UNITED STATES

AMLR ANTARCTIC MARINE LIVING RESOURCES PROGRAM

AMLR 2004/2005 FIELD SEASON REPORT

Objectives, Accomplishments and Tentative Conclusions

Edited by
Jessica D. Lipsky

December 2005

NOAA-TM-NMFS-SWFSC-385

Southwest Fisheries Science Center
Antarctic Ecosystem Research Division

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The U.S. Antarctic Marine Living Resources (AMLR) program provides information needed to formulate U.S. policy on the conservation and international management of resources living in the oceans surrounding Antarctica. The program advises the U.S. delegation to the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), part of the Antarctic treaty system. The U.S. AMLR program is managed by the Antarctic Ecosystem Research Division located at the Southwest Fisheries Science Center in La Jolla.

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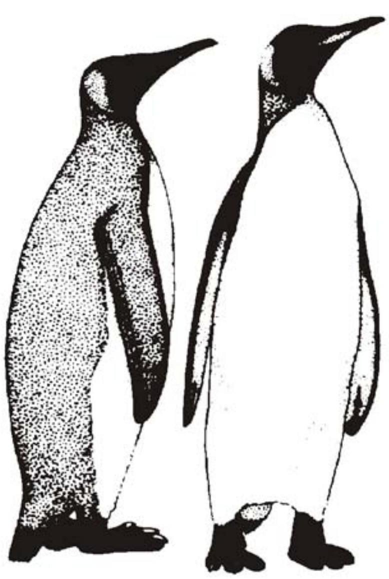

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BACKGROUND

The long-term objective of the U.S. AMLR field research program is to describe the functional relationships between Antarctic krill (*Euphausia superba*), their predators, and key environmental variables. The field program is based on two working hypotheses: (1) krill predators respond to changes in the availability of their food source; and (2) the distribution of krill is affected by both physical and biological aspects of their habitat. To refine these hypotheses a study area was designated in the vicinity of Elephant, Clarence, and King George Islands, and a field camp was established at Seal Island, a small island off the northwest coast of Elephant Island. From 1989-1996, shipboard studies were conducted in the study area to describe variations within and between seasons in the distributions of nekton, zooplankton, phytoplankton, and water zones. Complementary reproductive and foraging studies on breeding pinnipeds and seabirds were also accomplished at Seal Island.

Beginning in the 1996/97 season, the AMLR study area was expanded to include a large area around the South Shetland Islands, and a new field camp was established at Cape Shirreff, Livingston Island (Figure 1). Research at Seal Island was discontinued due to landslide hazards. Shipboard surveys of the pelagic ecosystem in the expanded study area are accomplished each season, as are land-based studies on the reproductive success and feeding ecology of pinnipeds and seabirds at Cape Shirreff.

Beginning in the 1997/98 season, bottom trawl surveys were conducted to assess benthic fish and invertebrate populations. Bottom trawl surveys were conducted in 1998, 1999, 2001 and 2003.

This is the 17th issue in the series of AMLR field season reports.

SUMMARY OF 2004 RESULTS

The Russian R/V *Yuzhmorgeologiya* was chartered to support the U.S. AMLR Program during the 2004/05 field season. Shipboard operations included: 1) two region-wide surveys of krill and oceanographic conditions in the vicinity of the South Shetland Islands (Legs I & II) (See Figure 2 for station locations); 2) calibration of acoustic instrumentation at the beginning and end of survey operations; 3) underway seabird and marine mammal observations; 4) deployment of drifter buoys and acoustically instrumented buoys with buoy-to-shore telemetry in the vicinity of Cape Shirreff; 5) a joint Zodiac/ship inshore survey of krill and oceanographic conditions near Cape Shirreff; and 6) shore camp support. Land-based operations at Cape Shirreff included: 1) observations of chinstrap, gentoo and Adélie penguin breeding colony sizes, foraging locations and depths, diet composition, breeding chronology and success, and fledging weights; 2) instrumentation of adult penguins to determine winter-time migration routes and foraging areas; 3) observations of fur seal pup production and pup growth rates, adult female attendance behavior, diet composition, foraging locations and depths, and metabolic rates; 4) collection of female fur seal milk samples for determination of fatty acid signatures; 5) collection of fur seal teeth for age determination and other demographic studies; 6) tagging of penguin chicks and fur seal pups for demographic studies; and 7) establishment of a weather station for continuous recording of meteorological data.

An oceanic frontal zone was mapped along the north side of the South Shetland Islands, running parallel to the continental shelf break and separating Drakes Passage water to the north from Bransfield Strait water to the south. At the beginning of Leg I, this frontal zone was at a wider range than in previous year and extended closer to the South Shetland Islands and became more clearly defined as Leg I progressed. At the end of Leg I, the zone had shifted further south and remained in this location through the beginning of Leg II. By the end of Leg II this zone had extended even further south and had become less defined. During Leg I, there was a clearly defined distinction of the classical Zone I (ACC) water at the offshore stations of the West and Northern Elephant Island Areas. Outer shelf stations in this area displayed a mixing of Zone I and II (Transition) waters. Mixing was also evident at many of the shallower inshore stations north of the islands where the distinction between Zone II (Transition), III (Transition) and IV (Bransfield Strait) waters was not as clear. Zone IV (Bransfield Strait) waters were predominant in the southeast portion of the Elephant Island Area, in the northern Joinville Island and South Areas, with the inshore stations of the South Area showing mixing, with surface waters (0 to 50m) having lower salinity and higher temperatures values. Zone V (Weddell Sea water) was present along the southeastern limit of the Elephant Island Area and in southern Bransfield Strait extending to the south of Livingston Island. During Leg II, classical Zone I (ACC) water occurred at only the outer most stations of the West Area and adjacent to the Shackleton Fracture Zone. The remainder of the West and northern Elephant Island Areas were predominantly Zone II (Transition) waters. Zone IV (Bransfield Strait) waters completely filled the Strait, except for pockets of Zone V (Weddell Sea) water at the southwestern and southeastern ends and east of Clarence Island. Therefore the mixed Zone II and Zone IV waters formed a coastwise-parallel buffer between the Weddell Sea water in the south and the Antarctic Circumpolar Current (ACC) water in the north.

In the West Area, chlorophyll concentrations during Leg I were below average compared with previous years. The pattern for surface chlorophyll concentration in the Elephant Island sector followed the bottom topography of the area. Chlorophyll concentrations during Leg I were slightly above average compared with the 12-year Leg I mean. The pattern for surface chlorophyll concentrations in the Bransfield Strait (South Area) and Joinville Island Area closely follows the zones of water, with low values found for the Weddell Sea (Water Zone V) and higher values for the Strait itself (Water Zone IV). For the South Area, chlorophyll concentrations were above average compared previous years. During Leg II in the West Area, chlorophyll values were slightly above average compared previous years. In the Elephant Island Area, phytoplankton biomass decreased slightly from that found during Leg I, and much lower than the 12-year average for Leg II. Phytoplankton biomass decreased considerably from Leg I values for the entire Bransfield Strait and the South Area phytoplankton biomass for Leg II was considerably less than the 12-year average. Too few data have been collected in the Joinville Island Area to make any comparisons with previous years.

Overall krill length-frequency distribution (predominantly 40-55 mm individuals) reflected strong recruitment success of the 2000/01 and 2001/02 year classes and minimal representation from the 2002/03 and 2003/2004 spawning seasons. Two successive years of poor recruitment success were not apparent in krill abundance or carbon biomass estimates which were similar to last years values. The presence of predominantly early calyptopis stage larvae during Leg I and a mixture of calyptopis and early furcilia stages during Leg II indicated a mid- to late December initiation of the seasonal spawning period. Proportions of advanced female maturity stages during the two surveys suggested a favorably timed spawning season that peaked in January 2005. Poor recruitment success following the prolonged, intense and apparently successful spawning period during 2003/04 and presumably favorable extensive sea ice in the Antarctic Peninsula region during spring 2004 indicate that other factors are involved in ultimately determining localized recruitment. These factors most likely include advective processes that influence retention vs. loss to downstream areas. The January 2005 abundance values of salps, *S. thompsoni,* were among the largest in the long term data set and likely result from el Niño-related conditions in 2003 and 2004 that promoted population growth and/or transport into the region. Substantially reduced salp abundance during February-March 2005 was associated with altered flow dynamics of the Shackleton Fracture Zone gyre and, based on the long term data set, may presage a period of relatively low salp abundance. Overall distribution patterns and water zone associations of *S. thompsoni* during both surveys differed markedly from those in the past and suggest input from the west via the Antarctic Circumpolar Current vs. Weddell Sea source areas to the east. Persistence of a depauperate zooplankton assemblage dominated by copepods (notably *Metridia gerlachei*), *S. thompsoni* and *T. macrura* that exhibited only a modest seasonal abundance increase reflects a coastally derived assemblage lacking enrichment by "West Wind Drift" plankton associated with the Antarctic Circumpolar Current Southern Front. These conditions also prevailed during the 1993 and 1998 el Niño periods.

For the second year consecutively, independent seabird and marine mammal observers joined the survey to collect data on the spatial distribution and abundance of seabirds and marine mammals. The importance of seabirds and mammals as indicators of the marine environment is unquestionable and the data collected at sea in collaboration with the 2003/04 AMLR survey, will provide insight on how pelagic predators respond to changes in of the distribution of Antarctic krill and the position of oceanographic features.

The eighth complete consecutive season of data collection at Cape Shirreff has enabled us to examine trends in penguin population dynamics, as well as inter-annual variation in penguin diet, and foraging behavior. The chinstrap breeding population at Cape Shirreff has continued to decline over the past six years, and is at its lowest size in the past eight years of study, and fledging success was poor compared to earlier years of study. The gentoo breeding population, in contrast, has remained relatively stable and had similar fledging success in 2004/05 as the long-term mean. Fledging weights of both species decreased from last year, and were the lowest average weights seen over nine years. The diet of both chinstrap and gentoo penguins contained primarily adult female Antarctic krill, peaking in the 46-50mm range, continuing a four year trend of increasing proportions of female krill and increasingly larger krill. The diet of both species contained less fish than in other years on average. Total chick meal mass was larger for chinstrap penguins compared to the past seven years of study, primarily in the digested portion of the meal. The interpretation of these diet patterns may be aided by analysis of foraging location and diving behavior data.

Fur seal pup production in 2004/05 at U.S. AMLR study beaches was the second highest on record since our studies began in 1997/98. Neonate mortality (4.5%), only slightly less than last year, was close to the eight year mean of 4.25%. The median date of pupping based on pup counts was one day earlier than last year and our tag returns of adult females confirm a two day change in the parturition date. Over winter survival for adult females, however, was lower than last year (89.8 vs. 92.1%) as was the natality rate (84.8 vs. 89.0%). Foraging trip durations and visits to shore were average compared to previous years. The 1999/00 and the 2001/02 cohorts continued to dominate tag returns as in previous years and the 2003/04 cohort had modest first year return rates. Fur seal diet studies recorded for the first time a total absence of *Electrona carlsbergi*.

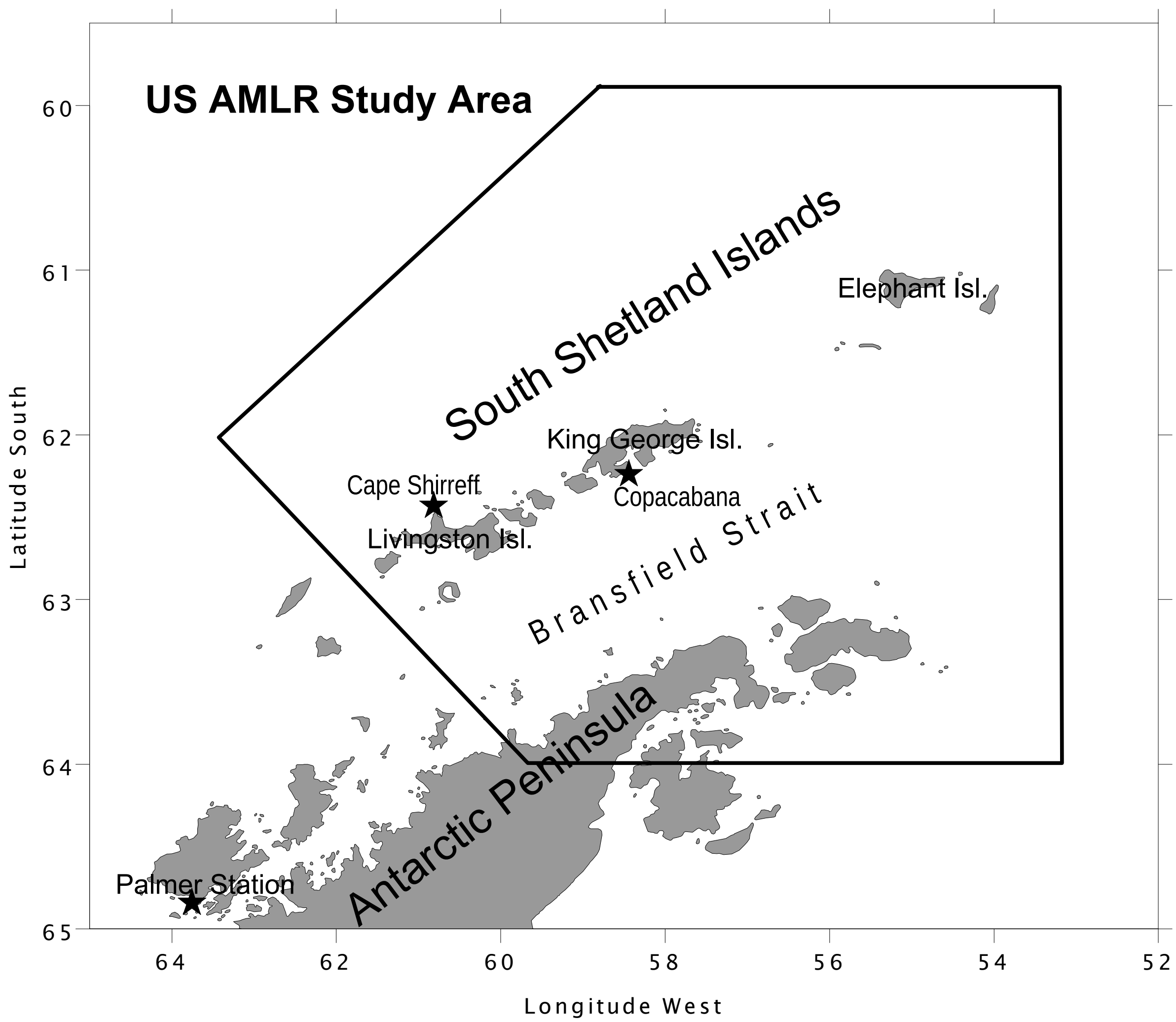

Figure 1. Locations of the U.S. AMLR field research program: AMLR study area, Cape Shirreff, Livingston Island and Copacabana, King George Island.

OBJECTIVES

Shipboard Research:

1. Conduct a survey in the AMLR study area during Legs I and II to map meso-scale features of the dispersion of krill, water mass structure, phytoplankton biomass and productivity and zooplankton constituents using the R/V *Yuzhmorgeologiya*.
2. Estimate abundance and dispersion of krill and krill larvae in the AMLR sturdy area.
3. Calibrate the shipboard acoustic system in Admiralty Bay, King George Island near the beginning of Leg I, and again at Admiralty Bay near the end of Leg II.
4. Conduct underway observations of seabirds and marine mammals during Leg I.
5. Conduct a high-resolution survey of krill in the vicinity of Cape Shirreff using a specially equipped Zodiac for the inshore areas and the *Yuzhmorgeologiya* for the offshore areas.
6. Deploy five instrumented buoys with acoustical sensors and buoy-to-shore telemetry in the vicinity of Cape Shirreff at the beginning of Leg I to be recovered at the end of Leg II.
7. Collect continuous measurements of the research ship's position, water depth, sea surface temperature, salinity, turbidity, fluorescence, air temperature, barometric pressure, relative humidity, and wind speed and direction.
8. Deploy WOCE drifter buoys during Leg I.
9. Provide logistical support to two land-based field sites: Cape Shirreff (Livingston Island), and Copacabana field camp (Admiralty Bay, King George Island).

Land-based Research:

<u>Cape Shirreff</u>

1. Estimate chinstrap and gentoo penguin breeding population size.
2. Band 500 chinstrap and 200 gentoo penguin chicks for future demographic studies.
3. Record at sea foraging locations for chinstrap penguins during their chick-rearing period using ARGOS satellite-linked transmitters (PTT's).
4. Determine chinstrap and gentoo penguin breeding success.
5. Determine chinstrap and gentoo penguin chick weights at fledging.
6. Determine chinstrap and gentoo penguin diet composition, meal size, and krill length/frequency distributions via stomach lavage.
7. Determine chinstrap and gentoo penguin breeding chronologies.
8. Deploy time-depth recorders (TDR's) on chinstrap and gentoo penguins during chick rearing for diving studies.
9. Collect data on foraging locations (using PTT's) and foraging depths (using TDR's) of chinstrap penguins while concurrently collecting acoustically derived krill biomass and location data during the inshore survey.
10. Deploy PTT's on chinstrap penguins following adult molt to determine migration routes and winter foraging areas in the Scotia Sea region.
11. Monitor female Antarctic fur seal attendance behavior.
12. Collaborate with Chilean researchers in collecting Antarctic fur seal pup mass for 100 pups every two weeks through the season.

13. Collect 10 Antarctic fur seal scat samples every week for diet studies.
14. Collect a milk sample at each female Antarctic fur seal capture for fatty acid signature analysis and diet studies.
15. Record at-sea foraging locations for female Antarctic fur seals using Platform Terminal Transmitters (PTT).
16. Deploy time-depth recorders (TDR) on female Antarctic fur seals for diving studies.
17. Tag 500 Antarctic fur seal pups for future demographic studies.
18. Collect teeth from selected Antarctic fur seals for age determination and other demographic studies.
19. Deploy a weather station for continuous summer recording of wind speed, wind direction, ambient temperature, humidity, and barometric pressure.

DESCRIPTION OF OPERATIONS

Shipboard Research:

For the ninth consecutive year, the cruise was conducted aboard the chartered research vessel R/V *Yuzhmorgeologiya*. “CS” stands for Cape Shirreff, “Copa” stands for Copacabana and SI stands for Seal Island.

Leg I:	Depart Punta Arenas	11-13 January 2005
	Calibrate in Admiralty Bay, King George Island	14 January
	Resupply & transfer personnel to CS, deploy buoys	15 January
	Large-area survey (Survey A)	16 Jan- 01 Feb
	Transfer personnel to CS, conduct nearshore survey	02-10 February
	Transfer personnel from Cape Shirreff	11 February
	Transfer personnel from Copa	12 February
	Skua survey at King George Bay	13 February
	Transit to Punta Arenas	14-16 February
Leg II:	Depart Punta Arenas	19-21 February
	Transfer supplies and personnel to Cape Shirreff	22 February
	Large-area survey (Survey D)	23 February - 10 March
	Close Cape Shirreff	11 March
	Close Copacabana and calibrate in Admiralty Bay	12-13 March
	Transit to Punta Arenas	14-16 March

Leg I

1. The R/V *Yuzhmorgeologiya* departed Punta Arenas, Chile via the eastern end of the Strait of Magellan and arrived at Cape Shirreff to deliver personnel and supplies to the field camp. The ship then transited to Admiralty Bay to deliver additional personnel and supplies to the Copacabana field camp.

2. The acoustic transducers were calibrated in Admiralty Bay, King George Island. Beam patterns for the hull-mounted 38, 120 and 200kHz transducers were mapped and system gains were determined.

3. Survey components included acoustic mapping of zooplankton, direct sampling of zooplankton, Antarctic krill demographics, physical oceanography and phytoplankton observations. Survey A consisting of 99 (out of 108 planned) Conductivity-Temperature-Depth (CTD) and net sampling stations, separated by acoustic transects, was conducted in the vicinity of the South Shetland Islands (Figure 2). Operations at each station included: (a) vertical profiles of temperature, salinity, oxygen, fluorescence, light transmission and collection of water samples at discreet depths; and (b) deployment of an IKMT (Isaacs-Kidd Midwater Trawl) to obtain samples of zooplankton and micronekton. Acoustic transects were conducted between stations at 10 knots, using hull-mounted 38kHz, 120kHz, and 200kHz down-looking transducers. An extensive field of icebergs was encountered in the southern and eastern portion of the survey area and precluded the conduct of survey operations in these areas.

4. Seabird and marine mammal observations were collected continuously throughout Leg I.

5. A high-resolution survey for krill and oceanographic conditions was conducted in the vicinity of Cape Shirreff (Figure 3). A specially-equipped Zodiac, R/V *Ernest*, conducted a series of acoustic transects, CTD deployments and for the nearshore areas and the *Yuzhmorgeologiya* for the offshore areas. A total of 40 stations were completed.

6. Deploy five buoys, instrumented with acoustical sensors and buoy-to-shore telemetry in the vicinity of Cape Shirreff.

7. Optical oceanographic measurements were conducted, which included weekly SeaWiFS satellite images of surface chlorophyll distributions and *in-situ* light spectra profiles.

8. Continuous environmental data were collected throughout Leg I, which included measurements of ship's position, sea surface temperature and salinity, fluorescence, air temperature, barometric pressure, relative humidity, wind speed, and wind direction.

Leg II

1. The R/V *Yuzhmorgeologiya* departed Punta Arenas, Chile via the eastern end of the Strait of Magellan and arrived at Cape Shirreff to deliver supplies to the field camp.

2. Survey D consisting of 97 (out of 108 planned) CTD and net sampling stations, separated by acoustic transects, was conducted in the vicinity of the South Shetland Islands (Figure 2). The field of icebergs was less extensive and allowed the conduct of most of the survey except for some stations in the Joinville Island Area and northwestern Weddell Sea. However, the positions of several stations at the southern ends of the transects had to be adjusted by as much as 5km because of the presence of icebergs.

3. Optical oceanographic measurements were conducted, which included weekly SeaWiFS satellite images of surface chlorophyll distributions and *in-situ* light spectra profiles.

4. Seabird and marine mammal observations were collected continuously throughout Leg II.

5. As on Leg I, continuous environmental data were collected throughout Leg II.

6. At the end of Leg II, the ship then transited to Cape Shirreff to embark personnel and close the field camp.

7. Following the completion of the close of Cape Shirreff, the acoustic transducers were calibrated in Ezcurra Inlet, Admiralty Bay, and King George Island. The Copacabana field camp was closed and field personnel were retrieved.

Land-based Research:

1. A five-person field team (M. Goebel, G. McDonald, Y. Tremblay, A. Miller and E. Leung) arrived at Cape Shirreff, Livingston Island, on 10 November 2004 via the R/V *Lawrence M. Gould*. Equipment and provisions were also transferred from the R/V *Lawrence M. Gould* to Cape Shirreff.

2. Two additional personnel (W. Trivelpiece and D. Krause), along with supplies and equipment, arrived at Cape Shirreff via the R/V *Yuzhmorgeologiya* 14 January 2005.

