menu/Transducer Depth	0.00 m	6.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m
/TRANSCEIVER MENU/Transceiver-3 Menu/Absorption Coef.	40.45 dBkm	40.45 dBkm	40.45 dBkm	39.13 dBkm	39.13 dBkm	41.10 dBkm	41.10 dBkm
/TRANSCEIVER MENU/Transceiver-3 Menu/Pulse Length	1.024ms	1.024ms	1.024ms	1.024ms	0.512ms	1.024ms	1.024ms
/TRANSCEIVER MENU/Transceiver-3 Menu/sample interval	0.1865m	0.1865m	0.1865m	0.1865m	0.0932m	0.1865m	0.1870m
/TRANSCEIVER MENU/Transceiver-3 Menu/Bandwidth	3088 Hz	3088 Hz	3088 Hz	3088 Hz	5972 Hz	3088 Hz	3088 Hz
/TRANSCEIVER MENU/Transceiver-3 Menu/Max. Power	320 W	320 W	320 W	320 W	320 W	320 W	320 W
/TRANSCEIVER MENU/Transceiver-3 Menu/2-Way Beam Angle	-19.60 dB	-19.60 dB	-19.60 dB	-19.60 dB	-19.60 dB	-19.60 dB	-19.60 dB
/TRANSCEIVER MENU/Transceiver-3 Menu/Sv Transd. Gain	26.30 dB	26.30 dB	26.30 dB	22.98 dB	26.30 dB	22.98 dB	23.79 dB
/TRANSCEIVER MENU/Transceiver-2 Menu/Sa correction	0.00 dB	0.00 dB	0.00 dB	-0.46	0	-0.46	-0.32
/TRANSCEIVER MENU/Transceiver-3 Menu/Angle Sens.Along	23	23	23	23	23	23	23
/TRANSCEIVER MENU/Transceiver-3 Menu/Angle Sens.Athw.	23	23	23	23	23	23	23
/TRANSCEIVER MENU/Transceiver-3 Menu/3 dB Beamw.Along	8.00°	8.00°	8.00°	9.40°	9.40°	9.40°	6.66°
/TRANSCEIVER MENU/Transceiver-3 Menu/3 dB Beamw.Athw.	7.90°	7.90°	7.90°	7.87°	7.87°	7.87°	6.83°
/TRANSCEIVER MENU/Transceiver-3 Menu/Alongship Offset	0.00°	0.00°	0.00°	0.27°	0.27°	0.27°	-0.22°
/TRANSCEIVER MENU/Transceiver-3 Menu/Athw.ship Offset	0.00°	0.00°	0.00°	0.03°	0.03°	0.03°	-0.11°
/TRANSCEIVER MENU/Transceiver-3 Menu/Frequency	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz
/TS DETECTION MENU/TS Detection-1 Menu/Min. Value=-90 dB							-80

/TS DETECTION MENU/TS Detection-1 Menu/Min. Echo Length=0.8		0.8	0.8			0.8	0.8
/TS DETECTION MENU/TS Detection-1 Menu/Max. Echo Length=2.5		1.3	1.3			1.3	1.5
/TS DETECTION MENU/TS Detection-1 Menu/Max. Gain Comp.=4.0 dB		2 dB	2 dB			2 dB	3 dB
/TS DETECTION MENU/TS Detection-1 Menu/Max. Phase Dev.=2.0		1	1			1	2
/TS DETECTION MENU/TS Detection-2 Menu/Min. Value=-90 dB							
/TS DETECTION MENU/TS Detection-2 Menu/Min. Echo Length=0.8		0.8	0.8			0.8	0.8
/TS DETECTION MENU/TS Detection-2 Menu/Max. Echo Length=2.5		2.5	1.3			1.3	1.5
/TS DETECTION MENU/TS Detection-2 Menu/Max. Gain Comp.=4.0 dB		2 dB	2 dB			2 dB	3 dB
/TS DETECTION MENU/TS Detection-2 Menu/Max. Phase Dev.=2.0		6	1			1	2
/TS DETECTION MENU/TS Detection-3 Menu/Min. Value=-90 dB							
/TS DETECTION MENU/TS Detection-3 Menu/Min. Echo Length=0.8		0.8	0.8			0.8	0.8
/TS DETECTION MENU/TS Detection-3 Menu/Max. Echo Length=2.5		2.5	1.3			1.3	1.5
/TS DETECTION MENU/TS Detection-3 Menu/Max. Gain Comp.=4.0 dB		2 dB	2 dB			2 dB	3 dB
/TS DETECTION MENU/TS Detection-3 Menu/Max. Phase Dev.=2.0		6	1			1	2
							checked, 30/03/04
* = computed by ek60, my spreadsheet makes these 10.28 dBkm, 28.84dBkm, and 42.08dBkm							

4. Fish and Cephalopod Catches

Martin Collins, Nadine Johnston & Tony North

Background

The main focus of JR100 was to determine the vertical and horizontal distribution of myctophid fish and how the distribution of these fish was related to the underlying oceanography and the distribution of ichthyophagus predators. Samples of fish were also utilised for a range of studies including trophic ecology, visual ecology, pollutants and enzyme activity.

Fishing gears

Two main gears were used to catch fish during JR100, the IYGPT (Pelagic Trawl) and the RMT25. For the IYGPT the main aim on this cruise was to develop a safe working practice, and it wasn't equipped with a net monitor, so it was of limited value for target fishing. A time depth recorder was fitted to it, which enabled the depth of the net to be known once it was back on deck. A safe working system was quickly established with the IGYPT, but the bulk of the fishing was undertaken with the RMT25. The RMT25 was fitted with two nets, and a net monitor, which allowed two targets or depth horizons to be fished on each deployment.

During the early part of the cruise acoustic transects were run in an east west direction and target fishing used to confirm the identity of targets. Both the IYGPT and the RMT25 were used, but, as detailed above, the RMT25 was more effective at fishing targets. After completing the acoustic transects work focussed on establishing the day and night vertical distribution of myctophids. This involved the RMT25 fishing discreet depth horizons from the surface to 1000 m.

In addition RMT8 hauls were undertaken at the shallow mooring site and at fixed stations in the Western Core Box, and provided a small number of additional fish samples. Neuston net hauls in the core box were designed to catch fish larvae.

A total of 67 net hauls (excluding bongos) were undertaken on JR 100 (Table 2.2), which was comprised of 13 IYGPT hauls, 31 RMT25 hauls, 13 RMT8 hauls and 10 neuston net hauls.

Catch Processing

When the nets had been recovered to the deck, samples were returned to the wet lab for sorting. With the RMT nets, the catch from one of the nets was usually taken immediately to the darkroom, where a small number of fish were removed for studies of fish vision.

For each net the total catch weight and/or volume was determined. Weights were obtained using a compensated sea-going balance. The catch was sorted, were possible, to the species level, and either total volume or weight obtained for each component species. For the invertebrate catches a known volume sub sample was often taken. For fish the whole catch was processed. Fish were stored on trays of ice to keep cool, and were measured (standard length, mm), sexed and in some cases a maturity stage assigned. Maturity was assigned using a three point scale of i) immature; ii) developing; iii) mature. All fish and invertebrate catch data were recorded in an MS Access Database.

Stomachs were dissected from most of the fish caught, stored in zip-lock plastic bags and frozen (-20). Otoliths were removed from a sample of the fish and stored dry in envelopes. Tissue samples were removed for fatty acid analysis (Dave Pond) and analysis of enzyme activities; contaminants and anti-oxidants (Cathy Debier).

A small number of samples were fixed in formalin, tissue samples were removed from these samples prior to fixation and stored in 90% ethanol for genetics studies.

Fish and cephalopod catch composition

A total of 3576 fish belonging to 42 species were caught during JR100 (Table 4.1). Fish catches were dominated by myctophids with the most abundant species being *Electrona carlsbergi*, *Protomyctophum bolini*, *Gymnoscopelus braueri*, *G. fraseri*, *Electrona antarctica*, *G. nicholsi*, *P. choriodon* and *Krefttichthys anderssoni*. Large

numbers of larvae and post-larvae of the notothenid *Lepidonotothen larseni* were also taken. In addition 55 cephalopods belonging to 4 species of squid (*Mastigoteuthis psychrophilia*, *Galiteuthis glacialis*, *Chiroteuthis veranyi* and *Slosarczykovia circumantarctica*) were caught (Table 4.2).

Target fishing in the early part of the cruise was used to identify acoustic marks and produced good catches of *Electrona carlsbergi* and *Gymnoscopelus nicholsi*, which form dense aggregations, the latter particularly associated with the shelf edge. Other myctophids such as *Protomyctophum choriodon*, *P. bolini* and *G. braueri* formed a diffuse layer at around 400 m during the day, but came closer to the surface at night. On the Shag Rocks shelf, the RMT25 yielded a good catch of *Patagonotothen guntheri*.

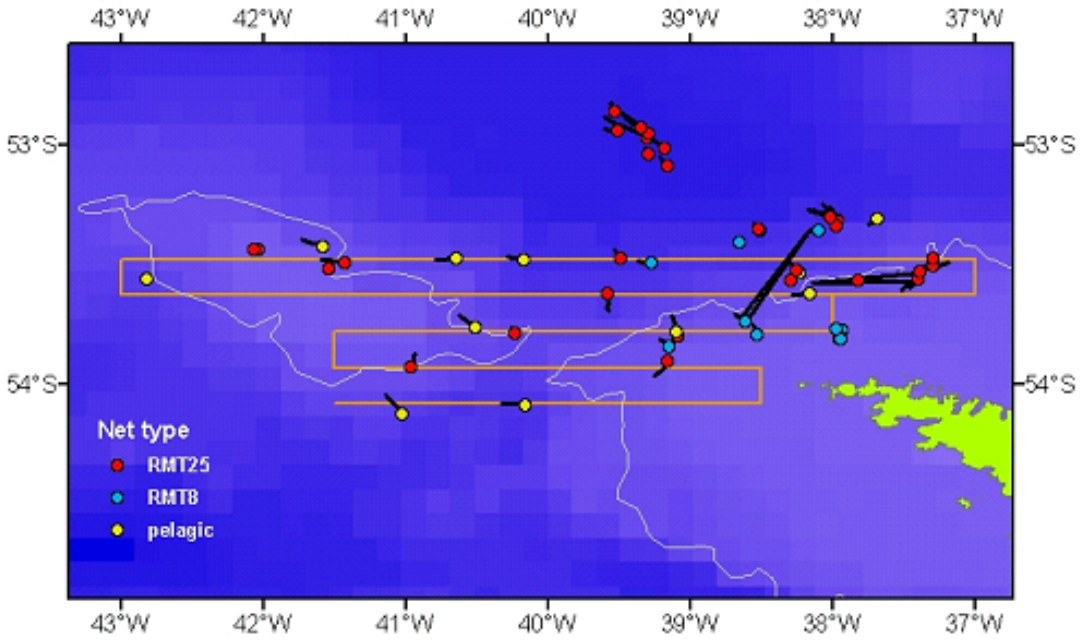

Figure 4.1. Locations of RMT8, RMT25 and IGYPT (Pelagic) hauls during JR100.

During the latter part of the cruise, when work focussed on the verical distribution of the mesopelagic fish, there were few fish in the top 200 m during daylight, but considerable more at night. Deeper nets produced good catches of *Lampanyctus achirus* and *Borostomias antarcticus*.

Table 4.1. Fish species caught during JR100 in different nets.

Species	NEUSTON	P	RMT25	RMT8	TOTAL
Argyropelecus spp.			1		1
Bathylagus antarcticus		2	4	1	7
Bathylagus gracilis		1	3		4
Bathylagus spp.			37		37
Bathylagus tenuis		3	49		52
Benthalbella elongata			8		8
Benthalbella macropinna			5		5
Borostomias antarcticus			104		104
Ceratioid angler			1		1
Chaenocephalus aceratus				10	10
Champsocephalus gunnari			2		2
Cyclothone spp.			55		55
Cynomacrurus piriei			5		5
Electrona antarctica		20	230	5	255
Electrona carlsbergi		118	385		503
Electrona spp		1	1		2
Gymnoscopelus bolini			13		13
Gymnoscopelus braueri		40	342	6	388
Gymnoscopelus fraseri		84	190	4	278
Gymnoscopelus microlampas			1		1
Gymnoscopelus nicholsi		138	74		212
Gymnoscopelus spp		14			14
Krefftichthys anderssoni		6	178	4	188
Lampanyctus achirus			96		96
Lepidonotothen larsoni		323	4	40	367
Lepidonotothen nudifrons		6	2		8
Melanostigma gelatinosum			2		2
Muraenolepis microps		14	4	13	31
Muraenolepis sp.			1		1
Nansenia antarctica		2	27		29
Nemichthys curvirostratus			3		3
Notolepis coatsi		1	6	2	9
Notolepis spp.			3		3
Notothenia coriiceps	4	2			6
Notothenia gibberifrons	4		6	1	11
Notothenia rossii	2	1			3
Paradiplospinosus gracilis		28	12	1	41
Patagonotothen guntheri			84		84
Poromitra crassiceps			3		3
Protomyctophum bolini		94	323	1	418
Protomyctophum choriodon		129	98	4	231
Protomyctophum gemmatum		1	6		7
Protomyctophum parallelum			35		35
Protomyctophum spp			1		1
Protomyctophum tenisoni		1	3		4
Pseudochaenichthys georgianus				1	1
Stomias boa boa			1		1
Stomias gracilis		9	24		33
Unknown		1	2		3

Table 4.2. Cephalopod catches in different nets on JR 100.

Species	IYGPT	RMT25	RMT8	TOTAL
Galiteuthis glacialis		35		35
Mastigoteuthis psychrophillia		7		7
Slosarczykovia circumantarctica	2	10		12
Chiroteuthis veranyi		1		
Unidentified Cephalopoda	1			1

Many of the *Electrona antarctica* caught were in spawning condition. Over 500 stomachs were collected from myctophids, with additional stomachs taken from other mesopelagic species.

5. The visual ecology of Antarctic mesopelagic fish

Elizabeth White

Introduction

Animals in the deep ocean are exposed to two sources of illumination: weak down-welling sunlight in the upper ocean depths, and bioluminescence produced by the animals themselves, that can be used to fulfil a range of functions from signalling to crypsis. Although the deep sea is often said to be an environment of perpetual darkness, this is clearly not the case: most deep-sea fish have well developed, fully-functioning eyes while around 80% of deep-water species are capable of producing their own light.

The aim of this AFI-funded project was to explore the visual systems of Antarctic mesopelagic fishes, with particular reference to the Myctophidae. Vision plays an important role in the life of myctophids, with all species possessing ventral light organs that are thought to play a role in species identification, sexual signalling and counter illumination. Vision will also play a role in foraging and predator avoidance, and differences in visual sensitivity may be related to foraging depth and prey preferences and we as their reactions to predators.

Although the visual systems of deep-water fish have been explored in other ocean systems, little work has previously focused on the visual ecology of Antarctic fish. Furthermore, although myctophids are very abundant and form a major part of the mesopelagic fauna, they have been investigated to a lesser degree than other species and much is still to be learn about their visual ecology.

Aims

There were three aims for this cruise: (1) to determine the visual sensitivity of a range of myctophid species from around South Georgia; (2) to relate the retinal sensitivity to the depth of occurrence and diet of the species; (3) to explore the visual systems of any other species collected, particularly focusing on species with 'unusual' visual adaptations and on the visual pigments of fish occurring at different depths.

Methodology

The visual sensitivity of mesopelagic fishes was determined by measuring the absorbance properties of the visual pigments contained in the retinal cells of the fish and the transmission of the ocular lens. As visual pigments are light-sensitive structures, all work was carried out

in a purpose-built darkroom, and all tissue manipulations carried out under dim red illumination from a head torch.

Animals

A total of 189 fish, comprising 38 species were obtained from RMT25, RMT8 and pelagic trawls at a range of depths from the surface to 1000m. Animals were both collected directly from the net and transferred immediately to a dark container of cold seawater, or the entire cod end was transferred to a black plastic bag and sorted under dim red illumination. In the darkroom, eyes were removed and dissected, in order to remove the lens and retina for examination.

Visual pigments

The sensitivity of an eye is largely dependent on the absorbance of the retinal visual pigments. Two types of analysis were carried out on retinae collected: visual pigment extraction, in which of the visual pigments are extracted from the retina, and as retinal wholemounts, in which the absorbance properties of the intact retina are measured. A full description of the methodologies used can be found in Douglas, Partridge and Hope (1995).

Briefly, visual pigments were extracted by homogenising retinae in 0.5 ml phosphate buffered saline (425 mOsm/kg) with 50µl of the detergent, n-dodecyl β-d-maltoside. Extracts were mixed for 1hr on a rotator wheel and the resulting mixture centrifuged at 4°C for 10min at 15,000 rpm (23,000 g). The supernatant was removed and placed in a quartz cuvette in a Shimadzu UV-2101 PC spectrophotometer. After an initial scan of the extract from 300-800nm, 50µl of 1*M* NH_2OH (pH 6.5) was added per ml extract and left for 15min to remove photoproducts to short wavelengths, before a second scan was performed.

In order to isolate the absorbance of specific visual pigments, the extract was rescanned following exposure to small quantities of light of decreasing wavelengths, a method known as 'partial bleaching' (Knowles and Dartnall, 1977). This was carried out using light from a fibre optic lamp, and regulated using narrow-band interference filters (15nm bandwidth, B40 filters, Balzer, Liechenstein). Typically, the protocol would begin with ca. 15min of light at 645nm, and progress through 624nm (ca. 5min), 585nm (5min), 560nm (3min), 543nm (2min), 501nm (2min) and white light (2min). Difference spectra were constructed from the scans taken at different stages of the bleaching process. If these spectra showed a significant change in maximum sensitivity (at a wavelength known as the λ_{max}), this indicated the presence of more than one visual pigment. In order to determine the λ_{max} values of the visual

pigments, the difference spectra obtained from bleaching were normalised and then fitted with a visual pigment template (Govardovskii et al., 2000). Visual pigment extraction was carried out on 27 of the species collected, and further extracts were frozen for further analysis in the UK.

In addition, retinal wholemount experiments were carried out. For this, small sections of fresh retina (ca. 4mm^2) were bathed in phosphate buffered saline with 100µl NH_2OH for 1min. They were sandwiched between a fine gauze frame and held in a cuvette within the beam of the Shimadzu spectrophotometer in front of a Shimadzu ISR-260 integrating sphere. After initial scanning, wholemounts were subjected to the same partial bleaching regime as described above. A total of 35 retinal wholemounts were carried out during the course of JR100.

Lens pigmentation

Since light must first pass through the lens and ocular media to reach the retina, measurements of lens transmission were also carried out. Ocular lenses were removed and placed in a pre-drilled aluminium baton within a cuvette where they were held within the beam of the spectrophotometer, in front of the integrating sphere. Lenses were scanned from 300-700nm. The lenses of 22 different species were measured and further lenses were frozen for subsequent measurement and pigment extraction in the UK.

Depth distributions and diet

Information relating to the depth information and diet of the species used in this study were collected as part of the sampling routine of JR100 (see elsewhere) and these data will be used to relate to the species' habitat and ecology.

Results

Visual pigments

Table 5.1 shows a summary (including taxonomy as per Gon and Heemstra, 1990) of the 38 species collected during the course of JR100. In most cases, the visual pigments were explored both through extract spectrophotometry and retinal wholemount and the transmission of the lens measured.

Species		Extract	Wholemount	Lens	Frozen
Microstomatidae					
	Nansemia antarctica		✓		✓
Bathylagidae					
	Bathylagus antarctica	✓	✓	✓	✓
	Bathylagus tenuis	✓	✓		✓
Stomiidae					
	Borostomias antarcticus	✓	✓		✓
	Stomias boa boa	✓	✓	✓	✓
	Stomias gracilis	✓	✓	✓	✓
Scopelarchidae					
	Benthalbella elongata	✓	✓	✓	✓
	Benthalbella macropinna	✓	✓	✓	✓
Paralepididae					
	Notolepis coatsi	✓	✓		✓
Myctophidae					
	Electrona antarctica	✓	✓	✓	✓
	Electrona carlsbergi	✓	✓	✓	✓
	Gymnoscopelus bolini	✓	✓	✓	✓
	Gymnoscopelus braueri	✓	✓	✓	✓
	Gymnoscopelus fraseri		✓		✓
	Gymnoscopelus nicholsi		✓	✓	✓
	Krefftichthys anderssonii	✓	✓		✓
	Lampanyctus achirus:	✓	✓		
	Protomyctophum bolini	✓		✓	✓
	Protomyctophum choriodon	✓	✓	✓	✓
	Protomyctophum gemmatum	✓		✓	✓
	Protomyctophum parallelum	✓	✓		✓
Melamphaidae					
	Poromitra crassiceps	✓			✓
Zoarcidae					
	Melanostigma gelatinosum	✓	✓	✓	✓
Nototheniidae					
	Gobionothene gerberifrons	✓		✓	✓
	Lepidonotothon squamifrons	✓	✓	✓	✓
	Lepidonotothen larsoni				
	Lepidonotothen larseni (juvenile)				✓
	Patagonotothen guntheri	✓	✓	✓	✓
Channichthyidae					
	*Chaenocephalus aceratus (*adult*)*	✓	✓	✓	✓
	*Chaenocephalus aceratus (*juvenile*)*		✓	✓	✓
	Champsocephalus gunnari	✓		✓	
	Pseudochaenychthys georgianas				✓
Gempylidae					
	Paradiplospinosus gracilis	✓	✓	✓	✓
Nemichthyidae					
	Nemichthys curvirostris	✓	✓		✓
Muraenolepidae					
	Muraenolepis sp. (mature)			✓	✓
	Muraenolepis sp. (juvenile)				✓
Macrouridae					
	Cynomacrurus piriei (juvenile)				✓
Ceratidae					
	Anglerfish (species to be determined)				✓

Table 5.1: Summary species examined during JR100. Ticks represent where experiments were carried out using extract spectrophotometry ('extract') and retinal wholemount ('wholemount') methods. For most species, the visual pigment λ_{max} values were determined during the course of the cruise. For those that were not, extracts or whole retinae were frozen for use in the UK. Similarly, for most species, lens transmission measurements were made in situ. Exact visual pigment λ_{max} values are not fully analysed and are thus not reported here.

For most species, difference spectra obtained from subsequent bleaches revealed a single visual pigment, with a wavelength of maximum sensitivity (λ_{max}) of between 479 and 496nm (see Figure 5.1). Some species, however, had more than one pigment, which was apparent as a distinct shift in λ_{max} with subsequent bleaching events (see Figure 5.2). Exact data for each species is not reported here, and will be more fully analysed on return to the UK.

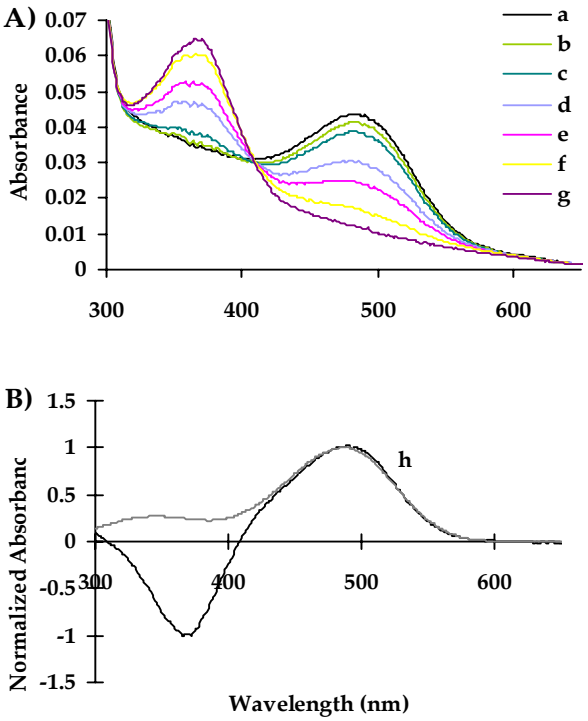

Figure 5.1A: Absorbance spectra of a retinal pigment extract from *Poromitra crassiceps* following various bleaches: (a) initial extract 15min after the addition of NA_2OH; (b) following 30min 645 nm light; (c) 5min 624 nm; (d) 8min 560 nm; (e) 2min 543 nm; (f) 2min 501 nm; (g) 2min white light. B: difference spectrum constructed using the curves a-g (h). This and all other differences have a maximum at 486 nm as indicated from a best-fitted rhodopsin visual pigment template (shown in grey).

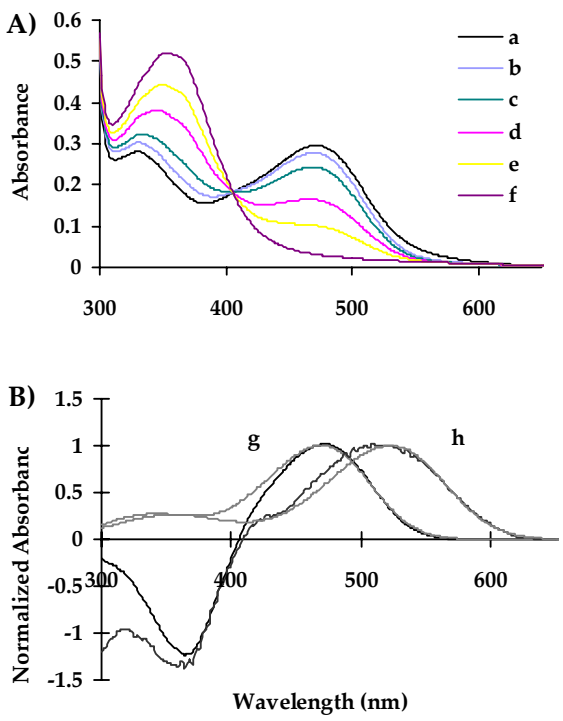

Figure 5.2A: Absorbance spectra of a retinal pigment extract from *Benthabella elongata* following various bleaches: (a) initial extract 15min after the addition of NA_2OH; (b) following 10min 585 nm light; (c) 15min 560 nm; (d) 3min 501 nm; (e) 5min 501 nm; (f) 2min white light. B: difference spectra constructed using the curves e-f (g) and a-b (h). Two visual pigments are indicated with maxima around 469 and 522 nm. Best-fitting rhodopsin templates are shown in grey.

