

Physical Oceanography and Underway Environmental Observations

Derek Needham and André Hoek

Abstract During the 2008/09 AMLR Survey, 142 CTD/carousel casts were completed at pre-determined stations on the AMLR Survey grid and during transits between surveys. Environmental observations were made continually throughout the survey period, and 121 XBTs were deployed. Data were collected from the South Orkney Island region during Leg II. The results from 2008/09 include:

- The southern boundary of the polar front fluctuated between 57°25'S and 59°30'S throughout the summer months (January – March).
- There was very little presence of Antarctic Circumpolar Current water around the South Shetland Islands; instead, most of the water was from the Bransfield Strait/Weddell Sea or transitional between the two sources.

Introduction

Objectives during the 2008/09 AMLR Survey were to collect and process physical oceanographic data in order to identify hydrographic characteristics and map oceanographic frontal zones, and to collect and process environmental data continually while underway in order to describe sea surface and meteorological conditions experienced during the surveys. These data may be used to describe the physical circumstances associated with various biological observations, as well as provide a detailed record of the ship's movements and the environmental conditions encountered.

Methods

Oceanography

A total of 103 CTD/carousel casts were completed during Leg I (Introduction, Figure 2), and 39 CTD casts at selected locations during Leg II (Introduction, Figure 3), to complement the trawling operations. CTD casts were also completed during acoustic calibrations in Admiralty Bay at the beginning of Leg I and at the end of the Leg II.

For Leg I, water profiles and samples were collected with a Sea-Bird SBE-911plus CTD system and Sea-Bird SBE-32 carousel water sampler equipped with 11 eight-liter sampling bottles. A pumped Sea-Bird SBE-43 dissolved oxygen sensor, Chelsea Instruments Aqua^{tracka} III fluorometer and WET Labs C-Star red transmissometer made up the auxiliary sensors. The above equipment was serviced and calibrated by Sea-Bird Electronics, Inc. prior to the cruise. A Biospherical QCP-2300 2 pi PAR sensor was also mounted on the CTD frame, but swapped to the older QCP200L PAR sensor. CTD scan rates were set at 24 scans/second during both down- and up-casts. Sample bottles were only triggered during the up-casts. Profiles were limited to a depth of 750 m, or 5 m above the sea bottom when shallower than 750 m. A Datasonics altimeter was used to stop the CTD descent 5 to 10 m from the seabed on shallow casts (Table 1.1). Standard sampling depths were 750, 200, 100, 75, 50, 40, 30, 20, 15, 10 and 5 m.

Deck sheets were generated for every station, CTD data was logged and bottles were triggered using Sea-Bird Sea-save Win32 Version 5.30a software. CTD "mark" files (reflecting data from the cast at bottle-triggering depths) were also collected. Data was processed using SBE Data Processing Version 5.30a software, averaged over one meter bins, and saved separately as up- and down-traces during post-processing. Downcast data was re-formatted using a SAS script and then imported into Ocean Data View (ODV) format for further presentation.

Water samples were collected on CTD casts during Leg I at 11 discrete depths and used for salinity and phytoplankton analysis. These were drawn from Niskin bottles by the Russian scientific support team. Salinity calibration samples were analyzed on board, using a Guildline Portasal salinometer. Comparisons of dissolved oxygen levels in the carousel water samples and levels measured via the CTD's SBE-43 DO sensor were completed using an automatic potentiometric titrator.

For Leg II, the CTD was rebuilt on a smaller frame for deployment over the port side of the ship. The carousel, fluorometer, transmissometer and PAR sensor were removed.

A total of 121 expendable bathythermographs (XBTs) were deployed during Legs I and II to complement the data collected by the CTD system. Twenty-one XBTs were dropped on the initial south-bound transit during January. An additional 57 XBTs were deployed during Leg I, including 21 on the transit from the South Shetland Islands to Punta Arenas at the end of the Leg. Forty-two XBTs were deployed during Leg II. Of the XBTs dropped during Leg II, 17 were deployed on the final south-to-north transit in March. The remaining XBTs were deployed during transits between stations and at cancelled stations around the South Orkney Islands.

Comparisons of the Sea-Bird SBE-21 thermosalinograph (TSG) with CTD data were performed during the main survey. Compared with 5 m CTD salinity data, the TSG salinity reading was, on average, -0.075 ppt (n=55) lower than the CTD reading.

Table 1.1. SCS and CTD sensor installation summary (Legs I & II).