3. The annual censuses of active chinstrap and gentoo penguin nests were conducted on 1-3 December 2004. Reproductive success was studied by following a sample of 100 chinstrap penguin pairs and 50 gentoo penguin pairs from egg laying to crèche formation.

4. Radio transmitters were attached to 19 chinstrap penguins in the first week of January 2005 and remained on until their chicks fledged in late February 2005. These instruments were used to determine foraging trip duration during the chick-rearing phase. All data were received and stored by a remote receiver and logger set up at the bird observation blind.

5. Four satellite-linked transmitters (PTTs) were deployed on adult chinstrap penguins and three on adult gentoo penguins during the time each species was feeding chicks in early January. The PTTs were removed and placed on fifteen new birds (eight chinstraps and seven gentoo) in mid-January to coincide with the time when the annual AMLR 2004/05 marine survey was adjacent to Cape Shirreff during Leg I. A final deployment of fifteen PTTs was made in early February during a special nearshore survey conducted by zodiacs with 10km of Cape Shirreff.

6. Diet studies of chinstrap and gentoo penguins during the chick-rearing phase were initiated on 9 January 2005 and continued through 9 February 2005. Chinstrap and gentoo adult penguins were captured upon returning from foraging trips, and their stomach contents were removed by lavaging.

7. Counts of all chinstrap and gentoo penguin chicks were conducted on 3 and 8 February 2005, respectively. Fledging weights of 171 chinstrap penguin chicks were collected

between 19 February and 2 March 2005. Two hundred gentoo penguin chicks were also weighed on 14 February 2005.

8. Five hundred chinstrap penguin chicks and 200 gentoo penguin chicks were banded for future demographic studies.

9. Reproductive studies of brown skuas and kelp gulls were conducted throughout the season at all nesting sites around the Cape.

10. Time-depth recorders (TDRs) were deployed on five chinstrap and four gentoo penguins for 7-10 days in mid-January to coincide with the marine sampling offshore at Cape Shirreff at the end of Leg I. The TDRs were retrieved, downloaded and redeployed on four birds of each species in late January.

11. Antarctic fur seal pups and female fur seals were counted at four main breeding beaches every other day from 17 November 2004 through 10 January 2005.

12. Attendance behavior of 29 lactating female Antarctic fur seals was measured using radio transmitters. Females and their pups were captured, weighed, and measured from 4-16 December 2004.

13. U.S. researchers assisted Chilean scientists in collecting data on Antarctic fur seal pup growth. Measurements of mass for a random sample of 100 pups were begun 30 days after the median date of pupping on 8 January 2005 and continued every two weeks until 23 February 2005.

14. Information on Antarctic fur seal diet was collected using three different methods: scat collection, enemas of captured animals, and fatty-acid signature analyses of milk.

15. Twenty-seven Antarctic fur seals were instrumented with time-depth recorders (TDR's) for diving behavior studies.

16. Sixteen Antarctic fur seal females were instrumented with ARGOS satellite-linked transmitters for studies of at-sea foraging locations from 16 December 2004 to 7 March 2005.

17. Four hundred and ninety-seven Antarctic fur seal pups were tagged at Cape Shirreff by U.S. and Chilean researchers for future demography studies.

18. A weather data recorders (Davis Instruments, Inc.) were set up at Cape Shirreff for wind speed, wind direction, barometric pressure, temperature, humidity, and rainfall.

19. A single post-canine tooth was extracted from fifteen perinatal and one previously tagged female fur seals for aging and demography studies. Studies of the effects of tooth extraction on attendance and foraging behavior were initiated for the fifteen perinatal seals.

20. One team member (M. Goebel) left Cape Shirreff via the R/V *Lawrence M. Gould* on 18 December 2004 and one team member (Y. Tremblay) left Cape Shirreff via the R/V *Yuzhmorgeologiya* on 10 February 2005.

21. The Cape Shirreff field camp was closed for the season on 11 March 2005; all U.S. personnel (R. Holt, D. Krause, G. McDonald, A. Miller, E. Leung and J. Hinke), garbage, and equipment were retrieved by the R/V *Yuzhmorgeologiya*.

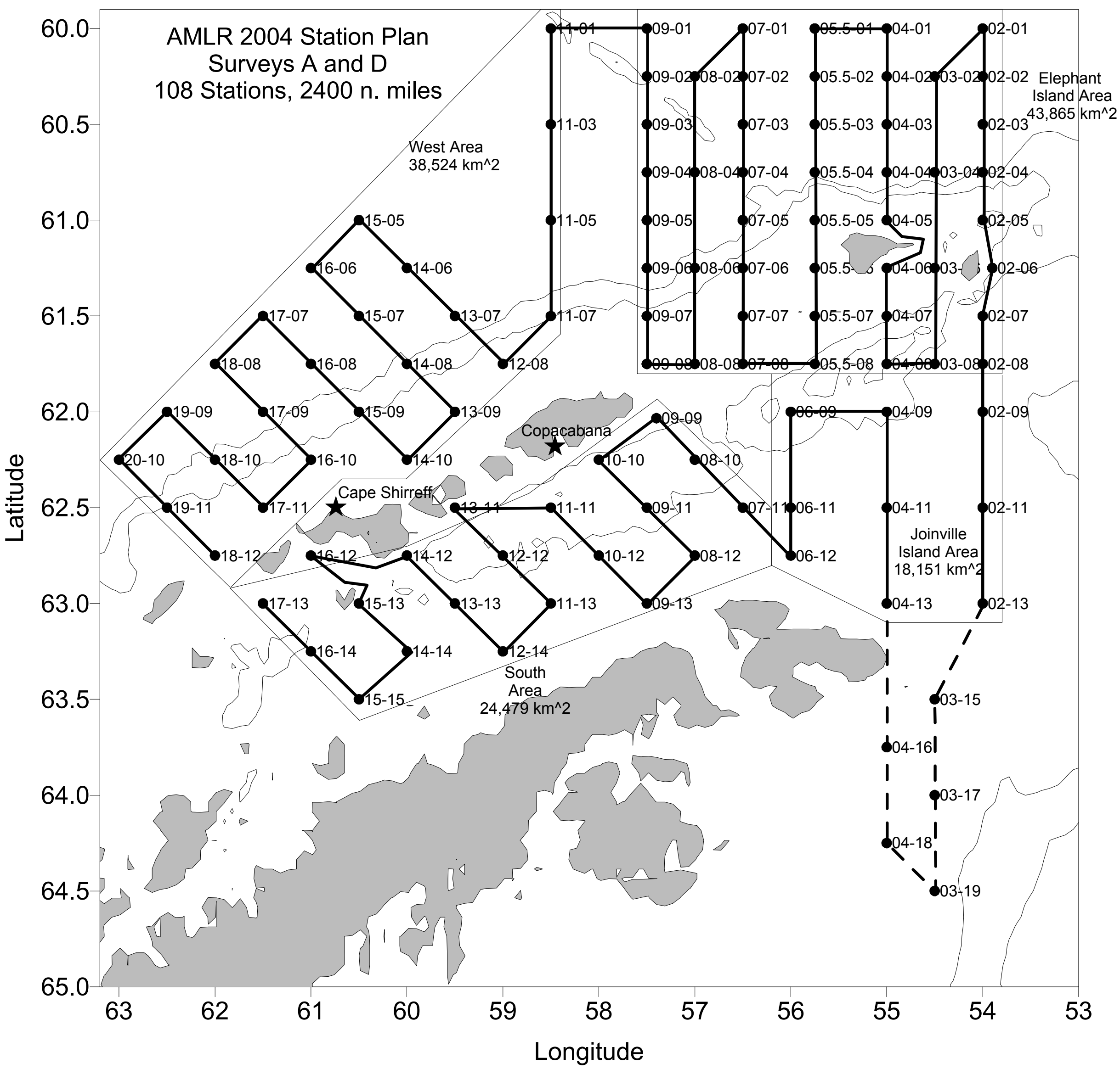

Figure 2. The planned survey for AMLR 2004/05 (Survey A & D) in the vicinity of the South Shetland Islands; field camp locations indicated by★. The survey contained four strata: the stratum containing stations in the western portion of the survey area north of Livingston and King George Islands was designated the West Area, the stratum located south of King George Island was designated the South Area, the stratum containing stations in the northern portion of the South Shetland Islands was designated the Elephant Island Area, and the stratum south of Elephant Island was designated the Joinville Island Area. Depth contours are 500m and 2000m. Black dots indicate station locations; heavy lines indicate transects between stations; and thin lines outline the stratum.

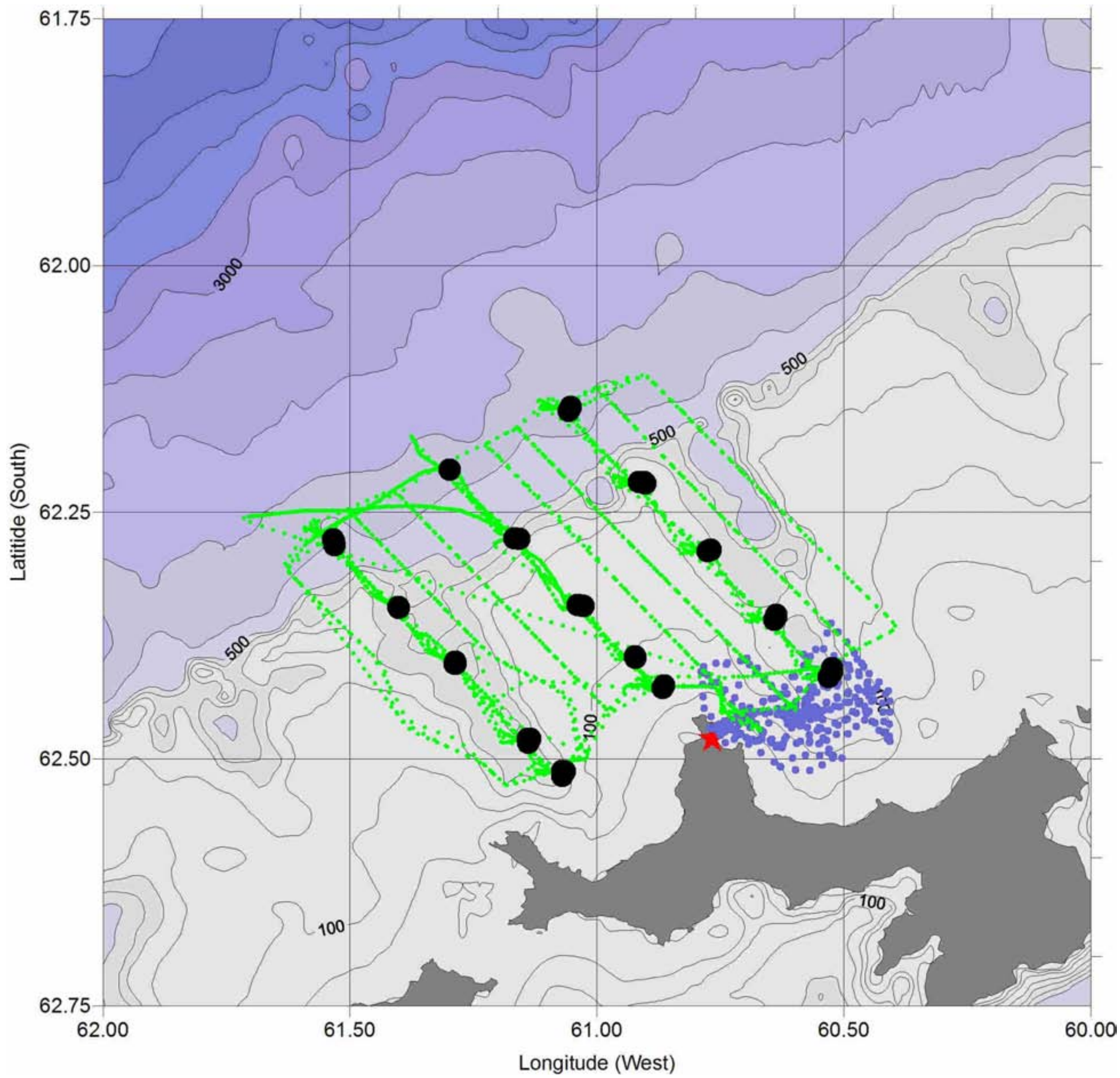

Figure 3. Cape Shirreff nearshore survey plan. Black dots indicate positions of CTD/net stations conduct by the R/V *Yuzhmorgeologiya*. The green dotted lines indicate the track lines of the R/V *Yuzhmorgeologiya* and the blue dotted lines indicate the track lines of the R/V *Ernest*.

SCIENTIFIC PERSONNEL

Cruise Leader:
Adam Jenkins, Southwest Fisheries Science Center (Legs I & II)

Physical Oceanography:
Derek Needham, Sea Technology Services (Leg I)
Marcel van den Berg, Sea Technology Services (Legs I & II)
Patrick Hayes-Foley, Sea Technology Services (Leg II)

Phytoplankton:
Christopher D. Hewes, Scripps Institution of Oceanography (Leg I)
Nora Rojas Henríquez (Leg I)
Cynthia P. Valenzuela Ramirez (Leg II)

Bioacoustic Survey:
Anthony Cossio, Southwest Fisheries Science Center (Legs I & II)
Christian Reiss, Southwest Fisheries Science Center (Legs I & II)

Krill and Zooplankton Sampling:
Valerie Loeb, Moss Landing Marine Laboratories (Legs I & II)
Michael Force (Legs I & II)
Adam Jenkins, Southwest Fisheries Science Center (Leg I)
Joe Warren, Southampton College of Long Island University (Leg I)

Fur Seal Energetics Studies:
Jessica D. Lipsky, Southwest Fisheries Science Center (Leg I)
Margi Cooper, Dalhousie University (Leg II)

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Douglas Futuyma, College of Staten Island (Leg I)
Blair Nikula, College of Staten Island (Leg II)
Rick Heil, College of Staten Island (Leg II)

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Joe Warren, Southampton College of Long Island University (Leg I)
Steve Sessions, Southwest Fisheries Science Center (Leg I)

AUV Survey:
Adam Jenkins, Southwest Fisheries Science Center (Leg I)
Mark Patterson, Virginia Institute of Marine Science (Leg I)

Cape Shirreff Personnel:
Michael E. Goebel, Camp Leader, Southwest Fisheries Science Center (11/10/04 to 12/21/04)
Yann Tremblay (11/10/04 to 2/10/05)

Gitte McDonald (11/10/04 to 3/11/05)
Aileen Miller (11/10/04 to 3/11/05)
Elaine Leung (11/10/04 to 3/11/05)
Douglas Krause, Southwest Fisheries Science Center (1/14/05 to 3/11/05)
Rennie S. Holt, Southwest Fisheries Science Center (1/14/05 to 3/11/05)

DETAILED REPORTS

1. Physical Oceanography and Underway Environmental Observations; submitted by Derek Needham (Leg I), Marcel van den Berg (Legs I & II).

1.1 Objectives: Objectives were to 1) collect and process physical oceanographic data in order to identify hydrographic characteristics and map oceanographic frontal zones; and 2) collect and process underway environment data 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.

1.2 Accomplishments:

1.2.1 CTD/Carousel Stations: 99 of the 102 planned CTD/carousel casts were made on Leg I (Survey A, Stations A02-01 to A20-10). No casts were cancelled due to bad weather, but 8 stations were cancelled due to icebergs, in the eastern and southern areas of the survey area, and station D16-12 was removed from the regular survey area. An extra station (A04-10) was inserted during the survey, after the southern stations of the Joinville Island Area were abandoned due to concentrated ice.

After the completion of the planned survey area of Leg I, 40 stations were completed near Cape Shirreff to accompany the data collected during the Nearshore Acoustic Survey (see Nearshore Survey, Chapter 5, of this report).

A total of 94 out of the possible 102 casts were completed during Leg II, 92 being stations on the planned survey grid and two others (D03-10 and D04-10) being stations inserted during the survey in the northern Joinville Island Area. Two stations (D16-14 and D17-13) were cancelled due to bad weather. During Leg II, a Seatech transmissometer was installed on the CTD frame for certain stations to obtain transmittance data in conjunction with the Wetlabs fluorometer and Licor PAR sensor, used for the duration of the survey.

Two additional casts were completed during acoustic calibrations in Admiralty Bay, at the beginning and end of the survey, bringing the total number of CTD casts to 236 for the entire cruise.

Water samples were collected at 11 discrete depths on all casts and used for salinity verification and phytoplankton analysis. These were drawn from the Niskin bottles by the Russian scientific support team. (See Figure 2 in the Introduction for station locations). Salinity calibration samples from all stations were analyzed on board, using a Guildline Portasal salinometer, and close agreement, between CTD-measured salinity and the Portasal values, was obtained with an average error of 0.0271%. The final CTD/Portasal correlation produced an r2=0.9964 (n=1,084) during the survey.

Underway comparison of the Seabird thermosalinograph (TSG) salinity data with 7m CTD salinity data showed agreement (average 0.036% difference), while the sea temperature showed the TSG to be on average 0.70°C (n=223) higher than the CTD 7m data. This can be attributed to the heating effects of positioning the temperature sensor downstream of the seawater pump. Comparisons of dissolved oxygen levels in the carousel water samples and the levels measured during the casts (via the O2 sensor) were not attempted during the survey.

1.2.2 Underway Environmental Observations: Environmental and vessel positional data was collected for a total of 63 days (37 days and 26 days during Legs I and II respectively) via the Scientific Computer System (SCS) software package. The SCS software (SCS Version 3.3a) was running on a Windows XP based Pentium IV Dell PC with an Edgeport-8 USB serial port expander. A Coastal Environmental Company Weatherpak system was installed on the port side of the forward A-frame in front of the bridge and was used as the primary meteorological data acquisition system. The data provided covered surface environmental conditions encountered over the entire AMLR survey area for the duration of the cruise including transits to and from Punta Arenas. At the start of Leg I a spare Licor 2pi PAR sensor was installed after the initial sensor malfunctioned. An additional Biospherical 4pi PAR sensor, installed mid-ships on the port side of the vessel, was integrated into the SCS system via a Fluke Hydra Data Bucket for the duration of the survey.

1.3 Methods:

1.3.1 CTD/Carousel: Water profiles were collected with a Sea-Bird SBE-9/11+ CTD/carousel water sampler equipped with 11 Niskin sampling bottles. The 11th bottle allowed for an additional 15m sample to be collected. Profiles were limited to a depth of 750 meters or 5 meters above the sea bottom when shallower than 750m. A Data Sonics altimeter was used to stop the CTD decent 5 to 7m from the seabed, on the shallow casts. Standard sampling depths were 750m, 200m, 100m, 75m, 50m, 40m, 30m, 20m, 15m, 10m and 5m. A Dissolved Oxygen (DO) sensor (Seabird SBE 13Y), a Wetlabs fluorometer, a Seatech transmissometer (Leg II only) and a Biospherical 2pi PAR sensor provided additional water column data during Legs I and II. Scan rates were set at 24 scans /second during both down and up casts. Sample bottles were only triggered during up casts. Plots of the down traces were generated and stored with the CTD cast log sheets and a copy given to the phytoplankton person, together with CTD mark files (reflecting data from the cast at bottle triggering depths) and processed up and down traces in Ocean Data View (ODV) format. Data from casts were averaged over 1m bins and saved separately as up and down traces during post processing. The data were logged and bottles triggered using Seabird Seasave Win32 Vs 5.3a and the data processed using SBE Data Processing Vs 5.3a. Downcast data was re-formatted using a SAS script and then imported into ODV for further analysis.

1.3.2 Underway Data: Weather data inputs were provided by the Coastal Environmental Systems Company Weatherpak via a serial link and included relative wind speed and direction, barometric pressure, air temperature and irradiance (PAR). 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 SeaBird SBE21 thermosalinograph (TSG) and integrated into the logged data. Ships position and heading were provided in NMEA format via a Furuno GPS Navigator and Guiys Gyro respectively. Serial data lines were interfaced to the Pentium 4 (Windows XP Professional based) logging PC via an Edgeport 8 serial RS232 to USB interface. An additional

Biospherical 4pi PAR sensor, installed mid-ships on the port side of the vessel, was integrated into the SCS system via a Fluke Hydra Data Bucket for the duration of the survey.

1.4 Results and Tentative Conclusions:

1.4.1 Oceanography: The position of the polar frontal zone, identified by pronounced sea surface temperature and salinity change, was located from the logged SCS data during all four transits from and to Punta Arenas and the South Shetland Islands survey area. This frontal zone is normally situated between 57-58° S. During the south transit of Leg I, the front was defined between 57° 40'S and 61°48'S. On the northern transect the front had become more clearly defined between 57°50'S and 58°30'S. On the south-bound transit of Leg II the front had moved south when compared to the north bound transect of Leg I, but was still clearly defined, laying between 58°30'S and 59°S. On the return transit, at the end of Leg II, the zone had become less defined and was located between 56°40'S and 58°20'S (Figure 1.1).

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 1.1. The Matlab program written during AMLR 2000/01 was used to confirm field classifications according to the criteria in Table 1.1, in an attempt to reduce any subjective influence on the classification of water zones (see AMLR 2000/01 Field Season Report for details).

The tentative water zone classifications according to the criteria in Table 1.1 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 V (Weddell Sea) waters in these areas could 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 1.1 were used. This was done to ensure consistency with past cruises and only serves as a "first attempt field classification".

During Leg I, there was a clearly defined distinction of the classical Zone I (ACC) water at the offshore stations of the West and Northern Elephant Island Areas (See Figure 1.2, generated using the Matlab water-zoning algorithm). Outer shelf stations in this area displayed a mixing of Zone I and II (Transition) waters. Mixing was also evident at many of the shallower inshore stations north of the islands where the distinction between Zone II (Transition), III (Transition) and IV (Bransfield Strait) waters was not as clear. Zone IV (Bransfield Strait) waters were predominant in the southeast portion of the Elephant Island Area, in the northern Joinville Island and South Areas, with the inshore stations of the South Area showing mixing, with surface waters (0 to 50m) having lower salinity and higher temperatures values. Zone V (Weddell Sea water) was present along the southeastern limit of the Elephant Island Area and in southern Bransfield Strait extending to the south of Livingston Island.

During Leg II, classical Zone I (ACC) water occurred at only the outer most stations of the West Area and adjacent to the Shackleton Fracture Zone. The remainder of the West and northern Elephant Island Areas were predominantly Zone II (Transition) waters. Zone IV (Bransfield Strait) waters completely filled the Strait, except for pockets of Zone V (Weddell Sea) water at the southwestern and southeastern ends and east of Clarence Island. Therefore the mixed Zone II and Zone IV waters formed a coastwise-parallel buffer between the Weddell Sea water in the south and the Antarctic Circumpolar Current (ACC) water in the north.

Three vertical temperature transects were chosen for plotting using ODV software – the same transects that were plotted for the 2001/02, 2002/03 and 2003/04 reports were chosen for comparisons (Figure 1.3). These transects were W05 in the West Area and EI03 and EI07 in the Elephant Island Area of the survey.