Lens pigmentation

The lenses of 22 different species were measured during the course of this study and examples are plotted in Figure 5.3. Most lenses measured typically contained no significant levels of pigmentation and had high transmittance between 400 and 800nm, with a smooth decline in transmission below 400nm. Variation between lenses is largely due to lens diameter or the use of species-specific structural lens proteins. Only two species had significant levels of pigmentation: both species of *Benthabella* (*B. macropinna* and *B. elongata*) had distinctly yellow lenses, which absorbed all light below 450 nm. It was also noted that the lenses of a myctophid, *Protomyctophum paralellum*, were distinctly yellow. Unfortunately the lenses of the single example of this species collected, were damaged to the point that transmission measurements were not possible.

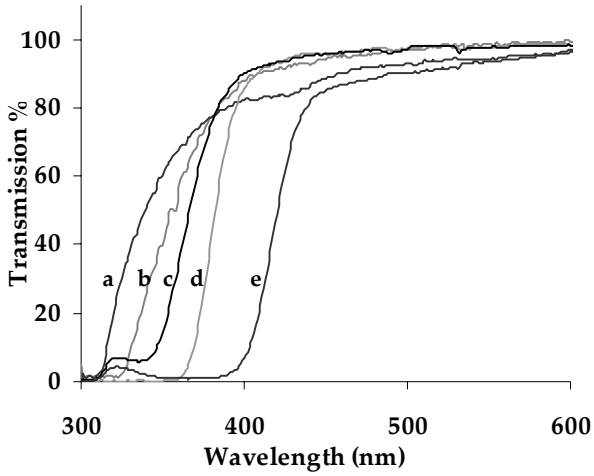

Figure 5.3: Whole lens transmission spectra for members of family Mycrophidae: (a) *Electrona antarctica* (similar transmission to *E. carlsbergi* and *Lampanyctus achirus*); (b) *Protomyctophum choriodon* (similar transmission to *P. bolini* and *P. germanium*); (c) *Gymnoscopelus fraiseri*; (d) *G. bolini* (similar to *G. nicholsi*); (e) *Kreftichthys andersonii*. Data between 600-700 nm are not shown but have uniform high transmission.

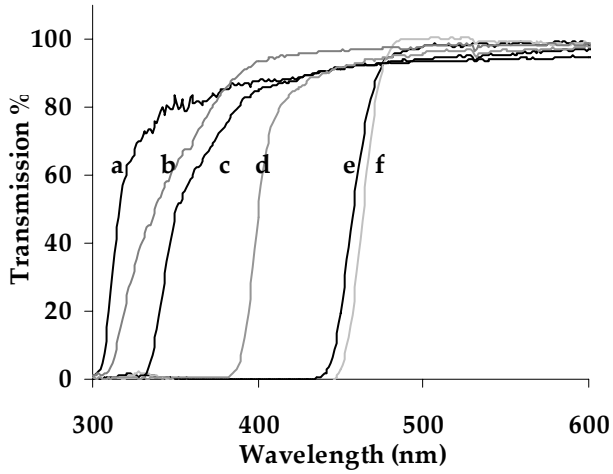

Figure 5.4: Whole lens transmission spectra for other species measured: (a) *Pseudochaenychthys georgianas*; (b) *Borostomias antarcticus* – most other species fell between the range of (a)-(b), with the exception of: (c) *Patagonotothen guntheri*; (d) *Paradiplospinosus gracilis*; and the distinctly yellow lenses of (e) *Benthalbella elongata*; and (f) *B. macropinna.* Data between 600-700 nm are not shown but have uniform high transmission.

Discussion and further work

JR100 enabled the collection of tissue from a wide range of species, from a range of depths, which have not previously been examined from a 'visual' perspective. Although significant amounts of work was achieved during the cruise, further work will be carried out on return to the UK, both in terms of running additional experiments to measure visual pigments and in detailed analysis of the data. Analysis will focus on how visual systems vary with taxonomy, depth, and species diet. In particular, we are interested in species that possess more than one visual pigment. Fish with more than one visual pigment may possess this as a mixture of the two pigments within the same retinal cells, or in different cells. If different pigments are housed in separate cells, it is possible that these fish may be able to distinguish light differing in spectral character, rather than the simple presence or absence of light that a single pigment would allow. Thus these species may have the capacity for colour vision that might be adaptive in terms of detecting differences between ambient light and bioluminescence, thus breaking the camouflage of counter-illumination.

We are also interested in potential sex differences between myctophids – particularly those species in which males have orbital photophores ('headlights'). Since these myctophids are

sexually dimorphic for this character, these characters are likely to function in mate detection and choice.

Of further interest is the ability of these fish to use vision for the avoidance of predators such as seals and penguins. Fundamental information about spectral sensitivity will potentially enable us to model the visualisation distance of fish and their ability to detect predators by using vision.

Acknowledgements

This work was undertaken using an AFI grant awarded to Dr. Martin Collins (BAS) and Prof. Ron Douglas (City University, London). It was carried out in collaboration with Dr. Julian Partridge (University of Bristol) who also provided all equipment used in this study.

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6. Biochemical and physiological analysis of antioxidative defence mechanisms in deep-sea fish

Cathy Debier

Introduction

Antioxidative defences of deep-sea fish appear to be much lower than those of surface fish. For example, the activity of antioxidizing enzymes such as superoxyde dismutase and glutathion peroxydase is 50-100 times lower in fish living at 1000m than in surface fish. This phenomenon seems to be linked to a decrease of the metabolic activity as depth increases. Antioxidizing enzymes are indeed correlated to the activity of citrate synthase, an enzyme involved in the Krebs cycle, which decreases with depth. Antioxidizing enzymes thus appear to be adapted to the endogen oxidative threat associated to the production of reactive oxygen species, generated by oxidative phosphorylations.

There is however another source of oxidative stress in deep-sea environments which occurs through the contamination by persistent organic pollutants or "POPs". Some of these xenobiotics are metabolised in the liver by the cytochrome P-450 system. This process can generate toxic oxidative stress as well as disrupt the metabolism of endogen molecules such as vitamin A. Very few studies have investigated the POP contamination and its impact on antioxidizing defence in deep-sea fish. Yet, such a study would be particularly important because POPs accumulate in deep-sea environments as a result of their adsorption in sediments. Consequently, levels encountered in deep-sea fish appear to be 1 or 2 orders of magnitude higher than those encountered in surface fish. Because of their low antioxidative defence, deep-sea fish may therefore be at risk when contaminated by these xenobiotics.

Objectives

In order to understand the impact of pollution on deep-sea fish, we will study the ability of fish's antioxidizing defence to adapt to the oxidative stress generated by POP contamination.

1. Study the relations in deep-sea fish that could link the activity of antioxidizing enzymes to
    a. the levels of POPs such as PCBs and DDT
    b. the activity of cytochrome P450 enzymes (detoxifying enzymes)

c. the metabolic activity
d. some non-enzymatic antioxidants such as vitamins A and E

2. Analyse the cellular response to the oxidative stress generated by POPs. Because it is not possible to keep deep-sea fish in captivity, we will develop techniques to keep some of their cells alive by collecting thin liver slices at low temperature and under sterile conditions in order to assess the adaptability of the enzymatic antioxidizing system to oxidizing agents.

Methods

Objective 1: sample collection for POP, enzyme and vitamin analyses

Liver, brain and muscle samples have been collected from various lantern fish species (Myctophidae). Specimen have been sampled at different depths by the RMT 25 and the Pelagic trawl during the transects as well as during the "round the clock" trawling (which was looking at vertical distribution patterns).

A total of 589 fishes have been dissected for liver and muscle samples. Whenever possible, depending on the size of the fish, samples have been divided into 3 pieces that were put in different polypropylene vials (1vial per type of analysis: POPs, enzymes and vitamins). Some brain samples have also been collected from 98 fishes for POP analyses. All samples have been stored at –80°C until lab analyses in Belgium (see "Future experiments").

Objective 2: liver slicing for cell culture experiments

Myctophids being fairly small, it has not been possible to conduct much of this part of the project, as liver needs to reach a certain size to allow proper slicing. However, it has been possible to carry out the experiment on one specimen.

Briefly, the liver has been removed and cut in cylinders using 2 different punches (5mm and 10 mm diameter) adapted to an electric drill. The liver cylinders have then been sliced at 4°C under the hood, using a Krumdiek tissue slicer, at diameters varying between 200 and 400 µm and recovered in cell culture medium (Belzer UW solution). The slices have then been quickly frozen on ice blocs (kept at –80°C) wrapped in aluminium foil and disinfected with

Ethanol. Once frozen, the slices have been stored individually in Nalgene sterile cryotubes at –80°C, until lab analyses in Belgium (see "Future experiments")

Future Experiments

Objective 1

Frozen samples of liver, muscle and brain will be kept on board of JCR and brought back to England and then Belgium in June 2004.

The following lab analyses will be conducted:

* OC analyses (PCBs and DDT and its metabolites op' and pp' DDE) in liver and muscle samples, by gas chromatography coupled to an electron capture detection (GC- ECD) or mass spectrometry (GC-MS), following sample extraction and purification.

* Cytochrome P-450 enzyme activity in liver, using fluoromertic methods

* Vitamins A and E analyses in liver and muscle, by high performance liquid chromatography (HPLC), following sample extraction.

*Antioxidant (catalase, superoxyde dismutase, glutathion peroxydase) and metabolic enzyme (citrate synthase) activities in liver and muscle by spectrophotometry.

Objective 2

The thin liver slices technique will allow us to study the response of hepatic cells to the contamination by xenobiotics. Frozen liver slices will be thawed, according to very precise parameters to ensure their survival and an optimal metabolic state. They will then be incubated in the presence of oxidizing molecules (peroxides, PCBs and DDT) in order to analyse the induction of CYP450s as well as the changes of antioxidizing enzymes during this exposition.

7. Seabird and marine mammal surveys

Andy Black

Introduction

For the first time since the project began, in October 2002, surveys were conducted from the British Antarctic Survey vessel RRS *James Clark Ross*. The observer had the opportunity to participate in a scientific cruise investigating the vertical and horizontal distribution of fish in an area between the Shag Rocks and South Georgia shelves (Figure 7.1), with the aim to relate fish distribution to the physical oceanography of the region and the foraging behaviour of fur seals. Much of the cruise was spent steaming along acoustic transects which was compatible with seabird and marine mammal surveys. Surveys were not undertaken during fishing operations.

Surveys were conducted whenever the vessel was steaming and weather conditions (generally Beaufort force 6 or less) and visibility were suitable. Seabird and marine mammal surveys were carried out using standard Seabirds at Sea Team (SAST) methods (Tasker *et al*. 1984, Webb & Durinck 1992). Nomenclature and taxonomy follows Gales (1998) for albatrosses, Harrison (1987) for all other seabirds and Jefferson *et al*. (1993) for marine mammals.

Survey coverage

The distribution of survey effort is shown in Figure 7.2. In total, 577.56 km^2 of survey effort was achieved, with 430.10 km^2 of this within the South Georgia Maritime Zone (SGMZ).

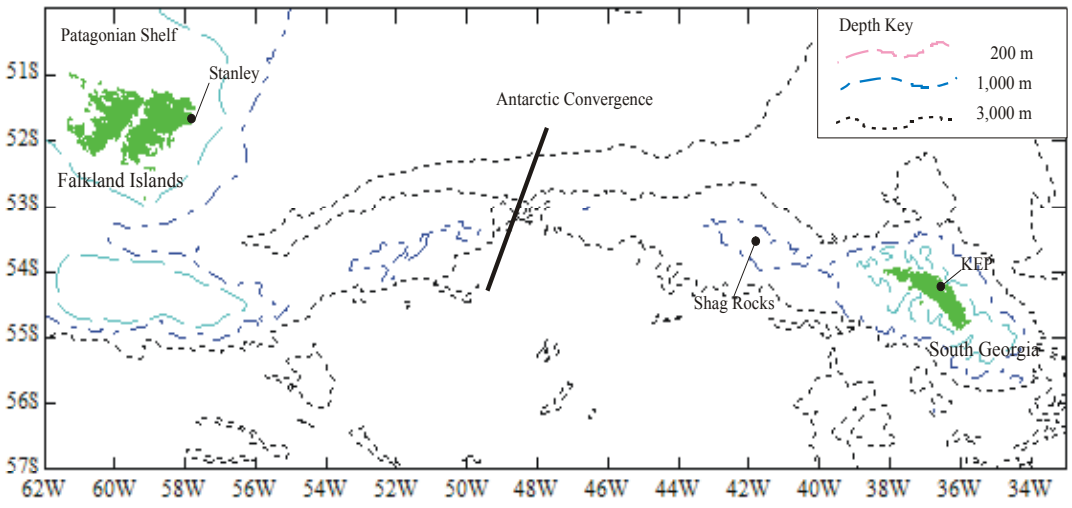


Figure 7.1 Survey area showing bathymetry, approximate position of the Antarctic Convergence and locations mentioned in the text.

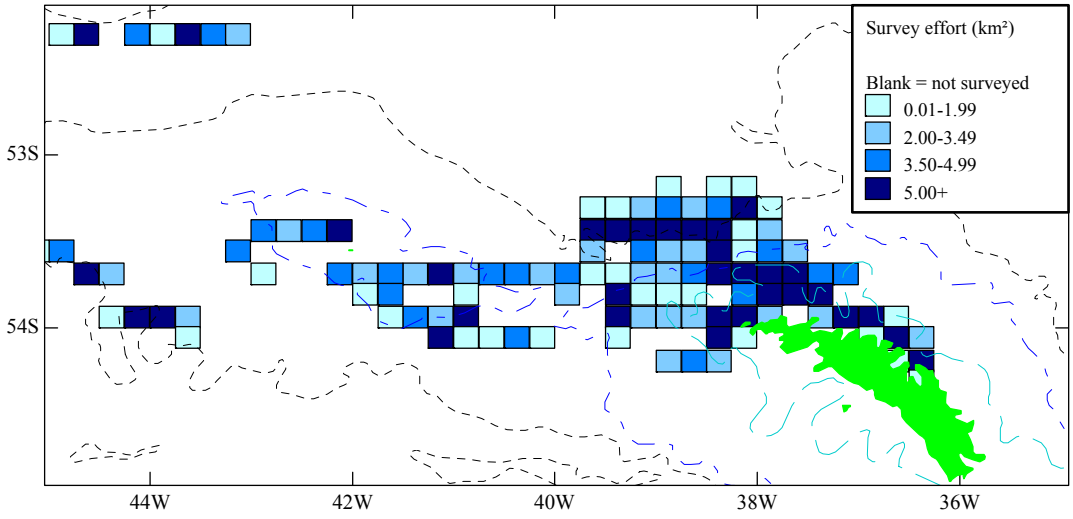


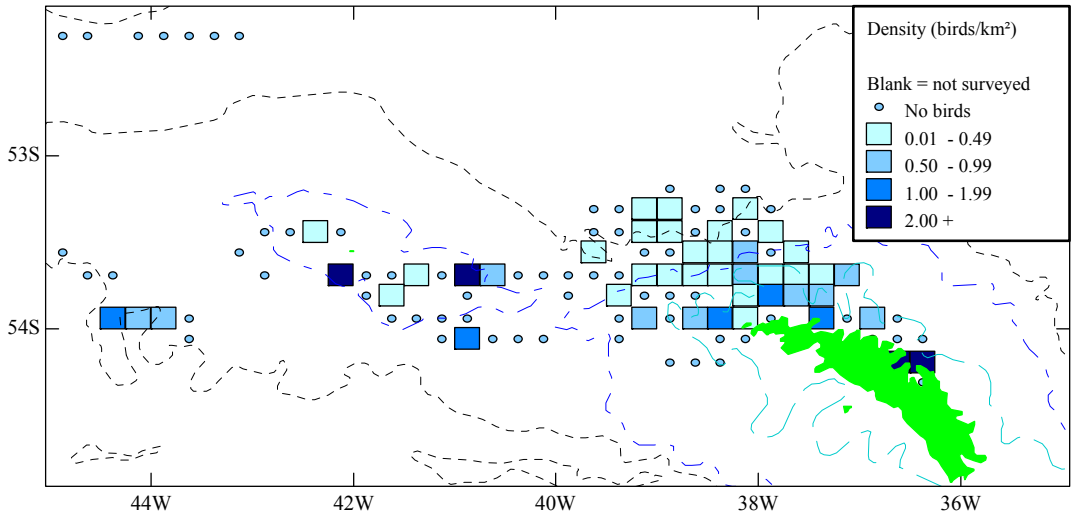
Figure 7.2. Distribution of survey effort, 11 March to 03 April 2004.

Seabirds

King penguin *Aptenodytes patagonicus*

King penguins were regularly recorded within the SGMZ. Generally, the density of birds recorded was low, however, relatively high numbers were encountered in coastal waters near Cumberland Bay and shelf waters surrounding Shag Rocks. As with the majority of species, very low densities of king penguins were recorded in the deeper waters between Shag Rocks and mainland South Georgia (Figure 7.3). In total, 164 king penguins were recorded.

Figure 7.3. King penguin distribution, 11 March to 03 April 2004



Gentoo penguin *Pygoscelis papua*

Gentoo penguins were only recorded in inshore waters (Figure 7.4) and were therefore absent from most of the core study areas. A total of 530 gentoo penguins were recorded.

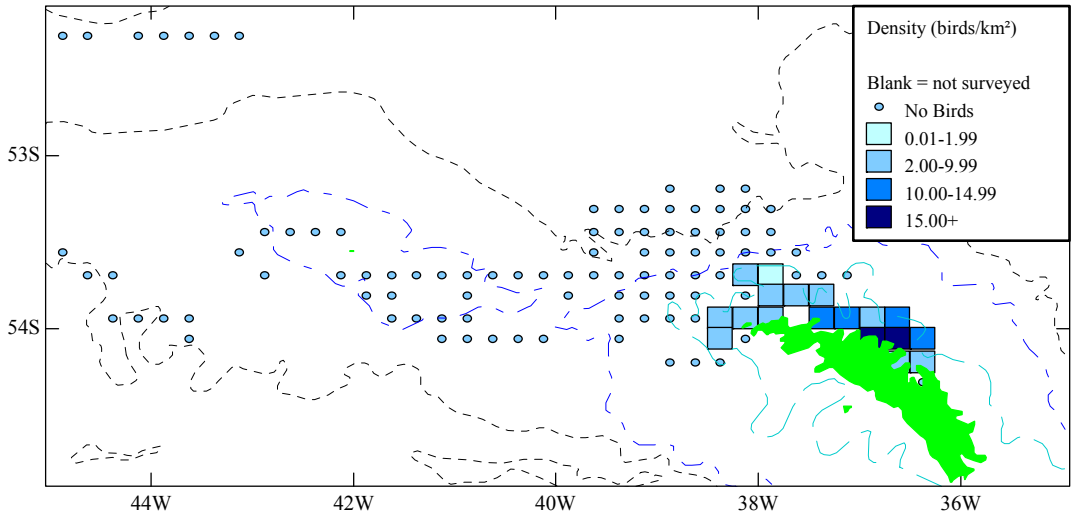


Figure 7.4. Gentoo penguin distribution, 11 March to 03 April 2004

Macaroni penguin *Eudyptes chrysolophus*

Macaroni penguins were recorded at low densities throughout most of the waters surveyed within the SGMZ. High densities were encountered in shelf waters adjacent to Shag Rocks and inshore waters adjacent to know colonies of this species (Figure 7.5). In total, 329 macaroni penguins were recorded.

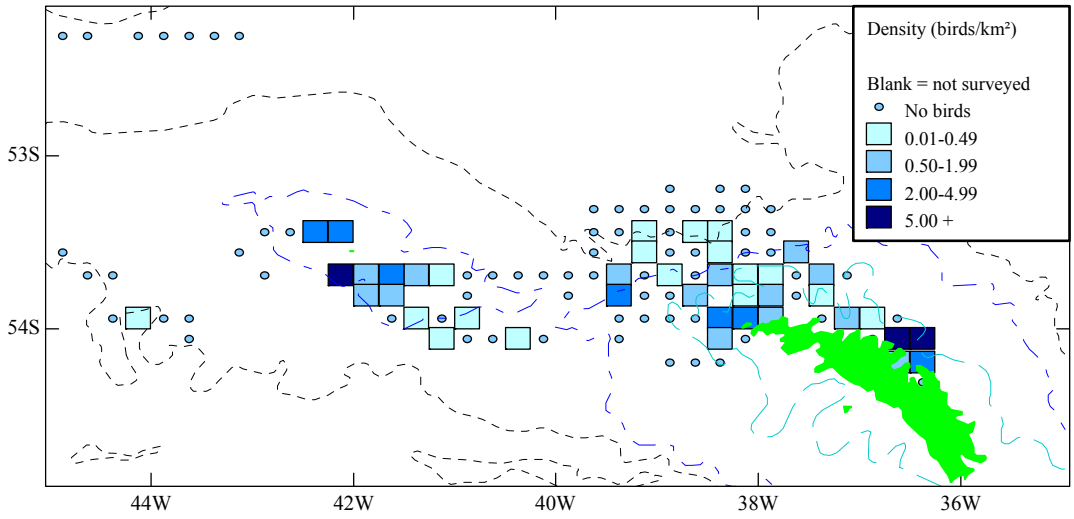


Figure 7.5. Macaroni penguin distribution, 11 March to 03 April 2004

Wandering albatross species *Diomedea exulans* spp.

Wandering albatrosses were recorded throughout the waters covered by the survey except Patagonian Shelf waters. A cluster of wandering albatross records occurred in the region of the shelf break to the north of Bird Island. In total, 56 wandering albatross were recorded.

Southern royal albatross *D. epomophora*

Five of the six southern royal albatrosses recorded were encountered above the Antarctic Convergence. The remaining bird was sighted over the edge of the shelf to the west of South Georgia.

Black-browed albatross *Thalassarche melanophris*

Black-browed albatrosses were recorded throughout the waters surveyed, although infrequently sighted over oceanic waters between the Falkland and South Georgia conservation zones. A total of 248 black-browed albatross was recorded.

Grey-headed albatross *T. chrysostoma*

Grey-headed albatrosses were recorded in low densities throughout the waters surveyed within the SGMZ. Outwith the SGMZ this species was infrequently sighted. In total, 70 grey-headed albatrosses were recorded.

Sooty albatross *Phoebetria fusca*

A single sooty albatross was recorded near the Antarctic Convergence as the vessel returned to Stanley.

Light-mantled albatross *P. palpebrata*

Most of the 16 light-mantled sooty albatrosses recorded were encountered over inshore waters around South Georgia.

Southern giant petrel *Macronectes giganteus* & Northern giant petrel *M. halli*

Of the 76 giant petrels recorded, 24 were positively identified as southern giant petrels and 17 as northern giant petrels. Most of the birds positively identified as southern giant petrels were recorded over the shelf and shelf-break waters to the north of South Georgia. Northern giant petrels showed a tendency to be slightly further offshore.

Cape petrel *Daption capense*

Cape petrels were not sighted within the core study areas. Most of the 15 Cape petrels recorded were sighted over inshore waters in the vicinity of Bird Island.

Blue petrel *Halobaena caerulea*

All of the 34 blue petrels recorded were encountered over the shelf break to the north of Bird Island, within the Western Core Box.

Prion species *Pachyptila* spp.

Prions were regularly recorded throughout the waters covered by the survey except Patagonian Shelf waters and were the most numerous species of seabird encountered, with 3,313 birds recorded. Locally very high densities of prions were found over shelf and shelf-break waters surrounding the north-west tip of South Georgia (Figure 7.6). Although most of these birds were not specifically identified the majority were thought to be Antarctic prions *P. desolata*. On several occasions prions were recorded feeding in association with groups of fur seals. In addition to those birds recorded as prion species, 26 Fairy prions *P. turtur* were positively identified. These birds were distributed throughout the core study areas.

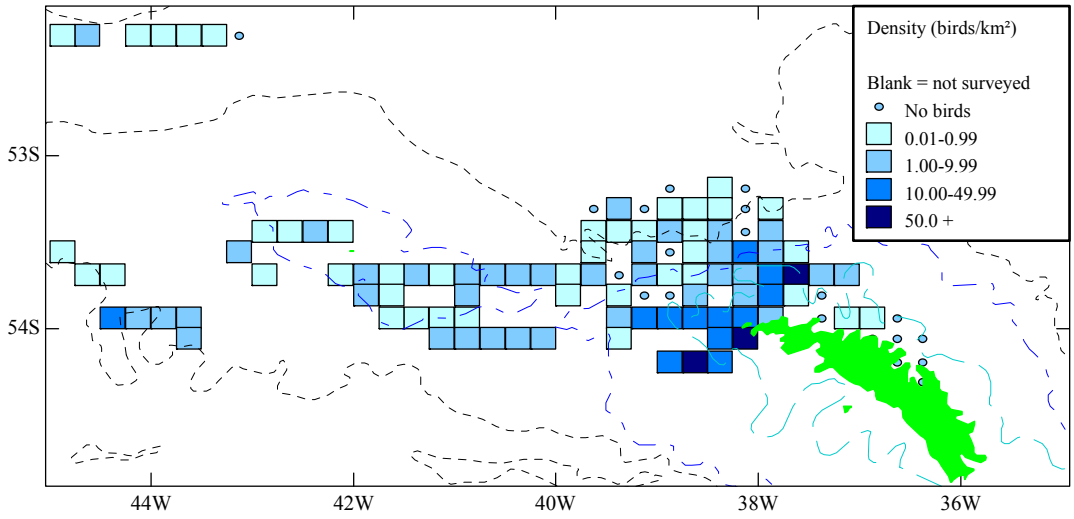


Figure 7. 6. Prion distribution, 11 March to 03 April 2004

Kerguelen petrel *Aphrodroma brevirostris*

Kerguelen petrels were infrequently recorded within the main study areas, they were more frequently encountered over oceanic waters above the Convergence. In total, 22 Kerguelen petrels were recorded.