SCS Sensor Installation Summary (2009)				
Sensor	Manufacturer	Model	Serial No.	Date Calibrated
Weather Station	Coastal Environmental Systems	WEATHERPAK-2000	798	30-May-08
PAR sensor (2 pi)	LI-COR	LI-190SZ Quantum	Q40069	12-Jul-08
PAR sensor (4pi)	Biospherical Instruments Inc.	QSR-2100	10281	1-Jun-06
Thermosalinograph	Sea-Bird Electronics, Inc.	SBE 21	2971	17-Jul-08
GPS navigator	Trimble Navigation Limited	-	-	-
Gyro compass	Guiys	-	-	-

Environmental Observations

Environmental and vessel positional data were collected during the transits to and from Punta Arenas and during the surveys on both Leg I and Leg II via the Scientific Computer System (SCS) software package. The SCS software (SCS Version 3.3a) ran on a Windows XP-based Pentium IV Dell PC with an Edgeport-8 USB serial port expander. A Coastal Environmental Systems Company WEATHERPAK system, a LI-COR 2 pi quantum PAR sensor and a Biospherical Instruments 4 pi QSR-2100 PAR sensor were installed on the port side of the forward A-frame in front of the bridge and were used as the primary meteorological data acquisition system. The above equipment was serviced and calibrated by Coastal

Environmental Systems Company prior to the cruise.

Weather data inputs included relative wind speed and direction, barometric pressure, air temperature and irradiance. The relative wind data were converted to true speed and true direction by the internally derived functions of the SCS logging software.

Measurements of sea surface temperature and salinity were received by the SCS, in serial format, from the Sea-Bird SBE-21 thermosalinograph (TSG) and integrated into the logged data. This TSG system was serviced and calibrated by Sea-Bird Electronics prior to the cruise.

Ship position and heading were provided in NMEA format via a Trimble GPS Navigator and Guiys Gyro in the ship's navigation room. Serial data lines were interfaced to the Pentium 4 (Windows XP Professional based) logging PC via an Edgeport 8 serial RS232 to USB interface (Table 1.1).

Results

Environmental Observations

Environmental data were recorded for the duration of the surveys and for the transits between Punta Arenas and the survey area. Processed data were averaged and filtered over one and five minute intervals (Figures 1.1 and 1.2).

Oceanography

AMLR 2008/09 - Leg I (South Shetland Islands)

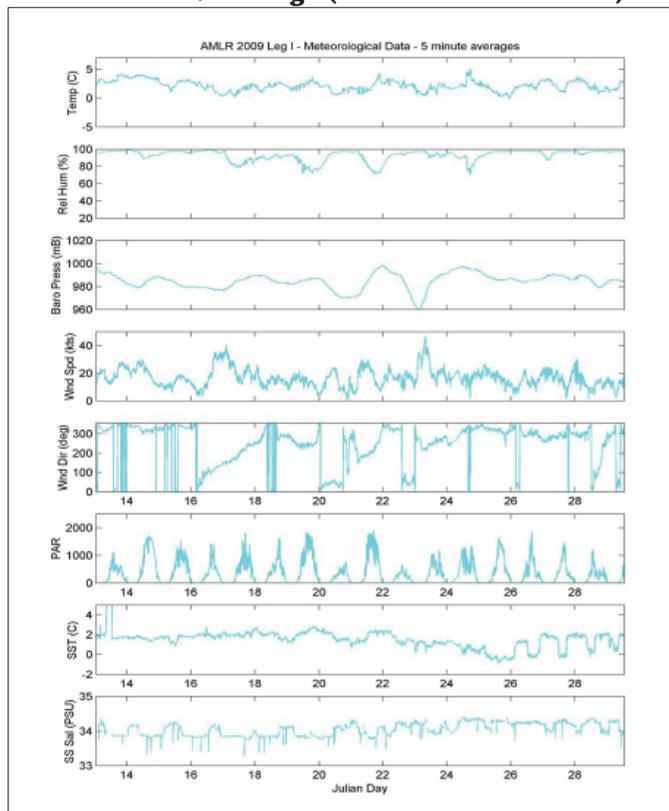


Figure 1.1. Meteorological data (5 minute averages) recorded between January 13th and January 29th during Leg I of the AMLR 2008/09 cruise.