A "first look" field attempt was made to determine direction and intensity of water flow inferred by water density derived from the CTD data. This was done to compare zooplankton distributions (See Chapter 4 of this Report) with hydrographic patterns during the surveys. ODV was used to plot Dynamic Heights at the surface relative to 300m and 500m depths (Figure 1.4). With reference to the isolines on these figures, going from high to low values and the influence of Coriolis force (southern hemisphere), results in flow to the left. These isolines show a flow of water from the Weddell Sea, moving northward and then eastward along with water from the West Antarctic Peninsula in the Western Bransfield Strait. Flow was to the northeast in Drake Passage offshore of the island shelf area. During Leg I northward transport of Bransfield Strait water occurred to the east of King George Island and between King George and Livingston Islands with subsequent westward movement over northern shelves of the South Shetland Islands and eddy formation due to eastward flow within Drake Passage. There are also indications of clockwise gyres within southwest Bransfield Strait, between King George and Elephant Islands and southeast of Elephant Island. The close spacing of the density isolines indicate a more intense flow over the southern shelves of the South Shetland Islands than other areas. Offshore a broad gyre with relatively sluggish flow was associated with topography of the Shackleton Fracture Zone.

During Leg II flow within the Bransfield Strait was comparatively constrained although there still were indications of northward flow and subsequent eddy formation between King George and Livingston Islands. Flow continued to be most intense south of the South Shetland Islands but was deflected south and west between King George and Livingston Islands. Clockwise gyres were also located between King George and Elephant Islands and northeast of Elephant Island. In contrast to Leg I, intensified flow and a greatly contracted gyre characterized the offshore region around the Shackleton Fracture Zone.

Comparing the Dynamic Heights plots (Figure 1.4) to the water zone assessments, demonstrates that there was a much more extensive presence of ACC water and sluggish flow offshore and a greater Weddell Sea water influence with westward flow and mixing during Leg I versus reduced presence of ACC water and a constricted and intensified gyre west of the Shackleton Fracture Zone offshore and reduced Weddell Sea water influence during Leg II. There are obvious gyres and frontal zones during both surveys, but the locations and intensities differ as indicated by the deflection and proximity of the isolines.

1.4.2 Underway Data: Environmental data were recorded for the duration of both Legs I and II and for the transits between Punta Arenas and the survey area (except for TSG data which is not available for transits in the Strait of Magellan). Processed data were averaged and filtered over 1-minute and 5-minute intervals to reduce the effects of transients, particularly in data recorded from the thermosalinograph, which was sometimes prone to the effects of aeration (Figures 1.5 and 1.6 for Legs I and II respectively).

Comparisons between the weather conditions experienced during Legs I and II show significant differences, primarily between wind speed and direction (Figure 1.7). During Leg I the wind direction was predominately west to northwest, with wind speeds averaging around 20 knots. This wind regime shifted from westerly to predominantly easterly winds towards the latter part of Leg II, with wind speeds averaging around 30 knots.

Weather during Leg II, compared with Leg I, was more often partly cloudy or overcast. A number of days of poor visibility and fog were experienced and snowfalls were recorded during Leg II, as can be seen when comparing the results from the PAR sensor, which indicate reduced levels of photosynthetic radiation, between Leg I and Leg II. A cold spell was also experienced towards the end of Leg II, with air temperatures remaining below zero (0°C) degrees for a period of over a week, with the minimum temperature of –5.8°C being recorded. The temperatures only started increasing to above zero (0°C) after crossing the convergence on the return journey after the completion of the survey.

1.5 Problems and Suggestions The CTD system performed well, with the usual maintenance required, attention having to be given to the underwater connectors. Very little data or time was lost during the 236 casts.

The Seabird CTD underwater unit (S/N 09P13966-0455) was replaced during Leg II with the spare Seabird CTD underwater unit (S/N 09P13966-0454) after the initial unit malfunctioned at Station D15-13. The spare conductivity, temperature sensors and the circulation pump were installed with the spare underwater unit and the oxygen sensor transferred over from the original to spare system. The station was repeated as the malfunctioned occurred before the downcast could be started.

Upon inspection of the faulty unit (S/N 09P13966-0455), it was noticed that some of the bulkhead connectors were showing signs of corrosion.

CTD communication problems and a blown deck-unit fuse on Leg II were traced to an intermittent short in the sea-cable underwater connector and a low impedance path at the winch slip-rings.

It is suggested that the spare CTD underwater unit has its sensors (i.e. temperature, conductivity and oxygen) and circulation pump pre-installed when returned to Seabird for re-calibration. This will minimize the time taken to install the unit when problems occur during the survey.

The dissolved oxygen sensor used for the duration of the survey was an upgraded Seabird SBE13Y, which preformed well, but did show some signs of hysteresis during down and up casts. These older units should be replaced with the newer Seabird SBE43 sensors in the future. These new sensors minimize the hysteresis effects that occur during down and up casts. A comparison of the dissolved oxygen levels in the carousel water samples and the levels measured during the casts (via the O_2 sensor) was not attempted, but there have been requests to start doing oxygen titrations on AMLR 2006, especially if the sensors are to be upgraded to Seabird SBE43 types.

During the above mentioned cold spell towards the end of Leg II, seawater had to be continuously run over the CTD sensors to prevent them from freezing up, especially the glass conductivity cell and oxygen sensor.

The SBE Carousel and General Oceanics Niskin bottles worked relatively trouble free, with only a few lanyard snags causing lost samples. A new set of bottles was used for the survey, which were fitted with rubber elastics instead of the metal springs used on previous cruises. Some problems occurred with leaking during the latter part of Leg I, and it was noted that the rubber elastic tended to lose its elasticity in the colder waters and had to be replaced at the start of Leg II. Although this system causes less damage to the bottles than the metal springs used in the past, spare rubber elastic should be available for replacement during the survey, as this problem will re-occur when working in colder waters.

Some problems occurred with the logging PC for the CTD / SCS systems where the software would “crash” during CTD casts. Either re-start of the software or a re-boot of the PC would normally correct this problem. The logging PC should be defragmented before the next survey and some older software and data removed to create more space on the hard drives for data logging.

A short occurred in the sea-cable underwater connector and the connector was replaced with a new one.

The Coastal Environmental Company Weatherpak system functioned well for the during of both Leg I and Leg II, except for the 2pi PAR sensor that malfunctioned during Leg I and was replaced with the spare unit. An additional Biospherical 4pi PAR sensor was also integrated into the SCS system for the duration of the survey and after comparisons between the two sensors, it was suggested that a 4pi PAR sensor be used for future surveys to obtain better quality data. If a system with an RS232 output is purchased, it can be connected directly to the SCS.

The TSG pump and debubbler system had to be periodically stopped and cleaned due to clogging by krill, seaweed and other biologicals.

Problems were experienced with the stability of the Guildline Autosal salinometer used for the analysis of salinity calibration samples during the survey. The normal method of passing Triton-X through the system did not correct the instability of the unit, after consultation with the manufactures via e-mail, it was suggested by them that the unit be cleaned with passing firstly “hot” vinegar and then alcohol through the tubing system of the instrument to remove any dirt and bio-foaling. This process improved the stability of the instrument remarkably and had to be repeated on various occasions during the survey.

The submersible Seatech transmissometer needs to be replaced before AMLR 2006, as the present unit is unstable, beyond repair and obsolete. It is suggested that a new submersible transmissometer, and possibly a new submersible fluorometer, be investigated. The models chosen should be directly compatible with the Seabird 911-plus CTD. There has also been a request to re install a flow through fluorometer, and a masthead Biospherical 4pi PAR sensor, interfaced to the SCS, for AMLR 2006.

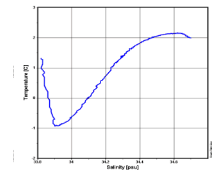
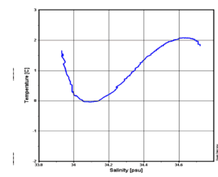
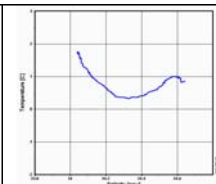
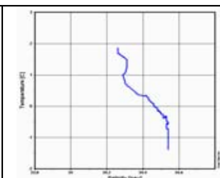
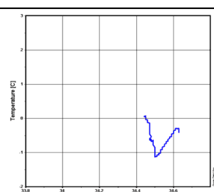
1.6 Disposition of Data: Data are available from David A. Demer, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA, 92037; phone/fax (858) 546-5603/(858) 546-5608; email: David.Demer@noaa.gov.

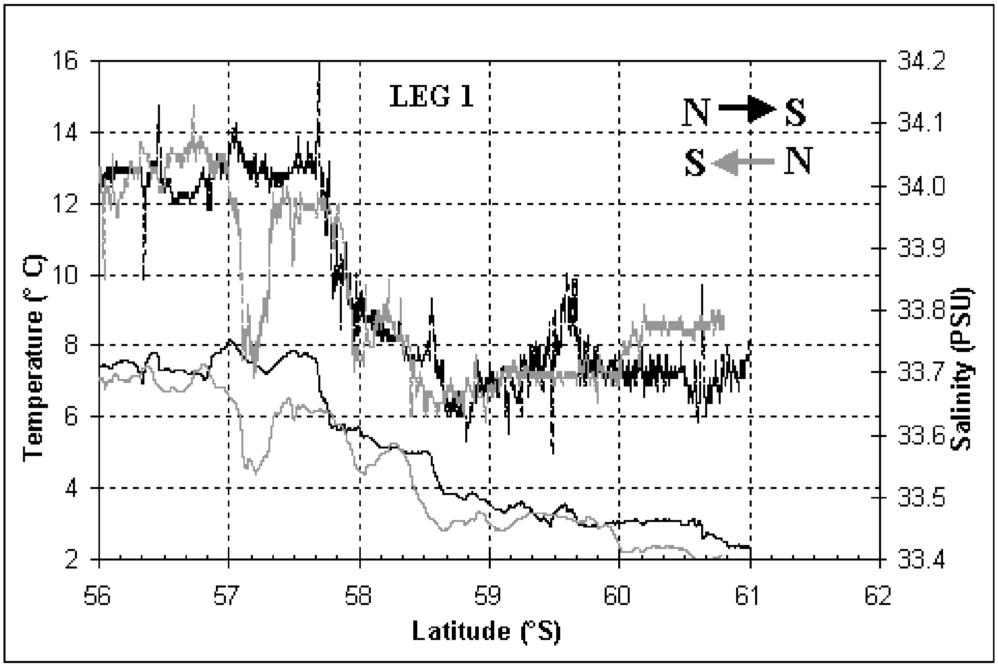
1.7 Acknowledgements: The co-operation and assistance of the Russian technical support staff was once again outstanding. All requests for assistance were dealt with efficiently and in a thoroughly professional manner.

1.8 References:

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

Table 1.1: Water Zone definitions applied for Legs I and II, AMLR 2004/05.

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



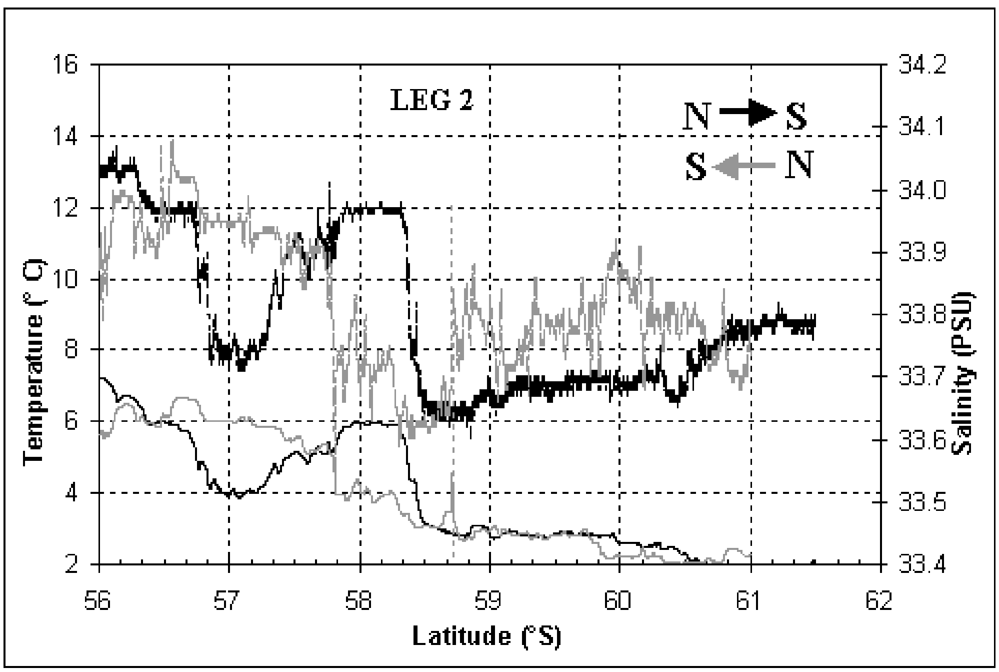


Figure 1.1 The position of the polar fronts as determined for AMLR 2004/05 Legs I (top) and II (bottom), from measurements of sea surface temperature (solid line) and salinity (broken line) for the south and north transits to and from the South Shetland Islands Survey area.

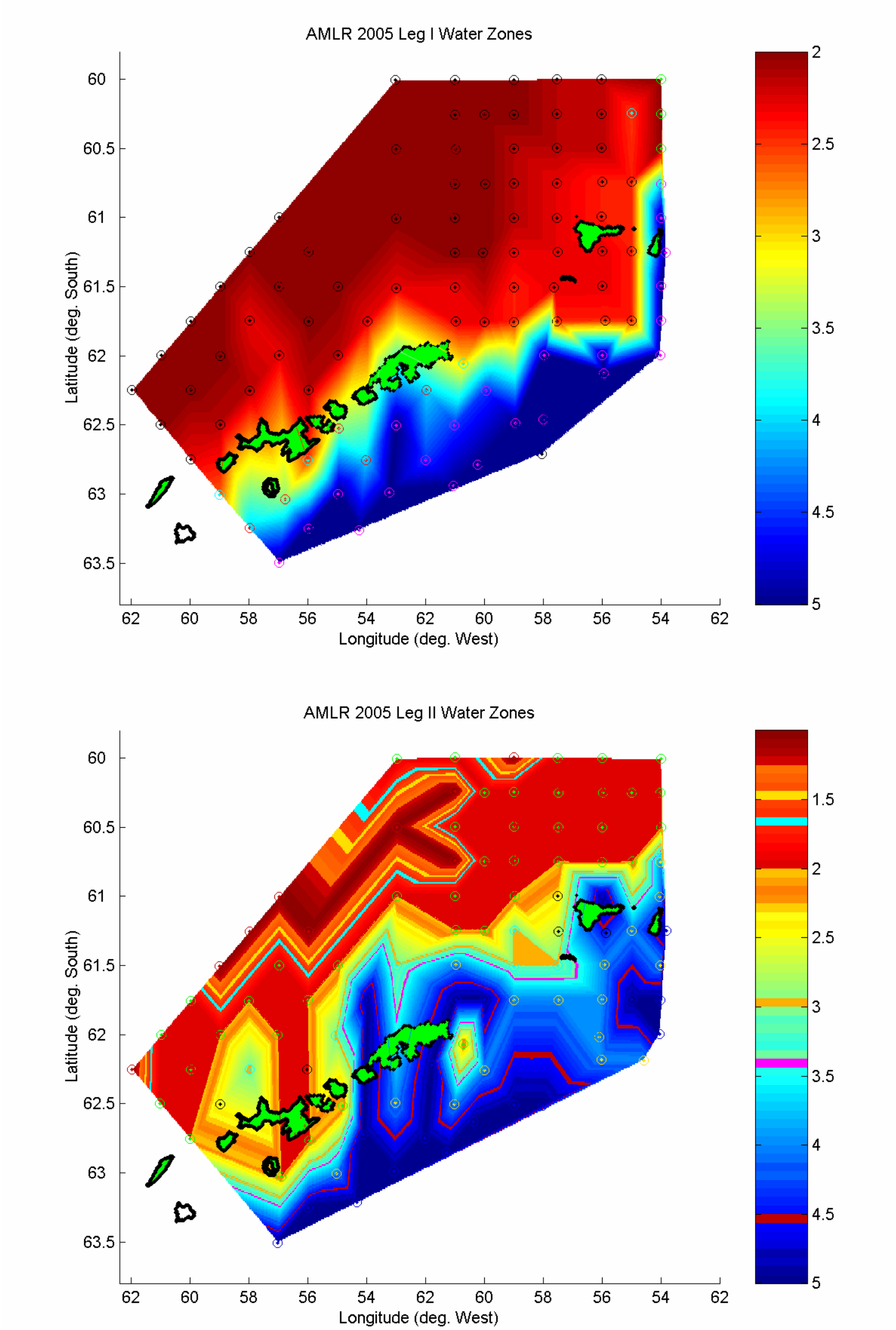


Figure 1.2 Classification of water zones for Leg I & II (top and bottom panels respectively) for AMLR 2004/05, as determined by the MATLAB classification routine developed during the AMLR 2000/01 survey. The colored bar on the right represents Water Zones I – V.

Leg I **Leg II**

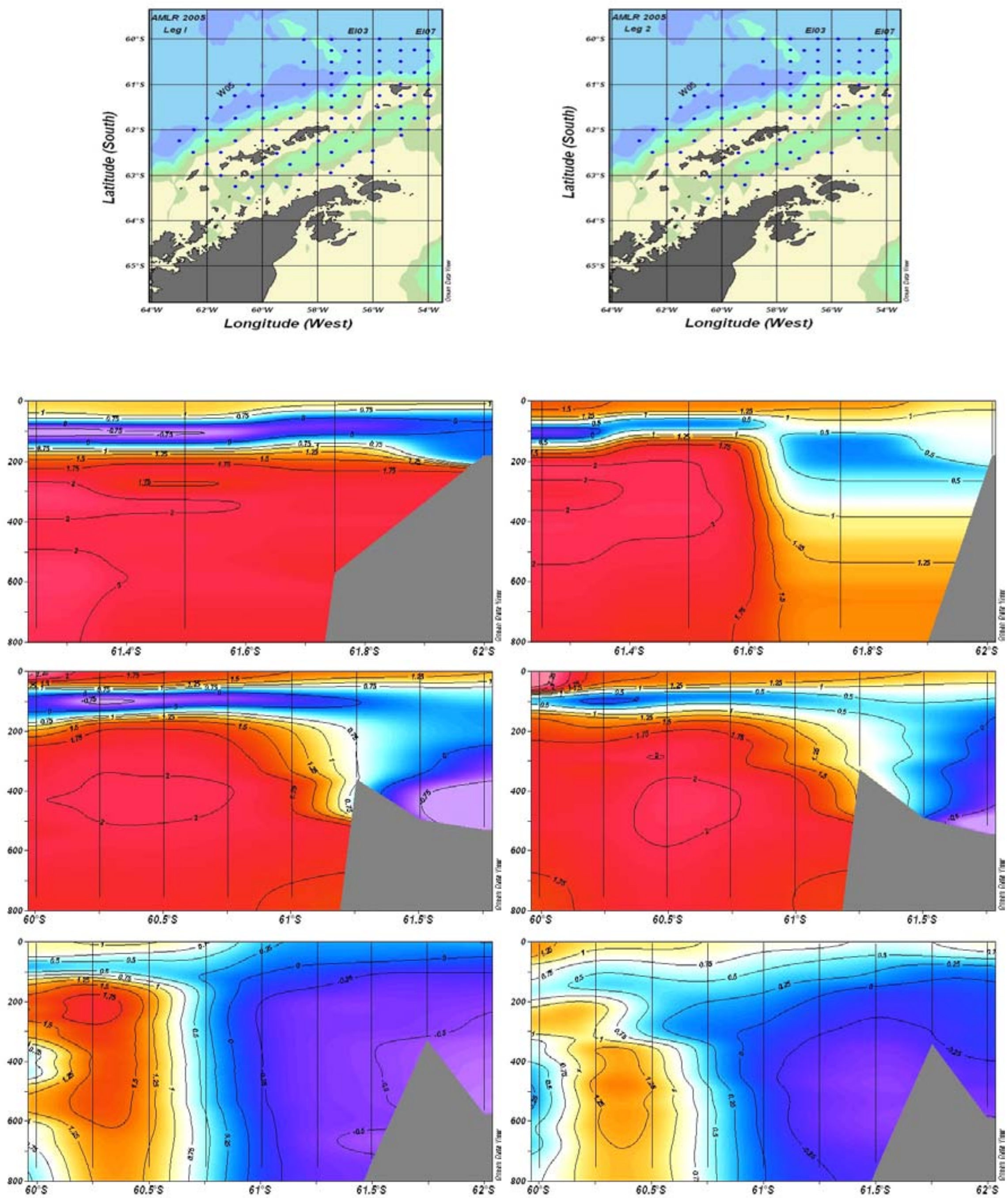
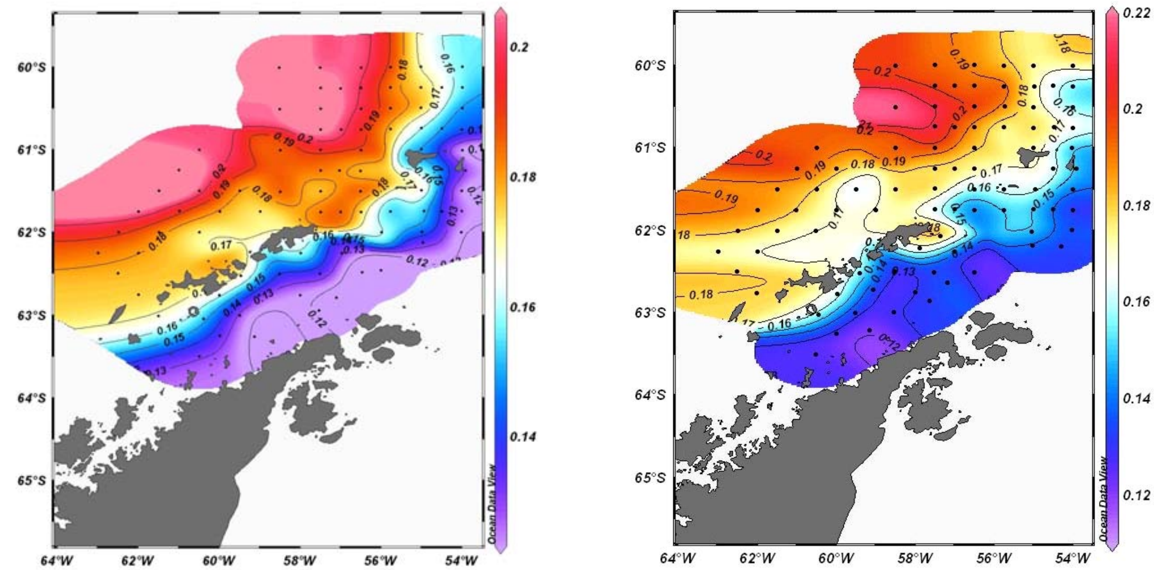
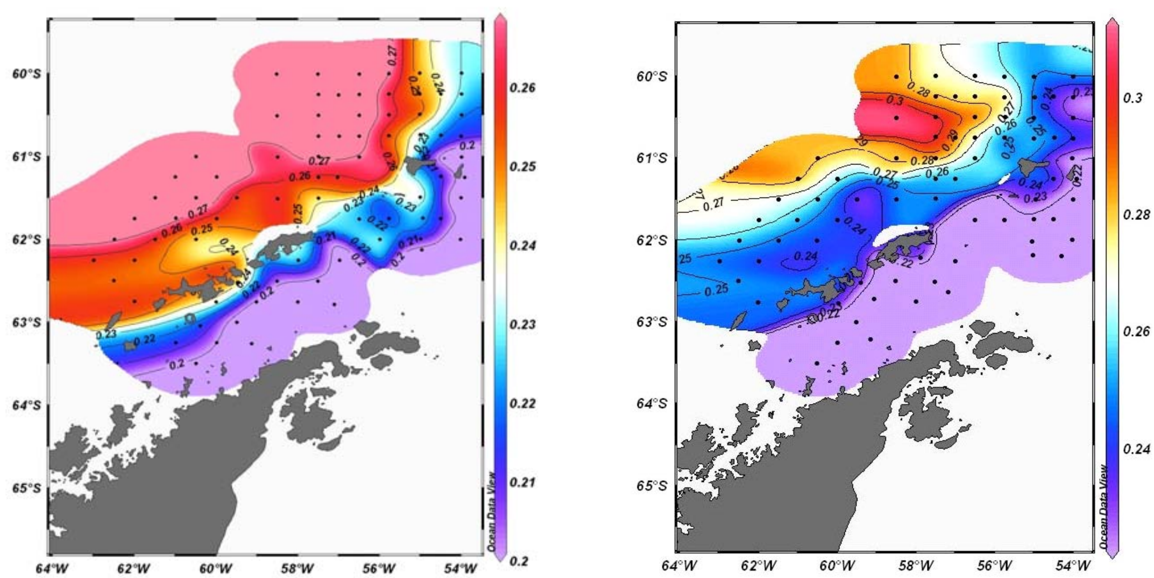


Figure 1.3 Vertical temperature profiles derived from CTD data recorded on three transects, W 05 (top), EI 03 (middle) & EI 07 (bottom), during Legs I (left column) & II (right column) of the AMLR 2004/05 South Shetland Island survey.