Great-winged petrel *Pterodroma macroptera*

A single great-winged petrel was recorded over oceanic waters above the Convergence.

Soft-plumaged petrel *P. mollis*

Soft-plumaged petrels were regularly recorded while surveying off shelf waters with sightings becoming more frequent when surveying above the Convergence. A total of 162 soft-plumaged petrels was recorded.

Atlantic petrel *P. incerta*

Two Atlantic petrels were recorded over oceanic waters above the Convergence while the vessel was on passage back to Stanley.

Grey petrel *Procellaria cinerea*

All but one of the 12 grey petrels recorded were encountered over oceanic waters above the Convergence.

White-chinned petrel *P. aequinoctialis*

White-chinned petrels were one of the most regularly recorded species within the main study area. In total, 570 white-chinned petrels were recorded.

Great shearwater *Puffinus gravis*

Great shearwaters were recorded in low numbers within the main study areas. In total, 26 great shearwaters were recorded.

Sooty shearwater *P. griseus*

High densities of sooty shearwaters were recorded over Patagonian Shelf waters as the vessel returned to Stanley. Low densities of sooty shearwaters were recorded throughout the other waters covered during the survey. In total, 274 sooty shearwaters were recorded.

Little shearwater *P. assimilis*

Four little shearwaters were recorded over oceanic waters above the Antarctic Convergence as the vessel steamed towards South Georgia.

Wilson's storm-petrel *Oceanites oceanicus*

Wilson’s storm-petrels were regularly recorded throughout the waters surveyed but inshore waters off the north-west tip of South Georgia supported higher densities than elsewhere (Figure 7.7). In total, 939 Wilson’s storm petrels were recorded.

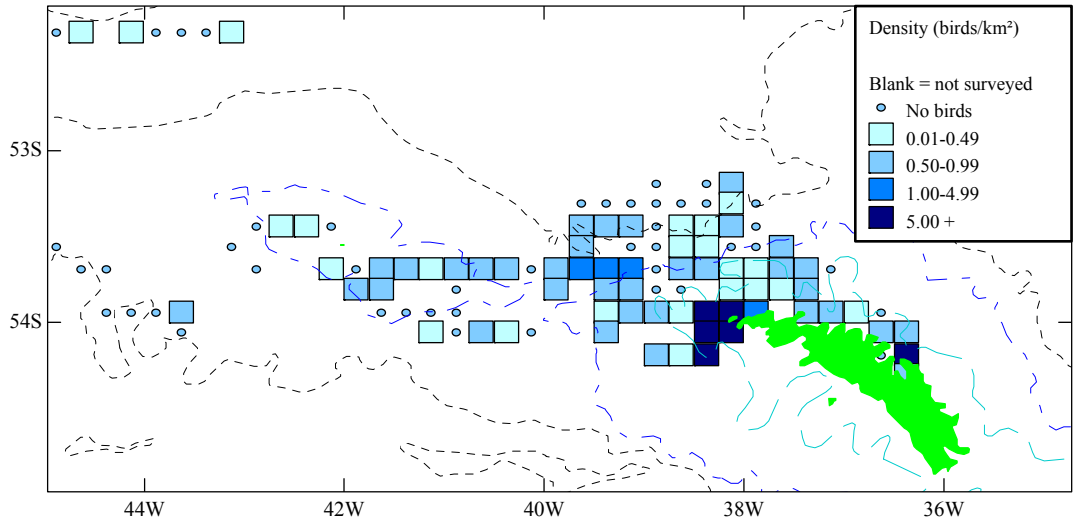


Figure 7.7. Wilson's storm-petrel distribution, 11 March to 03 April 2004

Black-bellied storm-petrel *Fregetta tropica*

Black-bellied storm-petrels were found throughout the waters surveyed below the Convergence but were less numerous over coastal waters. Very low densities were encountered above the Convergence. A total of 161 black-bellied storm-petrels was recorded.

Grey-backed storm-petrel *Garrodia nereis*

All but one of the 11 grey-backed storm-petrels recorded during the survey were recorded over waters above the Convergence.

Diving-petrel species *Pelecanoides* spp.

Very high densities of diving-petrels were recorded in shelf waters near Bird Island. Elsewhere diving-petrels were regularly encountered at low densities (Figure 7.8). In total, 2,101 diving-petrels were recorded.

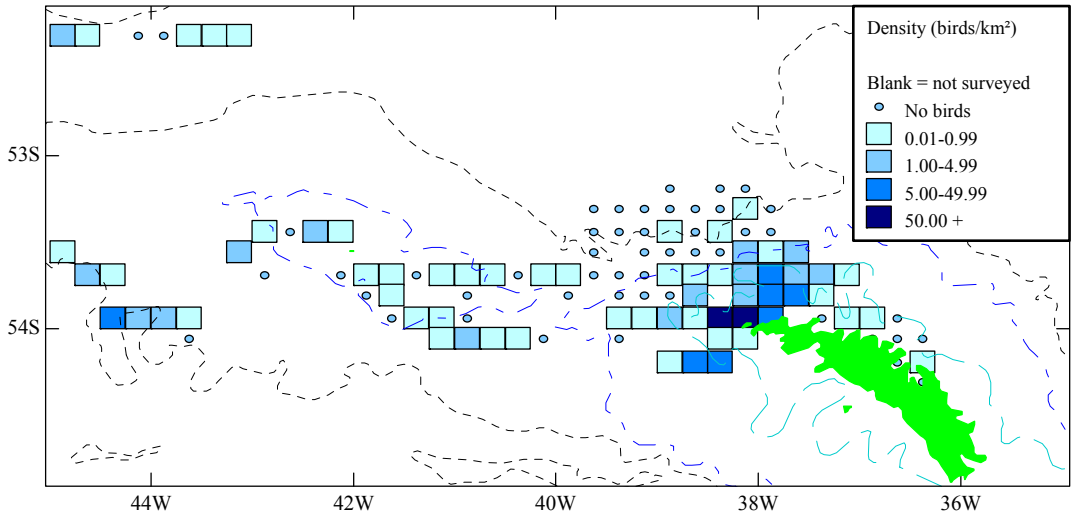


Figure7.8. Diving-petrel distribution, 11 March to 03 April 2004

Imperial shag *Phalacrocorax atriceps*

Imperial shags were only recorded over coastal waters near Stanley, Bird Island and Shag Rocks. In total, 14 imperial shags were recorded. Of these, six were recorded near Stanley and were of the *P. a. albiventor* sub-species and those around South Georgia (eight) were of the *P. a. georgianus* sub-species.

Antarctic skua *Catharacta antarctica*

Antarctic skuas were widespread throughout the waters surveyed but were more frequently encountered over inshore waters. In total, 24 Antarctic skuas were recorded.

Long-tailed skua *Stercorarius longicaudus*

A single long-tailed skua was recorded over oceanic waters within the FICZ.

Antarctic tern *Sterna vittata*

Antarctic terns were regularly recorded over coastal waters around South Georgia. A total of 23 Antarctic terns was recorded.

Marine mammals

Southern right whale *Eubalaena australis*

A single southern right whale was recorded near the edge of the continental shelf to the north of South Georgia (Figure 7.9).

Fin whale *Balaenoptera physalus*

A single fin whale was recorded in relatively shallow water to the west of Shag Rocks (Figure 7.9).

Sei whale *B. borealis*

Several sightings of sei whales occurred in oceanic waters at the northern end of the Western Core Box (Figure 7.9). In total, nine sei whales were recorded.

Minke whale *B. acutorostrata*

A single minke whale was recorded in inshore waters near Cumberland Bay (Figure 7.9).

Sperm whale *Physeter macrocephalus*

A single sperm whale was encountered in waters of approximately 1,000m depth to the south-east of Shag Rocks (Figure 7.9).

Southern bottlenose whale *Hyperoodon planifrons*

Two groups of southern bottlenose whales, totalling four animals, were recorded over oceanic waters between Shag Rocks and mainland South Georgia (Figure 7.9).

Killer whale *Orcinus orca*

Two groups of killer whales, totalling 13 animals, were recorded. One group was encountered while surveying near the edge of the continental shelf to the north of South Georgia the other was found over deeper waters to the north (Figure 7.9).

Hourglass dolphin *Lagenorhynchus cruciger*

There were seven records of hourglass dolphins during the survey, totalling 33 animals. Of the seven records of hourglass dolphins, five came from waters within the SGMZ (Figure 7.9) with the other two coming from within the FICZ. All records came from waters greater than 200m in depth.

Peale's dolphin *L. australis*

Ten Peale's dolphins were recorded in Patagonian Shelf waters as the vessel departed from and returned to Stanley.

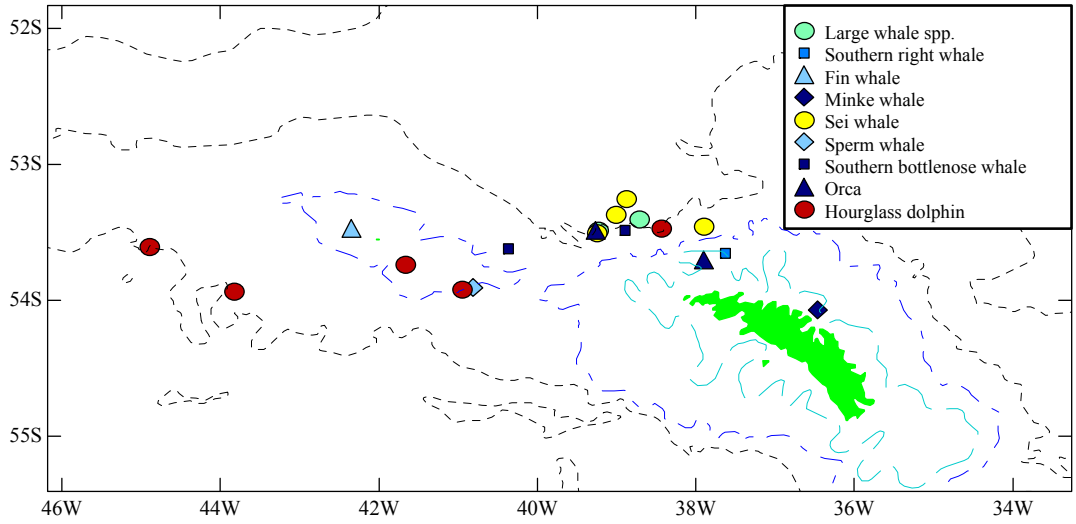


Figure 7.9. Distribution of cetacean records, 11 March to 03 April 2004

Fur seal species *Arctocephalus* spp.

Fur seals were the most numerous 'species' encountered during the survey, with 4,291 animals recorded. Generally, fur seals occurred in high to very high densities in the east of the area surveyed with low densities in the west (Figure 7.10). On one occasion a fur seal was observed chasing and catching a macaroni penguin. This was the first incident of fur seals predating on penguins recorded by SAST.

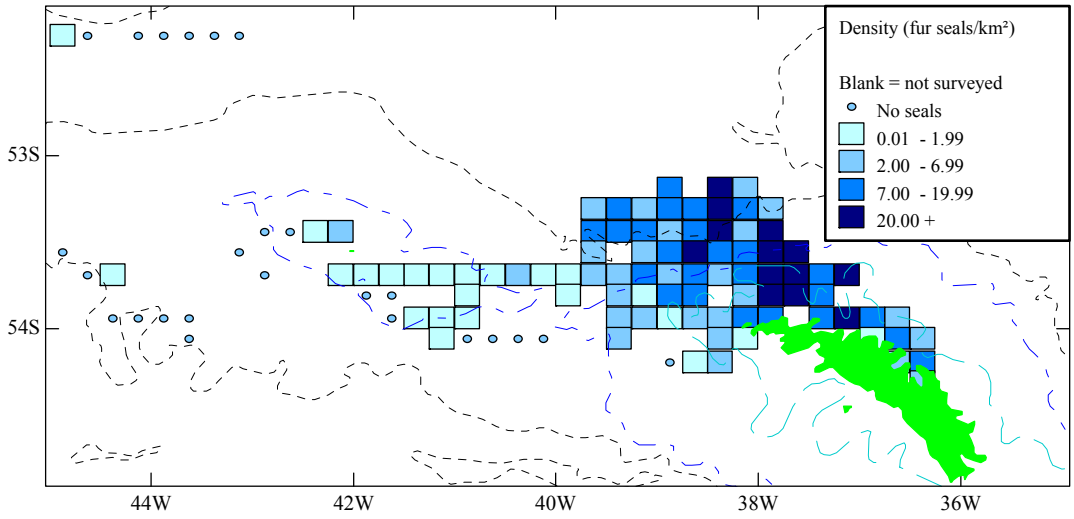


Figure 7.10. Fur seal distribution, 11 March to 03 April 2004

Floating matter

Kelp

Patches of floating kelp were encountered throughout the waters surveyed, however, kelp was encountered more frequently in coastal waters and to the east of land-masses than offshore oceanic waters. Six grey-backed storm-petrels and one Antarctic skua were recorded in association with patches of floating kelp.

Ice

Pieces of floating ice were recorded in transect on 2,381 occasions. These were all encountered below the Convergence and reflect the distribution of icebergs. Several species (120 prions, 32 Wilson's storm-petrels, eight Cape petrels, four gentoo penguins and a single Antarctic skua) were recorded in association with ice.

Summary

During the first phase of the trip, surveys concentrated on transects running east to west between Shag Rocks and mainland South Georgia. At this time, seabird and marine mammal densities within this area were generally low. In particular fur seals were only present in large numbers in the extreme east of the area covered. Surveys conducted

during March 2003 (Black 2003) found fur seals throughout this area. Shallow waters around Shag Rocks supported relatively high densities of king and macaroni penguins. However, highest seabird densities, primarily prions, Wilson's storm-petrels and diving-petrels, were encountered while surveying coastal waters around the Willis and Bird Islands.

Surveys of the Western Core Box identified high densities of fur seals but seabird densities were generally low. On several occasions several species of cetaceans, notably sei whales were recorded near the shelf break to the north of Bird Island. However, when compared with surveys conducted within the same general area during March 2003 (Black 2003), the number of Mysticeti whales recorded during this trip was low. As noted in 2003, oceanic waters between the Falklands and South Georgia supported a diversity range of bird species. Many of these species breed on the Tristan da Cunha group of islands; sooty albatross, Kerguelen petrel, soft-plumaged petrel, great-winged petrel, grey petrel, great shearwater and little shearwater.

Acknowledgements

We would like to thank the South Georgia and South Sandwich Islands Government for their continued support and funding for the project. Martin Collins was instrumental in facilitating my participation in the cruise. I would like to take the opportunity to thank the Captain and crew of RRS *James Clark Ross* for their assistance and hospitality throughout the trip.

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8. Bongo net activities

Geraint Tarling, Andrew Hirst, David Pond & Chuck Cook

Gear and deployment protocol

Two types of Bongo net (a device which has two nets, side-by-side) were deployed during the cruise, one with a 65cm mouth diameter for each net, the other with an 18 cm mouth diameter. On the larger device, one net had 100µm mesh, the other a 200µm mesh. On the smaller device, both nets had a 50µm mesh. The smaller device also had a flow meter fitted to the mouth of one of the nets. There was no flow meter in the larger device.

The larger device has a motion-compensation spring that reduces the amount of erratic movements during deployment, so keeping the catch in a good condition. This spring broke on 14th March (the 3rd day of sampling). After this point, all net hauls with the large device were carried out without any motion-compensation.

Protocol for net deployment was to sample with a vertical haul between 0 and 200 m or to within 20 m of bottom where bottom depths were shallower than 200 m. A total of three net deployments were made at every station in the Fish Survey and Core Box parts of the cruise. The first two deployments were carried out with the larger device: deployment 1 being used to pick out live animals; deployment 2 left intact and preserved in 4% buffered formaldehyde. Deployment 3 was done with the fine mesh bongo from which both net samples were left intact and preserved in 4% buffered formaldehyde. Note that there are some exceptions to this order of deployments (e.g. events 17, 24 and 31 where the large net was under repair)

The Bongos were deployed at a total of 19 stations (Table 8.1), time of day varied according to when the ship was on-station. A full station list with comments can be found under the 'Bongo' folder in the JR100 directory (Bongo_Nets_JR100.xls)

Live-material analyses

In most instances, material was picked out from deployment 1 at each station. In addition to the work described below by Geraint Tarling (GT), some individuals were extracted by Andrew Hirst (AH) for work on *Oithona* spp., by Chuck Cook (CC) for genetics analysis, and by Dave Pond for reproductive biochemistry and food web analyses (see later sections)

CN analysis (GT)

GT picked out several target species/stages
1, *Calanoides acutus* CIV and CV stages
2, *Calanus simillimmus* females
3, *Rhincalanus gigas* females

The CIV and CV stages of *C. acutus* were placed in preweighed tin-capsules (either 5 CV stages or 15 CIV stages per capsule) and stored at –80^{o}C for carbon:nitrogen analysis in Cambridge. The females were incubated for 24 h (although 36 h in some instances) after which any eggs produced in that time were counted (see below). A sub-sample of these females were transferred to the tin-capsules after an incubation had been completed (5 *C. simillimmus* females or 1 *R. gigas* female per capsule) and stored at –80^{o}C. Table 3. 2 shows the events where material was placed in tin capsules.

It is notable that, although *C. acutus* CV was relatively abundant, very few CIVs were observed. In some stations, the size of CVs differed greatly. The SACCF was crossed several times during the course of the transect. In stations to the north of the front, the *C. acutus* population appeared to be dominated by similarly sized CVs. South of the front, the size of CVs was more variable and CIVs were more likely to be found

These trays were packaged in a red plastic biscuit box and combined with the POC samples in a larger cardboard box with the Bill of Lading number: JS/C/04/4809. They are stored at –80^{o}C.

Table 8.1: All Bongo deployments

Date & Time	Event Number	Latitude	Longitude	Bongo Device	Net Depth	Preserved
31/03/2004 13:42	203	-53.64975	-38.1	Small	0-130m	1 net only
31/03/2004 13:19	202	-53.64975	-38.09997	Large	0-130m	Yes
31/03/2004 13:17	201	-52.90356	-39.48448	Large	0-130m	No
29/03/2004 05:41	193	-53.4317	-38.69545	Small	0-200m	Yes
29/03/2004 05:24	192	-53.43168	-38.69543	Large	0-200m	Yes
29/03/2004 05:08	191	-53.43165	-38.69545	Large	0-200m	No
28/03/2004 21:44	181	-53.75854	-38.59369	Small	0-200m	Yes
28/03/2004 21:29	180	-53.75856	-38.59365	Large	0-200m	Yes
28/03/2004 21:10	179	-53.43168	-38.69543	Large	0-200m	No
28/03/2004 07:32	176	-53.84627	-39.14346	Small	0-200m	Yes
28/03/2004 07:11	175	-53.84629	-39.14347	Large	0-200m	Yes
28/03/2004 06:54	174	-53.84629	-39.14347	Large	0-200m	No
27/03/2004 22:20	165	-53.49289	-39.25108	Small	0-200m	Yes
27/03/2004 22:00	164	-53.49289	-39.25108	Large	0-200m	Yes
27/03/2004 21:43	163	-53.49291	-39.25109	Large	0-200m	No
21/03/2004 06:20	126	-53.48346	-37.01663	Small	0-200m	Yes
21/03/2004 06:00	125	-53.48346	-37.01665	Large	0-200m	Yes
21/03/2004 05:45	124	-53.48346	-37.01664	Large	0-200m	No
20/03/2004 16:14	117	-53.48725	-38.49984	Small	0-200m	Yes
20/03/2004 15:53	116	-53.48725	-38.49986	Large	0-200m	Yes
20/03/2004 15:33	115	-53.48723	-38.49986	Large	0-200m	No
20/03/2004 02:20	106	-53.48351	-39.99934	Small	0-200m	Yes
20/03/2004 01:59	105	-53.4834	-39.99965	Large	0-200m	Yes
20/03/2004 01:40	104	-53.48345	-39.99942	Large	0-200m`	No
19/03/2004 11:55	98	-53.48331	-41.5003	Small	0-200m	Yes
19/03/2004 11:33	97	-53.48336	-41.50029	Large	0-200m	Yes
19/03/2004 11:18	96	-53.48341	-41.50032	Large	0-200m	No
18/03/2004 12:48	87	-53.48343	-43.00026	Small	0-200m	Yes
18/03/2004 12:27	86	-53.48345	-43.00024	Large	0-200m	100um only
18/03/2004 11:57	85	-53.48343	-43.00026	Large	0-200m	200um only
17/03/2004 22:40	79	-53.63362	-42.33084	Small	0-180m	Yes
17/03/2004 22:39	78	-53.63367	-42.32633	Large	0-180m	Yes
17/03/2004 22:38	77	-53.48331	-41.5003	Large	0-180m	No
17/03/2004 14:04	75	-53.63301	-40.75035	Small	0-200m	Yes
17/03/2004 13:42	74	-53.63303	-40.74974	Large	0-200m	Yes
17/03/2004 13:24	73	-53.63322	-40.7495	Large	0-200m	No
17/03/2004 01:01	66	-53.63297	-39.27138	Small	0-200m	Yes
17/03/2004 00:40	65	-53.63298	-39.27135	Large	0-200m	Yes
17/03/2004 00:25	64	-53.63298	-39.27135	Large	0-200m	No
15/03/2004 23:06	56	-53.7709	-38.27678	Small	0-120m	Yes
15/03/2004 22:51	55	-53.77092	-38.27675	Large	0-120m	Yes
15/03/2004 22:41	54	-53.7709	-38.27678	Large	0-120m	No
15/03/2004 09:55	48	-53.78326	-40.00028	Small	0-200m	Yes
15/03/2004 09:35	47	-53.78326	-40.00031	Large	0-200m	Yes
15/03/2004 09:19	46	-53.78329	-40.00027	Large	0-200m	No
14/03/2004 19:26	39	-53.78306	-41.50045	Small	0-170m	Yes
14/03/2004 19:10	38	-53.78308	-41.50045	Large	0-170m	Yes
14/03/2004 18:54	37	-53.78306	-41.50045	Large	0-170m	No
14/03/2004 13:47	33	-53.7709	-38.27678	Large	0-200m	Yes
14/03/2004 13:31	32	-53.93349	-40.75051	Large	0-200m	No
14/03/2004 13:10	31	-53.93341	-40.75043	Small	0-200m	Yes
13/03/2004 22:55	24	-53.93341	-40.75043	Small	0-200m	1 net only
12/03/2004 23:13	17	-54.08198	-39.99991	Small	0-200m	1 net only
12/03/2004 22:49	16	-54.08352	-40.00008	Large	0-200m	Yes
12/03/2004 22:36	15	-54.08352	-40.00008	Large	0-200m	No
12/03/2004 05:25	7	-54.08233	-41.49954	Small	0-200m	No
12/03/2004 05:00	6	-54.0823	-41.49954	Large	0-200m	Yes
12/03/2004 04:30	5	-54.08227	-41.49953	Large	0-200m	No

Table 8.2: material placed in tin capsules for CN analysis

Event	*C. acutus* CV	*C. acutus* CIV	*R. gigas* female	*C. simillimmus* female
15	30 individuals (Tray A: A1-A6)			
32	30 individuals (Tray A: A7-A12		15 individuals (Tray A: C9-D11)	
37	30 individuals (Tray A: B1-B6)		2 individuals (Tray A: B7-B8)	
46	30 individuals (Tray A: B9-C2)		30 individuals (Tray A: D12-G5)	
54	30 individuals (Tray A: C3-C8)			
64	30 individuals (Tray A: G6-G11)			
73	30 individuals (Tray A: G12-H5)			
77	30 individuals (Tray A: H6-H11)			15 individuals (Tray B: A7-A9)
85	30 individuals (Tray B: A1-A6)		9 individuals (Tray B: B7-C3)	15 individuals (Tray B: B4-B6)
96	30 individuals (Tray B: A10-B3)			15 individuals (Tray B: C4-C6)
115	30 individuals (Tray B: C8-D1)	15 individuals (Tray B: C7)		15 individuals (Tray B: D2-D4)
163	10 individuals (Tray B: D5-D10)			15 individuals (Tray B: E5-E7)
179	30 individuals (Tray B: D11-E4)			15 individuals (Tray B: F2-F4)
191	30 individuals (Tray B: E8-F1)			
201	30 individuals (Tray B: F5-F10)	15 individuals (Tray B: F11)		5 individuals (Tray B: F12)

Incubation experiments (GT)

The incubation experiments were carried out in 1.5 litre Kilner jars with plastic tube inserts that contained a 200um meshed bottom. 10 females were placed in the inserts whilst any eggs produced sank through the mesh to the outer jar (so avoiding egg cannabalism). A maximum of 3 jars were set up (i.e. 30 females; 10 female per jar) if there were an adequate numbers of females in the sample. The jars were filled with filtered seawater.

The incubations were kept at a temperature of ~4°C. Incubations were kept running for 24 h in most instances, but were sometimes stopped after 36 h if shift patterns were unsuitable. After the incubation time, the tube inserts containing the females were removed and the filtered seawater in the outer-jar was filtered down and the eggs contained therein counted. Females in the tube inserts were subsequently counted, in case any were lost during their transfer to the plastic inserts at the start of the

experiment. A subsample of these females were placed in tin-capsule for CN analysis (see above).The table below gives the results of these incubations.