AMLR 2008/09 - Leg II (South Orkney Islands)

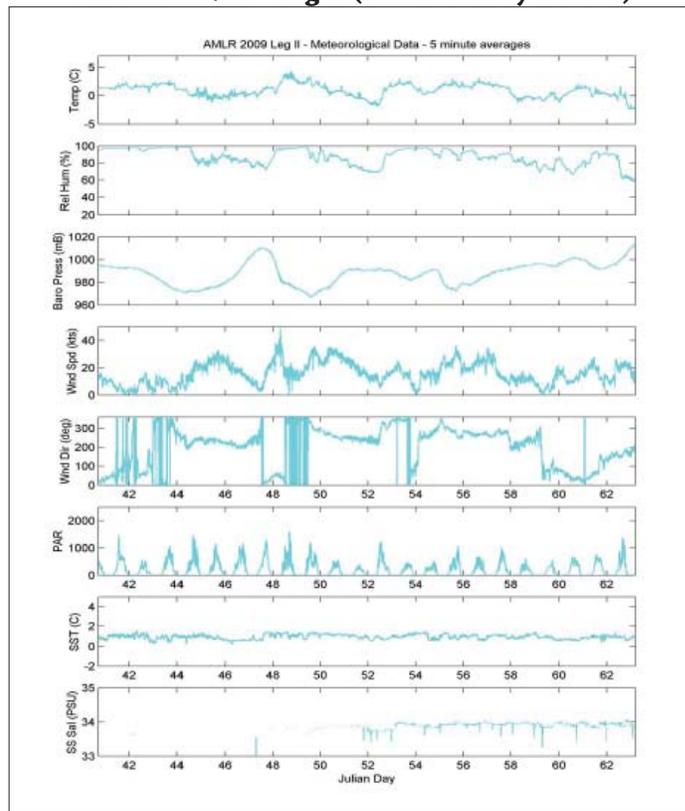


Figure 1.2. Meteorological data (5 minute averages) recorded between February 4th and March 4th during Leg II of the AMLR 2008/09 cruise.

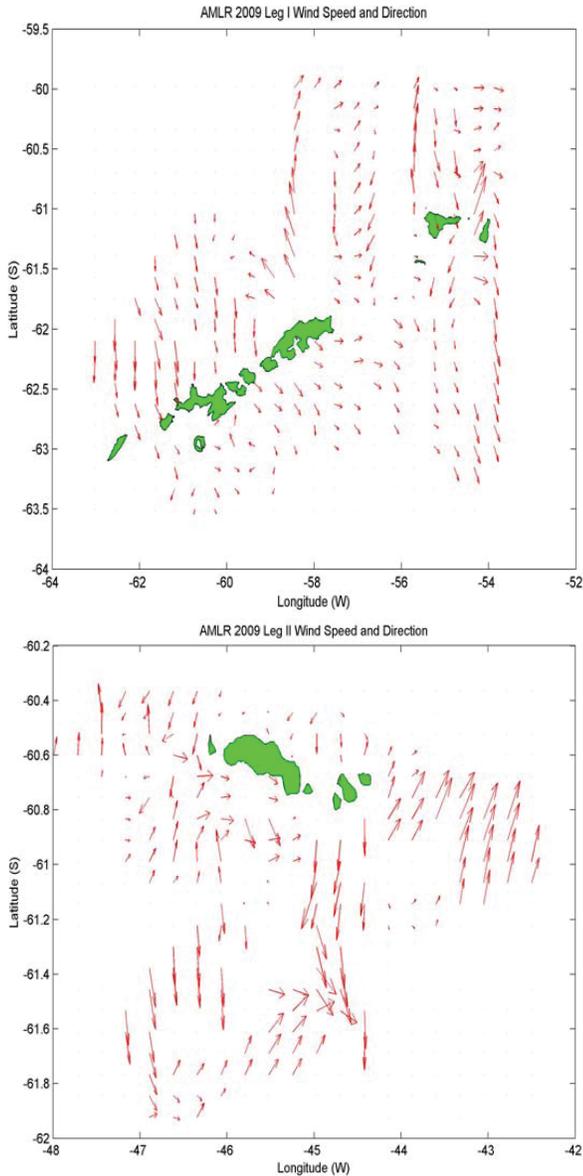


Figure 1.3. Vectors representing wind speed and direction for Legs I (top) & II (bottom), derived from data recorded by the SCS logging system during AMLR 2008/09.