Dynamic Height – 300 (dyn m)



Dynamic Height – 500 (dyn m)

Figure 1.4 Dynamic Heights for Leg I & II (left and right panels respectively) for AMLR 2004/05, as determined by ODV.

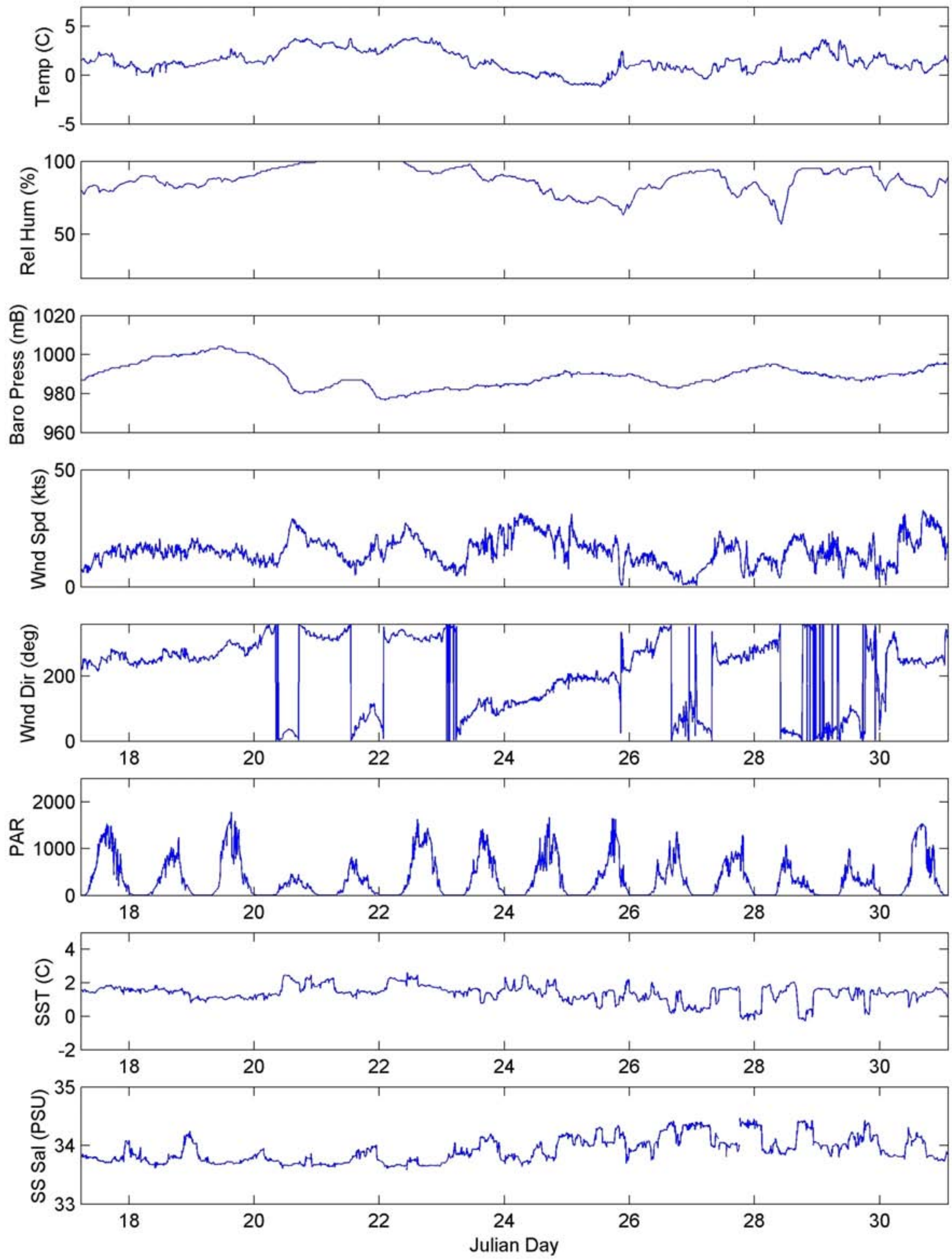


Figure 1.5 Meteorological data (5 minute averages) recorded between January 17th and January 31st during Leg I (survey only) of the AMLR 2004/05 Cruise. (PAR is photo-synthetically available radiation).

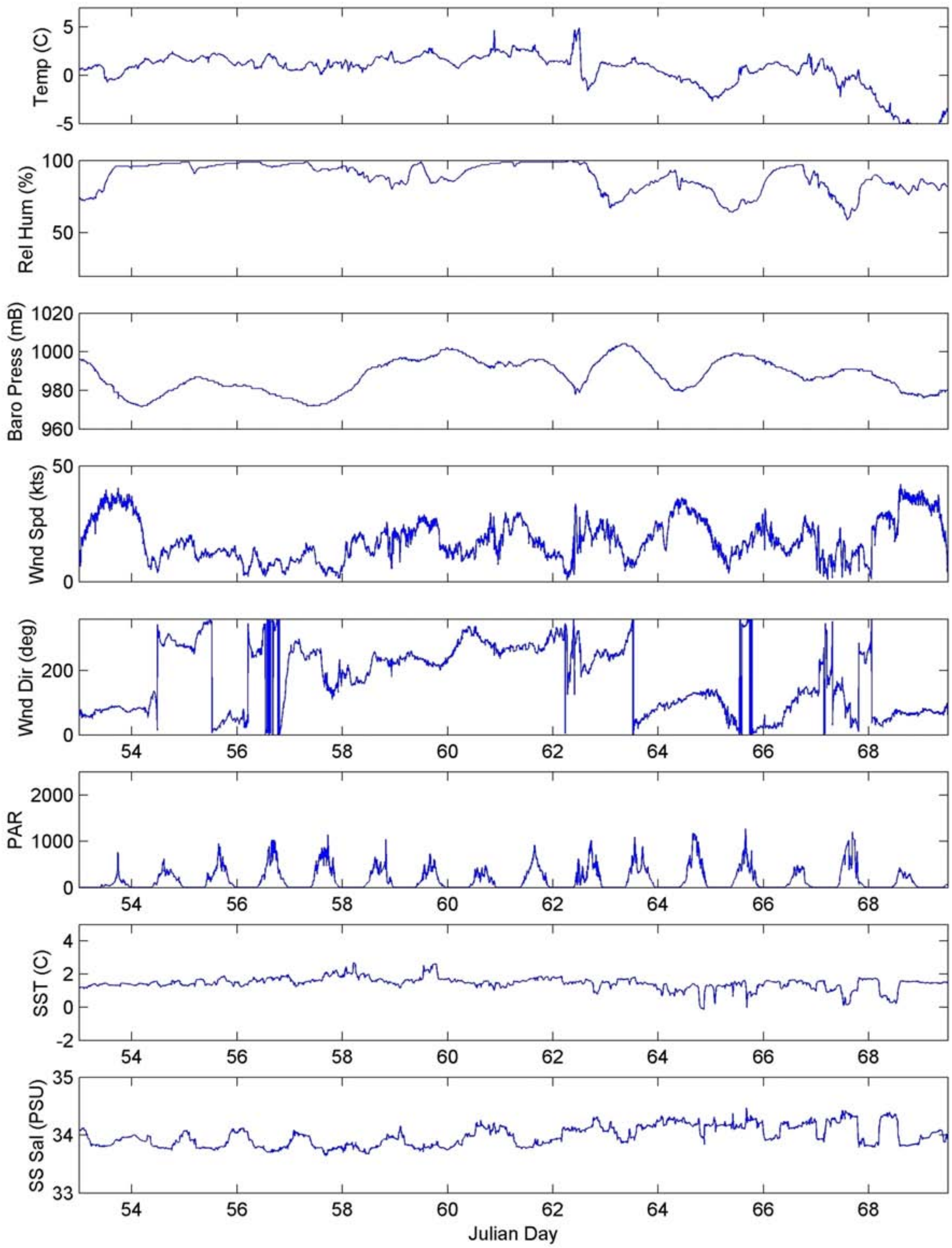
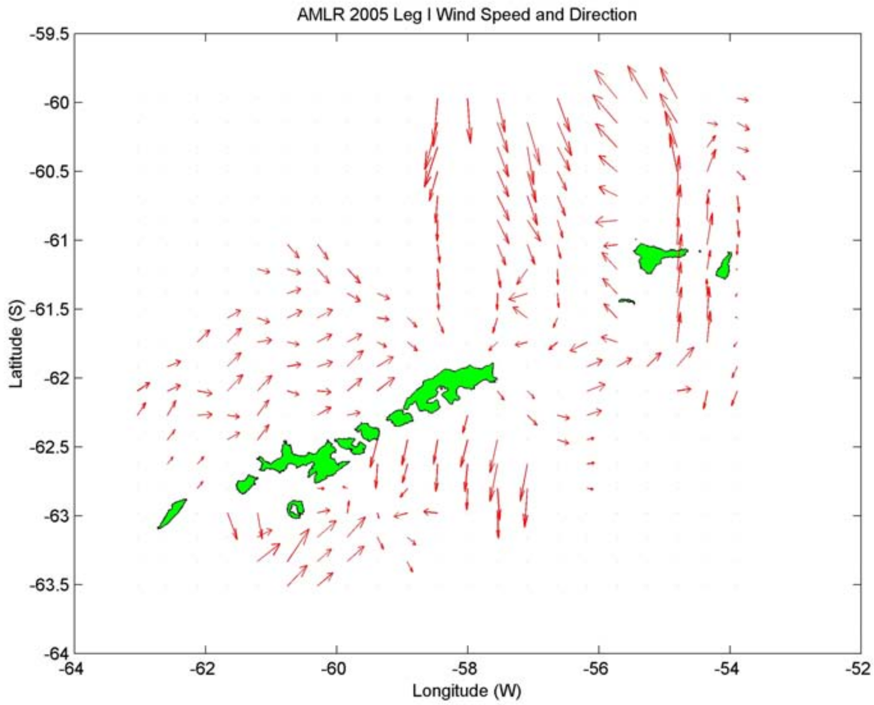


Figure 1.6. Meteorological data (5 minute averages) recorded between February 22nd and March 9th during Leg II (survey only) of the AMLR 2004/05 Cruise. (PAR is photo-synthetically available radiation).



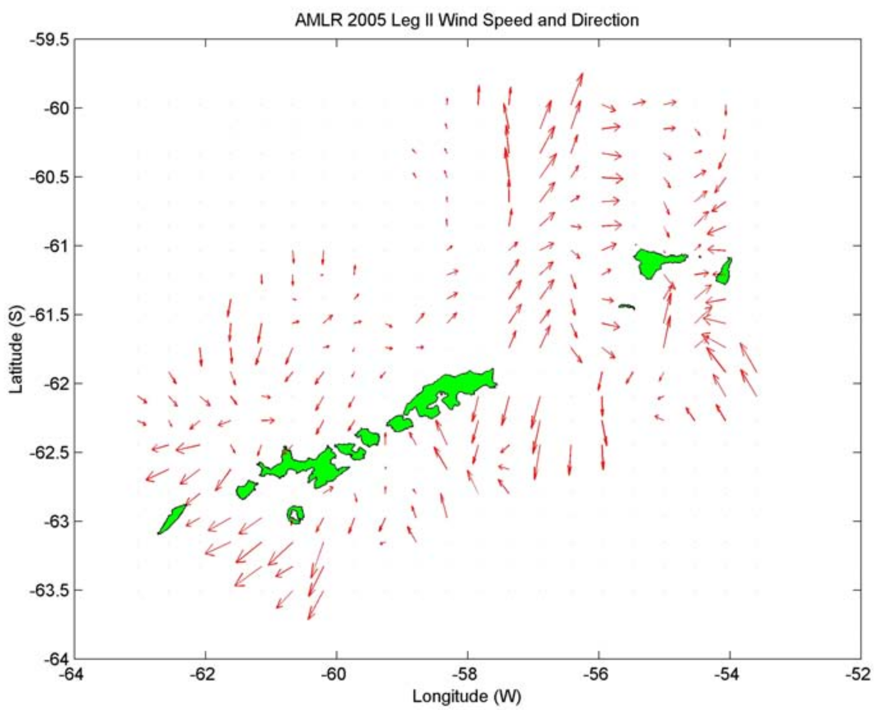


Figure 1.7 Vectors representing wind speed and direction for Legs I (top) and II (bottom) derived from data recorded by the SCS logging system during AMLR 2004/05 survey of the South Shetland Islands.

2. Phytoplankton Studies; submitted by Christopher D. Hewes (Legs I & II), Nora Rojas (Leg I), Cynthia Valenzuela (Leg II), B. Greg Mitchell, Mati Kahru, and Osmund Holm-Hansen (SIO).

2.1 Objectives: The overall objective of our research project was to assess the distribution and concentration of food reservoirs available to the herbivorous zooplankton populations throughout the AMLR study area during the austral summer. The specific objectives of our work were:

(i) to determine the distribution and biomass of phytoplankton in the upper water column (surface to 200m), with emphasis on the upper 100m,
(ii) to provide satellite coverage of surface chlorophyll distribution in the AMLR survey area and adjoining waters,
(iii) to better our understanding of the reasons for the variability in distribution of phytoplankton in relation to dynamic physical processes, nutrient concentrations, and solar irradiance in the upper 100 m of the water column.

2.2 Methods and Accomplishments: The major types of data acquired during these studies, together with an explanation of the methodology employed, are listed below.

2.2.1 Sampling Strategy: All water column data were obtained from the CTD carousel, which held the water sampling bottles and various profiling sensors. The carousel was lowered to 750 m depth at all deep stations and within 10 m of the bottom at the shallow stations. The bottles were closed on the up-cast to obtain water samples for various analyses. At the time of bottle closure, a ~1 second binned record was obtained of all data recorded by sensors on the carousel. The same sampling protocol was used during both Legs of the AMLR surveys. Instrumentation on the CTD carousel included:

(A) Temperature, conductivity, depth, and altimeter sensors (see Physical Oceanography report for details)

(B) A Sea Tek profiling fluorometer for measurement of *in situ* chlorophyll-*a* (chl-*a*) fluorescence.

(C) A cosine PAR (photosynthetic available radiation; 400-700 nm) sensor (Biospherical Instruments QCP-200L) for measurement of attenuation of solar radiation in the water column.

(D) Ten 8-liter General Oceanics Niskin bottles. Water samples at every station were obtained at 5, 10, 15, 20, 30, 40, 50, 75, 100, and 200 m (or 10 m above the bottom) target depths, and used for the analyses described below.

In addition to the above in-water sampling, incident solar radiation was measured continuously during both Legs with two sensors which were mounted on the superstructure of the ship: (i) a scalar PAR sensor (Biospherical Instruments QSR 240) and (ii) a Li-cor Model LI-190 (a cosine light sensor).

2.2.2 Measurements and Data Acquired: The types of measurements and the data acquired during and in conjunction with Legs I and II were:

(A) Chlorophyll-*a* concentrations: Chl-*a* concentrations of water samples were determined by measurement of chl-*a* fluorescence after extraction in an organic solvent. Sample volumes of 100mL (for routine measures) were filtered through glass fiber filters (Whatman GF/F, 25mm) at reduced pressure (maximal differential pressure of 1/3rd atmosphere). The filters with the particulate material were placed in 10mL of absolute methanol in 15mL tubes and the photosynthetic pigments allowed to extract at 4EC for at least 12 hours. The samples were then shaken, centrifuged, and the clear supernatant poured into cuvettes (13 x 100mm) for measurement of chl-*a* fluorescence before and after the addition of two drops of 1.0 N HCl (Holm-Hansen *et al*., 1965; Holm-Hansen and Riemann, 1978). Fluorescence was measured using Turner Designs Fluorometer TD-700 having been calibrated using spectrophotometrically determined chl-*a* concentrations of a prepared standard (Sigma). Stability of the fluorometer was verified daily by use of a fluorescence standard.

(B) Continuous profiles of chl-*a* and PAR: The Sea Tek fluorometer voltage data, in conjunction with the measurement of cosine PAR, was used to estimate chlorophyll concentrations *in situ*, using the algorithm of Holm-Hansen *et al*. (2000) as applied specifically for the AMLR survey region.

(C) Phytoplankton community size structure: For phytoplankton size-class determinations, water samples were gravity filtered through 2, 5, 10, and 20 µm 47mm PFTE membrane filters (Poretics); at no time was the filter allowed to dry, with the filter funnel removed from the sample container having 10-50mL of sample remaining. Chlorophyll concentrations were determined with methods described in (A) above, except that 200mL of sample was filtered. A total of 16 stations (10 m target depth) were analyzed as above, and an additional 12 stations during Leg II were analyzed for the 10 µm size-class alone.

(D) Phytoplankton taxa: At 25 stations during Leg I and 12 stations during Leg II, a 100 mL seawater sample from 5 or 10 m target depth Niskin bottle was preserved with 0.5% buffered formalin. Formalin preserved seawater samples were delivered to J. L. Iriarta (Universidad Austral de Chile, Puerto Montt, Chile) for taxonomic analysis of phytoplankton species.

(E) Incident Light Intensity: A scalar PAR sensor was used to measure incident light continuously over a 24-hour period. Incident PAR combined with measures of cosine PAR in the water column were used to estimate depth of the euphotic zone (1% incident light). In conjunction with surface chlorophyll concentrations, incident PAR can also be used to provide an estimate of daily primary productivity (Hewes, *in prep*.).

(F) Inorganic macronutrient concentrations: During Leg I, 15 stations were chosen for macronutrient sampling at 10, 30, 50, 75 m, and, when possible, 100, and 200 m target depths. Water samples were pored into acid washed 4 oz. polypropylene bottles and immediately frozen. These frozen seawater samples were delivered to N. Silva (Universidad Católica de Valparaiso Valparaiso, Chile) to be analyzed by auto-analyzer for nitrate, phosphate, and silicate concentrations (Atlas, 1971).

2.3 Tentative Results and Conclusions:

2.3.1 Overview of phytoplankton distributions in the AMLR survey area January-March:

2.3.1.1 Leg I (refer to Figure 2.1A; Tables 2.1 & 2.2):

West Area: For the West Area (n = 24), chlorophyll-*a* at 5m averaged 0.33 ± 0.39 mg m^{-3}, and values integrated to 100m were 29 ± 27 mg m^{-2}. For this area, chlorophyll concentrations during Leg I were below average compared with previous years (5 meter being 0.63 ± 0.99 mg chl-a m^{-3} n = 131; 100 meter integrated being values of 34 ± 22 mg chl-a m^{-2}, n = 111).

Elephant Island Area: The pattern for surface chlorophyll concentration in the Elephant Island sector followed the bottom topography of the area. Five-meter chlorophyll averaged 0.84 ± 0.69 mg m^{-3}, and integrated (100 meters) chlorophyll averaged 57 ± 33 mg m^{-2} for the entire section (53 stations). Chlorophyll concentrations this Leg were slightly above average compared with the 12 year Leg I mean (5 meter being 0.79 ± 0.79 mg m^{-3} n = 644; 100m integrated being 43 ± 35 mg m^{-2}, n = 591).

Joinville Island and South Areas: The pattern for surface chlorophyll concentrations in the Bransfield Strait (South Area) and Joinville Island Area closely follows the zones of water, with low values found for the Weddell Sea (Water Zone V) and higher values for the Strait itself (Water Zone IV). Five-meter chlorophyll averaged 1.46 ± 0.58 mg m^{-3}, and integrated (100 meters) averaged 68 ± 19 mg chl m^{-2} for the entire Bransfield Strait. The Joinville Island Area has been studied for only a few years, thus a reliable long term average for chlorophyll concentrations cannot be derived as of yet. For the South Area, chlorophyll concentrations this Leg were 1.60 ± 0.58 mg chl m^{-3} for the surface, and integrated to 100 meter were 51 ± 34 mg chl m^{-2} (n = 18). These values were above average compared previous years (5 meter having 1.30 ± 0.89 mg chl m^{-3} n = 63; 100m integrated having 51 ± 34 mg chl m^{-2}, n = 45).

2.3.1.2 Leg II (refer to Figure 2.1B; Tables 2.1 & 2.2):

West Area: Surface chlorophyll concentrations averaged 0.83 ± 0.68 mg m^{-3} and integrated to 100 meter averaged 66 ± 50 mg chl m^{-2} (24 stations). These values were slightly above average compared previous years (5 meter being 0.64 ± 0.72 mg chl m^{-3} n = 94; 100m integrated being 40 ± 36 mg chl m^{-2}, n = 78).

Elephant Island Area: Five-meter chlorophyll averages for the Elephant Island Area were 0.62 ± 0.40 mg m^{-3}, and integrated (100 meters) averages 50 ± 28 mg m^{-2} for the entire Elephant Island Area (51 stations). Thus phytoplankton biomass decreased slightly from that found during Leg I, and much lower than the 12-year average for Leg II of 1.08 ± 1.23 mg chl m^{-3} (n = 445) for 5 meters and 61 ± 57 mg chl m^{-2} (n = 504) for 100m integrated values.