Table 8.3: Eggs produced over an incubation period by *R. gigas* and *C. simillimmus*

Event	Species	Incubation time	Eggs produced	Females found	Eggs/h/female
46	R. gigas	24 h	1, 106 eggs 2, 118 eggs 3, 222 eggs	1, 10 2, 10 3, 10	0.62
77	C. simillimmus	36 h	1, 44 eggs 2, 50 eggs 3, 17 eggs	1, 8 2, 9 3, ? (assume 10)	0.11
85	C. simillimmus	24 h	1, 63 eggs 2, 37 eggs 3, 34 eggs	1, 10 2, 9 3, 9	0.20
85	R. gigas	24 h	1, 107 eggs	1, 10	0.45
96	C. simillimmus	24 h	1, 5 eggs 2, 130 eggs 3, 178 eggs	1, 8 2, 10 3, 10	0.47
115	C. simillimmus	24 h	1, 85 eggs 2, 88 eggs 3, 110 eggs	9, 10 and 9 in no particular order	0.42
163	C. simillimmus	24 h	1, 21 eggs 2, 22 eggs 3, 124 eggs	1, 8 2, 8 3, ? (assume 10)	0.25
179	C. simillimmus	24 h	1, 0 eggs 2, 0 eggs 3, 0 eggs	1, 10 2, 9 3, 8	0
201	C. simillimmus	36 h	1, 1 egg	1, 9	0.003

R. gigas females were generally rare in the samples (observed in 2 out of 29 stations). However, when they were found, they were quite productive, generating an average of 0.54 eggs female^{-1} h^{-1}. *C. simillimmus* females were much more abundant but their rates of egg production differed considerably between stations, with a maximum rate of 0.47 eggs female^{-1} h^{-1} and a minimum rate of 0.

Oithona work (AH)

Oithona has infrequently been examined in the Southern Ocean, and rarely have rate or population dynamics been examined in waters below 5^{o}C. Our samples will therefore provide an excellent opportunity to obtain new information on this ubiquitous genera; emphasis will be placed on *Oithona similis*, although *Oithona frigida* was also common at several locations. The fine mesh plankton samples were preserved, and upon return to the laboratory will be examined. Stage abundance will

be determined from egg to adult. Depending upon the state of the population (i.e. if the population is not strongly cohortic) it may also be possible to derive stage-specific mortality rates using a vertical life-table approach. As *Oithona* is a sac spawners it will be possible to derived fecundity from the egg-ratio method:

$E_P = E/AD$

Where E_P=egg production rate (eggs female^{-1} d^{-1}), E=egg abundance (m^{-3}), A=Adult abundance (m^{-3}) and D=Egg development time (days).

Fortunately there is a large amount of information relating egg hatch time to temperature in *Oithona similis*, and hence we are able to predict from temperature the egg hatch rate for this species.

The population processes will be related to Chl*a* and POC measurements that were made during the cruise at the locations of the net hauls.

Extraction and preservation of material for genetic analysis (CC)

Background

A major focus of BAS' biological science programme has been to understand ecosystem function in the Southern Ocean. Fundamental to this research is knowledge of the dynamics of fish and plankton populations: these populations are assessed by study of samples collected by netting during BAS biological cruises. "Large" (ca. >0.5 cm) planktonic organisms such as euphausid crustaceans (krill), and larger species of copepods (e.g. *Rhincalanus gigas*, *Calanoides acutus,* and some *Calanus spp.*) are easily identified by eye or with a low power dissecting microscope. However, smaller organisms—most notably small calanoid crustaceans but also including pelagic species from many other taxa—are not easily identified by morphology. The purpose of this project is to develop DNA-based methods for the identification of the smaller components of the pelagic plankton.

Shipboard activities

I participated in this cruise in order to collect the first set of samples for DNA-based plankton biodiversity assessments. As this was the first time plankton samples have been collected during a BAS cruise specifically for DNA-based research one of my tasks was to develop protocols for preserving plankton so that DNA can be successfully extracted and analyzed from the samples.

Cruise activities have included bongo netting, neuston netting, and fishing with a pelagic trawl and with RMT8 and RMT25 nets. My primary task has been to collect and preserve small plankton from the bongo nets. I have also collected individuals of various species from the bongo, neuston, and RMT nets for use as reference samples.

DNA breaks down in dead organisms when nucleases found in the cytoplasm mix with DNA from the nucleus and mitochondrion as cellular membranes disintegrate. Successful preservation of DNA requires freezing or dehydration, both of which stop all biochemical activity. Dehydration is best accomplished using organic solvents that are miscible in water; i.e., ethanol or acetone. Acetone is a more effective dehyrating agent and I have used it for sample preservation during this cruise. The goal of sample preservation is to reduce the water content of the sample to 5% by volume or less. Thus, a 1 g sample (assumed to contain 1g of water) should be preserved in a minimum of 20 mL of acetone. A similar dilution can be accomplished, using less solvent, by immersing the sample in small volume of solvent (i.e. 1 ml), allowing time for the solvent to penetrate the sample, then decanting the solvent (now containing water from the sample) and adding a second aliquot of solvent. This can be repeated as necessary until the total water content is estimated to be below 5% by volume. For samples collected during this cruise I used freezing for large individuals (krill, decapods) and acetone for bongo net samples and for small individuals (copepods).

Sample preservation protocol. Samples were preserved in 50 ml white-top vials, 50 and 15 ml Falcon tubes, and 2 ml Eppendorf tubes. Acetone evaporate quickly. In order to reduce evaporation from the samples flexible plumber's tape was used on the threads of all screw-top containers. In addition, all container lids were wrapped in parafilm, and all samples are stored at –20 degrees. I have samples preserved in this manner that show no sign of evaporation after five years. All samples were given an

individual number. Labels that include the sample number, event number, date, and identification (species name or bongo net size) were prepared in duplicate. One label, written in pencil on filter paper, was inserted into each sample container. A second sticky label, also written in pencil, was affixed to the outside of each sample.

Freezing. Larger individuals were placed into an appropriately sized container and "snap" frozen at –80 degrees for 30 minutes. They were then transferred to the –20 freezer for long term storage.

Acetone. Smaller individuals (ca. 0.2 g or less) were placed in a 2 ml Eppendorf tube and immersed in 1.5 ml of acetone for 10 minutes. This was repeated twice and a final volume of 1.8 ml acetone added for permanent storage. Samples were stored at –20 degrees.

Bongos. Bongo samples were concentrated by filtering 1-4 litres of the neat bongo sample through a 50 μm filter so that approximately 3 ml of plankton was recovered. The concentrated plankton was washed out of the filter into a 50 ml vial or tube using acetone, to a total volume of 50 ml, then labelled and preserved as described above.

Sample summary.

I preserved 26 bongo net subsamples from 22 separate bongo net deployments, and 58 samples representing 35 named species for use as reference samples. These reference samples include multiple collections of *Euphausia superba, Themisto gaudichaudii, Rhincanalnus gigas, Calanus simullimus, Calanus propinquus,* and *Calanoides acutus,* for possible study of genetic variation within populations of these common organisms.

Copepod reproductive biochemistry (DP)

Understanding the reproductive physiology of copepods is key to predicting their recruitment and population dynamics. Using a technique recently developed at BAS, it is now possible to quantify the contribution of somatic and dietary lipid sources to

egg production under different food concentrations. In brief, the technique involves the analysis of pentafluorobenzyl ester fatty acid derivatives by gas chromatography mass spectrometry (GC-MS) in chemical ionisation mode. During JR100, only female *Calanus simillimus* were sufficiently abundant in the bongo net samples for shipboard experimentation. Female copepods were incubated at 3 different concentrations of freeze dried 100% ^{13}C labelled diatoms (0.25, 0.5 and 1.0 mg organic carbon litre^{-1}). A total of 30 females for each food concentration were incubated for 10 days to allow food intake and reproductive output to reach a steady state. Each 24 hours, copepods were transferred to fresh food and all eggs counted and stored for fatty acid analysis in the UK.

Food web analysis (DP)

Throughout the cruise, a wide range of fish and potential prey items were collected from the pelagic trawl and RMT25 net hauls. These samples will be subjected to fatty acid biomarker and stable isotope analysis (^{13}C and ^{15}N) in the UK to complement the main ecological and dietary (stomach content analyses) scientific objectives of the cruise.

9. Krill studies

Geraint Tarling, David Pond, Ryan Saunders

Although the JR100 cruise was aimed at myctophid fish sampling, many of the catches contained krill. These were analysed and preserved for:

1. Population dynamics: assessment of the length-frequency and maturity status of the population around South Georgia
2. Stomach content and biochemical analyses

Population dynamics

Samples were taken with three types of net: RMT25, RMT8 and Pelagic Trawl. Where possible, the length frequency and, in some cases, the maturity status of the animals were taken when the animals were fresh. Total length was measured from the front of the eye to the tip of the telson, rounded down to the nearest millimetre. Maturity status was based on the Makarov and Denys scale for juveniles, subadults and males and on the Cuzin-Roudy & Amsler scale for adult females. Some, but not all of these samples were preserved in 4% buffered formaldehyde

In other instances, there was no time to analyse the fresh animals and they were preserved straight away. Between 50 and 200 animals were preserved in 4% buffered formalin. A full list of stations and comments can be found in the Excel file: Krill_sample_log.xls' placed in the 'Krill' directory of JR100. Table 9.1 is a summary of this information.

Table 9.1. Record of krill catches analysed/preserved for population dynamic studies.

Time	Event	Latitude	Longitude	Net type	Which nets analysed	Fresh analysis	Sample preserved
15/03/2004 14:05	51	-53.366	-38.4883	RMT25	Net 2	Yes	Yes
16/03/2004 04:46	57	-53.366	-38.4883	RMT25	Nets 1 and 2 (combined)	Yes	Yes
19/03/2004 23:53	103	-53.4719	-40.29	Pelagic trawl	n/a	No	Yes
20/03/2004 07:30	109	-53.492	-39.4522	RMT25	Net 2	No	Yes
20/03/2004 18:38	118	-53.5414	-38.2191	Pelagic trawl	n/a	Yes	No
22/03/2004 23:44	135	-53.5294	-37.3819	RMT25	Net 2	No	Yes
23/03/2004 10:00	137	-53.3091	-37.6799	Pelagic trawl	n/a	Yes	No
25/03/2004 22:02	148	-53.3272	-37.938	RMT8	Nets 1 and 2	Yes (both)	Yes (both)
26/03/2004 00:02	149	-53.7818	-37.9002	RMT8	Net 1	Yes	Yes
26/03/2004 21:06	159	-53.7818	-37.9002	RMT8	Nets 1 and 2	No	Yes (both)
26/03/2004 21:43	160	-53.6893	-38.6394	RMT8	Nets 1 and 2	No	Yes (both)
01/04/2004 18:08	210	-52.9515	-39.2822	RMT25	Net 1	Yes	No
02/04/2004 01:24	212	-52.8593	-39.5283	RMT25	Net 1	No	Yes

Results

Length distributions from all events where analysis was carried out on fresh specimens were combined to produce a length-frequency plot. Equal weight was given to all events, irrespective of the total number of krill in the catch.

There were two distinct cohorts present: one with a modal peak around 38 mm, the other with a modal peak around 54 mm.

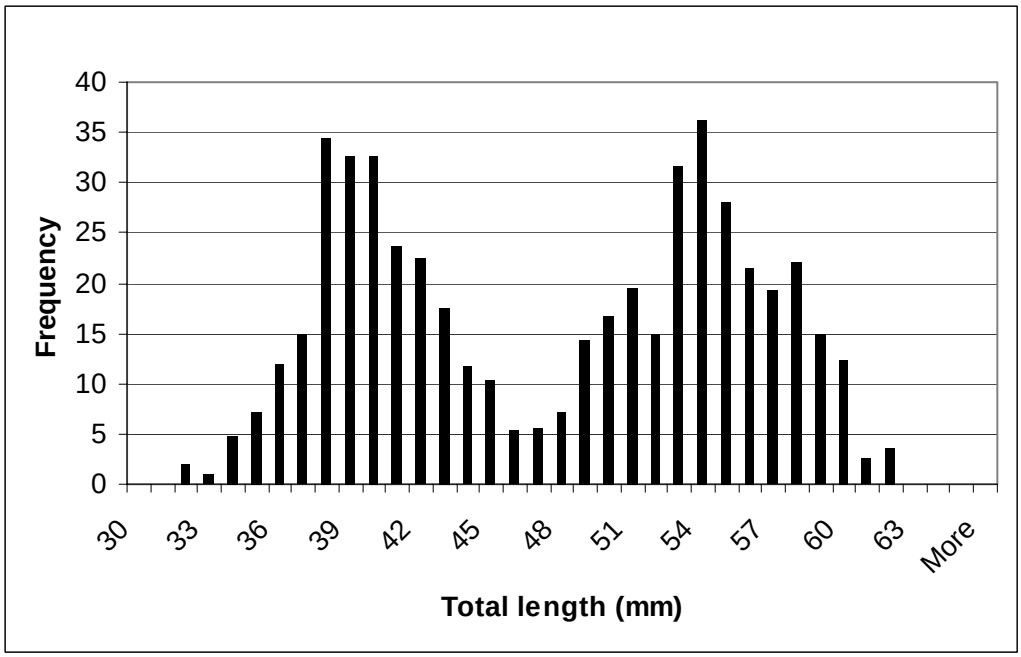

Figure 9.1. Length frequency of krill (Euphausia superba) caught during JR100.

Maturity stage analyses on fresh specimens found that reproduction had mostly ceased in this area by the time the survey had started (15th March). Large females with swollen thoraxes were still present but the large mass within the thorax was mainly fat body rather than oocytes. Some females had recently spawned but the ovary was in regression since there were no further oocytes being produced. Some males still bore spermatophores but the majority did not.

With respect to the cohorts, animals belonging to the smaller cohort were generally in sub-adult or juvenile condition. Only animals in the larger cohort showed any evidence of having reproduced in the past weeks.

Stomach content and biochemical analyses

Animals were frozen within 15 minutes of being brought on-board for stomach content and biochemical analyses. These analyses will be carried out by Katrin Schmidt and Angus Atkinson as part of an AFI proposal looking at krill feeding and growth. Approximately 30-60 animals were chosen randomly from various catches and transferred to plastic trays, which were then placed in –80oC freezer (such animals have been referred to as "T0"s in previous cruises). The catches are detailed in Table 9.2.

Table 9. 2. Krill frozen for stomach contents and biological analyses

Date and Time	Event	Latitude	Longitude	Net type	Which nets	Number of animals frozen
15/03/2004 14:05	51	-53.366	-38.4883	RMT25	Net 2	~50
17/03/2004 05:06	68	-53.4264	-41.5793	RMT25	Net 1	~30
19/03/2004 00:40	92	-53.4264	-41.5793	Pelagic trawl	n/a	45
19/03/2004 17:10	101	-53.4719	-40.29	Pelagic trawl	n/a	39
20/03/2004 07:30	109	-53.492	-39.4522	RMT25	Net 1	15
22/03/2004 15:43	133	-53.5047	-37.282	RMT25	Net 2	33
23/03/2004 17:59	139	-53.3092	-37.9831	RMT25	Unknown	35
29/03/2004 06:46	194	-53.4076	-38.644	RMT8	Net 1	~40

These animals were packed into a cardboard box with the Bill of Lading number: JS/C/04/4808.

10. Gear Report

Doug Bone

RMT25

This net was used to make 32 hauls, more than on any previous cruise. It proved to be very effective, and gave very little trouble. During the last 24 hr sampling series some problems were experienced in getting the release mechanism to open/close the net. This appeared to be due to slow running of the motor within the release gear. This motor is driven from an internal battery, although the battery had been recently charged this is thought be the source of the problem. It is expected that the battery will be eliminated from the system before this net is used again.

For this cruise the net was fitted with an inclinometer to gather information on the mouth angle at various towing speeds. The designed mouth angle is 45^{o} at which the mouth area that the net presents when towed horizontally is 25 m^2. Because the ships pitching motion is transferred to the net the side wire angle is constantly changing and some care is needed to interpret the data. In addition the drag force is acting in different places along the side wire according to which net is open.

With the standard weight bar (688kg) the angle appeared to be too high, (weight bar dragged too far back), when towed at 2.5-3 knots. A further 84 kg were added and this appeared to be about right. For future use the weight bar should be made up to about 772kg.

Initially standard RMT filtering cod-ends were used with the net, latterly these were replaced by non-filtering cod-ends to improve the condition of the captured animals.

RMT8

Use of the RMT8 was limited to standard hauls on Western Core Box, and a limited number of target hauls (13 in all). During a haul which followed another in which around 30 lt of krill were caught, a side panel of the net ripped away completely from two sides. A similar problem has been experienced before. As a result of this second incident a critical look will be taken at the design of the net.

The net was rigged in what has become the standard configuration for this work employing two nets, rigged so that the second does not open when the first closes but requires a further 'firing' of the release.

Care should be used in using the flow data for the RMT as the wrong calibration factor was used for some of this time. If flow data do not look reasonable consult Doug Bone or Nathan Cunningham.

LHPR

The LHPR was used 6 times, in hauls down to 1000m. A catch diverter device was used to allow the descent to be done with the mechanism inactive. The diverter vents the catch from the cod-end of the net until the first advance command is sent, at that point it lines up with the recorder box and the catch enters.

The existing electronics that allowed the diverter to respond just once to an advance command were potted into the cable connection between the DWNM and the recorder box. After one haul to 1000m these failed, probably due to physical damage to the components resulting from the pressure, the potting medium not being rigid. Subsequently these were replaced by a set built into the monitor housing by Vsevolod Afanasyev.

Down Wire Net Monitor

During this cruise the DWNM has been used on the 'Biological wire' as normal for the RMT8 and the LHPR, and on the 17mm co-ax cable (ROV Cable) for towing the RMT25.

Generally the DWNM has performed satisfactorily, but there are a few issues that require addressing, notably the lack of ruggedness of some of the sub-boards attached to the main PCB in the underwater unit, and calibration of the flow meters. We have also experienced some problems of spurious command signals appearing on the screen. The cause of these has been determined with some certainty as resulting from the use of HF radio on high power and Morse transmissions. Problems of this nature have occurred in the past but not recently. This is probably because use of this radio equipment during scientific cruises is now rare.

The designer of the net monitor electronics, and author of the current software has now left BAS, much of the information required to modify both the electronics and the software (particularly), has been lost; probably as a result of a hard disc failure in the controlling PC and a failure to back up the information elsewhere.

In order to overcome these problems and enable the system to keep up with new requirements it is planned to develop a new version of the monitor, incorporating the best of the current system but also taking the opportunity to eliminate some of the problems.

UOR

As a result of the problems experienced with ice and weather on the Western Core Box survey the UOR was only deployed five times. Last year, on JR82 the vehicle gave considerable trouble in terms of flight control. Several modifications were carried out for this season, these included the adding of around 30kg of ballast to both increase the overall weight and to bring the trim to neutral. Also the arm connecting the servo unit to the 'wing' was increased to improve the mechanical advantage.

The effects of these changes were first tried out in January 2004 on JR96. Flight has proved to be much more controllable, no stalling events were experienced. On this cruise the effect of changing between the first and second bridle attachment positions was investigated, not unexpectedly when attached at the first position the vehicle reaches the surface more easily and struggles to attain depth. When the second position is used, depth is more easily attained and the vehicle struggles to get to the top. The second position is probably the most useful, height can be attained by oversetting the top depth.

We purchased a new underwater modem unit this year but it has failed to work on the full towing cable, this problem will be sorted out by Chelsea Instruments when the equipment returns to UK. The 'old' modem stopped working during the first deployment, this was found to have been caused by a poorly seated connector. The connectors involved are showing signs of corrosion and changing both the bulkhead connector on the Modem and the connecting cable should be considered.

The PC used to run the NSHUTTLE software has also proved to be rather unreliable, probably due to the physical strains imposed by the very large Amlicon break out connector. We think that this could now be made redundant and the possibility of getting a new PC with simplified connections will be investigated.

It is hoped that the modification to the Minipack and N-Shuttle software means that we have a working system. It is very tempting to develop our own minipack software and I am sure with a bit of work the whole UOR operating environment could be improved dramatically, not in the least by making it reliable.

The PAR sensors continues to operate, producing voltages and having a calibration certificate that doesn't make much sense. Along with the seawiff sensors, work is required to ensure that we are logging meaningful data.

The DAS system developed by Jeremy Robst has proved extremely useful in logging the viewing the logged data.. When the system is fully operation with the download facilities then UOR along with all the logged data will accessible in a straightforward manner.

Jeremy Robst's, Polynomial Program to convert input from a logger to calibrated values worked very well and has been essential in converting the minipack data stream to meaningful data. This was necessitated by the continuing flakiness and unreliability of Chelsea's minipack software.

11. AFI 3/16 Moorings Report

Peter Enderlein, Doug Bone & Ryan Saunders

Background, aim and methodology

The AFI moorings are designed to investigate intra-annual variability in krill abundance and water-mass physical characteristics of South Georgia and are described in detail in the JR82 cruise report.

Recovery and redeployment during JR 100

The deep water mooring recovery started at 10:30 GMT of March 24th with a CTD to 200m, 2 cables from the dropping position followed by EK 60 acoustics on the dropping point of the mooring for 1/2 hour from 11:00 to 11:30 GMT. The weather was fine (force 2-3), calm sea, and good visibility. The releases were first activated at 11:40 GMT and a positive response "hook released" was received. Nothing happened, so the second one was released, again provoking a positive answer, but again nothing happened. After ½ an hour both releases were released again and after just 3 min at 12:30 the mooring appeared at the surface. Thereafter he whole mooring was recovered without any problems and at 13:20 the whole mooring was on deck.

Following visits to Stromness for the acoustic calibration and to KEP, the shallow water mooring recovery started at 16:57 GMT on March 25th with a CTD to 200m, again 2 cables away from the original dropping position followed by EK 60 acoustics on the original dropping point for ½ hour from 17:30 to 18:00 GMT. The mooring was released at 18:30 GMT and surfaced just 2 min later. At 19:00 the mooring was successfully recovered without any problems.

The quick and successful recovery of both moorings gave us time to fish for 24 hours around the shallow water mooring position to ground truth the acoustic data. Over 24 hours 6 RMT 8 nets and 2 LHPR deployments were achieved (Table 11.1), both in darkness as well in light, to learn more about the vertical distribution of plankton, krill, mysids and fish around these particular position during day and night time.

Table 11. 1: List of fishing events around the shallow water mooring position

Time	Event Number	Latitude	Longitude	Water depth	Ship's speed	Type of net
26/03/2004 21:43	160	-53.78669	-37.9431	304.8	2.47	RMT8
26/03/2004 21:06	159	-53.78183	-37.90018	179.6	2.38	RMT8
26/03/2004 15:51	156	-53.8066	-37.91399	236	2.33	LHPR
26/03/2004 13:25	155	-53.813	-37.92111	321.2	2.04	RMT8
26/03/2004 11:20	154	-53.81815	-37.93584	296.4	2.22	RMT8
26/03/2004 02:36	150	-53.78757	-37.91655	197.2	3.6	LHPR
26/03/2004 00:02	149	-53.7892	-37.9345	299.6	2.97	RMT8
25/03/2004 22:02	148	-53.7691	-37.92106	182.8	0.79	RMT8

After finishing the fishing the "deep water mooring" was redeployed 300 m West of the shallow mooring station on 26.03.2004, 18:16 GMT at 53° 47.7'S & 37° 56.59'W in around 320m of water. Immediately afterwards the shallow water mooring was prepared for redeployment and was successfully redeployed on 26.03.2004, 19:13 GMT at 53° 47.69'S & 37° 56.31'W.

Both deployment took place as described in the second deployment report in JR96 with the following changes:
To control the release of the weights, the weights were lowered over the stern with the starboard Effer crane on a strop and a sacrificial rope attached to the weights was threaded through two deck eyes. The weights were then lowered down until the sacrificial rope took up the weight, and the strop removed. At the release point the rope was cut on top of a piece of wood between the eyebolts using a sharp knife.

Monitoring problem with the ARGOS beacon 35520

Initially it appeared that ARGOS has problems receiving our ARGOS beacon 35520 from the deep mooring. We got no reply from them but frequency tests on board showed that both beacons were working. Therefore a further test was carried out on the afterdeck with the beacon switched on for approx. 2 hours. Again we received no position report from ARGOS. Contacting ARGOS revealed that they had not monitored beacon 35520 since May 2003 when the mooring surfaced unexpected. All required forms to monitor the system again are filled in and ARGOS is monitoring the beacon again.

Data verification

All 4 instruments have worked perfectly fine. The CTD data indicate that the shallow water mooring had been sitting at around 197 m and the deep mooring at around 225. Both ADCP data are showing a clear vertical migration over the last deployment. Overall a very good performance of the instruments with a nice dataset.

Work carried out

WCP: Both instruments currently not available – going to ASL for checks

CTD: Data download

Batteries changed

ADCP: Data download

Batteries changed

NOVATEC beacons

Batteries changed

ARGOS beacons

Batteries changed

Releases: Batteries in all 4 releases changed

New Instrument settings (general)

	ADCP		CTD	
	Shallow	Deep	Shallow	Deep
Start time	26.03.04	26.03.04	26.03.04	26.03.04
Duration	210 days	210 days		
Sample interval	5 min	5 min	300 sec	300 sec
Pings in interval	7	7		

Table 11.2. Details of the RMT and LHPR sampling undertaken at the shallow moorings location.