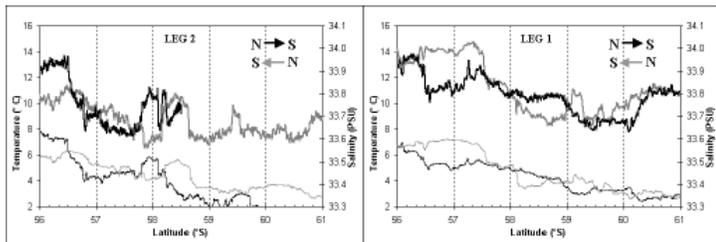


Figure 1.4. The position of the polar fronts during AMLR 2009/09 Legs I (top) and II (bottom), as determined from measurements of sea surface temperature and salinity, for the south- and north-bound transits to and from the South Shetland Islands.

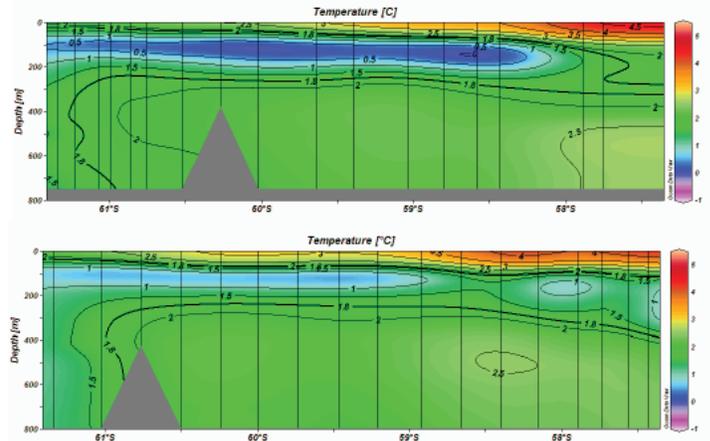


Figure 1.5. XBT temperature data for AMLR 2008/09: Leg I (top) & Leg II (bottom) northbound transects.

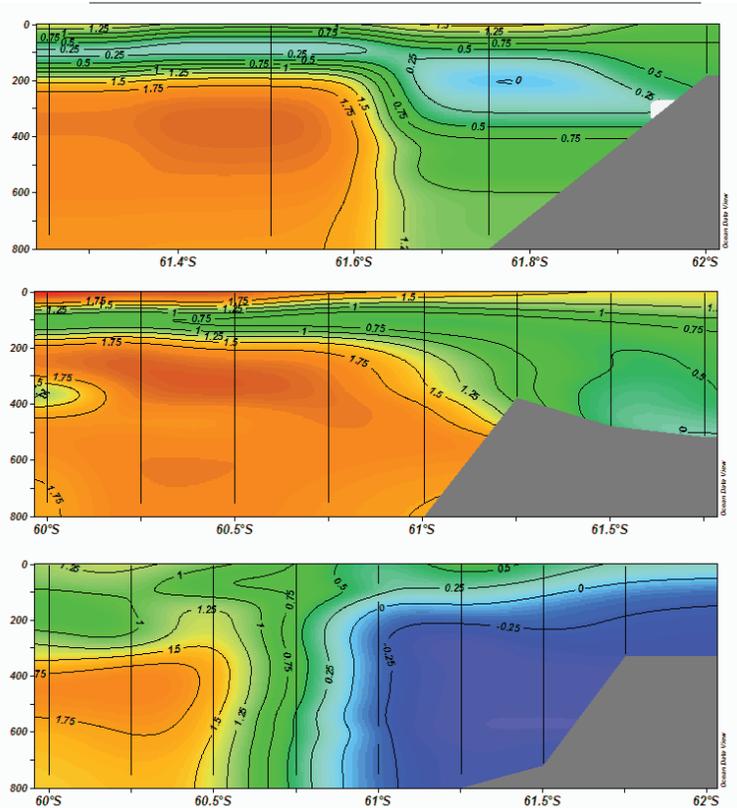


Figure 1.6. Vertical temperature profiles derived from CTD data recorded on three transects, W 05 (top), EI 03 (middle) and EI 07 (bottom), during Leg I of the 2008/09 AMLR Survey.

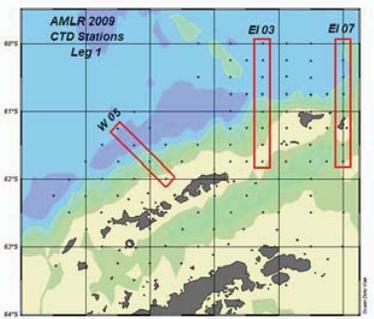


Table 1.2. Water Zone definitions applied during the 2008/09 AMLR Survey.