Joinville Island and South Areas: Phytoplankton biomass decreased considerably from Leg I values for the entire Bransfield Strait, with 5m chlorophyll values of 0.56 ± 0.22 mg m^{-3} and integrated values of 45 ± 26 mg chl m^{-2} (n = 23). The South Area surface concentrations were 0.61 ± 0.19 mg chl-a m^{-3} and 44 ± 10 mg chl-a m^{-2} (n = 16) for 5m and integrated (100m) chl, respectively. The South Area phytoplankton biomass for Leg II was considerably less than the 12-year average of 1.93 ± 1.91 mg chl m^{-3} for 5 meters and 110 ± 110 mg m^{-2} for integrated (100m) chlorophyll. Too few data have been collected in the Joinville Island Area to make any comparisons with previous years.

2.3.2 Surface chlorophyll distribution in the AMLR survey and surrounding areas: MODIS-Aqua Satellite imagery monthly composites (Figure 2.2) indicate that the area of the pelagic Drake Passage west of the Shackleton Fracture Zone had exceptionally low chlorophyll concentrations as measured during the January-March AMLR field season. This is in contrast to the much richer conditions that were apparent in December. As discussed above, higher surface chl-*a* concentrations occurred along the shelf and shelf-break (e.g., coastal) regions and in the Bransfield Strait. In addition, very rich blooming occurred to the northeast of the AMLR survey area in the Scotia Sea. These images indicate slightly different patterns than depicted by our measured chl-*a* in the field (i.e., Figure 2.1). This is primarily because our field sampling occurred from mid-month through to mid-month, whereas the satellite composite images cover the period from beginning through end of each month. Hence, the higher concentrations of chlorophyll imaged in the Bransfield Strait for February were sampled during Leg I, while that for March sampled during Leg II. In contrast, chlorophyll as imaged for the areas north of the South Shetland and Elephant Islands were sampled in January, while that for February was sampled during Leg II.

2.3.3 Incident and water column light regimes: Two different types of PAR sensors to measure incident light while underway have been used during AMLR cruises. Prior to 2000, a BSI Model QSR-240 scalar PAR sensor was used, and after which, a LI-COR Model LI-190 cosine PAR sensor used. A scalar sensor measures light from all directions (e.g., direct + scattered light). A cosine PAR sensor only measures light from a relatively singular (i.e., direct) direction (~80° angle of incidence). For shipboard studies, it is usually desirable to use a scalar sensor primarily because the rolling of a ship can result with a cosine sensor obtaining highly variable data on sunny days. This season we took underway measurements using both sensors, and found they agreed well (Figure 2.3A), however the LI-COR had slightly higher (~5%) values. Hourly averaged PAR data from both sensors, as well as the mean hourly PAR, obtained during Leg I are plotted in Figure 2.3B. The average intensity of PAR during Leg I was much less than half the theoretical maxima, indicating that overcast and foggy conditions existed during most of this cruise. Such conditions scatter the incident light, and could be the explanation for the good comparison between the different types of PAR sensors.

In the ocean, phytoplankton account for most variability found in the attenuation of incident light through the water column (Morel, 1988). From Figure 2.4, it is observed that equal percentages of light penetrate deeper in the water column for low chl-*a* (Figure 2.4A) than they do in for blooms (Figure 2.4B-C). The depth of the euphotic zone is usually considered that depth at which 1% of incident PAR can be obtained. This is often used as a standard depth with which to integrate phytoplankton biomass or primary productivity. In Figure 2.4, the range for the 0.1-1.0% incident PAR (actual measurements) has been indicated. For low biomass conditions (Figure 2.4A), integration of chlorophyll through the euphotic zone accounts for most of the total chl-*a* found for the water column. However, integration of chlorophyll to 1% incident PAR for bloom waters accounted for only ~30-50% of the total (Figure 2.4C) as integrated to 100 m. Therefore, interpretation of how much biomass of phytoplankton is available as a food source to krill by examining euphotic zone values may actually be greatly underestimated. Historically, estimates reported to AMLR have been chl-*a* values integrated to 100 m (i.e., Table 2.1).

2.3.4 Phytoplankton size-class distributions: As noted in previous years (Hewes *et al*., 2001), the pelagic waters north of the South Shetland Islands were found to have a different phytoplankton community size-structure than populations analyzed in shelf and shelf-break waters and Bransfield Strait waters (Figure 2.5). Regardless that total chlorophyll of Bransfield Strait and shelf and shelf-break areas were of near-bloom to bloom (i.e., >1 mg chl-*a* m^{-3}) concentrations, populations were dominated by nanoplankton (<10 µm diameters) cells. This is interesting in light of the dogma that nanoplankton dominate low biomass and large cells usually dominate high biomass regions of the Southern Ocean (i.e., Hewes *et al*., 1985). Taxonomic investigation by examination with microscope for these samples is currently in progress to help elucidate differences between phytoplankton communities for Drake Passage and "other" waters.

2.3.5 Other: Samples for nutrient chemistry, phytoplankton taxonomy and dissolved organic carbon (DOC) are in the process of being analyzed at the time of this report.

2.4 Disposition of the Data: All chlorophyll and CTD-interfaced sensor data obtained during these cruises have been archived with AERD, Southwest Fisheries Science Center.

2.5 Problems and Suggestions: This was an excellent survey cruise, although the coordination and communication by the near-shore survey NSF-investigators to the AMLR oceanography team could have been better.

2.6 Acknowledgements: We want to express our gratitude and appreciation to the entire complement of the R/V *Yuzhmorgeologiya* for their generous and valuable help during the entire cruise. They not only aided immeasurably in our ability to obtain the desired oceanographic data, but they also made the cruise most enjoyable and rewarding in many ways. We also thank all other AMLR personnel for help and support which was essential to the success of our program. This report has been funded in part to O. Holm-Hansen from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, under grant NA17RJ1231. The views expressed herein are those of the authors and do not necessarily reflect the views of NOAA or any of its sub-agencies.

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Table 2.1. Mean and standard deviation of surface and integrated (100m) chl-a concentrations for the different AMLR survey regions of each Leg as measured during the 2004/2005 field season.

Leg	Area	Surface Chl-a, mg m^{-3}			Integrated Chl-a, mg m^{-2}			*n*
I	EI	0.84	±	0.69	57	±	33	53
I	JI	1.14	±	0.46	68	±	19	8
I	SA	1.60	±	0.58	77	±	18	18
I	WA	0.33	±	0.39	29	±	27	24
II	EI	0.62	±	0.40	50	±	28	51
II	JI	0.45	±	0.26	36	±	17	7
II	SA	0.61	±	0.19	44	±	10	16
II	WA	0.83	±	0.68	66	±	50	24

Table 2.2. Mean and standard deviation of surface chl-a concentrations for pelagic (>2000 meter bottom depth) and shelf/shelf-break (<2000 meter bottom depth) areas north of the Shetland/Elephant Island areas, and also for the Bransfield Strait for each Leg measured during the AMLR 2004/2005 field season.

Leg	Area	Chl-a (mean ± std. dev), mg m^{-3}			*n*
I	Shelf/break	0.39	±	0.48	44
I	Pelagic	0.46	±	0.35	42
I	Bransfield	1.46	±	0.58	26
II	Shelf/break	1.06	±	0.66	33
II	Pelagic	0.98	±	0.53	33
II	Bransfield	0.56	±	0.22	23

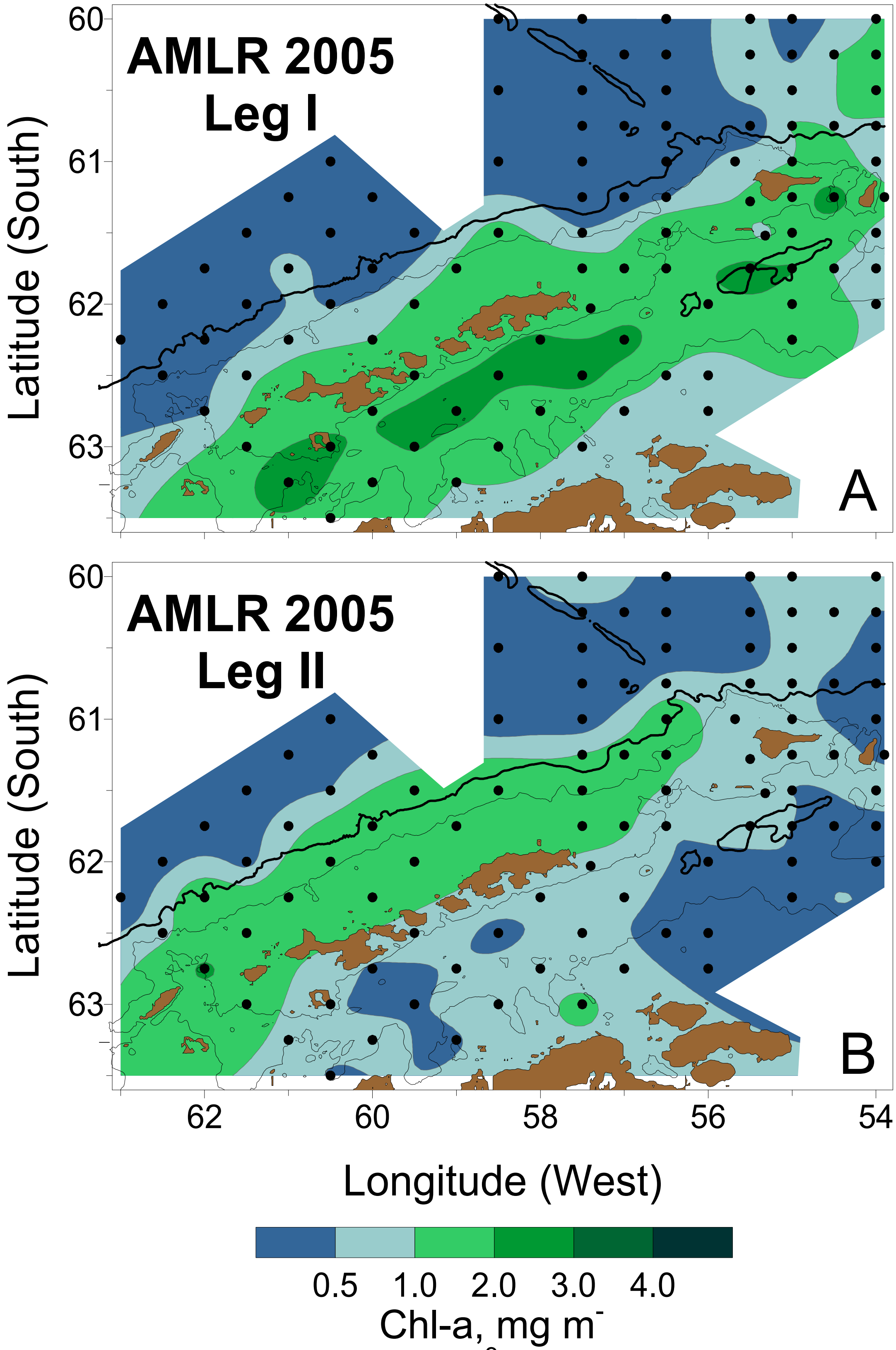

Figure 2.1. Distributions of near surface chlorophyll concentrations during (A) Leg I, and (B) Leg II. The 2000 meter (thick) and 500 meter (thin) bottom depth contour lines are shown. Filled circles represent locations where bottle samples were obtained.

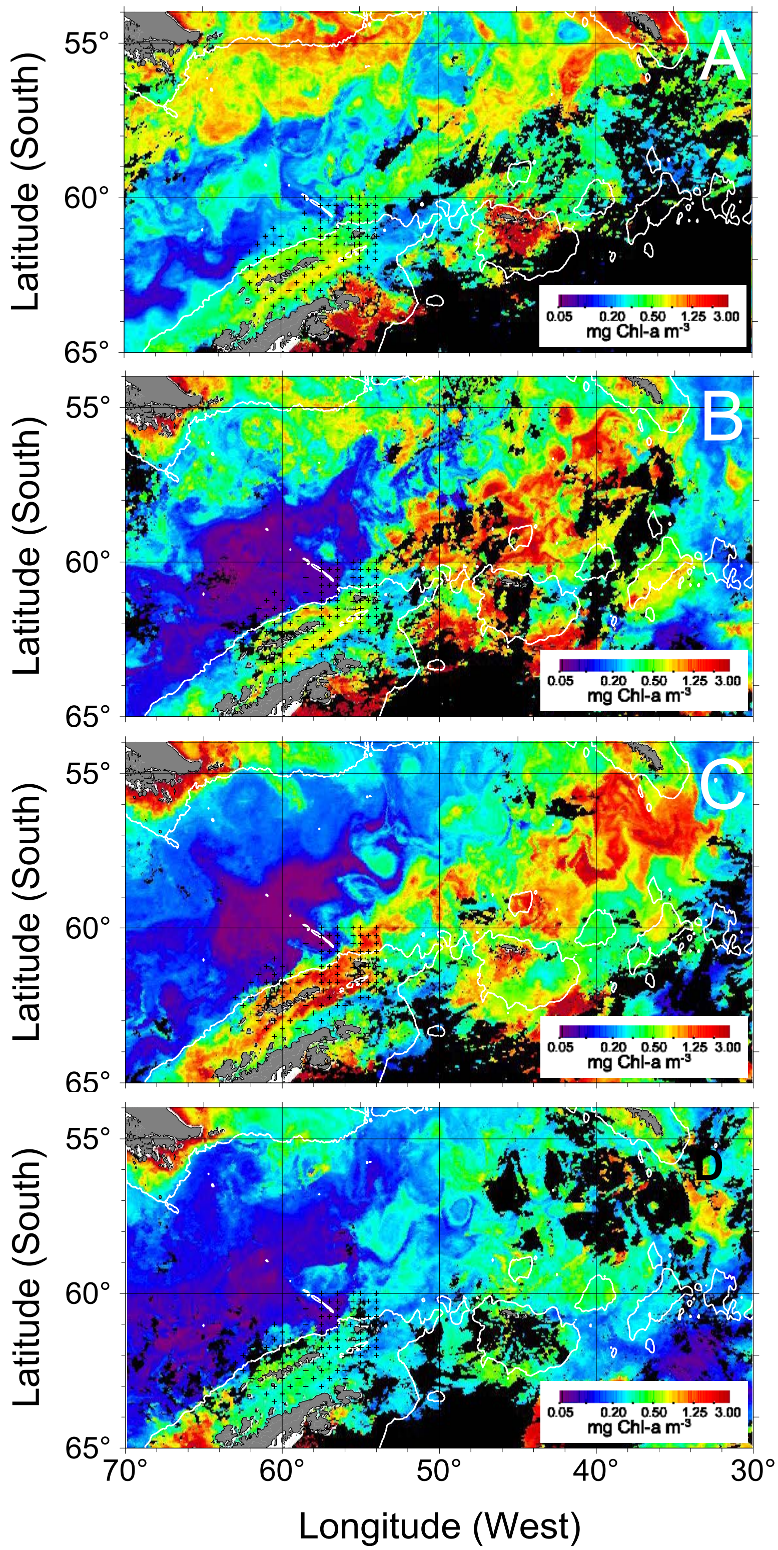

Figure 2.2. Surface chlorophyll concentrations in the AMLR survey area (grid of symbols) and surrounding area as obtained by MODIS-AQUA satellite for December (**A**), January (**B**), February (**C**), and March (**D**), 2005. The 2000 meter contours shown as white lines, black areas indicate insignificant data.

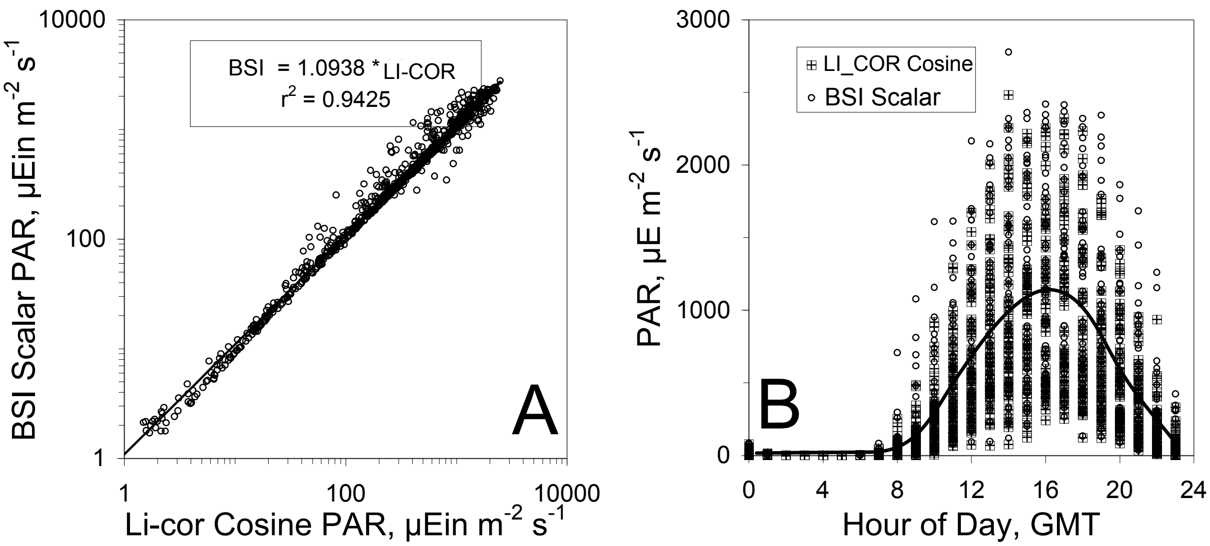

Figure 2.3. (**A**) Comparison of incident PAR measured by the Biospherical Instruments (BSI) Model QSR-240 (a scalar light sensor) and that by the LI-COR Model LI-190 (a cosine light sensor). The relationship between the two sensors listed is for PAR > 1 µEin m^{-2} s^{-1}. (**B**) Mean hourly PAR measured each day during Leg I for both BSI (circles) and LI-COR (crosses) PAR sensors. The mean hourly scalar PAR for the entire Leg I indicated by the solid line in **B**. These data indicate that the average day during Leg I was overcast or foggy.

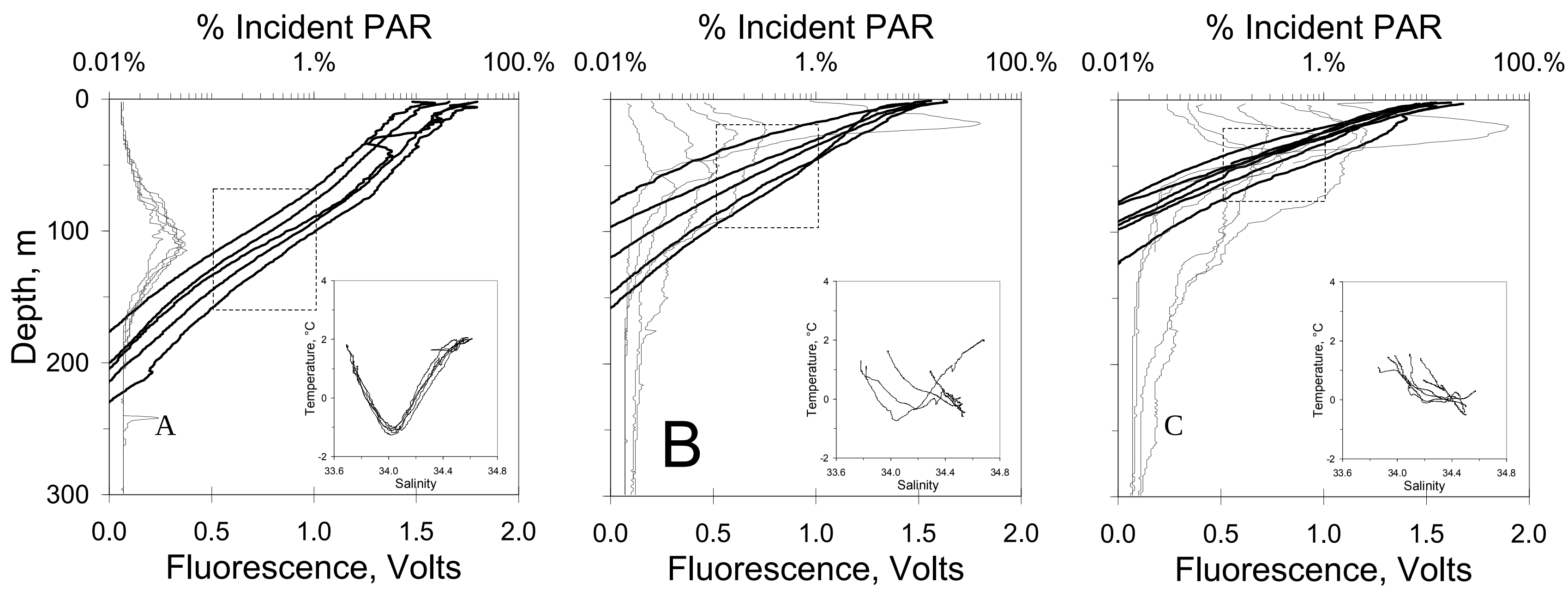

Figure 2.4. Influence of chlorophyll concentration at depth (mg chl-a m^{-3} ~ 1.2 * Fluorescence (Volts), gray lines) on the underwater PAR (heavy black lines) for pelagic Drake Passage (**A**), and the shelf-break (1000-2000 meter bottom, **B**), and shelf (< 800 meter bottom, **C**) off the northern shores of the South Shetland Islands. Data were selected from stations made between 10-2100 hours (GMT) during Leg I, which were in the range of maximal daylight hours as shown in Figure 2.3B. Plot inserts show the temperature/salinity characteristics for the stations in each group. The boxes drawn indicate the range of PAR values between 0.1% and 1.0% incident PAR, where 1% PAR is usually considered as extent of the euphotic zone depth. In shelf and shelf-break waters, considerable phytoplankton biomass was found below the euphotic zone.