Event	Depth range	*Analyses*	*Fate of sample*	*Comment*
160	Net 1: 270-200;	Species and weights analysed in subsamples	Subsamples of both nets preserved	Mainly mysids but quite a lot of krill;
	Net 2: 200-100m			Mainly mysids with some *Thysanoessa*
159	Net 1: 100-50m;	Species and weight analysed on subsamples	Subsamples of both nets were preserved	Dominated by *E. superba* (4480g) with 130g of mysids;
	Net 2: 50-0m			Dominated by *E. superba* with some *E. frigida* and *Themisto*
156	0-220m	Rough notes were made on species in patches	Frozen at -20oC	27 patches spooled on decent and ascent; an average of 15m per patch
155	Net 1: 300-200m;	These were analysed for species and weights; Ryan measured lengths and breadths of 50 mysids	Net 1 and Net 2 were combined and a subsample preserved in 3 jars	Mysids and Themisto were the most common animals
	Net 2: 200-100m			
154	Net 1: 100-=50m;	Both nets were analysed for species and weights	Not preserved; 32 individuals in -80oC for DW	Both nets contained almost exclusively Themisto; Ryan did length and breadth measurements on 32 specimens - these were frozen at -80oC for DW; wet weight of 300 individuals was 35g (0.1166g per ind.)
	Net 2: 50-0m			
150	0-217m	Descriptions of species in patches made	Frozen at -20oC	Total of 29 patches
149	Net 1 300-200m;	Net 1 was analysed for species and weights; Ryan L-F for E. superba (105 individuals); Net 2 was torn so discarded	Subsample of Net 1 was preserved in two jars	
	Net 2 200-100m			
148	Net 1: 100-50m;	Subsamples of each net were analysed for species and weights;	Net1 and Net2 subsamples preserved	Net 1 77 litres of krill; some mysids and Themisto;
	Net 2: 50-0m)	Ryan L-F analysis for E. superba for Net 1 and Net 2 (100 individuals each)		Net 2 had 25 litres of krill

12. Chlorophyll, phytoplankton and POC sampling

Simeon Hill

Introduction

Phytoplankton are responsible for the majority of marine primary production and form the base of the pelagic food web. Data on chlorophyll *a* density were collected throughout the cruise, using fluorometers and direct sampling. These data will reveal the horizontal and vertical distribution and the taxonomic composition of the phytoplankton community in relation to the physical and chemical features of the marine environment. Additionally, these data will compliment those on higher trophic levels collected during the survey, allowing investigation of the scales of interaction between phytoplankton and the invertebrate, fish, bird and mammal community that ultimately depends on phytoplankton primary production. In addition, particulate organic carbon (POC) samples were taken from approximately 20m at each CTD station to provide a measure of resource availability to the invertebrate community.

Methods

The vessel was equipped with a Turner 10-AU underway fluorometer and CTD-mounted fluorometer and PAR (photosynthetically active radiation) sensors.

The underway fluorometer was attached to the vessel's uncontaminated seawater supply with a flow rate maintained at around 0.6l.min^{-1} and provided continuous chlorophyll *a* concentration readings which were logged as part of the survey's routine data collection.

Seawater samples were collected on an approximately hourly basis while the vessel was in transect in both the myctophid survey and the Western Core Box. These samples will be used to calibrate the underway fluorometer readings, and were taken from the fluorometer outlet hose. A volume of water was collected according to the following criteria: 500 ml for readings <5mg.m^{-3}; 350ml for readings of 0.5 to 1 mg.m^{-3}; 250ml for readings >1 mg.m^{-3}. The water was filtered through a 47 mm GF/F filter using a hand-pumped vacuum unit at a pressure difference not exceeding 0.1

atmosphere. The filters were then placed in plastic centrifuge vials, frozen at -80°C, and stored at -20°C for future analysis of the residue.

At CTD stations, flourometer and PAR readings were logged in the CTD dataset. Water samples were collected from the CTD bottles fired at nominal depths of 20m, 40m, 60m, 80m and 100m. An additional sample was collected from the ship's pumped seawater supply to give a reading for 0m. The samples were temporarily stored in darkness and then filtered using the method for underway fluorometer calibration samples given above. For the 0m and 20m samples, the volume filtered was determined by the underway fluorometer reading according to the criteria above. For all other samples, 500ml was filtered.

A 247.5ml sample of seawater was taken from the CTD bottle fired at a nominal depth of 20m at each CTD station. This was added to 2.5ml of 10% Lugol's iodine solution to produce an iodine solution of 1%. The samples were stored in darkness at 4°C for future identification of the phytoplankton.

Water was also collected from the CTD bottle fired at a nominal depth of 20m at each CTD station for POC sampling. Two replicates of 3l were filtered onto separate pre-ashed filters using a vacuum unit attached to an electric pump. The filters were then placed in plastic petri slides and frozen and stored at -80°C for future analysis of the residue.

Data

All data collected for chlorophyll and POC analysis are time and position referenced. Underway fluorometer readings were logged in the SCS underway dataset. 131 underway fluorometer calibration samples were collected. Details of these were logged in the "JR100 Chlorophyll underway" datasheet. The samples will be delivered to Dr. Rebecca Korb (BAS) for analysis.

CTD fluorometer and PAR readings were logged in the CTD dataset. PAR readings are available for all stations and fluorometer readings are available from event 82 onwards.

126 CTD station chlorophyll samples were collected from 21 CTD stations, 13 in the myctophid survey, six from the Western Core Box, and one each from the shallow and deep-water LHPR stations. Details were logged in the datasheet "JR100 Chlorophyll CTD". The samples will be delivered to Dr. R. Korb for analysis.

Seawater samples for phytoplankton identification were collected from each of the 21 CTD stations, from the bottle fired at a nominal depth of 20m. The samples will be delivered to Dr. R. Korb for analysis.

Two replicate POC samples were collected at each of the 21 CTD stations, from the bottle fired at a nominal depth of 20m. In each case 3l of seawater was filtered for each replicate, except at event 36 where 2.7l were filtered for one of the replicates. The samples were given to Dr. Geraint Tarling (BAS) for analysis in conjunction with Dr. Peter Ward (BAS).

13. Western Core Box Netting

Geraint Tarling, Tony North, Nadine Johnston

Protocols

Net samples for the Western Core Box (WCB) were taken between 28th and 31st March, 2004. A large amount of ice in the region made it impossible in some instances to sample at the pre-designated station sites, especially the inshore sites. In such instances, we sampled at the nearest position to the site. At each station, the following procedure was followed:

1. RMT8 0-250m; Net 1 open on descent, Net 2 open on ascent
2. 2 x Neuston nets during the time the RMT8 was in the water
3. 3 x Bongo nets (0-200m or to within 20m of bottom if too shallow)
4. CTD (0-1000m or to within 20m of bottom if too shallow)

The order of these events was sometimes reversed.
Details on the Bongos and CTDs are given elsewhere. Table 13.1 details the RMT8 and Neuston net catches only.

Catch Processing

For the RMT8 nets, Net 2 was analysed fresh and not retained. Details of these catches can be found in the net catch database. Net 1 was not analysed but all fish and a subsample of the zooplankton was preserved in 4% buffered formaldehyde. Some samples of krill were analysed for length-frequency, and some preserved for future determination of sex and maturity stage.

The Neuston nets were analysed fresh and results entered into the net catch database. The zooplankton were not retained. All fish captured where frozen for potential genetic studies.

Worsening weather conditions curtailed activities on Transect 3. Only 1 RMT8 was achieved at the northerly site (no accompanying Neutsons or Bongo nets).

Identification of net catches was a lot more detailed than on JR82 and JR70 because of the greater taxonomic expertise on board. All specimens were identified to species where possible. We created a new log sheet containing a list of possible species, based on our observations. This is shown in Appendix 1. David Pond took digital photos of many species and it is hoped that a photo guide to these species will be produced for future cruises

Note that other RMT8 deployments were made during 28th and 29th. These were targeted at catching krill targets. Details of these events can be found in the event log. Samples were generally not retained unless for krill population dynamic work (see the Krill studies section of this report)

Figure 13.1. Locations of transects and stations in the Western Core Box.

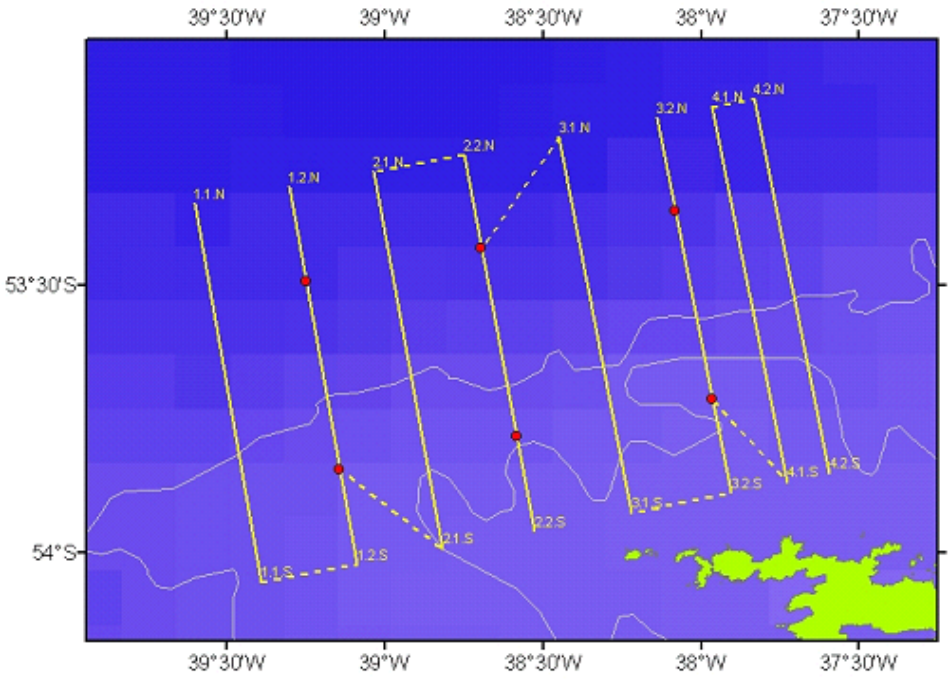

Table 13.1 Details of net events in the Western Core Box.

Date &Time (GMT)	Event	Station	Water Column Depth (m)	Ship's speed (knots)	Net	Fate of sample	Comment
28/03/2004 00:02	168	W1.2N	3178	2.86	RMT8	Subsample of Net 1 preserved	0-250m oblique
28/03/2004 00:11	169	W1.2N	3196	2.62	Neuston	Zooplankton not retained. Fish frozen	Surface haul
28/03/2004 00:33	170	W1.2N	3230	2.19	Neuston	Zooplankton not retained. Fish frozen	Surface haul
28/03/2004 04:37	171	W1.2S	277	2.44	RMT8	Subsample of Net 1 preserved	0-250m oblique haul
28/03/2004 04:45	172	W1.2S	295	2.38	Neuston	Zooplankton not retained. Fish frozen	Surface haul; second net not done because of brash ice
28/03/2004 22:54	183	W2.2S	260	1.55	RMT8	Subsample of Net 1 preserved	0-250m oblique haul
28/03/2004 23:08	184	W2.2S	269	2.48	Neuston	Zooplankton not retained. Fish frozen	Surface haul
28/03/2004 23:28	185	W2.2S	292	3.18	Neuston	Zooplankton not retained. Fish frozen	Surface haul
29/03/2004 02:49	186	W2.2N	3027	2.88	RMT8	Subsample of Net 1 preserved	0-250m oblique haul
29/03/2004 02:53	187	W2.2N	3368	2.98	Neuston	Zooplankton not retained. Fish frozen	Surface haul
29/03/2004 03:13	188	W2.2N	3422	2.85	Neuston	Zooplankton not retained. Fish frozen	Surface haul
29/03/2004 22:17	199	W3.2N	2678	3.14	RMT8	Subsample of Net 1 preserved	0-250m oblique haul

14. Longhurst-Hardy Plankton Recorder

Geraint Tarling, Andrew Hirst, Doug Bone

Introduction

The initial aim was to carry out midday and a midnight deployments at two stations: a shelf-site (53° 53.47S, 38° 39.34W) and a deep water site (53° 2.76S, 39° 21.6W). The samples were for Peter Ward (PW) to study the vertical distribution of zooplankton fauna over different seasons. PW instructed to take the samples as late on in the cruise as possible to ensure that their timing was truly autumnal.

This year there was an exceptional amount of ice on the shelf around South Georgia, which made sampling in this region difficult. Ice-bergs prevented us getting to the pre-designated shelf water site. The nearest position where samples could be taken was several miles to the north-east (52.9036S; 39.4845W). Two successful deployments were made at this site, one around midday (Event 129, 21st March), the other at midnight (Event 131, 21st-22nd March).

The deep-water site was visited at the end of the cruise. A successful deployment was made at midnight (Event 213, 2nd April). However, the weather worsened rapidly and sampling became impossible the following day. The midday deployment was abandoned and the ship started its return to Port Stanley.

During the course of the cruise, 3 other LHPR deployments were made to give background information to other cruise objectives.

1 deployment (Event 142) was made at a site of a major fishing effort. The site was sampled with an RMT25 day and night over 48 h to determine the vertical distribution of myctophids. The LHPR was used to describe the major zooplankton layers that these fish may be preying upon.

2 deployments (Events 150, 156) were made in the vicinity of the shallow water mooring. These were taken for the AFI Moorings Project to determine the identity of acoustic backscattering layers. The samples were particularly interesting since they revealed that krill and mysids dominated the biomass and had characteristically different vertical migration patterns.

LHPR performance

The LHPR performed well during all deployments. However, some trouble was experienced with the diverting mechanism. This mechanism diverts water away from the collecting device during descent, so enabling the device to sample only on its ascent and thus saving on the amount of gauze used. The device started to malfunction after Event 142 and was not used for Events 150 and 156; the device was allowed to spool on descent and ascent in these instances. Doug Bone and Vsevelod Afanasyev repaired the diverter on 1st April and it functioned properly for Event 213

The number of patches expected did not always correspond with the number of patches found; the maximum difference was 2. This was because it was sometimes difficult to distinguish patches because of a blurring effect, mainly caused by the capture of a large amount of zooplankton (especially mysids and krill) or a fish. The 'Comments'section in the table below contains our assessment of where mistakes were probably made when dividing up the spool into patches.

Once identified, patches were cut and placed in sequence in a plastic box, a sequence number accompanying each patch. The box was placed in a –20oC. The 6 boxes (1 for each deployment) were packaged together in a larger cardboard box. Bill of lading number for this box was JS/C/04/4704

The table below details all LHPR events and any comments made on deployment and subsequent patch division. Data files for the deployments are located in the JR100 directory under the folder 'lhpr'.

Table 14.1 Details of LHPR deployments during JR100.

Event	Date & Time (GMT)	Water column depth	Ship's speed	Interval per patch	Max depth of LHPR	Total number patches	Comment
129	21/03/2004 15:09	230.4	2.74	60 secs	187m	23 patches	Ice at location of shallow water LHPR; this was the nearest. Hauled in at 15m/min; profile gave ~ 10 m per patch
131	22/03/2004 02:33	308	3.75	57 s	190m	21 (19 totally in the water)	Ice at location of shallow water LHPR; this was the nearest. Hauled in at 15m/min profile gave ~ 10 m per patch
142	24/03/2004 05:00	2813.6	2.12	90 s	1000 m	51 expected; 49 patches identified	LHPR taken to provide information on the food available to myctophids, as part of an intensive 48 hour effort focussed on catching mycophids with RMT25; extra patches not identified are possible in patch 4 and patch 8
150	26/03/2004 02:36	236	2.3	90 s	217 m	28 patches expected; 29 patches identified (note: 29th patch is probably a result of a test trigger on deck)	At the site of the shallow mooring; the diverter was disabled since it was malfunctioning; spooling was carried out on the descent and ascent. A lot of krill and mysids blurred many of the separations between patches
156	26/03/2004 15:51	236	2.3	90 s	220m	28 patches expected 27 found	Second LHPR at the mooring site (daytime). The missing patch is probably between patches 12 and 14. Note the spooling occurred on descent as well as ascent

15. At sea observations on fur seal distribution

Kate Cresswell

Introduction

Fur seals, *Arctocephalus gazella*., are one of the most abundant predators in the Southern Ocean. Determining their prey type preferences and foraging distributions is therefore important, and was tackled in this cruise by gathering data on the distribution of one of their main prey types, myctophids, and the distribution of the fur seals themselves around South Georgia, where large colonies are known to breed. Results from at sea observations such as these are particularly useful when combined with results from a variety of other techniques used to determine foraging behaviour of marine mammals, such at satellite tagging, gut contents analysis and time-depth recorders.

Aim

The aim was to map the at sea distribution of fur seals, both along the east to west transects undertaken at the start of the cruise, and later, the north to south transects undertaken in the Western Core Box (WCB).

Methods

Observations took place when visibility and weather conditions were acceptable, and when the ship was moving along transect. The observer counted the number of seals in a square of approximately 300m^2 in area, with the bottom of the square extending 150m each side of the ship and 300m ahead. The total number of seals observed in this moving transect for each minute of time was recorded.

The number of seals per minute was entered into an excel spreadsheet, along with the corresponding latitude and longitude positions of the ship at each minute, in GMT. A formula was used to calculate the distance between each of these ship positions, so that the number of seals in each 1km^2 area could be determined. This was an approximation to the nearest minute of travelling that completed an area of 300m by 3333m, 1km^2. The time taken to complete an area of 1km^2 depended on the speed of

the ship, usually 8 to 10 minutes of travelling. The total number of seals for that period was tallied, to give seals km^{-2}. This resulted in too large a number of data points, so an average of seals km^{-2} was taken each $5km^2$.

Claire Waluda plotted the data, using ArcGIS. Colours represent level of seal abundance (Figure 15.1).

Table 15.1. Defining the levels of seal abundance per km^2.

Level	0	1	2	3	4	5	6
Seals per km^2	0	0.1 to 0.49	0.5 to 0.99	1.0 to 1.99	2.0 to 4.99	5.0 to 9.99	10.0 to 24.99

Results

Seal density was higher towards the eastern end of each transect (Figure 15.1). At the western end, seals were mainly absent or of low abundance (Figure 15.1). The observations outside of the planned transects (orange line) are a result of the ship avoiding icebergs.

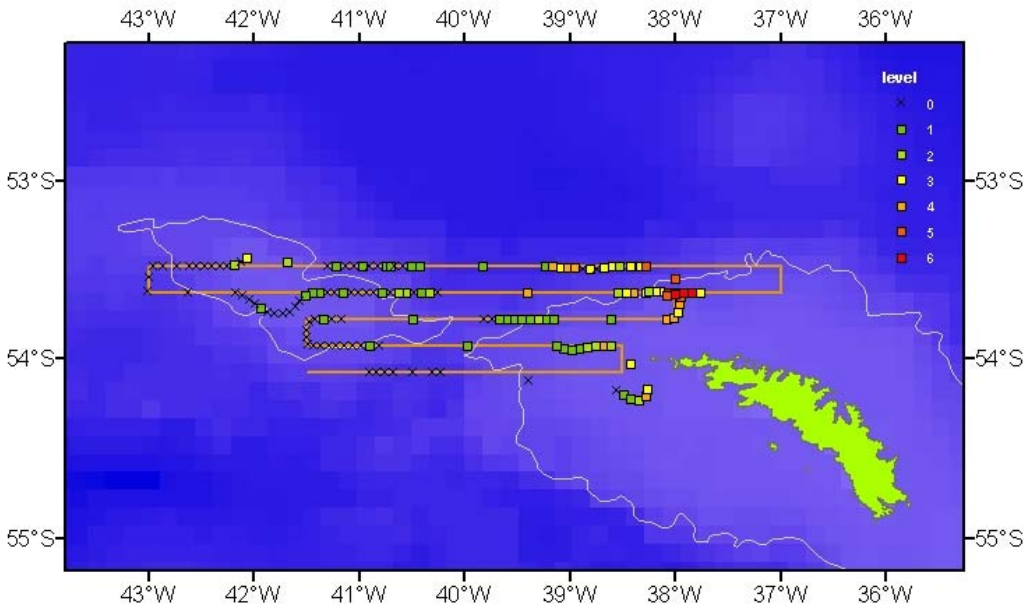

Figure 15.1. Seal observations in the east/west transects.

In the Western Core Box, seals had generally a higher abundance than in the previous transects (Figure 15.1, Figure 15.2). Unfortunately, observations could not take place for a large part of the WCB due to a high abundance of ice.

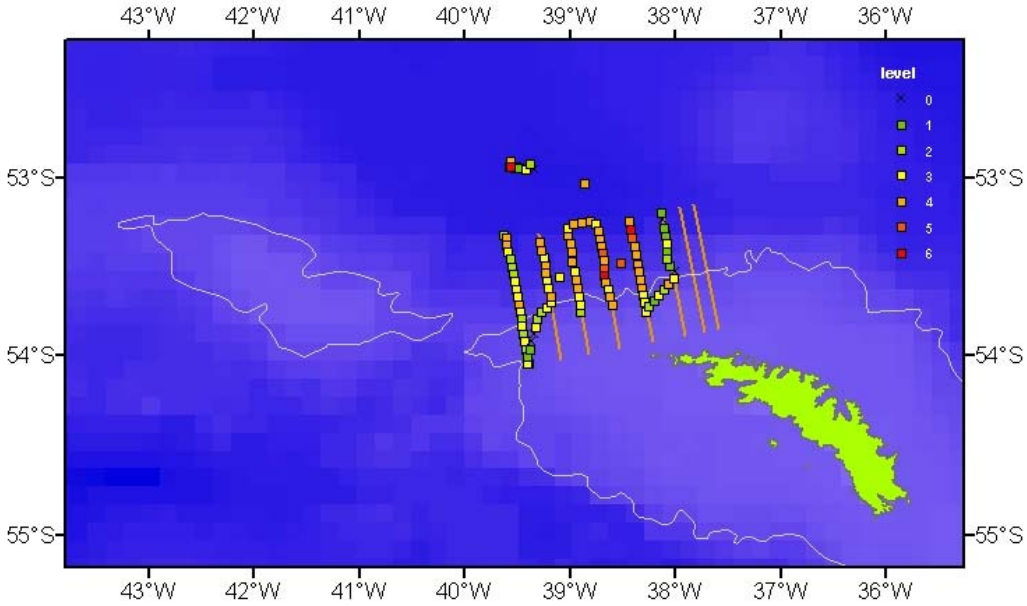

Figure 15.2. Seal observations in the WCB.

16. The distribution of foraging trips and diet of *Arctocephalus gazella* at Bird Island

Sarah L Robinson & Nicolas L Warren

Background

Predators may have a key role to play as indicators of environmental variation in the Southern Ocean at a range of spatial scales that cannot be exploited using conventional sampling methods (Reid *et al* 1999). During the breeding season, female Antarctic fur seals alternate between periods of foraging at sea and time ashore suckling their pups. This central place foraging behaviour means they are particularly suited to use as platforms for monitoring the marine environment.

Throughout the cruise period studies on Bird Island provided information on the distribution of foraging fur seals. Using satellite tags and time depth recorders as well as results from diet analysis enabled the cruise to focus on areas known to be hotspots of fur seal foraging activity.

Methods

Deployment of instruments

Prior to deployment, the three instruments, satellite tag, time depth recorder (TDR) and radio transmitter, were attached onto a piece of webbing using cable ties. Female seals observed suckling a pup were captured and immobilised using standard techniques (Gentry and Holt 1982). Self-piercing tags with unique identity numbers were applied to the fore flippers. The seal was weighed, and length and girth measurements recorded. The package of instruments was attached by epoxy onto the animal's back on the mid-line posterior to, or between, the scapulae. Once the epoxy had set the seal was released to return to suckling. Frequent checking using a radio transmitter established the beginning of the foraging trip.

When the seal returned to the beach after foraging, a radio receiver detected its presence. The seal's location was established using a hand held radio receiver. The seal was restrained and the instruments were removed by cutting the cable ties, the strap was left attached to moult off naturally. This kept the damage to the seal's coat to a minimum. After instrument retrieval faecal material for diet analysis was collected using an enema.

Diet sampling

With the seal captured and restrained the tube of the enema apparatus was inserted into the colon via the anus. Approximately one litre of warm soapy water was introduced. The tube was then removed and the resulting enema water, expelled by the seal, was collected in a tray for analysis in the laboratory.

Samples were decanted into a beaker and broken down with water, and supernatant material was decanted from the beaker through a sieve. The sieve collects krill (*Euphausia superba*) carapaces that float off the top of the faecal matter. Remains were rinsed, transferred to a sorting tray and floated to allow separation. Individual carapaces were collected from the tray using fine forceps and measured under a binocular microscope. Fish otoliths and squid beaks were separated from the material remaining in the beaker, identified and measured.

Scats were sampled weekly over the summer and bi-weekly over the winter with 10 fresh whole scats collected at one time. This allows assessment of dietary changes throughout the year.

Results

During the cruise period 21 device deployments were undertaken, with all instrument retrievals and diet sampling successfully conducted, 60 *A. gazella* scats were also analysed during this period.

All seals foraged in an area approximately Northwest of Bird Island. Figure 16.1 shows the foraging trips of five satellite tagged females. Figure 16.2 shows the foraging density plot for lactating female fur seals tracked from Bird Island during the cruise period. Two of the five seals (W7159, W7164) travelled a greater distance from Bird Island and for a longer period of time (mean foraging trip duration = 12 days) compared to the remaining three , (W7153, W7163, W7166, mean foraging trip duration = 6.7 days) all of whom foraged closer to the island. The greatest difference in dive data was seen between the maximum dive depths of individuals. The biggest variation being observed between the maximum depths reached by W7163 and W7166 (Fig. 15.3), both were seen to have foraged in different areas (Fig.16.1).