Water Zone Definition	T/S Relationship			Typical T/S Curve (from 2002)
	Left	Middle	Right	
Water Zone I (ACC)	Pronounced V shape with V at <0 C			
Warm, low salinity water, with a strong subsurface temperature minimum, Winter Water, approx. -1°C, 34.0 ppt salinity, and a temperature maximum at the core of the CDW near 500m.	2 to >3°C at 33.7 to 34.1 ppt	<0°C at 33.3 to 34.0 ppt	1 to 2°C at 34.4 to 34.7ppt (generally >34.6 ppt)	
Water Zone II (Transition)	Broader U-shape			
Water with a temperature minimum near 0°C, isopycnal mixing below the temperature minimum and CDW evident at some locations.	1.5 to >2°C at 33.7 to 34.2 ppt	-0.5 to 1°C at 34.0 to 34.5 ppt (generally >0°C)	0.8 to 2°C at 34.6 to 34.7 ppt	
Water Zone III (Transition)	Backwards broad J-shape			
Water with little evidence of a temperature minimum, mixing with Type II transition water, no CDW and temperature at depth generally >0°C	1 to >2°C at 33.7 to 34.0 ppt	-0.5 to 0.5°C at 34.3 to 34.4 ppt	< 1°C at 34.7 ppt	
Water Zone IV (Bransfield Strait)	Elongated S-shape			
Water with deep temperature near -1°C, salinity 34.5 ppt, cooler surface temperatures.	1.5 to >2°C at 33.7 to 34.2 ppt	-0.5 to 0.5°C at 34.3 to 34.45 ppt	<0°C at 34.5 ppt (salinity <34.6ppt)	
Water Zone V (Weddell Sea)	Small fish-hook shape			
Water with little vertical structure and cold surface temperatures near or < 0°C.	Aprox. 1°C at 34.1 to 34.4 ppt	-0.5 to 0.5°C at 34.5 ppt	<0°C at 34.6ppt	

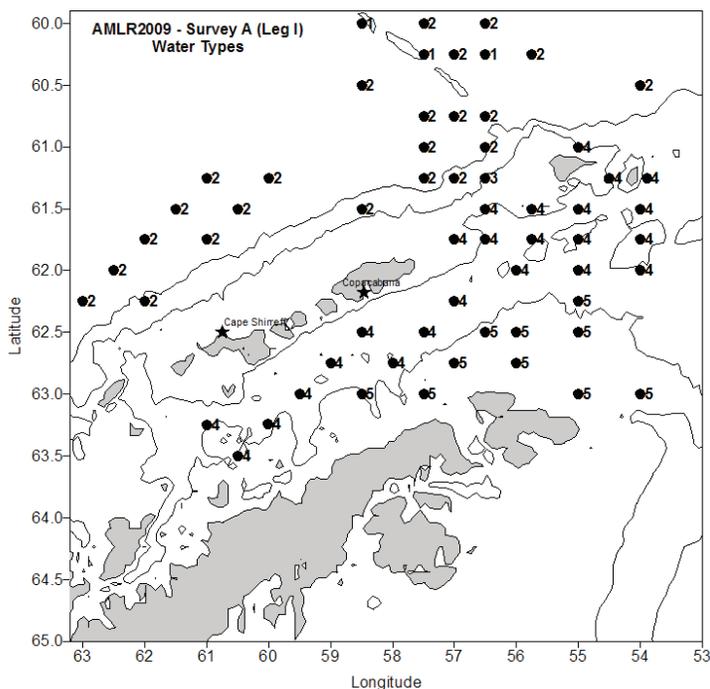


Figure 1.7 Classification of water zones for Leg I for AMLR 2008/09, as defined in Table 1.2

The position of the polar frontal zone, identified by pronounced sea surface temperature and salinity change, was located from the logged SCS data during the two transits between Punta Arenas and the South Shetland Islands. This frontal zone is normally situated between 57-58° S.

During the south-bound transit of Leg I, a broad front was encountered between 57°30'S and 59°30'S, where sea surface temperature (SST) changed from 5.8°C to 3°C. On the north-bound transit, the front was more defined around 58°10'S to 57°25'S, where SST changed from 3.5°C to 6.8°C. On the south-bound transit of Leg II, the front was well defined between 58°05' S and 59° S, where SST decreased from 6°C to 2°C. On the return transit, at the end of Leg II, the zone was located between 58° 40' S and 57° 50' S, where SST increased from 4.0°C to 6.5°C (Figure 1.4).