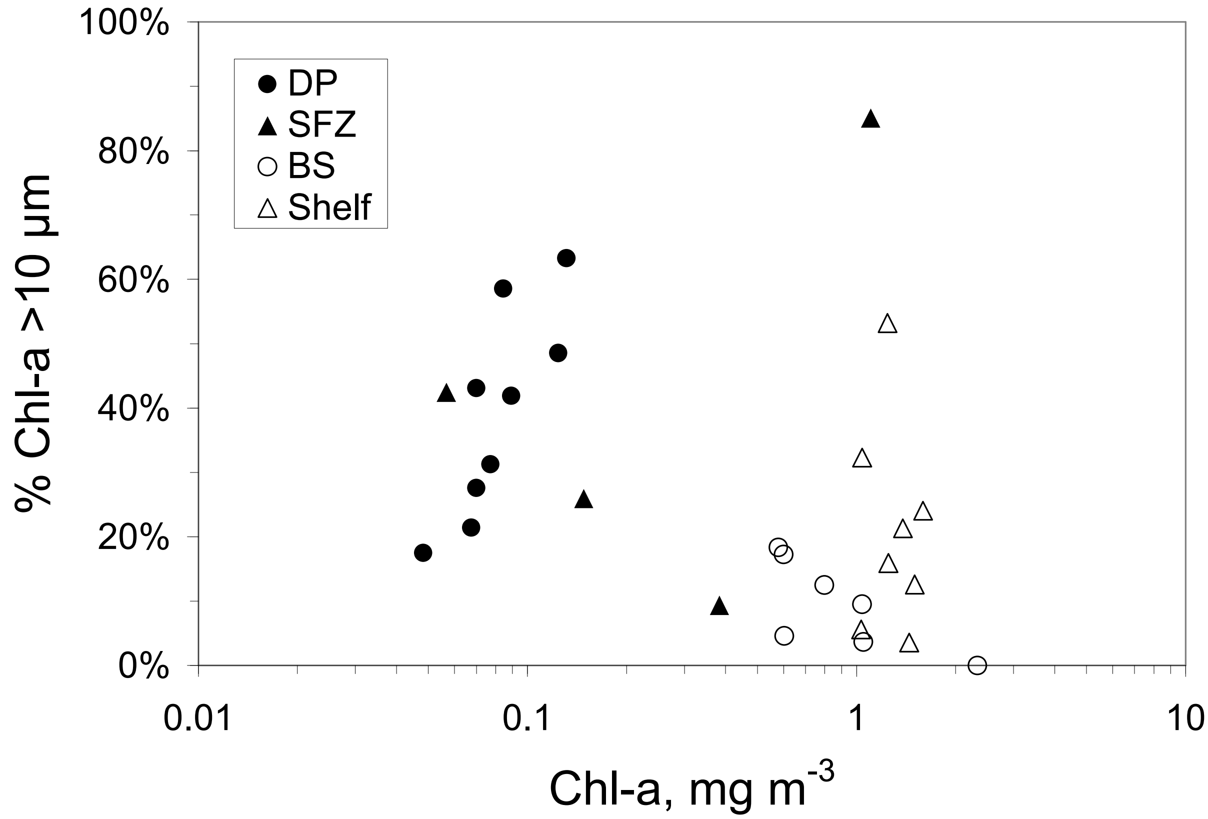

Figure 2.5. Relationships between chlorophyll concentration and the size-class distribution of phytoplankton cells for different areas within the AMLR survey grid. Two distinct groupings of phytoplankton community structure were found. The Bransfield Strait (BS: combining JI and SA areas) and shelf/shelf-break (Shelf: <2000 meter bottom depth, all areas) having a greater proportion of <10 µm phytoplankton (probably flagellate) with respect to total chlorophyll concentration as compared with pelagic regions (>2000 meter bottom depth, WA and EI areas) of the Drake Passage. This, with exception of those populations measured in the vicinity of the Shackleton Fracture Zone (SFZ), which indicated a mixture between these two groupings.

3. Bioacoustic survey; submitted by Anthony M. Cossio (Legs I & II), Christian Reiss (Leg I & II) and Stefan Leeb (Leg II).

3.1 Objectives: The primary objectives of the bioacoustic survey during Legs I and II were to map the meso-scale dispersion of Antarctic krill (*Euphausia superba*) in the vicinity of the South Shetland Islands; to determine their association with predator foraging patterns, water mass boundaries, spatial patterns of primary productivity, and bathymetry. In addition, efforts were made to map the distribution of myctophids and to determine their relationship with water mass boundaries and zooplankton distribution.

3.2 Methods and Accomplishments: Acoustic data were collected using a multi-frequency echo sounder (Simrad EK60) configured with down-looking 38,70, 120, and 200 kilohertz (kHz) split-beam transducers mounted in the hull of the ship. System calibrations were conducted before and after the survey using standard sphere techniques while the ship was at anchor in Admiralty Bay, King George Island. During the surveys, pulses were transmitted every 2 seconds at 1 kilowatt for 1 millisecond duration at 38 kHz, 70 kHz, 120 kHz, and 200 kHz. Geographic positions were logged every 60 seconds. Ethernet communications were maintained between the EK60 and one Windows XP workstation. The workstation was used for primary system control, data logging, and data processing with SonarData Echoview software.

Acoustic surveys of the water surrounding the South Shetland Islands were conducted on Legs I and II. These surveys were divided into four areas (See Figure 2 in Introduction): (1) a 43,865 km^2 area centered on Elephant Island (Elephant Island Area) was sampled with seven north-south transects; (2) a 38,524 km^2 area along the north side of the southwestern portion of the South Shetland archipelago (West Area) was sampled with six transects oriented northwest-southwest and one oriented north-south; (3) a 24,479 km^2 area in the western Bransfield Strait (South Area) was sampled with seven transects oriented northwest-southwest; (4) and an 18,151 km^2 area north of Joinville Island (Joinville Island Area). Due to extensive sea ice accumulation, only three transects were completed in the Joinville Island Area during Leg I (Survey A) and three were completed during Leg II (Survey D).

3.2.1 Krill Delineation (Legs I & II, Surveys A & D): Krill abundance was estimated using a three-frequency delineation method (Hewitt *et al.*, 2003) as opposed to the two-frequency method used in past research (Madureira *et al.*, 1993). A ?MVBS window of 4 to 16 was selected between 120 kHz and 38 kHz with the second window of -4 to 2 defined between 120 kHz and 200 kHz. The window ranges for krill were selected based on models of krill backscattering strength at each frequency.

3.2.2 Myctophid Delineation (Legs I & II, Surveys A & D): A ?MVBS window of -5 to 2dB was applied to the two-frequency method for the purpose of delineating myctophids. This range was chosen based on observed differences in myctophid backscattering values between 38 kHz and 120 kHz. The use of the three-frequency method to further delineate myctophids was unnecessary. The two-frequency method sufficiently reduced the acoustic data to include myctophid targets only.

3.2.3 Abundance Estimation and Map Generation: Backscattering values were averaged over 5m by 20s bins. Time varied gain (TVG) noise was subtracted from the echogram and the ?MVBS window was applied. TVG values were based on levels required to erase the rainbow effect plus 2dB. The remaining volume backscatter classified as krill was integrated over depth (500m) and averaged over 1,852m (1 nautical mile) distance intervals. These data were processed using SonarData Echoview software.

Integrated krill nautical area scattering coefficient (NASC) (Maclennan and Fernandes, 2000) was converted to estimates of krill biomass density (?) by applying a factor equal to the quotient of the weight of an individual krill and its backscattering cross-sectional area, both expressed as a function of body length and summed over the sampled length frequency distribution for each survey (Hewitt and Demer, 1993):

$$\rho = 0.249 \sum_{i=1}^{n} f_i (l_i)^{-0.16} \, NASC \quad (\mathrm{g/m^2})$$

Where

$$\mathrm{NASC} = 4\pi r_0^{\,2} (1852)^2 \int_{15}^{500} S_v \qquad (\mathrm{m^2/n.mi.^2})$$

And f_i = the relative frequency of krill of standard length l_i. Where the reference range for backscattering strength equals 1 m (r_0= 1 m).

For each area in each survey, mean biomass abundance attributed to krill and its variance were calculated by assuming that the mean abundance along a single transect was an independent estimate of the mean abundance in the area (Jolly and Hampton, 1990). We used the cluster estimator of Williamson (1982) to calculate the variance of NASC within each area and to expand the abundance estimate for each leg to the South Shetlands.

No myctophid biomass estimates were made because of the lack of target strength data and length frequency distributions. The NASC attributed to myctophids was integrated using SonarData Echoview software and then used to map their distribution.

3.3 Tentative Conclusions:

3.3.1 Leg I (Survey A): High abundances of krill were observed around Elephant Island with the greatest densities to the north east along the shelf break (Figure 3.1). Krill abundances were calculated to be 24.2, 36.4, 14.8, and 17.9 g/m² for the West, Elephant Island, South and Joinville Island Areas respectively (Table 3.1). Abundance estimates by transect are listed in Table 3.2.

The distribution of mean NASC of myctophids was mapped and found to be highest along the 2000m isobath (Figure 3.2). Areas of greater abundance were observed northeast of Livingston Island and northwest of Elephant Island.

3.3.2 Leg II (Survey D): Krill abundances declined from Leg I. Krill abundance was highest northeast of Livingston Island. Abundance was 12.5, 6.1, 3.3, and <1 g/m^2 for the West, Elephant Island, South and Joinville Island Areas respectively.

The spatial distribution of myctophid NASC was lower than Leg I. There were only two aggregations where there were significant NASC values, northeast of Livingston Island.

3.4 Disposition of Data: All integrated acoustic data will be made available to other U.S. AMLR investigators in ASCII format files. The analyzed echo-integration data consume approximately 10 MB. The data are available from Anthony Cossio, Southwest Science Center, 8604 La Jolla Shores Dr, La Jolla, CA 92037; phone/fax: +1(858) 546-5609/546-5608; e-mail: Anthony.Cossio@noaa.gov.

3.5 References:

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Table 3.1. Mean krill biomass for surveys conducted from 1992 to 2005. Coefficients of variation (CV) are calculated by the methods described in Jolly and Hampton, 1990, and describe measurement impreeision due to the survey design. 1993 estimates are omitted due to system calibration uncertainties; only one survey was conducted in 1997; 1999 South Area values are not available due to lack of data. Data values are based on the three-frequency krill delineation method (4-16dB difference between 120 and 38 kHz and -4-2dB difference between 200 and 120 kHz). See Figure 2 in the Introduction Section for description of each survey. Values in parentheses indicate previous estimates that have been revised.

Survey	Area	Mean Abundance (g/m^2)	Area (km^2)	Biomass (10^3 tons)	CV %
1992 A (late January)	Elephant Island	38.03	36,271	194	20.1
D (early March)	Elephant Island	7.91	36,271	287	14.3
1994 A (late January)	Elephant Island	3.07	41,673	128	34.7
D (early March)	Elephant Island	2.14	41,673	13	33.7
1995 A (late January	Elephant Island	7.47	41,673	311	23.5
D (early March)	Elephant Island	13.22	41,673	551	28.8
1996 A (late January)	Elephant Island	26.85	41,673	1,119	29
D (early March)	Elephant Island	17	41,673	708	36
1997 A (late January)	Elephant Island	50.04	41,673	2,085	21.4
1998 A (late January)	Elephant Island	60.22	41,673	2,509	19.4
	West	75.39	34,149	2,575	30.5
	South	29.35	8,102	238	27.1
D (late February)	Elephant Island	20.84	41,673	868	16.3
	West	75.03	34,149	2563	28.7
	South	37.87	8,102	307	12.4
1999 A (late January)	Elephant Island	14.84	41,673	619	38.1
	West	16.92	34,149	578	31.6
	South	15.52	8,102	126	14.8
D (late February)	Elephant Island	13.37	41,673	557	39.8
	West	16.18	34,149	552	35.7
2000 D (late February)	West	32.51	34,149	1,110	37.4
	Elephant Island	34.57	41,673	1,441	28.6
	South	19.83	8,102	161	4
2001 A (late January)	West	4.7	34,149	161	16.4
	Elephant Island	6.65	41,673	277	19.1
	South	6.5	8,102	53	20.9
D (late February)	West	7.83	34,149	268	42.8
	Elephant Island	5.99	41,673	250	10.4
	South	2.77	8,102	22	40.1
2002 A (late January)	West	2.29	38,524	88	117.6
	Elephant Island	3.34	43,865	147	78.7
	South	2.11	24,479	351	53.3
D (late February)	West	1.69	38,524	65	19.3
	Elephant Island	1.17	43,865	51	23.5
	South	1.05	24,479	26	32.9
2003 A (late January)	West	28.42 (28.58)	38,524	1,095 (1,101)	15.1 (13.9)
	Elephant Island	25.06 (24.48)	43,865	1,099 (1,044)	16.2 (0.2)
	South	11.50 (13.1)	24,479	281 (331)	35.4 (0.3)
D (late February)	West	35.86 (36.71)	38,524	1,381 (1,414)	20.2(19.3)
	Elephant Island	17.05 (16.86)	43,865	748 (739)	18.4 (23.5)
	South	17.18 (20.34)	24,479	421 (498)	15.4 (13.1)
2004 A (late January)	West	36.39 (13.75)	38,524	1402 (530)	14.8 (16.1)
	Elephant Island	40.06 (11.45)	43,865	1757 (502)	15.5 (12.0)
	South	40.65 (3.81)	24,479	995 (93)	11.1 (24.1)
D (late February)	West	12.19 (8.41)	38,524	470 (324)	37.3 (33.6)
	Elephant Island	41.75 (14.71)	43,865	1832 (645)	15.9 (16.4)
	South	30.77 (4.49)	24,479	753 (110)	40.8 (75.9)
2005 A (late January)	West	24.22	38,524	933	16.0
	Elephant Island	36.41	43,865	1,597	19.0
	South	14.75	24,479	360	12.7
D (Late Febnıray)	West	12.47	38,524	480	53.0
	Elephant Island	6.07	43,865	266	16.1
	South	3.27	24,479	80	30.9

Table 3.2. Krill density estimates by area and transect for Surveys A and D, (Legs I and II). n = 1 interval = 1 nautical mile.

West Area				
		Survey A		Survey D
	n	krill (g/m²)	n	krill (g/m²)
Transect 1	32	22.05	25	11.72
Transect 2	46	24.40	44	8.46
Transect 3	5	102.48	1	1.33
Transect 4	72	30.76	67	34.19
Transect 5	21	15.50	22	6.96
Transect 6	71	15.53	35	5.98
Transect 7	60	11.86	90	2.47
Elephant Island Area				
		Survey A		Survey D
	n	krill (g/m²)	n	krill (g/m²)
Transect 1	81	22.26	75	7.27
Transect 2	37	15.23	32	3.20
Transect 3	79	13.82	58	6.06
Transect 4	80	57.32	58	4.47
Transect 5	80	58.65	77	9.84
Transect 6	101	27.63	30	2.63
Transect 7	108	47.02	66	4.69
Joinville Island Area				
		Survey A		Survey D
	n	krill (g/m²)	n	krill (g/m²)
Transect 1	7	7.90	1	0.12
Transect 2	35	19.98	21	0.20
Transect 3	46	17.92	31	0.99
South Area				
		Survey A		Survey D
	n	krill (g/m²)	n	krill (g/m²)
Transect 1	16	18.85	20	2.10
Transect 2	47	13.48	14	4.30
Transect 3	21	11.82	40	1.67
Transect 4	35	20.13	1	0.85
Transect 5	36	15.37	39	5.21
Transect 6	21	5.01		
Transect 7	25	7.53		

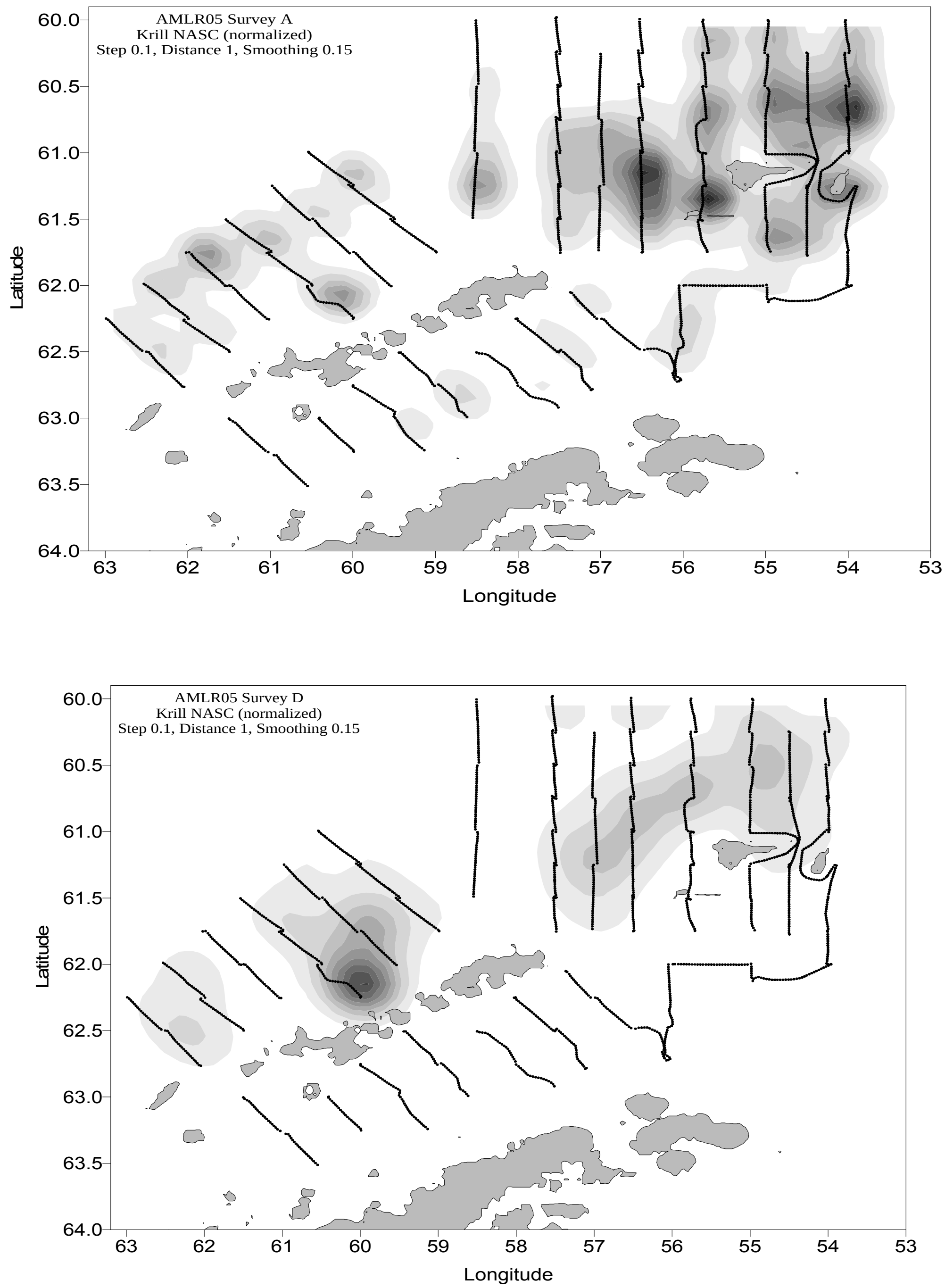

Figure 3.1. Normalized krill NASC values for Surveys A and D at 120 kHz using both day and night data. (Latitude is south and longitude is west).

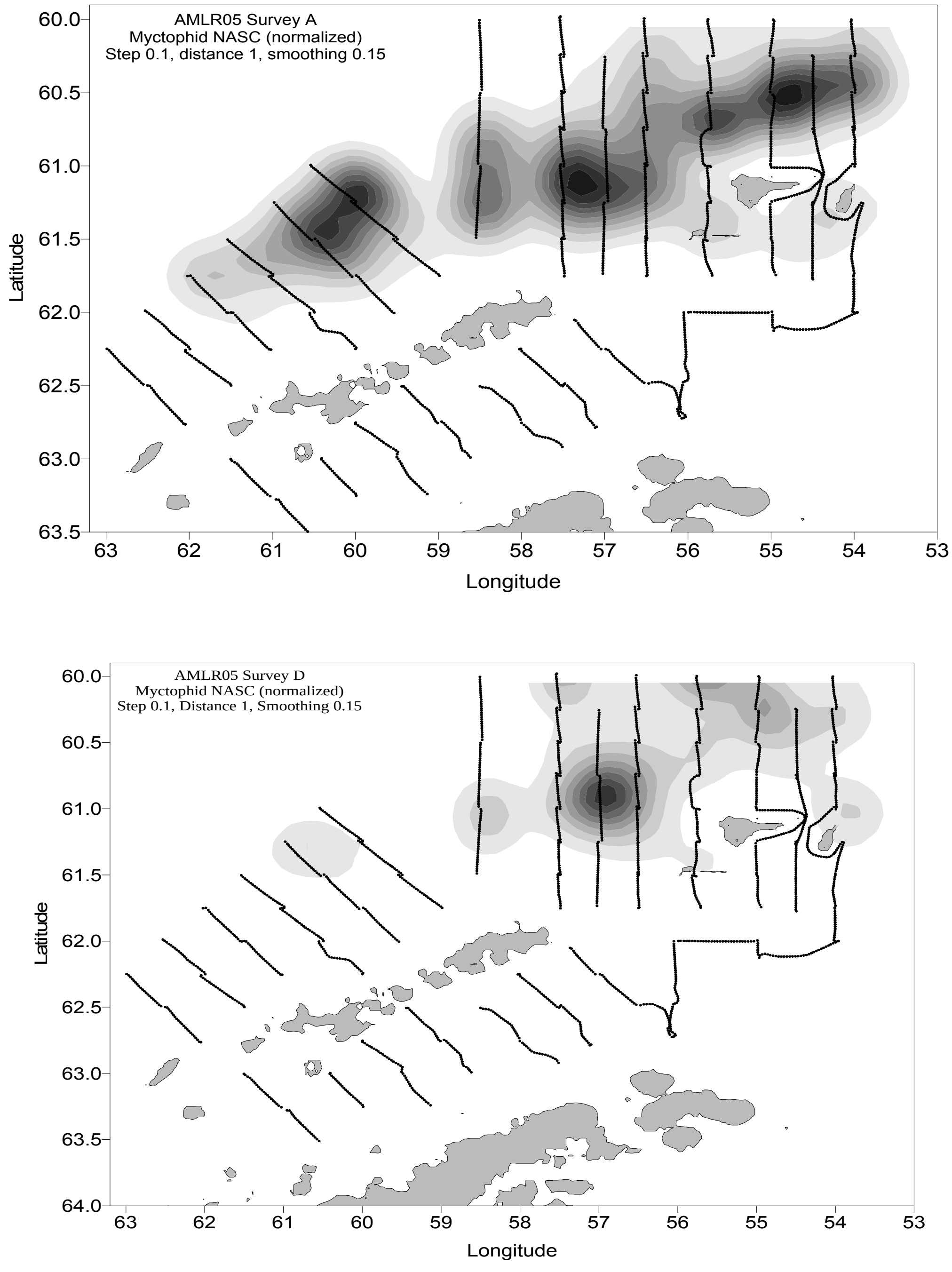

Figure 3.2. Normalized myctophid NASC values for Surveys A and D at 120 kHz using both day and night data. (Latitude is south and longitude is west).

4. AMLR 2005- Net sampling: Krill and zooplankton; submitted by Valerie Loeb (Legs I & II), Kimberly Dietrich (Legs I & II), Ryan Driscoll (Legs I & II), Darci Lombard (Legs I & II), Kyla Zaret (Legs I & II), Tache Bentley (Leg II), Michael Force (Leg II), Peter Kappes (Leg I), Kristy Kroeker (Leg II), Tasha Reddy (Leg I), Steve Sessions (Leg I), Joe Warren (Leg I) and Stephanie Wilson (Leg I).