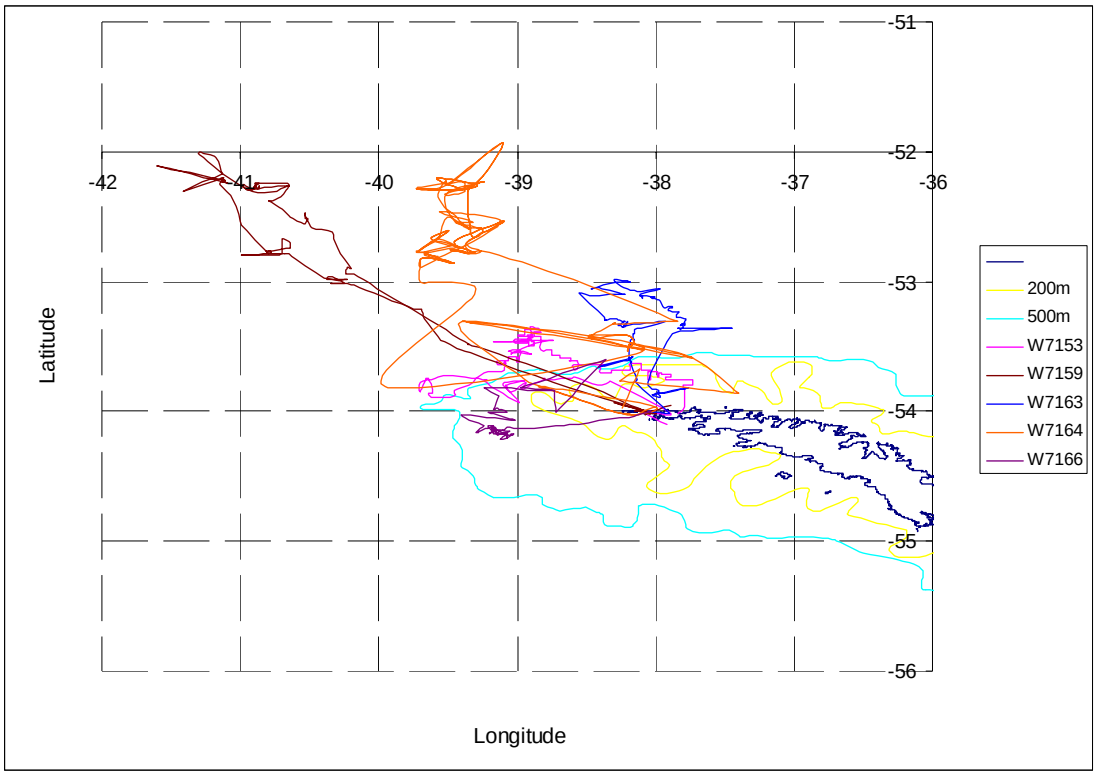

Figure 16.1. The foraging tracks of five female *A. gazella* (each individual is denoted in the key by their tag number). Tags were deployed between the 24/02/2004 and the 16/03/2004.

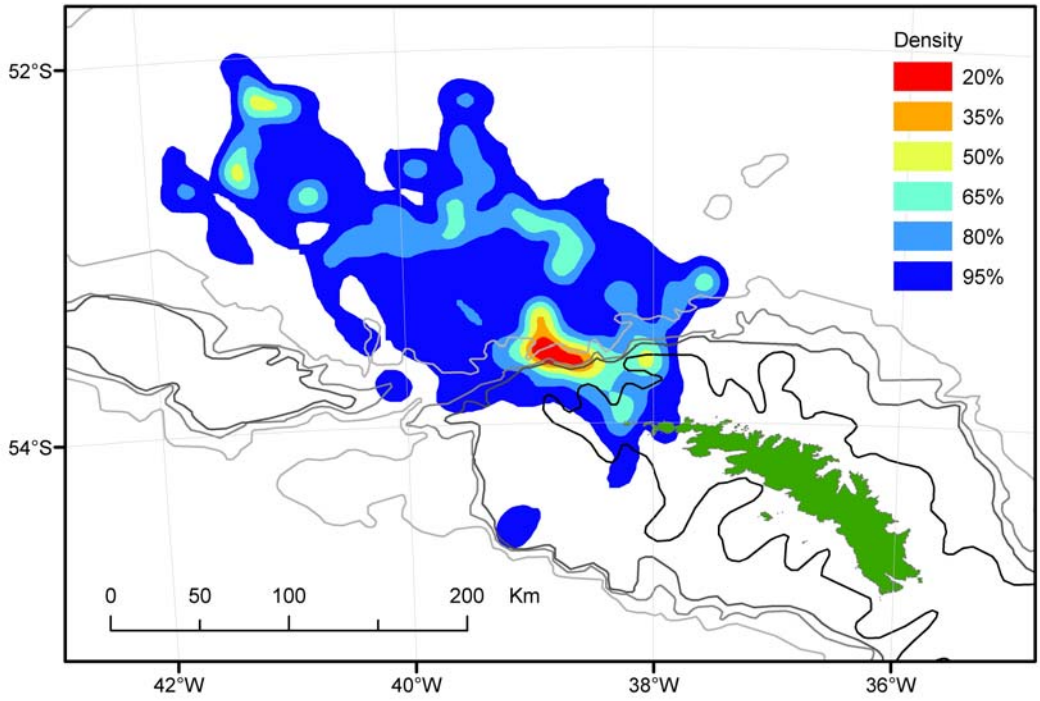

Figure 16.2. Foraging density plot for lactating female fur seals tracked from Bird Island during the cruise period. The colour scale represents a kernel analysis of satellite derived locations.

Of 21 enemas collected 11 contained fish remains, 9 of which had measurable otoliths. Analysis of the 60 scats collected over the same period found 21 with fish remains, 11 of those 21 containing measurable otoliths. *Lepidonotothenon larseni (agg)* was the most commonly found species in the enemas analysed, but was less prominent in the scats with *Protomyctophum choriodon* being the most common species found (Table 16.1). All mean krill lengths fluctuated between 45mm and 53.6mm with one exception, W7163 had a mean krill length of 34mm (Fig. 16.4).

Table 16.1. The breakdown of fish found in all diet samples taken between 24/02/2004 and 14/04/2004

Sample contents	**Cruise enemas**	**Weekly scats**
no fish	10	39
fish remains but no otoliths	2	10
otoliths	9	11

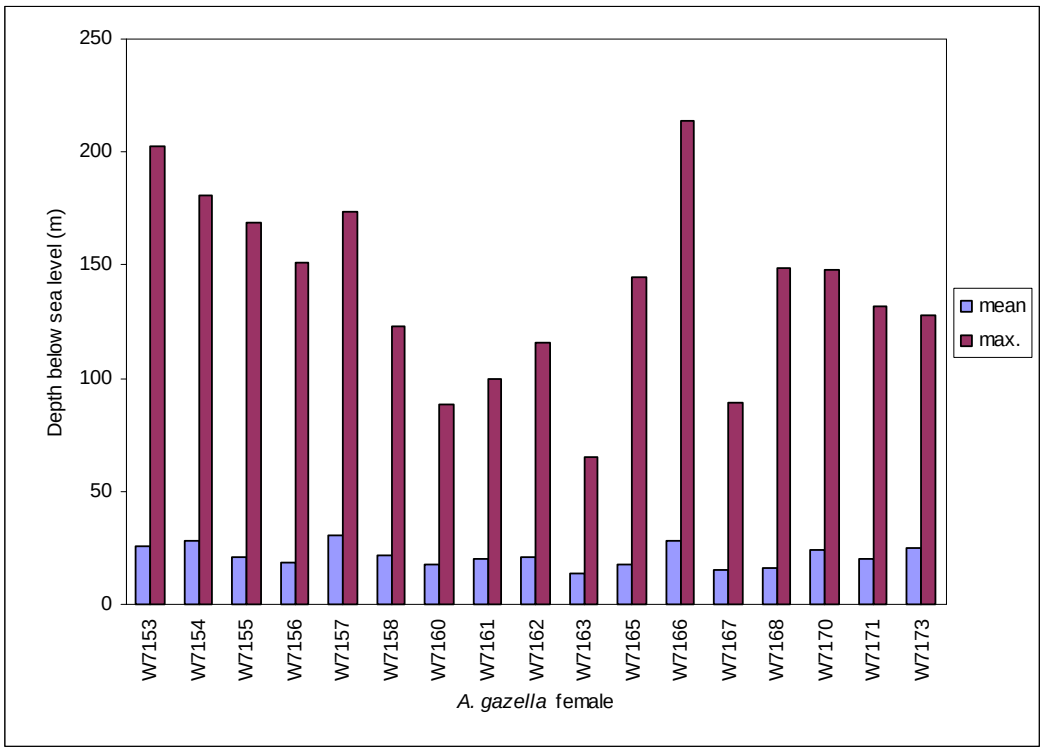

Figure 16.3. The maximum dive depth recorded by each individual, and the mean depth of all dives taken below 3 metres.

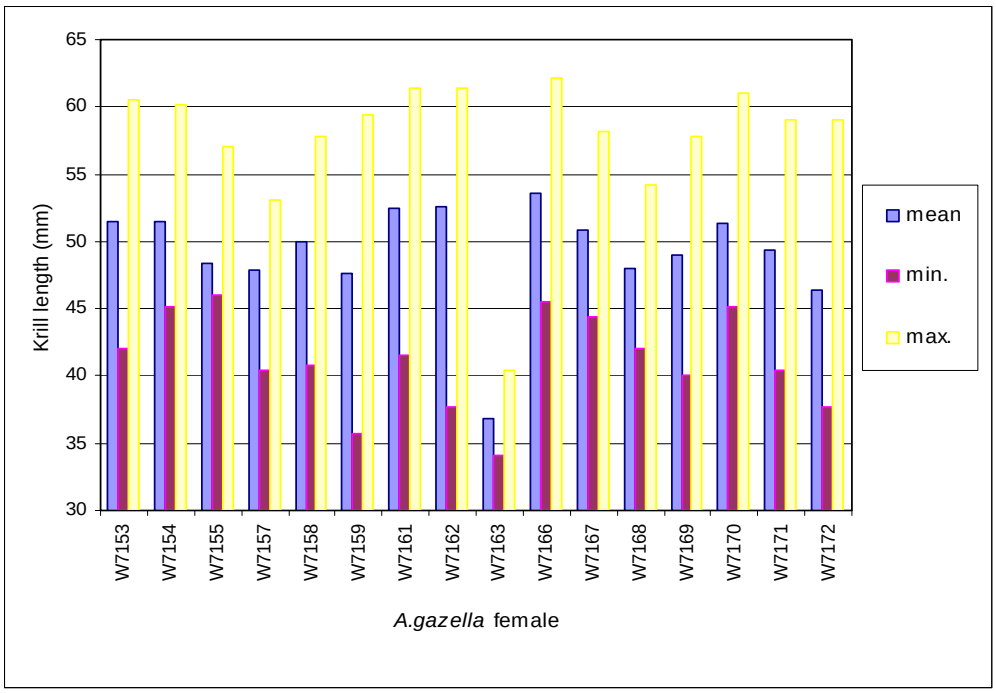

Figure 16.4. The krill length results for all satellite tagged *A. gazella* females with enemas containing krill.

Table 16.2. Percentages of species identified in all samples containing otoliths from scats collected during the cruise period.

Species	Enemas	Weekly scat
Champsocephalus gunnari	0.68	10.56
Paradiplospinosus gracilis	1.36	0
Lepidonotothenon larseni (agg)	97.28	32.55
Protomyctophum choriodon	0.68	54.25
Gymnoscopelus nicholsi	0	2.64

Preliminary Conclusions

Variation can be observed between the diets of seals foraging at different locations and depths, although there are too few observations here for confirmation with statistical significance. It is clear that during the breeding season female Antarctic fur seals can be used as effective system samplers, with Bird Island having the infrastructure in place to collect and analyse the data provided by them.

References

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Reid K, Barlow K, Croxall J, Taylor R (1999). Predicting changes in the Antarctic krill *Euphausia superba* population at South Georgia. Marine Biology 135: 647-652

Acknowledgements

Thanks to Chris Green and Janet Silk for their help in analysing the dive data and to Isaac Forster and Iain Staniland for corrections and alterations on earlier drafts.

17. Pelagic Trawling

Len Featherstone

Introduction

Pelagic trawling for target species (target fishing) requires a great deal of skill and knowledge of the equipment used, which can only be gained with experience. I could write a book on fishing methods and techniques but obviously the purpose of this report is to give an honest and professional opinion of the operation of the PT154 from the James Clark Ross.

The following is a brief description of the method that I used on research cruises when fishing for target species with the pelagic trawl.

Pelagic Trawling Methods

When a target has been selected to fish, break off the survey and manoeuvre the vessel back to and over the mark, crossing it at different angles to assess its density. Then work out the best angle of attack taking into account weather, tide and ice conditions. Steam on the reciprocal course to that of which has been chosen to shoot for a distance of about one mile. Still on the same heading, shoot the net, pay away the bridles and clip up the doors. Then turn and shoot at the mark paying away the required warp.

The two main factors that govern the attitude of the net in the water column are speed of the ship and warp length. It must be said at this point that net monitoring equipment is a must, without it the whole operation becomes impossible. I like to settle the gear well before arriving over the mark, to achieve this I use a warp ratio of 4 to 1, and finely adjust the speed up or down in small degrees also warp length is adjusted in or out in 5m sections. It is quite common with the PT154 to be constantly adjusting speed and warp to keep the net stable, these small nets are very flighty.

On approach of the mark, one has to be prepared to drop or lift the net quickly, if the target has altered its swimming depth. It is also usual for the net to have a headline

transducer to detect fish entering the net giving indication if the target has been caught or not if you have missed.

Pelagic Trawling on James Clark Ross

The deck side operations started off badly, the main problem was the winches, which in fairness had not been used for a long time. When the problem was rectified and some adjustments made to the net, the shooting and hauling procedures went quite smooth. Safety was obviously of paramount importance especially with a crew lacking fishing experience, but things soon got into a routine. Myself and the ships chief officer were quite satisfied that the crew had become aware of danger areas and that all safety procedures were been adhered to.

The net had no real-time monitoring equipment on it, so all fishing was purely guess work not knowing were the net was. A time-depth recorder (TDR) was fitted to the net, so that depth data could be subsequently downloaded. The vessel could only shoot and tow head to wind and I had to recommend speed from the UIC to the bridge officer, making fine control difficult. Warp length was also dictated by me, but changes in warp were first approved by the bridge officer, making it a very slow, and unresponsive process. Without monitoring gear everything done was guess work, but in reality it is also impossible to fish dictating orders through a medium.

Conclusion

I think that the James Clark Ross is quite capable of deploying and recovering a pelagic trawl with no problems, but there will be a requirement for some sort of fishing advisor (not me). The towing of the net and attack response from the vessel would always present problems, without experienced personnel doing the fishing. The saying is horses for courses, and I feel that the James Clark Ross is not the course for the pelagic net as the vessel is not equipped or manned for fishery research.

I would take this opportunity to thank Captain Burgan his officers and crew in their professional approach to something different, and their friendliness shown to me.

18. Data Management Cruise Report

Nathan Cunningham & Claire Waluda

Underway Data Logging

Underway data was logged to the SCS. The following streams were logged.

Table 18.1. SCS Streams for JR100

Stream Name	Start Time	End Time
Anemometer	07/03/2004	05/04/2004
BASSTCM	-- No Data --	-- No Data --
Doppler Log	07/03/2004	05/04/2004
Emlog	07/03/2004	05/04/2004
GPS-ADU	07/03/2004	05/04/2004
Glonass	07/03/2004	05/04/2004
Net-Monitor	07/03/2004	05/04/2004
OceanLogger	07/03/2004	05/04/2004
SeaSPY	07/03/2004	05/04/2004
Seatex	07/03/2004	05/04/2004
Simrad-ea500	07/03/2004	05/04/2004
Simrad-em120	07/03/2004	05/04/2004
TSSHRP	07/03/2004	05/04/2004
Trimble	07/03/2004	05/04/2004
Truewind-spd	07/03/2004	05/04/2004
Winch	07/03/2004	05/04/2004
gyro	07/03/2004	05/04/2004
minipack	07/03/2004	05/04/2004
minipack-real	07/03/2004	05/04/2004
new_stcm	07/03/2004	05/04/2004
pmlbox	-- No Data --	-- No Data --

The EK60 was logged to the Unix machine. The Gyro and the STCM are logged using Andy Barkers' Java Data Logging system.

The UOR was logged as an SCS file and will be available for download via the DAS system. It was logged as engineering units as $minipack and converted using a polynomial perl module developed by Jeremy Robs to 4minipack_real. .

Any breaks in the streams were logged and documented by ITS. The SCS performed well and the data has been collected and backed up to return to Cambridge.

Migration from RVS and PSTAR has been started. Jeremy Robst/ Nathan Cunningham has provided web services for directly accessing the SCS files. Mark Brandon/ Lizzy Hawker has started to migrate PSTAR routines and functionality to Mat lab. Nathan Cunningham has started to define the data model and schemas for the JCR. This work will continue and hopefully will be completed by the next cruise and will mean that the phasing out of RVS and PSTAR can start. Below is a brief project description for the web based JCR Data Logging Interface and JCR Log sheets

The functionality of the RVS listit command

It would be useful to be able to select a time period from which a data stream can be selected, displayed and a CSV text file produced. The main reason for this is to enable the user to easily generate local data sets of transects, station events etc. Ideally, the ability to request data from any of the streams would offer the greatest flexibility to the user, but this is not a critical function.

Graphing tool

Graph any data stream(s) from a user defined period (or current time).

Template Tool

Setting up user-defined templates for the Data Logging, the Log sheets and the Graphing tools. This would allow the user to select any data streams and variables and save this selection to a reusable template, for example met data from the ocean logger and the anemometer and call this data set Meteorology Data. The same would work for event logs.

Amend and Delete to JCR Log Sheets

This would allow to the log sheet creator to have administrator rights and could amend the sheet (column order, add a column, delete a column) and delete or amend records. Any user generating a new instance of the event would be allowed to amend and delete their records, but not the entire sheet or other user records.

Amend and Delete functionality to other tools

As outlined above, based on administrator and user read, write execute privileges. The main use would be for user editing when creating a template.

Save screen output as an csv file

This would produce an image file from the current output of SCS Interface tool being used. This would be especially useful for the graph tool to quickly analyse interesting events.

It is hoped that the user community will use this tools as the primary way of accessing the underway data and generate there own data set for visualisation (which in the bioscience community is predominantly in MS Excel). The logsheets were very successful and widely used by all the scientists on the cruise. Further development work is required with the log sheets and the DAS system.

Along with the move to Matlab from Pstar, the old RVS system etc can gradually be fazed out as it is becoming dated and the skill base in the user community is very low or non-existent. Future work will include heuristic cleaning the scs streams, matlab processing suite and arc marine geodatamodel.

Other data streams to be converted into SCS system files are XBT,CTD, Sound Velocity data. Work has already started but requires a java based parser for the data streams and/or a text file grabber. Hopefully this work will be completed by the summer.

Data visualisation

During JR100, data were visualised using Geographic Information System (GIS) software (Arc GIS 8.2). Cell-based (raster) bathymetry data at 5' resolution (terrainbase), and coastline data at a scale of 1:250,000 (world vector shoreline) were obtained from the National Oceanographic and Atmospheric Administration (NOAA) National Geophysical Data Center (NGDC) and used to produce a base map of the study region in a Mercator projection. The planned cruise and western core box transects were digitised and displayed as part of this base map [see Fig. 1.2], along with the location of the ships cruise track (obtained via the SCS logging system) for comparison with the transects [Fig 1.3].

Details of all scientific activities were logged in an event log. These data were spatially referenced using decimal degrees and held in an Access database linked to Arc GIS. Events were classified as: fishing (RMT25, RMT8, pelagic net, neuston net, LHPR, bongo nets (large and small)), oceanographic (CTD, XBT, UOR), and moorings (recovery and deployment) [Fig. 18.1]. In addition, data describing the foraging locations of a number of fur seals (n=9) and macaroni penguins (n= 2) tagged at Bird Island, South Georgia were obtained, along with at-sea observations of seal and bird distributions .

All data were plotted onto the base map, and individual events were plotted as requested e.g. fishing cruise tracks [Fig. 4.1], and the location of XBT and CTD drops [Fig. 2.1]. It is planned that XBT and CTD data will be used to create 3D images of temperature at depth across the study region. In addition, the distribution of fish species and abundance will be plotted relative to depth, along with information on the distribution and abundance of predator and prey species.
http://www.ngdc.noaa.gov/mgg/global/seltopo.html (terrainbase)
http://oas.ngdc.noaa.gov/mgg/plsql/extractor.mapit (world vector shoreline)

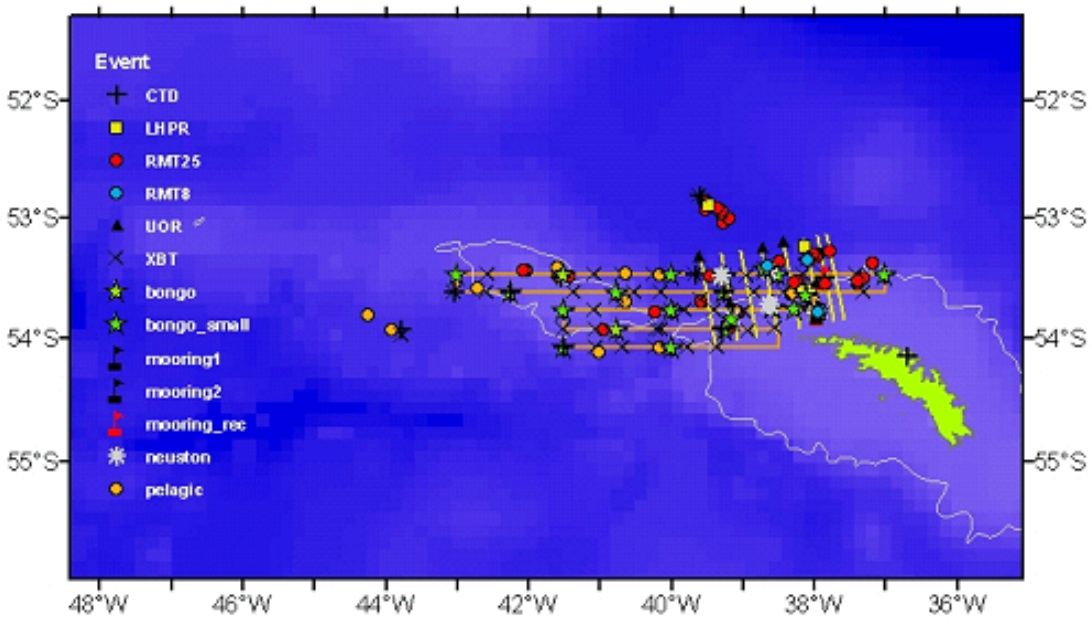


Figure 18.1. Example of data visualisation Map of the survey area, showing the transect locations and locations of different event types.

19. Procedure for the Acoustic transects on JCR: Echoview analysis

J.C. Xavier, C. Goss, R. Saunders

Background

The following comments are in respect of analysis regarding the James Clark Ross (JCR) cruise acoustic transects, using Echoview version 3.1. The objective of this exercise is to go through various steps needed to assure that minimum errors are produced while during this laborious procedure on correcting acoustic files before exporting parameters, such as biomass (i.e. NASC), to Microsoft Excel.

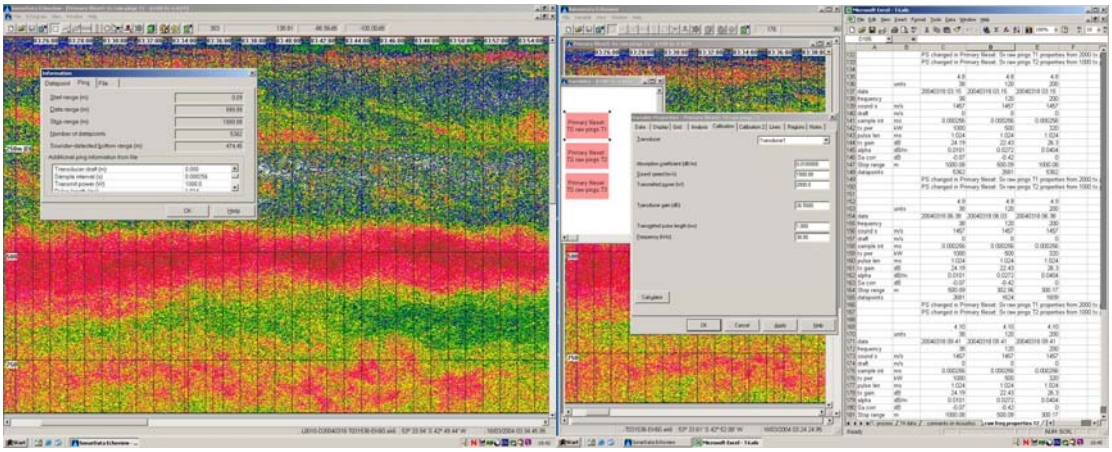
Procedure

The acoustics transects analysis procedure was produced during JCR100 (Fish survey in March/April 2004) and changes might apply according to the objectives of each cruise. During this cruise transects were carried out at 10 knots and data was recorded using echolog and EK60 (ping length =1.024ms). Various examples are illustrated to simplify what the problem is and how they can be solved.

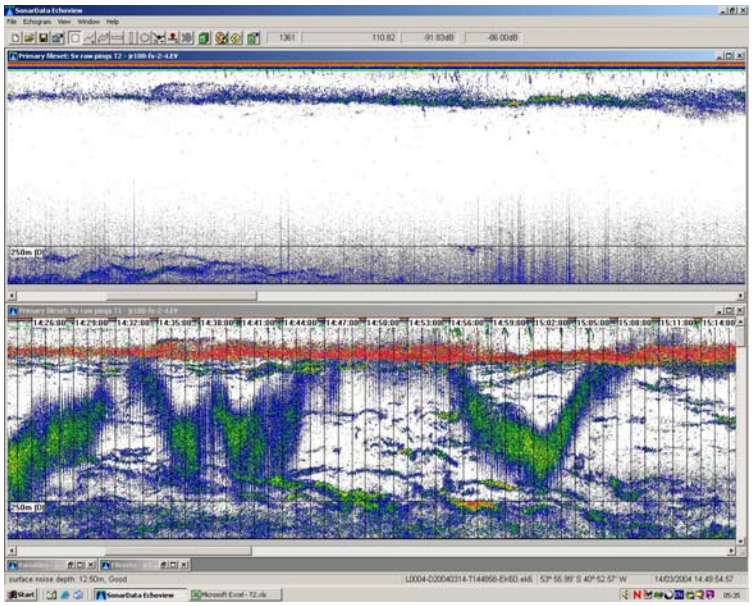
To various steps that should be carried out, in a methodical manner, are:

1. **Select files**. Put EK files (U:/JR100/Echolog…) in a proper directory with the transect name (e.g. folder T1) in the C drive.
2. Create a Excel file with details on start /end of transect, comments on acoustics and checking on parameters chosen for each frequency (i.e. date, frequency, sound speed, draft, sample interval, power, pulse length, transducer gain, alpha, Sa correction, stop range, data points).
3. **Create EV file.** Select EK files for a section of the transect (e.g. T1.2) and create an EV file. Use fs-ek60 as a template.
4. **Process cruise track** and check if the transect looks credible (i.e. being on a straight line).
5. **Check Frequency properties** (for 38, 120 and 200kHz frequencies). Open any basic echogram (e.g. Primary fileset: Sv raw pings T1), right click and choose Show Information. Add this information into the Excel file. Then, compare these values with the information in the Primary fileset: Sv raw pings T1 box (right click on it in Variables) and check if the values correspond. Do this procedure for the other two frequencies.