The two northbound XBT transects across the Drake Passage were plotted in Figure 1.5. The 1.8°C temperature isotherm was highlighted to show the polar fronts, which coincided with the data obtained from the SCS.

Three vertical temperature transects were chosen for plotting using ODV software – the same transects that were

plotted for previous reports were chosen for comparison (Figure 1.6). These transects are W05 in the West Area and EI03 and EI07 in the Elephant Island Area of the survey.

As in previous years, an attempt was made to group stations with similar temperature and salinity profiles into five water zones, as defined in Table 1.2. The tentative water zone classifications, according to the criteria in Table 1.2, were sometimes prone to ambiguity, particularly in the coastal regions around King George & Livingston Islands and in the south and southeast of Elephant Island. Classifications of Zone IV (Bransfield Strait) and Zone V (Weddell Sea) waters could also change if other oceanographic data, such as density, are considered. For the purpose of this report, in which only tentative conclusions are reported, only the criteria contained in Table 1.2 were used. The geographic distribution of Water Zones are shown in Figure 1.7.

With a reduced salinometer processing routine (see Protocol Deviations), close agreements between CTD measured salinity and the Portasal values were obtained, with an average error of 0.0047%. The final CTD/Portasal correlation produced an $r^2=0.993$ ($n=283$) during the cruise.

Discussion

During Leg I, only three stations exhibited characteristics of the Zone I (ACC) water type. These were encountered around the Shackleton Fracture Zone. The majority of the offshore stations to the west of Elephant Island exhibited characteristics of Zone II (Transition) type water. Mixed Zone II/III water types were found north and northeast of Elephant Island. Zone IV (Bransfield Strait) water was encountered around Elephant Island, between Elephant and Livingston Islands, the northern Joinville Island Area stations and the majority of the South Area stations. A cluster of Zone V (Weddell Sea) water types were encountered at the southern stations of the Joinville Island Area and southeast stations of the South Area. Figure 1.3 shows the stations with classifications similar to the defining parameters in Table 1.2. Stations with more complex structures, not readily defined according to the first attempt field classification criteria, are not shown in Figure 1.3.

Protocol Deviations

At the start of the main survey grid of Leg I, an additional station (A15-10) was added north of Cape Sherriff. Two stations (A11-05 and A03-02) had to be abandoned due to rough sea conditions; the CTD logged only a downcast at station A02-02 due to a PC crash. Station A02-03 was re-cast after replacing the CTD/SCS PC, owing to another PC crash during the first attempt at A02-03. Downtime due

to technical problems was limited to the 2.5 hours it took to replace and reload the CTD/SCS PC and associated software. Disturbed salinity traces at stations A05.5-04, A04-06 and A02-05, at an average depth of 68-133m, coincided with a salp layer. Very few icebergs were encountered in the south of the Joinville Area allowing an additional station to be sampled (A03-14).

An initial problem with a worn mechanical clutch inside the salinometer was rectified. This repair was not ideal as the parts needed to be replaced and no spares were available. To extend the life of the temporary repair a reduced number of samples were processed to cover a range of salinities over the entire survey grid.

Disposition of Data

Data are available from Christian Reiss, NOAA Fisheries, Antarctic Ecosystem Research Division, 3333 Torrey Pines Court, Room 412, La Jolla, CA 92037. Ph: 858-546-7127, FAX: 858-546-5608

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References

Schlitzer, R., Ocean Data View, <http://www.awi.bremerhaven.de/GEO/ODV>, 2001.



UNITED STATES

AMLR ANTARCTIC MARINE LIVING RESOURCES PROGRAM

AMLR 2008/2009 FIELD SEASON REPORT

Objectives, Accomplishments and Tentative Conclusions

Edited by
Amy M. Van Cise

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U.S Department of Commerce
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National Marine Fisheries Service
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Antarctic Ecosystem Research Division
8604 La Jolla Shores Drive
La Jolla, California, U.S.A. 92037

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Inquiries should be addressed to:

**Antarctic Ecosystem Research Group
Southwest Fisheries Science Center
8604 La Jolla Shores Drive
La Jolla, California, USA 92037**

**Telephone Number: (858) 546-5600
E-mail: Amy.VanCise@noaa.gov**