4.1 Objectives: Here we provide information on the demographic structure of Antarctic krill (*Euphausia superba*) and abundance and distribution of salps and other zooplankton taxa in the vicinity of Elephant, King George, Livingston and Joinville Islands. Essential krill demographic information includes length, sex ratio, maturity stage composition and reproductive condition. Information useful for determining the relationships between krill and zooplankton distribution patterns and ambient environmental conditions was derived from net samples taken at established CTD/phytoplankton stations. The salps *Salpa thompsoni* and *Ihlea racovitzai* and biomass dominant copepod species receive special attention because their interannual abundance variations reveal underlying hydrographic processes influencing the Antarctic Peninsula ecosystem. Results from the two cruise legs (Surveys A and D) are compared to determine the nature and magnitude of seasonal changes. These results are also compared to those from previous AMLR surveys to assess between-year differences in krill demography and zooplankton composition and abundance over the 1992-2005 period. Additional historical data from the Elephant Island Area are used to examine copepod species abundance and abundance relations between 1981 and present.

4.2 Accomplishments:

4.2.1 Large-Area Survey Samples: Krill and zooplankton were obtained from a 6' Isaacs-Kidd Midwater Trawl (IKMT) fitted with a 505 μm mesh plankton net. Flow volumes were measured using a calibrated General Oceanics flow meter mounted on the frame in front of the net. All tows were fished obliquely from a depth of 170 m or to approximately 10 m above bottom in shallower waters. Real-time tow depths were derived from a depth recorder mounted on the trawl bridle. Tow speeds were about two knots. Samples were collected at Large-Area survey stations during both cruise legs. Four regionally distinct groups of stations are considered (Lipsky *et al*., this volume; Figures 4.1A,B). "Elephant Island Area" stations represent the historically sampled area used for long-term analyses of the Antarctic Peninsula marine ecosystem. "West Area" stations, north of King George and Livingston Islands, form a data base with which to examine the abundance and length composition of krill stocks to predator populations at Cape Shirreff and to the krill fishery that operates in this area during summer months. Within Bransfield Strait the "South Area" stations are used to monitor krill supplies available to predator populations in Admiralty Bay, King George Island, while "Joinville Island Area" stations, to the east, are sampled to determine whether significant aggregations of juvenile krill occur there in association with Weddell Sea influence.

4.2.2 Shipboard Analyses: All samples were processed on board. Krill demographic analyses were made using fresh or freshly frozen specimens. Other zooplankton analyses were made using fresh material within two hours of sample collection. Abundance estimates of krill, salps, and other taxa are expressed as numbers per 1000 m^3 water filtered. Twilight samples were collected between one hour before and one hour after local sunrise and sunset. Abundance information is presented for the Elephant Island, West, South and Joinville Island Areas, and for the total survey area.

(A) Krill: Krill were removed and counted prior to other sample processing. All krill from samples containing <100 individuals were analyzed. For larger samples, generally 100 individuals were measured, sexed, and staged. Measurements were made of total length (mm); stages were based on the classification scheme of Makarov and Denys (1981). Length-at-age estimates are based on Siegel (1987) and Siegel and Loeb (1994).

(B) Salps: All salps were removed from samples of two liters or less and enumerated. For larger catches the numbers of salps in one to two liter subsamples were used to estimate abundance. For samples with ≤100 individuals, the two life stages (aggregate/sexual and solitary/asexual) were enumerated and internal body length (Foxton, 1966) was measured to the nearest mm. Representative subsamples of ≥100 individuals were analyzed in the same manner for larger catches.

(C) Fish: All adult myctophids were removed, identified, measured to the nearest mm Standard Length, and frozen.

(D) Zooplankton: After krill, salps, and adult fish were removed the remaining zooplankton fraction was analyzed. All of the larger organisms (e.g., other postlarval euphausiids, amphipods, pteropods, polychaetes) were sorted, identified to species if possible, and enumerated. Following this the samples were aliquoted and smaller zooplankton (e.g., copepods, chaetognaths, euphausiid larvae) in three or four subsamples were enumerated and identified to species if possible using dissecting microscopes. After analysis the zooplankton samples (without salps and adult fish) were preserved in 10% buffered formalin for long-term storage.

The long-term AMLR zooplankton data set reflects the evolution of shipboard sample processing and identification techniques. Taxonomic diversity increases evident over the past decade result in part from inclusion of smaller taxa (e.g., copepod species and euphausiid larvae). Additionally, recent survey grid expansions into higher latitudes incorporate zooplankton taxa not encountered by earlier surveys. Most notable are areas influenced by Weddell Sea shelf water (Weddell Sea and Joinville Island Areas) and by outflow from Gerlache Strait. Use of a more protective cod-end starting in 2002 also increases the numbers of previously unidentifiable delicate taxa such as jellies and pteropods.

4.2.3 Statistical Analyses: Data from the total survey area and four subareas are analyzed here for between-cruise and between-year comparisons. Because of distinct water zones represented across the survey area this year, species abundances are also related to Zone numbers I to V which represent a variety of mixtures between Antarctic Circumpolar Current water (1) to high latitude coastal water (V). Analyses include a variety of parametric and nonparametric techniques. Among these are Analysis of Variance (ANOVA), Kendall's Tau (T) correlations, Mann Whitney U tests, Cluster Analysis, Percent Similarity Indices (PSIs) and Kolmogorov-Smirnov cumulative percent curve comparisons (D_{MAX}). Cluster analyses use Euclidean distance and Ward's linkage method; clusters are distinguished by a distance of 0.40 to 0.70. Clusters based on size characteristics utilize proportional length-frequency distributions in each sample with at least 18 krill or 100 salps. Zooplankton clusters are based on log-transformed sample abundance data (N+1) for taxa present in at least 16% of samples. Statistical analyses were performed using *Statistica* software (StatSoft).

4.3 Results and Preliminary Conclusions:

4.3.1 Survey A

4.3.1.1 Krill:

<u>Postlarval Frequency, Distribution and Abundance (Table 4.1A, Figure 4.1A)</u>

Postlarval krill were present in 80% of the 99 Survey A samples with overall mean and median abundance values of 20 and 3.8 per 1000 m^3. Largest catches (266-350 individuals, 127-162 per 1000 m^3) were located in the northeast corner of the Elephant Island Area and in Bransfield Strait east of King George Island. Krill were most evenly distributed across the Elephant Island Area where they were collected in 92% of samples and had mean and median concentrations of 27 and 15 individuals per 1000 m^3. They occurred in about 67% of samples within the other areas where mean concentrations ranged between 8.4 and 28 per 1000 m^3 (West and Joinville Island Area extremes) and median concentrations were between 1.0 and 2.8 per 1000 m^3 (South and West Area extremes) reflecting differing distributional attributes (e.g., patchiness).

<u>Length and Maturity Stage Composition (Table 4.2; Figures 4.2A; 4.3A)</u>

Large mature krill dominated the catches in all four areas. Overall lengths were distributed around the median and modal length of 47 mm and only 10% were <40 mm. Accordingly, juveniles comprised only 4% and immature forms 11% of the total. These results reflect a paucity of individuals from the 2003/04 and 2002/03 spawning seasons and a population comprised of mostly 3-4 year old krill (the successful 2000/01 and 2001/02 year classes).

Length frequency and maturity stage composition varied somewhat between areas. The most limited composition was in the West where 97% of individuals were mature and 93% were >44 mm. Mature males greatly outnumbered females (69% vs. 28% of total). Less than half of the mature females here were in advanced reproductive stages (F3c-e). Elephant Island and South Area krill shared various demographic features: median and modal lengths were 46 -48 mm; juveniles made up ca. 3% of individuals; and males outnumbered females by 50%. Greatest differences occurred in the proportions of immature stages (mostly F3a and M2c) which constituted ca. 9% in the Elephant Island Area vs. 20% in the South. Active spawning within the Elephant Island Area is indicated by the large proportion of advanced female maturity stages there (12% with developing ovaries, 16% gravid, 3.5% spent). In contrast to the other areas Joinville Island Area krill exhibited a bimodal length distribution centered around 27 mm and 45 mm lengths representing 1 and 3+ age classes (Siegel, 1987). Juvenile and immature (F3a, M2b,c) stages respectively contributed ca. 22% and 27% of the total here.

<u>Distribution Patterns (Figures 4.4A; 4.5A)</u>

Cluster analysis performed on krill length frequency data from 40 samples resulted in two length/maturity groupings with different geographical distributions. Cluster 1 was comprised of 98% mature individuals, predominantly >40 mm long with lengths centered around 50 mm. Mature males and females respectively comprised 68% and 30% of the total; 80% of the mature females were in advanced stages. These krill were present at 23 stations primarily between Elephant and King George Islands and offshore of the island shelf regions. Cluster 2 had a smaller (45 mm) length mode and 20% of individuals were $\leq$40 mm; 6% were juvenile and 19% immature stages. Males and females were equally represented. Reproductively mature males and females comprised 24% and 46% of the total with 57% of the mature females in advanced stages. This group, which basically reflects the distribution of <40 mm length krill, was mostly located in a curved band extending from eastern Bransfield Strait, east of Clarence Island and northwest and offshore of Elephant Island. This distribution possibly is the result of concentration at frontal zones within, and subsequent advection out of, Bransfield Strait (see Oceanography report).

Larval Krill Distribution, Abundance and Stage Composition (Tables 4.3; 4.4, 4.5A; Figure 4.6A)

Larval krill were present in 52% of samples with overall mean and median concentrations of 19 and 0.5 per 1000 m^3. These were most frequent and abundant in the Joinville Island Area (all six samples, 31 and 14 per 1000 m^3 mean and median values) and South Area (19 of 20 samples, 26 and 1.2 per 1000 m^3 mean and median). Larvae were scarce in the West Area (28% of samples, 2.8 and 0 per 1000 m^3 mean and median). Three of the largest catches (103-521 per 1000 m^3) were located in the northeast and southeast corners of the Elephant Island Area promoting a relatively high mean value there (22 per 1000 m^3). The general distribution pattern resembled that of Cluster 2 postlarval stages and may reflect advection from Bransfield Strait to offshore waters northeast of Elephant Island.

Virtually all larvae (99%) were calyptopis stages, predominantly C1, resulting from relatively recent (e.g., mid-December) spawning. These made up 84-91% of larvae in the West and Elephant Island Areas while older C2 and C3 stages were relatively more abundant (21-30% of total larvae) in the Joinville Island and South Areas. The greatest catch of furcilia stage (F1) larvae was in the West Area adjacent to the Shackleton Fracture Zone gyre.

4.3.1.2 Salps:

Salpa thompsoni Frequency, Distribution and Abundance (Tables 4.4, 4.5; Figure 4.7A)

Salpa thompsoni occurred in all but two Survey A samples (98%). With respective mean and median concentrations of 1028 and 383 per 1000 m^3 this was the most abundant taxon collected. It was present in all West and Elephant Island Area samples. The mean and median concentrations here (1209-1578 and 424-671 per 1000 m^3) were similar but an order of magnitude greater than those of the South and Joinville Island Areas (107-185 and 19-38 per 1000 m^3). Greatest concentrations were over and offshore of island shelf areas, especially in the vicinity of the Shackleton Fracture Zone gyre, and clearly associated with Zone I water (see Oceanography section; *T*=0.55, P<0.001). Mean abundance at stations characterized by Zone I water (2137+/- 2001 per 1000 m^3) was significantly greater (ANOVA, P<0.05) than in the other water zones.

<u>Size and Maturity Stage Composition (Figure 4.8 A,B)</u>

The aggregate stage contributed 96% of total individuals. Lengths ranged from recently released 4 mm zooids to 67 mm, with the majority <56 mm. Based on an estimated 0.44 mm per day growth rate the initiation of aggregate chain production was early to mid-September. The total length frequency distribution was polymodal with peaks around 13, 21-25 and 35 mm reflecting an elevated production period between early November and late December. Length frequency and maturity stage composition were most similar between the West and South Areas (98% aggregates, 21-23 mm median length, D_{MAX}=9.8). Elephant Island aggregates were slightly larger (25 mm median) and included greater proportions (6%) of solitaries. Joinville Island aggregates had a median length of 17 mm, representative of a younger population. Solitary stages, primarily in the Elephant Island Area, were generally <20 mm (80%) resulting from recent release by reproductively mature aggregates (i.e., >25 mm; Foxton 1966). Large, reproductively mature solitary lengths >55 mm were extremely scarce, suggesting that small aggregates were advected from source areas outside of the survey area and/or actively budding solitaries generally remained at depths greater than were sampled (i.e., >170 m).

<u>Aggregate Stage Distribution Patterns (Figure 4.9A,B)</u>

Cluster analysis performed on 74 samples with $\geq$100 measured salps yielded three distinct aggregate length groups. Cluster 1 aggregates were mostly (80%) 15-42 mm with a polymodal distribution centered around a 27 mm median. This group represents the accumulation of production and growth over the spring and summer season with little recent chain production. Cluster 2 was dominated by smaller individuals; 80% of these were $\leq$26 mm and demonstrated a distinct peak around 16 and 14 mm median and modal lengths. This reflects a pulse of chain production within the past month. Large, old aggregates dominated Cluster 3; 80% of these were $\geq$32 mm with median and modal lengths of 41 and 45 mm. This group has been isolated from new production for several months and probably represents individuals nearing the end of their life span. The distributions of these three groups appear related to hydrography as indicated by dynamic heights (See Physical Oceanography section). Cluster 1 was the most widely distributed, present at 41 stations largely in Drake Passage. Cluster 2 was represented at 21 stations primarily offshore or between King George and Elephant Islands in areas characterized by enhanced flow, possibly resulting from advection to and concentration within those areas. Cluster 3 was limited to 12 stations over or adjacent to island shelves in areas characterized by gyres or eddies.

<u>*Ihlea racovitzai* (Tables 4.4A, 4.5A; Figure 4.7A)</u>

Generally small numbers of *I.* racovitzai were present at 22 stations mostly within the Joinville Island Area and east of Elephant Island. Mean abundance in the respective areas was 4.2 and 3.2 per 1000 m^3. Distribution of this salp was significantly correlated with Weddell Sea water

(Zone V, *T*=+0.0.42, P<0.001) and abundance within this water zone (10.6 +/- 13.4 per 1000 m^3) was significantly greater than in the others (ANOVA, P<0.01). The presence of small numbers of *I. racovitzai* at scattered locations over island shelf areas and in Bransfield Strait are indications of minor Weddell Sea and Polar Slope water influence there relative to other years.

4.3.1.3 Zooplankton and Micronekton Assemblage:

<u>Overall Composition, Abundance and Distribution Patterns (Tables 4.4A, 4.5A; Figure 4.10A)</u>

Salpa thompsoni, copepods and postlarval and/or larval *Thysanoessa macrura* numerically dominated the Survey A zooplankton assemblage and zooplankton collected within each of the four areas. In accordance with its affiliation with Zone I water *S. thompsoni* was the most abundant taxon in the West and Elephant Island Areas where it comprised, respectively, 69% and 62% of total mean abundance. Salps were least abundant in the Joinville Island and South Areas where mean and median abundance values (107-185 and 19-38 per 1000 m^3) were an order of magnitude lower, and they respectively made up 4% and 10% total abundance and ranked 4 and 3 in total mean abundance. Overall salps contributed 50% of total mean zooplankton abundance.

Copepods were the second most abundant taxon (27% total mean abundance). They had similar mean and median abundance within the West and Elephant Island Areas (343-365 and 123-126 per 1000 m^3) where they respectively contributed 15% and 18% mean zooplankton abundance. Mean and median copepod concentrations in the Joinville Island and South Areas were two to seven times higher, and significantly greater, than in the West and Elephant Island Areas (ANOVA, P<0.05). Here they were the most abundant category, constituting 66% and 50% of total zooplankton. Greatest concentrations occurred in areas characterized by frontal zones and eddies within Bransfield Strait and offshore of island shelves. Eight copepod species and three groupings were identified but the vast majority of individuals were attributed to *Metridia gerlachei* (58%), *Calanoides acutus* (18%) and “other” small species (12%). *Metridia gerlachei* was similarly represented in water Zones II-V but concentrations in Zone I water (27.3 +/- 69.8 per 1000 m^3) were an order of magnitude lower, and significantly less, than in adjacent mixed Zone II water (513.3 +/- 940.5 per 1000 m^3; P<0.05). *Calanoides acutus* was most abundant in southern Bransfield Strait and to a lesser extent offshore of the South Shetland Islands; their concentrations in Zone V water (449.3+/- 461.3 per 1000 m^3) were an order of magnitude, and significantly greater, than in other water zones (P<0.001).

Postlarval *T. macrura* were also equally represented in the West and Elephant Island Areas (171-179 1000 m^3 and 110-116 per 1000 m^3 mean and median values). Greatest concentrations within the South Area (457 and 462 per 1000 m^3 mean and median, 25% of total mean zooplankton abundance) were significantly greater than in the other areas (ANOVA, P<0.05) and associated with Bransfield Strait Zone IV water. Maximum concentrations of larval *T. macrura* were adjacent to the Shackleton Fracture Zone (Zone I) and south and east Bransfield Strait (Zone V). As in the past, the larval and postlarval distributions were negatively correlated (Kendalls Tau=-0.17, P<0.05). Abundance of postlarval stages was positively correlated with that of *Metridia gerlachei* (T=+0.27, P<0.01) while that of the larvae was correlated with *Calanoides acutus* (T=+0.34) and larval krill (T=0.30; P<0.001 in both cases).

Other relatively frequent and/or abundant taxa included chaetognaths, *Euphausia frigida*, larval and postlarval krill and amphipods *Themisto gaudichaudii* and *Cyllopus magellanicus*. This relatively depauperate assemblage dominated by *S. thompsoni, T. macrura, M. gerlachei* and krill is characteristic of coastal influences and the "East Wind Drift" (Mackintosh, 1934; Schnack-Schiel and Mujica, 1994).

Zooplankton Assemblages (Table 4.6A; Figure 4.12A)

Cluster analysis applied to the abundance of 25 relatively frequent taxa produced three groups with distinct distribution patterns that, like the salp clusters, conform well to the flow regime depicted by dynamic heights. These clusters, represented by similar mean and median abundance characteristics, define Coastal (southern Bransfield Strait), Offshore (Drake Passage) and Intermediate taxonomic groupings. The Offshore cluster was strongly dominated by *S. thompsoni* (80%); modest proportions were also contributed by copepods, postlarval and larval *T. macrura*, *T. gaudichaudii* and .*C. magellanicus.* Numbers of *S. thompsoni, T. gaudichaudii* and *C. magellanicus* here were significantly greater, and those of copepods significantly smaller, than in the other clusters (ANOVA, $P<0.05$). Copepods, postlarval and larval *T. macrura* dominated the coastal cluster (ca. 80%). Modest contributions were also made by sipunculids, *S. thompsoni*, larval and postlarval krill, chaetognaths and pteropod *Limacina helicina.* Significantly greater numbers of sipunculids, *I. racovitzai*, *L. helicina, Clione limacina* and larvaceans here vs. the other clusters presumably result from high latitude influences. The intermediate cluster, primarily located over and adjacent to the island shelves, represents a mixture of coastal and offshore assemblages. PSI values indicate a greater similarity between the intermediate and coastal (65.2) vs. offshore (49.2) groupings, suggesting limited mixing offshore. The great disparity between taxonomic abundance relations in the offshore and coastal clusters is indicated by a low PSI value of 21.2.

4.3.2 Survey A Between-Year Comparisons:

4.3.2.1 Krill:

Postlarvae (Table 4.7, 4.8A; Figure 4.13)

Although mean krill abundance in the Elephant Island Area was below average for January the median value (15 per 1000 m^3) was second to the maximum observed in 2003 (31 per 1000 m^3); both result from wide spread distributions and high frequency of occurrence (i.e., 92-93%) in samples. Unlike 2003, dominated by small and intermediate length/maturity categories, these were predominantly large mature individuals. However, both are derived from highly successful recruitment of the 2000/01 and 2001/02 year classes which are now three and four years in age.. Cumulative percent curves indicate that the overall length frequency distribution was most similar to those in 1991, 1994, 1995 and 2001 (D_{MAX}=6.6-11.7) and reflect aging populations with only modest recruitment over the previous two years. This has been a recurring pattern exhibited on about 3-4 year scales over the past 17 years. The overall and individual maturity stage composition was most like those in 1999 and 1995 (PSI's 97.0 and 95.3, 63.4 and 59.5, respectively) and like those years followed two years characterized by el Niño conditions. The relatively large proportions of advanced female maturity stages (81.2%) group with the highs of January 1995-1997, 1999 and 2002 (83-98%) suggesting a favorably timed spawning season.

Based on the low proportions of juveniles in the Elephant Island Area (2.6%) recruitment of the 2003/04 year class was only slightly higher than that of 2002/03, both of which are among the lowest in the long-term AMLR data set. This is quite puzzling in that the 2003/04 season was characterized by a prolonged, intense and apparently successful spawning period and good recruitment was predicted, given optimal overwintering conditions. Theoretically prolonged sea ice extent in the Antarctic Peninsula region over Austral spring 2004 provided optimal conditions thereby promoting strong year class success. Obviously other factors are involved in ultimately determining localized recruitment and these most likely include advective processes influencing retention vs. loss to downstream areas (Hofmann and Murphy, 2004). A similar situation occurred in 1999 when relatively large larval krill concentrations, including advanced stages, were observed in the Elephant Island Area during January-March surveys but only small numbers of juveniles were sampled there the following season, suggesting low recruitment success within the area. However, these may have been the source of abundant juveniles collected off South Georgia during the 2000 krill stock assessment survey (AMLR 1999/00 Field Season Report). Such advective transport is vital for krill-dependent predator populations in downstream areas.

Larvae (Tables 4.3; 4.7; 4.10)

The frequency of occurrence and mean abundance of larval krill across the large survey area (52% of samples, 19 per 1000 m^3) as well as mean and median abundance within the Elephant Island Area (22 and 1.1 per 1000 m^3) were similar to values observed during January 1997 and represent the median within the long-term data set. Virtual absence of furcilia stages was also observed in January 1996, 1999, 2001 and 2003 while overwhelming dominance of calyptopis stage 1 larvae, suggestive of a mid- to late December spawn, also characterized 2003. Maximum concentrations also occurred within the Joinville Island Area during January 2002 but then included relatively large proportions of furcilia stage larvae.

4.3.2.2 Salps:

Salpa thompsoni (Tables 4.7, 4.9, 4.10)

January 2005 mean and median abundance values of *S. thompsoni* were among the largest in the long term Elephant Island data set, rivaling the highs of 1993 and 1994. This represents the second successive year of increases following lows in 2003 and possibly results from el Niño-related conditions in late 2003 and 2004 (Austral spring) that promoted population growth and/or transport into the region. Potentially significant were the unusually large proportions of small overwintering solitary stages during February-March 2004 which could have produced a major bloom the following season. Of great interest is the clear association with Zone I water. During the 1992-1998 period greatest salp concentrations generally occurred in the southern and eastern portion of the survey area and appeared to have been advected there from Weddell Sea source areas. Distribution patterns in previous AMLR surveys suggest that a change in relative importance of salp source areas occurred after 1998, however this must be ascertained through statistical analyses of water mass affiliations across the long term data set. Overall length-frequency composition of the aggregate stage was typical for January but most resembled that of 1998 (D_{MAX}=7.9 at 33 mm indicating slightly greater proportions smaller individuals in 2005).