6. **Start and End**. Allocate the beginning and end areas in any basic echogram (it has a knock on effect) using Vertical tool (5). Suggest looking at the cruise track again after selecting start/end of transect to assess that the time periods that were rejected were the correct one's.



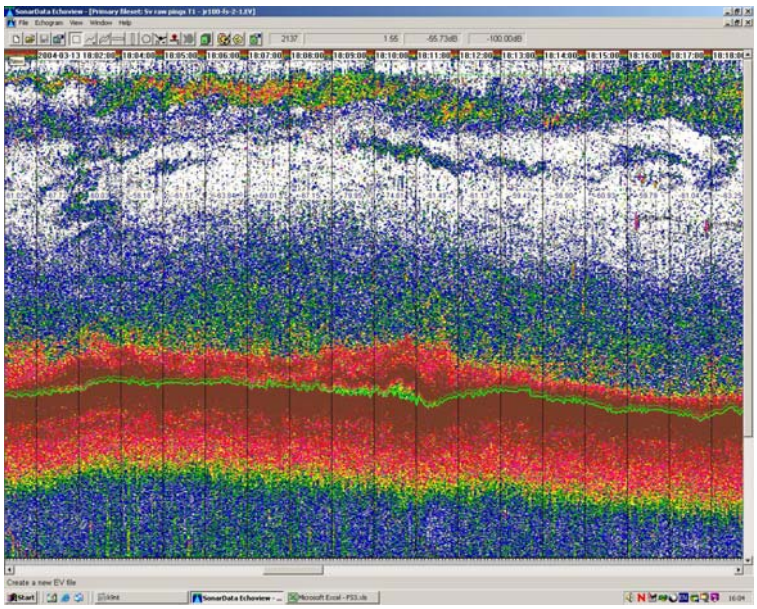
7. **False bottom**. Use 38kHz basic echogram (i.e. Primary fileset: Sv raw pings T1) to search for these (minimum threshold between –80dB and –100dB). Compare it with 120kHz basic echogram (i.e. Primary fileset: Sv raw pings T2). If only present in 38kHz, it means that it needs to be removed (using Parallelogram tool (3) in 38kHz echogram).



8. **Spike search** (brown marks in 38kHz basic echogram). Open files 38-S, 120-S, 200-S and compare them. If find errors (i.e. brown marks) remove them by using Rectangle tool (1), right click, define region (Type: bad data; Class:

missed pings) from 38kHz basic echogram. Recommend changing minimum threshold, using F11 and F 12, various times to assess if it is a brown mark or not.

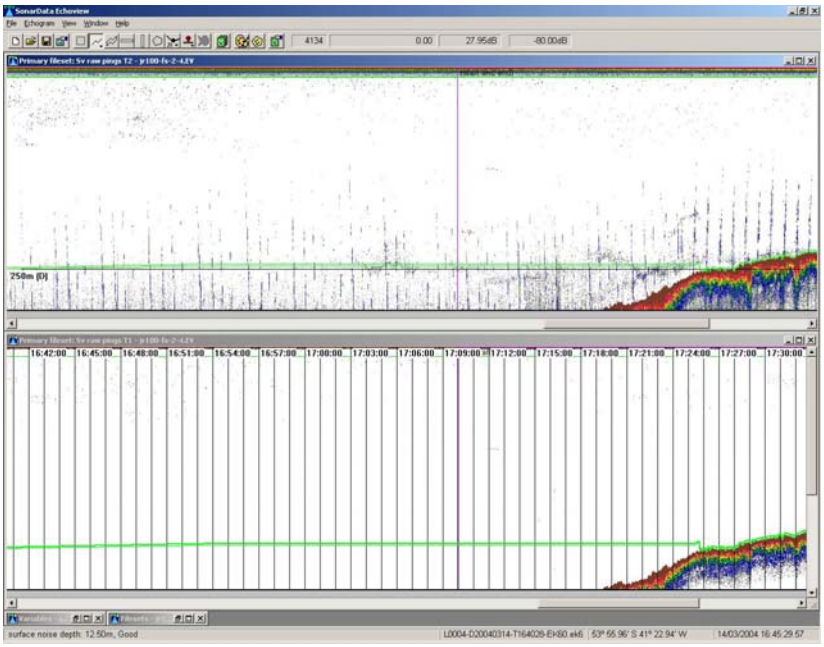
9. **Sort out bottom**. Use 38kHz basic echogram (with minimum threshold between –80dB and –100dB; change it accordingly). If it goes too deep draw a line at 250m deep (this is specific of this cruise). Draw the Integration Stop line (EV file properties-Lines-Source: Line pick from current echogram – Overwrite existing line: integration Stop). Check the Line pick properties (EV file properties-Line Pick: Maximum Sv with backstep, -50, -50, **Backstep range:-1**, 20, 1000). Make the corrections on bottom using this line. To check if the job was nicely done:
    a. create a new line name "Check bottom" with –2 meters based on the integration stop line.
    b. Variable properties-Grid: time, 1 min., depth/range, 300 meters (changeable according the bottom depth)
    c. Variable properties-Analysis: exclude above line: check bottom; exclude below line: integration stop
    d. PRESS I for Sv values on the screen. Check for dodgy values and make the appropriate corrections on the bottom.

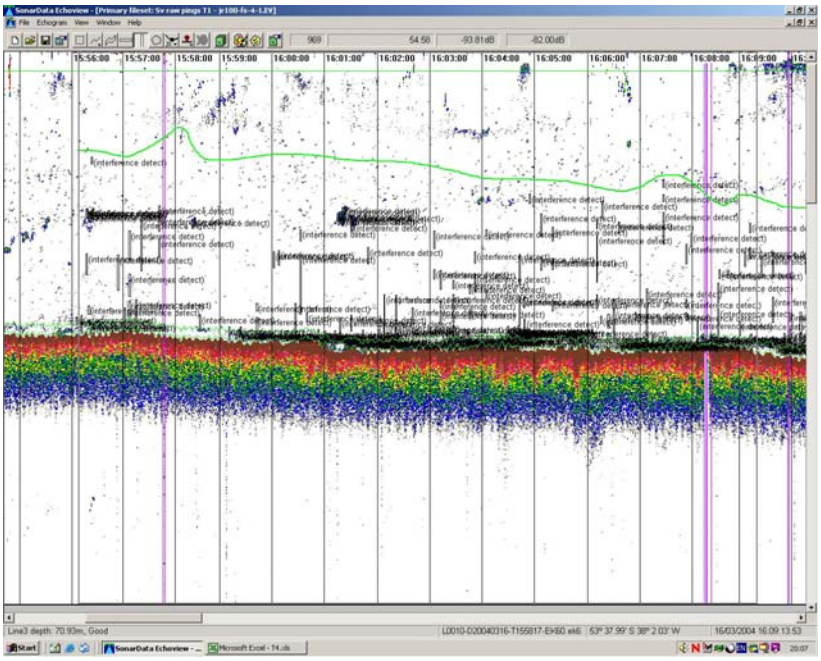


10. **On shelf noise search on 120 kHz**. Use the 120 kHz basic echogram (Primary fileset: Sv raw pings T2 using –80dB as minimum threshold) and compare it

with 38kHz basic echogram. For selecting spikes using Ctl+J might help. Another technique is to use the shoals detection technique. This technique, applied when there are loads of interference.

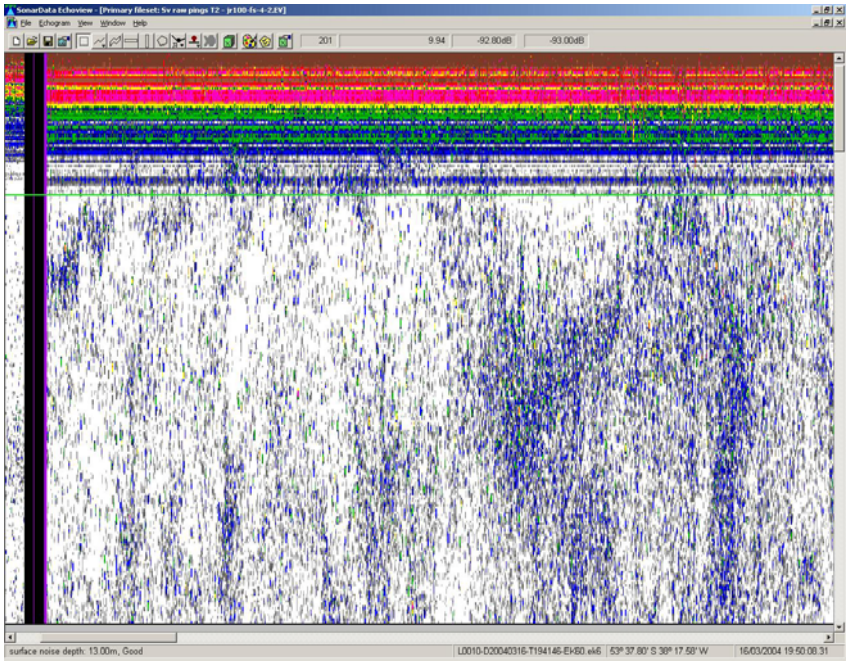
a. Create 2 lines (e.g. Line 3 and Line 4) using EV file properties- Lines- New – Source: None. Draw the lines around the interference (one on top and another at the bottom). Then go to Variable properties- Analysis- exclude above line: Line 3; exclude below line: Line 4
b. Go to variable properties-Data: Minimum threshold- Click Apply…
c. Use Vertical tool (5) to choose vertically the area of interference. Then right click-Detect schools. This will select automatically potential noise. Record and check the school detection settings; i.e. if they are appropriate and change them if not picking schools appropriately; These are : Min. School length: 4, Min. total school height: 3, Min. candidate length: 4, Min. candidate height: 1, Max. Vertical linking distance:3, Max. horizontal linking distance:0
d. Echogram-Region manager (it converts everything into Bad data-interference; remember to change accordingly)
e. Turn off (or click off) variable properties-Data: Minimum threshold- Apply PS Review the process and assess if the interference was correctly selected. Secondly, it is possible to select smaller areas for interference (useful if there are plenty of biological data around that can be misunderstood as interference), using Rectangular Tool (1), then right click-detect shoals (important to check that all the settings are still applying before doing it).



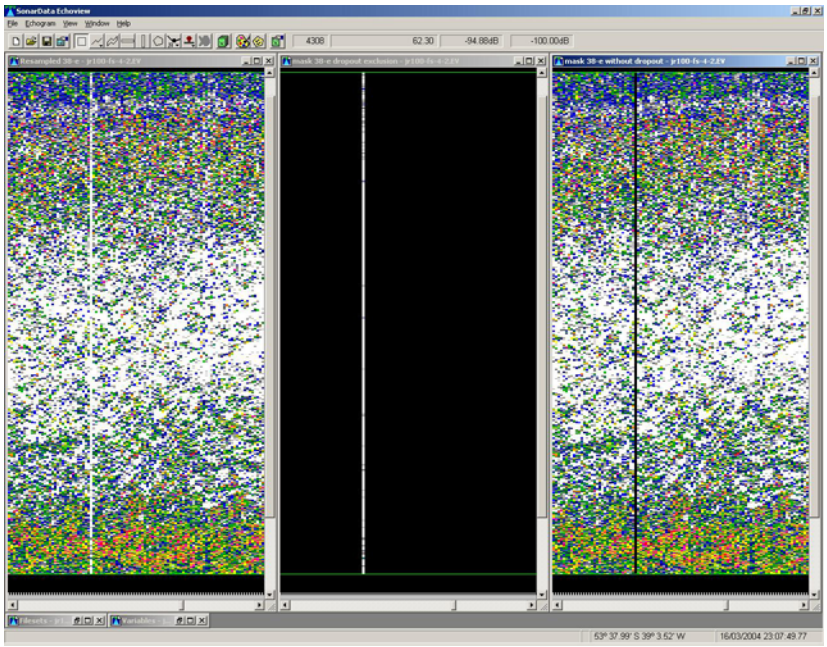


11. **Noise level 120kHz**. Display 120-S, noise 120 and 120-s-c echograms from Variables (they should cover same depth range and with the same colour minimum). Decide to which treshold should be used. Display echograms, then go to Variable properties (of Noise 120)- Generator-Output type: Sv-149db and change the Sv values just to see the effects according to depth. The final result is to have the similar effect at depths as is obtained closer to the surface.
12. **Surface line sorting** (using the basic 120kHz echogram Primary fileset: Sv raw pings T2 using –100dB as minimum treshold). Just check through the

transect at the surface where noise is (usually between 10-14 meters deep and is like a line). Re-create a line of surface noise if necessary.



13. **Remove drop out** (produced by bubbles and it looks like long white stripes in Mask-e 38 dropout exclusion). Open and compare Resampled 38-e, Mask-e 38 dropout exclusion and 38kHz Mask-e without dropout. Use Ctl+J to select them and take them off as bad data (use Resampled 38-e echogram for this).



14. **Creation of variables before exporting the data**. But before need to correct some values in the following variables (at Variable properties-output):
    a. **38-S**: upper depth (0m), lower depth (300m) and n. data points (120).

b. **38-s no dropout**: upper depth (0m), lower depth (300m) and n. data points (120). Two variables should be produced **mask 120-s-c no dropout** and **mask 38 fish no dropout**. The first has been already produced (as part of the template) but the latter needs to be created. Following the basic 38kHz echogram Primary fileset: Sv raw pings T1, down the variables, the variable Mask 38 fish no dropout should be created as a combination of two other variables (range diff-fish and mask 38-fish):
    i. Copy variable range diff-fish (right click after selecting this variable), select variable properties and change:
        1. Notes (to range diff-fish no dropout),
        2. Operands (to diff-s-120-38 no dropout),
        3. data range bitmap (Min:-20 and Max:2)
    ii. Copy variable Mask 38-fish (right click after selecting the variable), select variable properties and change:
        1. Notes (to Mask 38-fish no dropout),
        2. Operands (Op. 1: 38 S-C no dropout;
        3. Op. 2: range diff-fish no dropout).

15. After this the file is ready to be exported to Excel. Select the parameters EV File properties-Export: Sv_mean, NASC, Sv-max, Height_mean, Depth_mean, Layer_depth_min, Layer_depth_max, Dist_E, Date_M, Time_M, Lat_S, Lon_S, Lat_E, Lon_E) and also go to:
    a. Variable properties- GRID:
    b. GPS distance (n.mi), 1, Depth/Range, 50 and go to
    c. Echogram –Export-Analysis by cells-Integration (choose directory Q:/JR100/excel/…)

KEYS useful:
U- Unzoom
S-Zoom
A- to synchronize echograms
W-unzoom what was zoomed before
M- Region properties to call for bad data allocations (i.e. current selection converted to bad data region)
Ctl+arrow- New page or sideways
I- to see Sv values on screen according to the time (i.e. cell) interval chosen
ALT+PRINT SCREEN SYS RQ- to have a screen image of echoview copied just press and go to Paint and click paste…

20. ITS Report

Johnnie Edmonston

Personal Computers

The R.O.'s PC had to have its hard drive replaced, as the old one failed. Apparently the failure came as no surprise to the RO who had been hearing knocking noises coming from it for some time. No data was stored on the drive and the RO was happy for a 20Gig drive to be fitted as only applications reside on it.

Netware

JRNA experienced no problems during the cruise. No abends to report, disk space is ok, NDS ok, groupwise integrity ok.

Unix / Linux

JRLA rebooted once when the server was not returning receipts. Otherwise ok.

The raid array on JRUF at the start of JR100 was running at 79% capacity. Upon further examination one user took up 15% of this space. As the cruise was generating data at a rate of approx 1% per day, it quickly became apparent that disk space was not going to last the cruise. A decision was therefore taken to back up the user data and then remove it from the server, bringing disk usage down to 64%. Further space was then reclaimed by clearing out old data belonging to the krill and pstar accounts and the user account of Sharon Grant (SAGR) - no longer employed by BAS. In all cases data was backed up DVD / CD rom and passed on to Nathan Cunningham, Biosciences Data Manager.

EM120

A similar situation as JRUF with regards to disk space. /data2 is running at approx 70 full. In this instance there is so much data to be removed that there isn't enough disk space to tar it all into one file and bzip it and before writing it to tape. Nathan Cunningham has offered to take back data to Cambridge, where upon confirmation of safe receipt and integrity, it will be removed from /data2.

SCS Logging System

The following instruments were logged to the SCS logging system:

Number	Sensor name	levc credat names
001	Glonass	gps_glos
015	GPS-ADU	gps_ash
023	Trimble	gps_nmea
029	Anemometer	Anemom
032	TSSHRP	Tsshrp
038	Oceanlogger	Oceanlog
058	Emlog	em_log
060	Dopperlog	dop_log
063	Simrad-ea500	sim500
065	Simrad-em120	em120
067	Net-Monitor	net-mon
082	Winch	Winch
090	pmlbox	pmlbox
096	Truewind-spd	
097	Truewind-dir	
098	Seatex	seatex
104	minipack	minipack
	new_stcm	new_stcm
	gyro	gyro

In addition, the ADCP was logged directly the RVS data streams.

Continuous data acquisition began at 1441 gmt on the 9th February 2004.

Underway events

Date	Time	Underway events
12/3/4	1545	All IP traffic stopped, JRNA complains of another MAC address
		having the same IP address.
12/3/4	1900	Fault found and rectified. Minipack serial out plugged directly into
		switch rather than SCS com port.
15/3/4	1921	JRUF restarted and scs2levc streams restarted, netmon stream hadn't
		updated correctly.
16/3/4	0004	Oceanlogger stopped being logged by SCS,
	0020	Oceanlogger found not be logging to SCS
	0034	Fault found and rectified – serial out had been knocked out of socket on
		wall
18/3/4	1347	Ashtec crashed
18/3/4	1352	Ashtec restarted, crashed again. SCS crashed.
18/3/4	1406	SCS restarted, Ashtec ok. TSSHRP looking suspicious - output garbage
18/3/4	1417	SCS restarted – TSSHRP still not ok.
		gyro data bad – level A crashed. Level A reset.
18/3/4	1440	SCS stopped to run a comtest on COM13 (TSSHRP), COM13 ok
		TSSHRP not ok – still garbage
		Ashtec ok, level A, gyro ok, SCS ok.
18/3/4	1442	restarted continuous data acquisition on SCS
		TSSHRP restarted – data output ok

A new socket message (COM27) was setup to send navigation data to the CTD; the previous socket message on COM28 has been redirected to the topas plotter.

Network

On the 12th March. 1245l (1545gmt), all IP traffic across the network stopped. JRUF lost sight of the SCS, all samba connections stopped and JRNA started complaining that another device on the network had stolen its IP address, causing complications on the netware network, which had also stopped.

After checking every laptop on the ship, and then isolating the ships network deck by deck, it quickly became apparent that the fault lay on the forecastle deck.

JRNA was set up to continuously ping jruf, whilst individual switches on the forecastle deck were then isolated. This eventually led to one port in the UIC, which when disconnected allowed IP traffic to flow with 0% packet loss.
When connected, packet loss remained uninterrupted for between 20 and 30 packets before a 1 in 3 packet loss occurred then eventually all traffic stopped.

The offending port was the serial out from the minipack, which had been set up to log to the SCS but had been plugged into the main network and not the SCS.
The minipack itself was turned off at all times during this period and I can only assume that serial card itself was acting in a manner similar to a dongle and responding to normal network broadcasts.

Other

When running the poly convert process:
c:\minipack>c:\perl\bin\perl poly_convert.pl poly_convert.xml routine the minipack-real.tpl file from a previous cruise had to copied into the SCS compress directory.

The Cambridge ITS and ITSonly webpages have been copied to O:\ITS\Cambridge ITS webpages. Dated early Feb 2004.

Large amounts of swath data, 3 cruises worth, remain on the RAID array; this should be removed as soon as confirmation is received from Cambridge as to safe receipt and restoration to the Cambridge file systems.

Work to be done/Recommendations

- Finish indent as a matter of priority during the first half of the AMT bearing in mind recommendations from JR104 cruise report.

Data retention on JRU - users on long cruises leaving behind large amounts of data can have a bearing on the amount of space left for active data acquisition. In the case of this cruise, had a clean up not been carried out, there would not have been enough disk space to finish the cruise. This was caused entirely by data, which in most likelihood has been taken to Cambridge. Should there be a policy implemented to prev

21. APPENDiCES

Appendix A: CTD Configurations

Report for Stations 001 to 007

Date: 03/19/2004

ASCII file: D:\data\Jr100\JR100origsetup.con

Configuration report for SBE 911/917 plus CTD

Frequency channels suppressed : 0

Voltage words suppressed : 0

Computer interface : RS-232C

Scans to average : 1

Surface PAR voltage added : No

NMEA position data added : No

Scan time added : No

1) Frequency, Temperature

Serial number : 032679

Calibrated on : 13-May-03

G : 4.36448805e-003

H : 6.44268079e-004

I : 2.37330434e-005

J : 2.31496586e-006

F0 : 1000.000

Slope : 1.00000000

Offset : 0.0000

2) Frequency, Conductivity

Serial number : 042255

Calibrated on : 14-May-03

G : -1.02537060e+001

H : 1.41054885e+000

I : -1.91533552e-003

J : 2.35323689e-004

CTcor : 3.2500e-006

CPcor : -9.57000000e-008

Slope : 1.00000000

Offset : 0.00000

3) Frequency, Pressure, Digiquartz with TC

Serial number : 09P15759-0480(67241)

Calibrated on : 24-Jul-03

C1 : -4.461418e+004

C2 : 3.038286e-002

C3 : 1.224130e-002

D1 : 3.645500e-002

D2 : 0.000000e+000

T1 : 2.999608e+001

T2 : -3.512191e-004

T3 : 3.729240e-006

T4 : 4.918760e-009

T5 : 0.000000e+000

Slope : 0.99995000

Offset : -0.96490

AD590M : 1.283280e-002

AD590B : -9.474491e+000

4) Frequency, Temperature, 2

Serial number : 034235

Calibrated on : 04-Dec-02

G : 4.34551188e-003

H : 6.45187364e-004

I : 2.21136893e-005

J : 1.74596052e-006

F0 : 1000.000

Slope : 1.00000000

Offset : 0.0000

5) Frequency, Conductivity, 2

Serial number : 042813

Calibrated on : 22-Nov-02

G : -9.74925216e+000

H : 1.45147141e+000

I : -4.32229127e-003

J : 3.61714849e-004

CTcor : 3.2500e-006

CPcor : -9.57000000e-008

Slope : 1.00000000

Offset : 0.00000

6) A/D voltage 0, PAR/Irradiance, Biospherical/Licor

Serial number : 7235
Calibrated on : 22/8/03
M : 1.00000000
B : 0.00000000
Calibration constant : 34129690000.00000000
Multiplier : 1.00000000
Offset : -0.04191480

7) A/D voltage 1, Free

8) A/D voltage 2, Oxygen, SBE 43

Serial number : 0245
Calibrated on : 27/8/02
Soc : 4.0080e-001
Boc : 0.0000
Offset : -0.4413
Tcor : 0.0014
Pcor : 1.35e-004
Tau : 0.0

9) A/D voltage 3, Free

10) A/D voltage 4, Oxygen, SBE 43, 2

Serial number : 0242
Calibrated on : 7/7/03
Soc : 4.6410e-001
Boc : 0.0000
Offset : -0.4707
Tcor : -0.0001
Pcor : 1.35e-004
Tau : 0.0

11) A/D voltage 5, Free

12) A/D voltage 6, Altimeter

Serial number : 2130.27001
Calibrated on :
Scale factor : 15.000
Offset : 0.000

13) A/D voltage 7, Free

CTD Configuration Report for Stations 008 and 009

Date: 03/19/2004
ASCII file: D:\data\Jr100\JR100setuptimes2.con
Configuration report for SBE 911/917 plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Scans to average : 1
Surface PAR voltage added : No
NMEA position data added : No
Scan time added : No

1) Frequency, Temperature

Serial number : 032679
Calibrated on : 13-May-03
G : 4.36448805e-003
H : 6.44268079e-004
I : 2.37330434e-005
J : 2.31496586e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency, Conductivity

Serial number : 042255
Calibrated on : 14-May-03
G : -1.02537060e+001
H : 1.41054885e+000
I : -1.91533552e-003
J : 2.35323689e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency, Pressure, Digiquartz with TC

Serial number : 09P30856-0707(89973)
Calibrated on : 10-Jul-02
C1 : -4.925971e+004
C2 : -2.136250e-001
C3 : 9.435710e-003
D1 : 3.900400e-002
D2 : 0.000000e+000
T1 : 2.983458e+001
T2 : -3.883229e-004
T3 : 3.262440e-006
T4 : 3.429810e-009
T5 : 0.000000e+000
Slope : 1.00000000
Offset : 0.00000
AD590M : 1.277500e-002
AD590B : -9.391456e+000

4) Frequency, Temperature, 2

Serial number : 034235
Calibrated on : 04-Dec-02
G : 4.34551188e-003
H : 6.45187364e-004
I : 2.21136893e-005
J : 1.74596052e-006
F0 : 1000.000
Slope : 1.00000000

Configuration Report for
Stations 001 to 007.
Offset : 0.0000

5) Frequency, Conductivity, 2

Serial number : 042813
Calibrated on : 22-Nov-02
G : -9.74925216e+000
H : 1.45147141e+000
I : -4.32229127e-003
J : 3.61714849e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, PAR/Irradiance, Biospherical/Licor

Serial number : 7235
Calibrated on : 22/8/03
M : 1.00000000
B : 0.00000000
Calibration constant : 34129690000.00000000
Multiplier : 1.00000000
Offset : -0.04191480

7) A/D voltage 1, Free

8) A/D voltage 2, Oxygen, SBE 43

Serial number : 0245
Calibrated on : 27/8/02
Soc : 4.0080e-001
Boc : 0.0000
Offset : -0.4413
Tcor : 0.0014
Pcor : 1.35e-004
Tau : 0.0

9) A/D voltage 3, Free

10) A/D voltage 4, Oxygen, SBE 43, 2

Serial number : 0242
Calibrated on : 7/7/03
Soc : 4.6410e-001
Boc : 0.0000
Offset : -0.4707
Tcor : -0.0001
Pcor : 1.35e-004
Tau : 0.0

11) A/D voltage 5, Free

12) A/D voltage 6, Altimeter

Serial number : 2130.27001
Calibrated on :
Scale factor : 15.000
Offset : 0.000

13) A/D voltage 7, Free

CTD Configuration Report for Stations 010 to 025.

Date: 03/19/2004

ASCII file: D:\data\Jr100\JR100.con

Configuration report for SBE 911/917 plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Scans to average : 1
Surface PAR voltage added : No
NMEA position data added : No
Scan time added : No

1) Frequency, Temperature

Serial number : 032679
Calibrated on : 13-May-03
G : 4.36448805e-003
H : 6.44268079e-004
I : 2.37330434e-005
J : 2.31496586e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency, Conductivity

Serial number : 042255
Calibrated on : 14-May-03
G : -1.02537060e+001
H : 1.41054885e+000
I : -1.91533552e-003
J : 2.35323689e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency, Pressure, Digiquartz with TC

Serial number : 09P30856-0707(89973)
Calibrated on : 10-Jul-02
C1 : -4.925971e+004
C2 : -2.136250e-001
C3 : 9.435710e-003
D1 : 3.900400e-002
D2 : 0.000000e+000
T1 : 2.983458e+001
T2 : -3.883229e-004
T3 : 3.262440e-006
T4 : 3.429810e-009
T5 : 0.000000e+000
Slope : 1.00000000
Offset : 0.00000
AD590M : 1.277500e-002
AD590B : -9.391456e+000

4) Frequency, Temperature, 2

Serial number : 034235
Calibrated on : 04-Dec-02
G : 4.34551188e-003
H : 6.45187364e-004
I : 2.21136893e-005
J : 1.74596052e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency, Conductivity, 2

Serial number : 042813
Calibrated on : 22-Nov-02
G : -9.74925216e+000
H : 1.45147141e+000
I : -4.32229127e-003
J : 3.61714849e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000

Offset : 0.00000

Scale factor : 15.000
Offset : 0.000

6) A/D voltage 0, PAR/Irradiance, Biospherical/Licor

Serial number : 7235
Calibrated on : 22/8/03
M : 1.00000000
B : 0.00000000
Calibration constant : 34129690000.00000000
Multiplier : 1.00000000
Offset : -0.04191480

7) A/D voltage 1, Free

8) A/D voltage 2, Fluorometer, Chelsea Aqua 3

Serial number : 088249
Calibrated on : 3 Dec 2001
VB : 0.129000
V1 : 2.088200
Vacetone : 0.122200
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

9) A/D voltage 3, Free

10) A/D voltage 4, Oxygen, SBE 43

Serial number : 0242
Calibrated on : 7/7/03
Soc : 4.6410e-001
Boc : 0.0000
Offset : -0.4707
Tcor : -0.0001
Pcor : 1.35e-004
Tau : 0.0

11) A/D voltage 5, Free

12) A/D voltage 6, Altimeter

Serial number : 2130.27001
Calibrated on :

13) A/D voltage 7, Free

Appendix B. JR100 Transect Log

Time	Transect name	Description	Latitude	Longitude	Start/end	Comment
04:50:00 04/01/2004	transit	transit	-53.0570	-39.2091	end	arrive deep LHPR site
21:32:00 31/03/2004	transit	transect 4.1 to deep LHPR site	-53.3371	-37.9126	start	280 degrees speed 7 knots night
21:30:44 31/03/2004	**wcb 4.1**	Transect finished north. Cut approx. 10 nm short because 1 hour after sunset	-53.3392	-37.9104	end	Making way to Deep LHPR site
20:05:08 31/03/2004	**wcb 4.1**		-53.3371	-37.9126	start	resume after fishing, sailing N
17:50:00 31/03/2004	**wcb 4.1**		-53.5549	-37.8325	end	off transect to go fishing
15:50:01 31/03/2004	**wcb 4.1**		-53.8589	-37.7357	start	south (parallel to original transect due to ice)
15:47:00 31/03/2004	stn 3.2s to 4.1	transit	-53.8748	-37.7403	end	
14:30:00 31/03/2004	stn 3.2s to 4.1	transit	-53.6470	-37.9660	start	Stn 3.2S to south end 4.1
12:36:00 31/03/2004	BI to stn 3.2s	transit	-53.6526	-38.0958	end	
10:50:06 31/03/2004	BI to stn 3.2s	Run from Bird Island to south station on 3.2	-54.0010	-37.9940	start	
17:21:50 29/03/2004	**wcb 3.2**		-53.1834	-38.1403	end	north
15:21:21 29/03/2004	**wcb 3.2**	Rejoined transect 3.2	-53.5197	-38.0253	start	Missed out the S part of transect due to ice.
13:03:18 29/03/2004	**wcb 3.1**	Transect W3.1 cut short because of ice	-53.5343	-38.0047	end	Will rejoin W3.2 nearly half way up due to ice around the south of the transect
09:33:18 29/03/2004	**wcb 3.1**		-53.2218	-38.4499	start	
06:30:03 29/03/2004	2.2 - 3.1 transit		-53.3973	-38.6551	end	
06:17:00 29/03/2004	2.2 - 3.1 transit		-53.4196	-38.6815	start	
02:33:00 29/03/2004	night wcb2.2		-53.4656	-38.6028	end	
00:29:00 29/03/2004	night wcb2.2	from sta 2.2S to 2.2N at night	-53.6936	-38.7188	start	
17:24:46 28/03/2004	**wcb 2.2**	ended transect sooner	-38.6030	-53.7386	end	Off transect and slowing down to 6 knots due to ice
14:16:33 28/03/2004	**wcb 2.2**		-53.2580	-38.7384	start	Slightly off transect due to ice
12:54:45 28/03/2004	**wcb 2.1**	finished transect	-53.4196	-38.6815	end	starting dead head to transect 2.2
09:52:59 28/03/2004	**wcb 2.1**		-53.7441	-38.8975	start	started 10 miles N of normal start owing to ice
09:30:00 28/03/2004	diagonal	Stn 1.2S to start 2.1	-53.7845	-38.9132	end	time approximate
07:50:00 28/03/2004	diagonal	Stn 1.2S to start 2.1	-53.8463	-39.1435	start	runs through dawn. 2.1 start shifted N due to ice

21:20:22 27/03/2004	**wcb 1.2**		-53.4943	-39.2506	end	
20:12:29 27/03/2004	**wcb 1.2**		-53.3157	-39.3026		re-start of 1.2
19:28:14 27/03/2004	**wcb 1.2**		-53.3158	-39.3039	end	Stop and restart
17:23:24 27/03/2004	**wcb 1.2**		-53.6660	-39.1955	start	
14:15:49 27/03/2004	**wcb 1.1**		-54.0565	-39.3909	end	
09:57:27 27/03/2004	**wcb 1.1**	WCB first transect w1-1 north to south	-53.3469	-39.6028	start	large swell towing UOR
07:46:00 27/03/2004	wcb diagonal		-53.3701	-39.4710	end	
00:18:01 27/03/2004	wcb diagonal	overnigt transit from shallow mooring site to NW corner of WCB	-53.7746	-38.0830	start	8 knots
10:18:45 26/03/2004	**wcb 3.2 east**	around shallow mooring site	-53.7843	-37.9091	end	other start and end points not entered because track generally not straight owing to ice
07:42:00 26/03/2004	**wcb 3.2 west**	around shallow mooring site	-53.7341	-37.9882	end	
06:29:00 26/03/2004	**wcb 3.2 west**	around shallow mooring site	-53.8623	-37.9467	start	wcb 3-2, on-shelf, 3*8-mile parallel transects
09:20:05 23/03/2004	**os-1**	offshore search	-53.2976	-37.8372	end	
07:04:00 23/03/2004	**os-1**	offshore search	-53.5673	-37.4668	start	diagonal across fishing box
11:16:02 22/03/2004	**is-4**	inshore search	-53.6179	-37.3612	end	
10:03:00 22/03/2004	**is-4**	inshore search	-53.4332	-37.3610	start	north - south
09:41:00 22/03/2004	**is-3**	inshore search	-53.4332	-37.3610	end	
08:34:36 22/03/2004	**is-3**	inshore search	-53.6195	-37.4546	start	south - north
08:03:54 22/03/2004	**is-2**	inshore search	-53.5950	-37.5449	end	
06:58:33 22/03/2004	**is-2**	inshore search	-53.4340	-37.5454	start	north -south
06:30:57 22/03/2004	**is-1**	inshore search	-53.4338	-37.6398	end	
05:24:19 22/03/2004	**is-1**	inshore search	-53.6152	-37.6369	start	south - north
12:13:16 21/03/2004	**5.14**	end of transect	-53.6382	-38.0036	end	
08:22:00 21/03/2004	**5.14**	travelling west towards the start of T4	-53.6467	-37.0029	start	
08:09:00 21/03/2004	**5.13**	turn to west	-53.6406	-37.0009	end	
06:59:00 21/03/2004	**5.13**	Southerly deadhead after T5D	-53.4885	-37.0003	start	
04:46:55 21/03/2004	**5.12**		-53.4834	-37.0140	end	
03:00:00 21/03/2004	**5.12**	Detour around iceberg ends around 03:51	-53.4792	-37.4401		
23:18:00 20/03/2004	**5.12**	E119 to T5D	-53.4839	-38.2807	start	

17:34:00 20/03/2004	**5.11**	fishing stop	-53.4827	-38.2538	end	
16:41:34 20/03/2004	**5.11**	start of transecting after T5-C	-53.4841	-38.4945	start	
14:23:42 20/03/2004	**5.1**	T5-C	-53.4872	-38.5000	end	
10:17:00 20/03/2004	**5.1**		-53.4830	-39.4693	start	
07:11:44 20/03/2004	**5.9**	stop for RMT test	-53.4829	-39.4748	end	
06:54:13 20/03/2004	**5.9**	rejoin transect after aborted fishing	-53.4823	-39.5465	start	
05:53:00 20/03/2004	**5.8**	stop for fishing	-53.4821	-39.5443	end	
03:59:24 20/03/2004	**5.8**	T5B to T5C	-53.4836	-39.9989	start	
01:24:00 20/03/2004	**5.7**	T5B	-53.4850	-39.9866	end	
00:34:54 20/03/2004	**5.7**	continuation after E103 to T5B	-53.4833	-40.2055	start	
21:47:00 19/03/2004	**5.6**	E103	-53.4834	-40.1485	end	
19:08:30 19/03/2004	**5.6**	From E101 toT5B	-53.4826	-40.8081	start	
15:53:01 19/03/2004	**5.5**	Breaking off to examine fish marks	-53.4829	-40.7092	end	
12:30:36 19/03/2004	**5.5**	Steaming to T5-B	-53.4833	-40.2055	start	
09:59:00 19/03/2004	**5.4**	T5A	-53.4950	-41.5262	end	
09:32:16 19/03/2004	**5.4**	return to T5A	-53.5105	-41.6327	start	
04:15:20 19/03/2004	**5.3**		-53.4825	-41.4892	end	
02:51:00 19/03/2004	**5.3**	fish search	-53.3939	-41.7612	start	
00:19:00 19/03/2004	**5.2**	fishing stop	-53.4475	-41.4906	end	
20:36:13 18/03/2004	**5.2**	Rejoin transect	-53.4330	-42.0982	start	
16:49:06 18/03/2004	**5.1**	Broke for fishing	-53.4336	-42.0305	end	
13:06:46 18/03/2004	**5.1**	Steam from T5-Z to T5-A	-53.4831	-42.9998	start	
10:37:56 18/03/2004	**4.1**		-53.4823	-43.0000	end	
09:43:23 18/03/2004	**4.1**	deadhead between transects 4 and 5	-53.6325	-43.0004	start	heading north
09:01:00 18/03/2004	**4.9**		-53.6333	-42.9815	end	
06:34:06 18/03/2004	**4.9**	from T4Z to end of transect	-53.6331	-42.2753	start	
05:40:16 18/03/2004	**4.8**		-53.6353	-42.2464	end	
03:25:54 18/03/2004	**4.8**	return to CTD station T4Z	-53.5761	-42.7419	start	
01:15:00 18/03/2004	**4.7**		-53.5960	-42.6993	end	

01:03:45 18/03/2004	**4.7**		-53.5964	-42.7425	start	
00:44:19 18/03/2004	**4.6**	90 degrees turn to the north	-53.6328	-42.7535	end	
22:19:30 17/03/2004	**4.6**		-53.6337	-42.2502	start	
20:39:25 17/03/2004	**4.5P**	Stopped for Station T4-Z	-53.6335	-53.6344	end	New station added west of Black/Shag Rocks
14:37:00 17/03/2004	**4.5P**		-53.6332	-40.7437	start	transect break added post hoc
12:13:00 17/03/2004	**4.5**		-53.6335	-40.7547	end	
10:08:40 17/03/2004	**4.5**		-53.6322	-40.1965	start	
09:31:00 17/03/2004	**4.4**		-53.6337	-40.0951	end	
07:27:50 17/03/2004	**4.4**		-53.6334	-39.5817	start	from E68
04:18:59 17/03/2004	**4.3**	fishing stop	-53.6349	-39.5763	end	fishing stop and search E68
03:11:00 17/03/2004	**4.3**	T4C	-53.6336	-39.2430	start	
23:52:00 16/03/2004	**4.2**	T4C	-53.6324	-39.2695	end	
19:56:00 16/03/2004	**4.2**	after fishing event 61	-53.6287	-39.2615	start	this time was end of fishing event needs updating to time when on course and at speed
17:13:26 16/03/2004	**4.1**	Stopped for fishing	-53.6397	-38.3086	end	Stopped for fishing (E61)
15:56:47 16/03/2004	**4.1**		-37.9581	-53.6245	start	start of transect 4
14:47:09 16/03/2004	**3.7**		-53.7835	-37.9994	end	End of transect 3
14:06:49 16/03/2004	**3.7**		-53.7813	-38.1699	start	After fishing (E 58) we are back on transect
09:39:27 16/03/2004		returning from fishing site to T3.C	-53.3371	-38.5440		?
04:30:46 16/03/2004	**3.6**		-53.3715	-38.4772	end	
01:24:00 16/03/2004	**3.6**		-53.5835	-38.2037		turned onto first south-north transect
00:15:00 16/03/2004	**3.6**	fish search to north of transect	-53.7133	-38.2408	start	parallel transects to cover the shelf break
22:30:00 15/03/2004	**3.5**		-53.7719	-38.2761	end	
18:45:00 15/03/2004	**3.5**		-53.7868	-39.0310		Leaving transect due to iceberg and speed down to 7 knots (fog and ice)
18:31:00 15/03/2004	**3.5**	E52 to T3C	-53.7834	-39.0945	start	
14:05:04 15/03/2004	**3.4**	RMT25 (E51) and Pelagic (E52)	-53.7864	-39.0688	end	stopped for fishing
10:24:57 15/03/2004	**3.4**		-53.7837	-39.9970	start	
08:09:51 15/03/2004	**3.3**		-53.7838	-39.9959	end	
07:15:48 15/03/2004	**3.3**		-53.7831	-40.0963	start	

04:52:28 15/03/2004	**3.2**	RMT25 (E44)	-53.7848	-40.2013	end	
03:47:21 15/03/2004	**3.2**		-53.7828	-40.4718	start	
00:35:00 15/03/2004	**3.1**	Pelagic trawl 42	-53.7728	-40.4923	end	
19:54:21 14/03/2004	**3.1**		-53.7834	-41.5005	start	
17:10:41 14/03/2004	**2.4**		-53.9332	-41.4971	end	End of transect 2
14:19:04 14/03/2004	**2.4**	back on transect 2	-53.9336	-40.7483	start	Going to finish transect 2
05:51:25 14/03/2004	**2.3**	E29	-53.9328	-40.7588		Fishing search and gone fishing; turning north of transect at CTD station
05:50:39 14/03/2004	**2.3**	T2A	-53.9336	-40.7554	end	
00:09:16 14/03/2004	**2.3**	T2B to T2A	-53.9332	-39.2618	start	
22:13:00 13/03/2004	**2.2**	T2.B	-53.9332	-39.2502	end	
22:02:15 13/03/2004	**2.2**	E23 to T2B	-53.9335	-39.2002	start	
19:30:57 13/03/2004	**2.1**	E23	-53.9335	-39.1915	end	Stopped for fishing (RMT25)
18:14:13 13/03/2004	**2.1**	on T2.B	-53.9390	-38.8334		have to leave transect due to ice
17:02:16 13/03/2004	**2.1**	T2C to T2B	-53.9311	-38.5156	start	
10:00:00 13/03/2004	**1.5**	turned towards Bird Island	-54.2236	-38.4546	end	End of transect 1; ended off original transect line owing to ice
04:22:38 13/03/2004	**1.5**	fish stop to T1C	-54.0832	-39.7247	start	no fishing winch unavailable. Ice on transect
01:28:32 13/03/2004	**1.4**	fishing stop	-54.0834	-39.7293	end	fishing stop
00:16:08 13/03/2004	**1.4**	T1B to fish stop	-54.0836	-39.9882	start	fish before 39W
21:17:23 03/12/2004	**1.3**	T1B	-54.0825	-39.9943	end	
20:02:19 03/12/2004	**1.3**	E13 to T1.B	-54.0829	-40.3583	start	
17:15:00 03/12/2004	**1.2**	E13	-54.0829	-40.3324	end	Fishing (Event 13)
13:43:32 03/12/2004	**1.2**	E10 to E13	-54.0821	-41.0678	start	
08:47:37 03/12/2004	**1.1**	E10	-54.0840	-41.0118	end	Fishing (Event 10)
06:57:11 03/12/2004	**1.1**	T1A to E10	-54.0835	-41.4975	start	

Appendix C. Net Sample Log Sheets

JR100

Event Number: **Total volume of sample (ML):**
Net Type: **Total weight of sample (g):**
Net Number: **Total volume of sub-sample (ML):**
Date: **Total weight of sub-sample (g):**

SPECIES NAME	CODE	No. in whole sample	Volume in whole sample (ML)	Weight in whole sample (g)	Sub-sampled?	No. in sub-sample	Weight in sub-sample (g)
Euphausiidae							
Euphausia superba	KRI						
Euphausia frigida	KRF						
Euphausia triacantha	KRT						
Thysanoessa macrura	THM*						
Thysanoessa spp.	THY						
unidentified Euphausiidae	KRX						
Decapoda							
Notocrangon spp.	NTX*						
Sergia spp.	SER*						
Sergestes	SEG*						
Gennadus spp.	GEX*						
Acanthaphyra cf. pelagica	ACP*						
Acanthaphyra cf. kingsleyi	ACK*						
Acanthaphyra spp.	ACX*						
Mysidacea							
Neognathouphausia spp.	NEE*						
mysid sp. A = Antarctomysis s	MYX*						
mysid sp. B	MYX*						
mysid sp. C	MYX*						
Antarctomysis spp.	ANX*						
Amphipoda							
Orchomene spp.	ORC*						
Paracallisoma alberti	PAA*						
Cyphocaris richardi	CYR*						
Danaella mimonectes	DAI*						
Eurythenes obesus	EUB*						
Eurythenes spp.	EUR*						
Eusiris spp.	EUS*						
Eusiroides stenopleura	EUT*						
Themisto gaudichaudii	THE*						
Hyperia macrocephala	HYM*						
Hyperia spp.	HYX*						
Hyperiella spp.	HPX*						
Pegohyperia princeps	PEG*						
unidentified Hyperiidae	HYP*						
Parandania boecki	PAB*						
Vibilia spp.	VIX*						
Cyllopus spp.	CYX*						

SPECIES NAME	CODE	No. in whole sample	Volume in whole sample (ML)	Weight in whole sample (g)	Sub-sampled?	No. in sub-sample	Weight in sub-sample (g)
Cyllopus lucasi	CYL*						
Cyllopus magellanicus	CYM*						
Primno macropa	PIO*						
Mimonectes sphaericus	MIS*						
Scina spp.	SCX*						
Cystisoma spp.	CYS*						
Cumaecea							
unidentified Cumacea	CUA*						
Copepoda							
Rhincalanus gigas	RHI*						
Paraeuchaeta spp.	PAE*						
Other copepods	COP*						
Ostracoda							
Gigantocypris spp.	GIX*						
Polychaeta							
Tomopteris spp.	TOM*						
Vanadis spp.	VAN*						
Chaetognatha							
Sagitta maxima	SAM*						
Sagitta spp.	SAX*						
unidentified Chaetognatha	CHX*						
Chordata (Salpida)							
Salpa thompsoni	SPT*						
Salpa thompsoni (colonial)	SPTC*						
Salpa thompsoni (solitary)	SPTS*						
unidentified Salpida	SPX						
Ctenophora							
Beroe spp	BEX*						
unidentified Ctenophora	CTX*						
Cnidaria (Hydroidomedusae)							
Sibogita spp.	SIB*						
Calycopsis spp.	CCX*						
unidentified Hydroidomed.	HYR*						
Cnidaria (Schyphozoa)							
Periphylla periphylla	PEP*						
Paraphyllina ransoni	PAR*						
Atolla wyvillei	ATW*						
Atolla spp.	ATO*						
Stygiomedusa gigantea	STG*						
unidentified Schyphomedusae	SCH						
Cnidaria (Hydrozoa)							
Diphyes sp.	DPX*						
Cnidaria (Calycophorae)							
unidentified Hippopodiidae	HIX*						
unidentified Siphonophorae	SIP*						

SPECIES NAME	CODE	No. in whole sample	Volume in whole sample (ML)	Weight in whole sample (g)	Sub-sampled?	No. in sub-sample	Weight in sub-sample (g)
Gelatinous zooplankton	GEL*						
Pteropods							
Limacina spp.	LIM*						
Clione spp.	CLI*						
Clio spp.	CLO*						
Clio pyrimidata forma sulcata	CLS*						
Spongiobranchia spp.	SPO*						
unidentified pteropods	PTX*						
Cephalopoda							
Moroteuthis knipovichi	MKN*						
Psychroteuthis glacialis	PSG						
Slosarczykovia circumantarctica	SLC*						
Allurotheuthis antarcticus	ALA*						
Unidentified Cranchiidae	CRX*						
Mastigoteuthis psychrophillia	MAY						
Unidentified cephalopoda	CEP						
Galiteuthis glacialis	GAG*						
Other invertebrates							
Total Fish Weight							
Myctophiformes							
Electrona antarctica	ELN						
Electrona carlsbergi	ELC						
Electrona subaspera	ELS*						
Electrona spp	ELT						
Gymnoscopelus braueri	GYR						
Gymnoscopelus nicholsi	GYN						
opisthopterus	GYO						
Gymnoscopelus bolini	GYB						
Gymnoscopelus fraseri	GYF						
Gymnoscopelus hintonoides	GYJ						
Gymnoscopelus microlampas	GYM*						
Gymnoscopelus piabilis	GYP*						
Gymnoscopelus spp	GYY						
Krefftichthys anderssoni	KRA						
Protomyctophum parallelum	PRP*						
Protomyctophum bolini	PRM						
Protomyctophum choriodon	PRY						
Protomyctophum gemmatum	PRA*						
Protomyctophum tenisoni	PRE						

SPECIES NAME	CODE	No. in whole sample	Volume in whole sample (ML)	Weight in whole sample (g)	Sub-sampled?	No. in sub-sample	Weight in sub-sample (g)
Protomyctophum spp	PVP						
Lampanyctus achirus	LAC						
Salmoniformes							
Nansenia antarctica	NSZ						
Bathylagidae							
Bathylagus antarcticus	BAA						
Bathylagus gracilis	BAG						
Bathylagus tenuis	BAN*						
Stomiiformes							
Stomias boa boa	SBB						
Stomias gracilis	SBG*						
Borostomias antarcticus	BRT						
Cyclothone microdon	YTM*						
Cyclothone pallida	YTP*						
Cyclothone spp.	YTX						
Aulopiformes							
Benthalbella elongata	BEE						
Aulopiformes							
Notolepis coatsi	NTO						
Notolepis spp.	NOE						
Gadiformes							
Muraenolepis microps	MOY						
Cynomacrurus piriei	MNI						
Beryciformes							
Sio nordenskoldii	SIN*						
Poromitra crassiceps	PMC						
Perciformes							
Nototheniidae							
Patagonotothen guntheri	NOG						
Lepidonotothen larsoni	NOL						
Lepidonotothen nudifrons	NOD						
Lepidonothothen sqamifrons	NOS						
Notothenia gibberifrons	NOG						
Notothenia coriiceps	NOC						
Notothenia rossii	NOR						
Melanostigma gelatinosum	MWG						
Channichthyidae							
Champsocephalus gunnari	ANI						
Pseudochaenichthys georgianus	SGI						
Chaenocephalus aceratus	SSI						
Gempylidae							
Paradiplospinosus gracilis	PDG						
Other fish							
Fish Larvae	TEL*						