Carbon biomass values represented by *S. thompsoni* in the Elephant Island Area were the largest over the past 10 January surveys, with mean and median values about 1.6 times the maxima observed in 1998 and 2001. However, the salp:krill carbon biomass ratio was kept moderately low (2.4:1) due to the large median krill carbon biomass value here.

Ihlea racovitzai (Tables 4.10A, 4.12)

Although *I. racovitzai* was half as frequent and an order of magnitude less abundant than during January 2004 frequency of occurrence and abundance values were greater than those in 2001-2003 surveys and similar to those in 1999. Restricted presence of this high latitude indicator species now suggests limited intrusion of Polar Slope water from the Weddell Sea during this El Niño associated period.

4.3.2.3 Nekton and Micronekton (Tables 4.7, 4.10A, 4.11, 4.12, 4.13):

Numerical dominance of the Elephant Island Area by *S. thompsoni*, copepods and postlarval *T. macrura* characterized the January 1994, 1997, 1998, 2004 and 2005 surveys. Salps were also the most abundant taxon in 1994 and 1998. January 2005 differs from these two years by somewhat reduced salp dominance (61% vs. 69-81% of mean zooplankton abundance) and substantially larger proportions of copepods than *T. macrura.* Greatest PSI values (76 and 78) result from taxonomic composition comparisons of 2005 with 1994 and 1998.

January mean and median copepod abundance values in the Elephant Island Area continued a steady decline from the extreme highs of 2002. However these values are still about an order of magnitude greater than lows of the 1993, 1994 and 1998 El Niño periods. The continued decline of copepod abundance this year was due to extremely low numbers of coastal species *M. gerlachei* as well as oceanic species *C. propinquus* and *C. acutus.* Interestingly, concentrations of *R. gigas*, a marker for lower latitude oceanic waters, were not also low. Of note are the relatively high mean and median abundance values of post larval *T. macrura* and *E. frigida* maintained across most of the last five January surveys compared to those prior to 1998.

4.3.3 Survey D

4.3.3.1 Krill:

Postlarval Frequency, Distribution and Abundance (Table 4.1B, Figure 4.1B)

Krill were again broadly distributed across the large survey area, represented at 80 of the 97 (82.5%) samples. They were least frequent in the West Area where they occurred in generally small numbers in 18 of 25 samples (72%); they were present in 83-89% of samples in the other areas. Greatest concentrations (260-2740 individuals per sample, 104-1158 per 000 m^3) were located over the shelf break north of Elephant Island, south shelf of King George Island, in

Bransfield Strait south of Robert Island and southeast portion of the Joinville Island Area. Highest and lowest mean abundance values were, respectively, in the South and Joinville Island Areas (97 and 30 per 1000 m^3) while greatest median abundance (2.9 vs. 1.3-1.6 per 1000 m^3) and most uniform distribution were in the Elephant Island Area.

Length and Maturity Stage Composition (Table 4.2; Figures 4.2B; 4.3B)

Large mature forms contributed 42% of individuals collected during Survey D while juveniles comprised 2.5% and immature stages 26%. The overall length distribution had a 45 mm median and 45 mm and 47-48 mm modal lengths but only 15% of individuals were $\leq$40 mm. Mature and immature stages respectively represented 89-90% and 9.6-10% of individuals in the West, Elephant and Joinville Island Areas. Median and (modal) lengths in these areas were, respectively 48 (47-48) mm, 47 (45, 48) mm and 45 (45) mm. Krill length distribution and maturity stage composition in the South Area were relatively diverse. Here juveniles comprised 4.6% and immature stages 39% of the total and the length distribution included 32, 42, 45 and 47 mm modes.

Males outnumbered females by 1.6:1 and 1.4:1 in the West and Elephant Island Areas. The majority of individuals here were fully mature stage 3b males (42% and 35%) and early female stages (3a,b,c). Relatively low proportions of advanced (gravid and spent) female reproductive stages in these areas (9.6% and 8.8%) suggest that the peak spawning season was over. Females slightly outnumbered males in the Joinville Island and South Areas. Half of the krill in the Joinville Island Area were stage 3a-b females, possibly resulting from southward post reproductive migration. In addition to juvenile and immature stages, ca. 10% of South Area krill were advanced males (3b) and 2% of the mature females were gravid or spent.

Distribution Patterns (Figures 4.4B; 4.5B)

Cluster analysis utilizing krill length data from 28 samples resulted in two groupings with more or less coherent spatial distribution patterns. Cluster 1 occurred at eight stations over and offshore of island shelves and one station between King George and Elephant Islands. This group, with lengths generally $\geq$48 mm, centered around a 50 mm mode, was almost exclusively mature males (89%) and females (11%), 30% of which were in advanced reproductive stages. These individuals may represent a final pulse of seasonal spawning activity. Cluster 2, represented at 20 stations largely over island shelves, over and east of the Shackleton Fracture Zone, is an amalgamation of four small groupings with a relatively large linkage distance (70). Lengths ranged from 19-55 mm, but 65% were $\leq$48 mm distributed around 32 and 47 mm modes. Juveniles, immature and mature stages respectively comprised 4%, 15% and 81% of the total with equal representation of males and females. The length and maturity stage composition appears to represent a mixture of recently introduced juveniles and immature stages along with post-reproductive adults.

Larval Distribution, Abundance and Stage Composition (Tables 4.3, 4.4B, 4.5B; Fig 4.6B)

Larval krill were present in 48% of the survey samples and exhibited an extremely patchy distribution. Small numbers occurred in only two West Area samples. Greatest frequency of occurrence (five of six samples) and concentrations (1014 and 33.2 per 1000 m^3 mean and median) were in the Joinville Island Area. Relatively high concentrations were also scattered around Elephant Island and the Shackleton Fracture Zone resulting in elevated mean and median values in the Elephant Island Area (195 and 4.6 per 1000 m^3). While present at 9 of the 18 South Area stations, dense concentrations occurred at only one station in southwest Bransfield Strait resulting in relatively high mean but low median values (127 and 0.4 per 1000 m^3).

Calyptopis stages represented 85% of larval krill collected and the C2 stage alone made up 55% of the total. Most of the more advanced larvae were furcilia stage 1. The C2-F1 stages most likely result from peak spawning around mid- to late December (Ross and Quetin) with relatively little subsequent spawning activity. Greatest concentrations of furcilia stages were in the South Area where they comprised >60% of larvae. Furcilia larvae represented 10% of the total in the Elephant Island Area. Concentrations of calyptopis and furcilia stages, as well as total larvae, were significantly higher in high latitude Zone V water than in the other zones (ANOVA, $P<0.0001$ in all cases) suggesting their possible source areas and/or aggregation at fronts associated with intrusion of these waters into the survey area.

4.3.3.2 Salps:

Salpa thompsoni Frequency, Distribution and Abundance (Tables 4.4B; 4.5B; Figure 4.7B)

Salpa thompsoni was present in all but five Survey D samples (95%) and its overall mean and median abundance values (716 and 330 per 1000 m^3) were second to those of copepods. Greatest concentrations (1086-5400 per 1000 m^3) were associated with frontal zones and gyres north of the islands, adjacent to the Shackleton Fracture Zone and in nearshore areas south of the South Shetland Islands (see Oceanography section). They were generally sparse in south Bransfield Strait and eastern portion of the Elephant Island Area. Elevated and similar mean (819 and 861 per 1000 m^3) and median (635 and 493 per 1000 m^3) densities characterized the West and Elephant Island Areas where they contributed 31-34% of total mean zooplankton abundance. Lowest mean (95 per 1000 m^3) and median (6.6 per 1000 m^3) values were within the Joinville Island and South Areas, respectively, but there were no significant differences between these and the other two areas. Unlike Survey A, there was not a significant relationship with Zone I water, however, maximum concentrations within mixed Zone II waters were significantly greater than in Zones IV and V ($P<0.001$).

Size and Maturity Stage Composition (Figure 4.8 C,D)

The numerically dominant aggregate form ranged from 4-70 mm with lengths distributed around mature 35 mm and recently budded 10 mm modes. Mature (30-38 mm) and recently budded (8-12 mm) length modes were represented in all four areas indicating a wide spread pulse of late-season budding activity along with an aging population. Solitaries made up 6% of the total with the majority (52%) recently released forms $\leq$25 mm. However, 25% of solitaries were large mature individuals $\geq$55 mm, most likely the source of recent aggregate chain production. Mature sizes comprised 32-34% of solitaries in the Elephant and Joinville Island Areas while recently released lengths contributed 63-78% of those in the West and South Areas.

Aggregate Stage Distribution Patterns (Figure 4.9 C,D)

Three aggregate length clusters were represented in the large survey area and demonstrated more uniform distribution patterns than during the previous month. Again these conformed to generally small, intermediate and large size categories. Cluster 1 lengths were broadly distributed around a pronounced 38 mm modal and median length with only 10% resulting from new chain production. Cluster 2 had a strong primary mode of 10 mm, representing chain release within the last two weeks, and a secondary 28 mm mode due to mature forms. Cluster 3 was predominantly comprised of older forms with 45, 50, 55 and 60 mm modes. The aging mature population represented by Cluster 1 occurred at 33 stations mostly offshore of the island shelves. The segment of the population undergoing active late season chain production represented by Cluster 2 was present at 32 stations largely over island shelf areas, adjacent to the Shackleton Fracture Zone and within Bransfield Strait. Large, post-reproductive aggregates of Cluster 3 were at 10 scattered locations adjacent to, or downstream of, islands and were characterized by gyral circulation.

Ihlea racovitzai (Tables 4.4B, 4.5B; Figure 4.7B)

Ihlea racovitzai were present at 26 stations generally in the eastern portion of the survey area. Greatest concentrations (6-58 per 1000 m^3) were east of Elephant Island. Like the previous survey its distribution was associated with Zone V water ($T=0.45$, $P<0.001$) and abundance in this zone was significantly greater than in other waters ($P<0.05$).

4.3.3.3 Zooplankton and Micronekton Assemblage:

Overall Composition, Abundance and Distribution Patterns (Tables 4.4, 4.5B; Figure 4.10B)

Copepods and postlarval *T. macrura* occurred in all Survey D samples and together with *S. thompsoni* were the numerically dominant taxa. Copepods were the most abundant taxon (1217 and 499 per 1000 m^3 mean and median) and contributed 43% of total mean zooplankton abundance. Second and third ranked *S. thompsoni* and postlarval *T. macrura* respectively contributed 26% and 17% of the total. Copepods, predominantly *M. gerlachei* and *C. acutus*, numerically dominated zooplankton collections in all but the West Area. Elevated concentrations were located: offshore over the Shackleton Fracture Zone; in southeastern Bransfield Strait; and as an undulating band extending from western Bransfield Strait over the South Shetland Island shelves, southeast of the Shackleton Fracture Zone and along the northern shelves of Elephant and Clarence Islands. Largest catches (5792-10201 per 1000 m^3) were in western and southeast Bransfield Strait and associated with Zone V water. Total copepod abundance, plus concentrations of *M. gerlachei, C. propinquus* and "other" species, in this water zone were significantly larger ($P<0.01$) than in the other water zones suggesting advection by and accumulation within areas influenced by coastal waters. *Rhincalanus gigas*, a lower latitude oceanic copepod, had significantly greater abundance in Zone I water ($P<0.01$). Salps numerically dominated in the West but their abundance respectively ranked two, three and four in the Elephant Island, South and Joinville Island Areas. Ubiquitous postlarval *T. macrura* had similar elevated mean and median values (441-566 and 275-398 per 1000 m^3) in the West, South and Elephant Island Areas while concentrations in the Joinville Island Area were about 50% lower. Larval krill ranked fourth in overall mean abundance (6.5% of total) due to extremely dense concentrations in the Joinville Island Area (second to copepods) and to a lesser extent in the Elephant Island and South Areas where they also ranked fourth. Other relatively frequent and/or abundant zooplankton taxa include postlarval krill, chaetognaths, *E. frigida*, *T. gaudichaudii*, *C. magellanicus* and larval *T. macrura*. Larval *T. macrura*, like larval krill, had significantly greater concentrations (P<0.01) in Zone V water while *T. gaudichaudii* was significantly more abundant in Zones I and II vs. the onshore waters.

Zooplankton Assemblages (Table 4.6B; Figure 4.12B)

Cluster analysis on the 24 most frequent zooplankton taxa again resulted in three groupings with Coastal, Offshore and Intermediate distributions. The Offshore cluster, present at 28 predominantly Drake Passage stations, was strongly dominated by *S. thompsoni* which accounted for 64% of the total mean abundance. Postlarval *T. macrura* and copepods respectively contributed 16% and 12% of the total. Offshore concentrations of *T. gaudichaudii*, *C. magellanicus*, *C. lucasi* and *P. macropa* were significantly greater than in the other clusters. The Onshore assemblage was represented at 16 stations. Copepods and postlarval *T. macrura* contributed 85% of mean onshore zooplankton abundance with the rest primarily due to chaetognaths, larval *T. macrura*, postlarval krill and sipunculids. Noteworthy is that abundance of larval *T. macrura* here was significantly greater than Offshore where it typically is in greatest abundance. The intermediate cluster, represented at 53 stations centered around the South Shetland and Elephant Islands, in southeastern Bransfield Strait and northeast of the Shackleton Fracture Zone gyre, was most wide spread and supported significantly greater zooplankton concentrations than the other clusters (P<0.01). Copepods, *S. thompsoni*, postlarval *T. macrura* and larval krill respectively contributed 49%, 21%, 16% and 6% of mean abundance. Other modest contributions were made by postlarval krill, chaetognaths and *E. frigida*. Copepod, postlarval *T. macrura* and *E. frigida* concentrations here were significantly higher than Offshore and onshore. The distribution of this cluster reflects prevailing southwest to northeast flow north and south of the South Shetland Islands and includes all water zones, their fronts and gyres and mixing areas. Mixing and topographically related retention features undoubtedly influenced the composition and abundance of the zooplankton assemblage here. Like Survey A, greatest similarity was between the Intermediate and coastal vs. offshore clusters (PSIs=71.2 and 51.0) while the coastal and offshore clusters shared little in common (PSI=30.1).

Diel Abundance Variations

Significant differences between day, twilight and night catch sizes of a number of zooplankton taxa indicate a variety of diel migratory behavior. Copepods had significantly greater night vs. day and twilight abundance due largely to *M. gerlachei* (P<0.001) and a lesser extent *C. propinquus* (P<0.05). Nighttime abundance of postlarval *T. macrura* and *E. frigida* were also significantly larger than during day (P<0.001) and twilight (P<0.05). *Salpa thompsoni*, postlarval and larval krill all had larger night vs. day concentrations (P<0.05). Twilight and night abundance of ostracods exceeded that during day (P<0.01). The amphipod *Primno macropa* differed from other taxa by having significantly greater day vs. night abundance (P<0.05) suggesting reverse diel vertical migration.

4.3.5 Survey A and D (Seasonal) Comparisons:

4.3.5.1 Krill:

Postlarvae (Tables 4.2, 4.4, 4.5; Figures 4.1, 4.2, 4.3, 4.4, 4.5)

Overall krill abundance demonstrated about a two-fold increase in mean and 50% decrease in median values between Surveys A and D that resulted from increased patchiness within the Elephant Island and South Areas. During this time the overall length frequency distribution underwent a significant change due to increased proportions of individuals of 38-48 mm lengths (D_{MAX}=0.22 at 45 mm, $P<0.05$), representatives of the 2001/02 and 2002/03 year classes, relative to individuals <33 mm and >49 mm. Decreased abundance of larger krill was most evident within the West and Elephant Island Areas while that of small (juvenile) krill was in the Joinville Island Area. The South Area had increased proportions of small and intermediate vs. large sizes with the advancing season. Associated with these changes were overall decreased proportions of juveniles and mature forms relative to immature stages which increased to 26% from 11% of total between the two surveys. Within the Elephant Island Area the proportions of advanced female maturity stages declined from 81% to 9% suggesting termination of seasonal spawning activity.

Distribution and composition of the krill size-maturity clusters reflected decreased numbers of large, reproductive adults in offshore waters (Cluster 1) and a shift to patchy, heterogeneous mixtures of juveniles, immature and post-reproductive adult stages, particularly within the Elephant Island and South Areas (Cluster 2), between Surveys A and D. This is most likely the result of seasonal onshore ontogenetic migration (Siegel, 1988).

Larvae (Tables 4.3, 4.4, 4.5; Figure 4.6)

Larval krill were encountered with similar frequency both surveys (ca. 50% of samples) but their mean and median concentrations during February-March were an order of magnitude greater than the previous month. Greatest concentrations in the Joinville Island Area demonstrated a 30X increase in mean and 2X increase in median values between Surveys A and D. Mean concentrations in the South and Elephant Island areas exhibited 20X and 8X seasonal increases. In contrast, frequency of occurrence and mean abundance in the West Area decreased over the survey period. While no water zone affiliation was apparent during Survey A, significantly greater concentrations were encountered in areas with high latitude coastal (Zone V) water during Survey D.

Larval development was apparent over the survey period with increased proportions of calyptopis stage 2 and 3 and furcilia larvae during Survey D. More advanced larval stages were represented in the South Area both surveys and during Survey D 60% were furcilia stages compared to 5% and 10% in the Elephant and Joinville Island Areas. These results suggest an earlier spawning period for larvae advected into western Bransfield Strait.

4.3.5.2 Salps:

<u>Salps (Tables 4.4, 4.5, 4.9; Figures 4.7, 4.8)</u>

Total mean abundance of *S. thompsoni* decreased by about 30% between the two surveys due primarily to smaller concentrations adjacent to the Shackleton Fracture Zone and in the Northern Elephant Island Area. As a result of these declines and increased copepod abundance salps went from being the numerically dominant taxon in January, comprising 50% of total mean zooplankton abundance overall and 61% within the Elephant Island Area, to second place constituting 26% overall and 32% within the Elephant Island Area in February-March. The overall composition demonstrated seasonal change through increased proportions of the solitary stage from 4.5% to 6.2% of total salps. Small solitaries, the overwintering stage, were primarily represented during Survey A (median lengths <20 mm) while a broader size range was represented during Survey D. The presence of large, reproductively mature lengths can explain the late season pulse of aggregate production. Despite increased numbers of small aggregates the overall median length increased reflecting a maturing population. This net somatic growth balanced decreased concentrations in the Elephant Island resulting in similar mean and median salp carbon biomass values for the two surveys. However, due to decreased median krill abundance the salp:krill carbon biomass ratio there increased to 19:1 from 2:1 over the survey period.

Between-survey differences in overall salp distribution as well as distributions of the three aggregate length clusters appear related to hydrographic conditions (See Oceanography section). The strong relationship between abundance and Zone I water during Survey A suggests input from the west via the Antarctic Circumpolar Current (ACC) with aggregation along the outer South Shetland Island shelf, around the broad Shackleton Fracture Zone gyre and west of Elephant Island as well as within the gyre itself. During Survey D, with a more constricted gyre core and enhanced flow, salp concentrations appeared primarily around the gyre and adjacent mixed Zone II water. Decreased concentrations here may be related to these changes in flow dynamics. Of note during Survey D is the alignment of salp concentrations and of active chain production (Cluster 2) with the Shackleton Fracture Zone that suggests a strong frontal feature and mixing here and along the outer shelf of Elephant Island. During both surveys, aging, post-reproductive aggregates (Cluster 3) appeared to be associated with gyres over and downstream of island shelf areas. Distinct length modes of Clusters 2 and 3 indicate increases of 14-15 mm over the 37 days separating Surveys A and D which suggests a growth rate of 0.38 mm per day which is somewhat smaller than the previously estimated average (44 mm +/- 0.03 per day).

Occurrence, abundance and distribution of *I. racovitzai* were similar both surveys. The significant association of this salp with Zone V vs. Zone I and II water underlies significant negative correlations between its distribution and that of *S. thompsoni* during both surveys (T=-0.25 and -0.20; $P<0.01$).

<u>Zooplankton (Tables 4.4, 4.5, 4.6; Figures 4.11, 4.12)</u>

Total zooplankton abundance demonstrated a significant seasonal increase ($P<0.05$) due primarily to copepods, postlarval *T. macrura* and chaetognaths ($P<0.01$ in all cases). The two fold copepod abundance increase reflected elevated concentrations of *M. gerlachei* and *R. gigas* ($P<0.01$ in all cases). Significant seasonal decreases occurred in concentrations of larval *T. macrura*, *Primno macropa*, *Limacina helicina*, sipunculids ($P<0.01$) and larvaceans ($P<0.05$). Much of the seasonal increase was due to the Intermediate cluster which had significantly greater total zooplankton abundance during Survey D ($P<0.01$) due to copepods (*C. acutus, M. gerlachei* and *R. gigas*), postlarval *T. macrura* and *C. magellanicus* ($P<0.05$). Within the Offshore cluster krill, *S. thompsoni, C. propinquus* and *Tomopteris spp.* exhibited significant decreases ($P<0.05$), and *T. macrura* and *C. lucasi* significant increases ($P\leq 0.01$), between Surveys A and D. A variety of taxa within the Coastal cluster also had significant abundance decreases between the surveys (larval *T. macrura, I. racovitzai, P. macropa, L. helicina,* siphonophores, larvaceans, radiolaria; $P<0.05$) while only two (*R. gigas* and *T. gaudicahauii*) had increased concentrations there ($P<0.01$). The southward deflection of the Intermediate cluster in eastern Bransfield Strait is associated with decreased influence of Weddell Sea water relative to Survey A.

Although taxonomic abundance relations within the three clusters demonstrated moderate seasonal changes (PSI's 80.0-83.7) the overall change in zooplankton composition was more substantial (PSI 70.5) due to increased spatial coverage of the Intermediate cluster (to 53 from 35 stations) vs. Offshore cluster (to 28 vs. 45 stations). These changes also coincided with expansion of Zone II (mixed) vs. Zone I (ACC) water.

4.3.6 Survey D Between-Year Comparisons:

4.3.6.1 Krill:

<u>Post larvae (Table 4.7, 4.8B)</u>

Mean and median krill abundance in the Elephant Island Area were about average for the 1992-2005 data set. Overall and individual maturity stage compositions (few juveniles, modest proportions of immature stages and dominance by mature males) were most similar to those of February-March, 1994 (PSIs 92.8 and 74.1, respectively). Low proportions of advanced female maturity stages (8.7%), suggesting a temporally limited spawning season, were also observed in 1993, 1998 and 2003 and likewise associated with el Niño events.

<u>Larvae (Tables 4.3; 4.7; 4.10)</u>

Mean larval krill abundance in the Elephant Island Area was slightly greater than last year and while both values were relatively large (177-195 per 1000 m^3) they were an order of magnitude lower than the extremes of February-March 1995 and 2000. The median value here (4.6 per 1000 m^3), however, was an order of magnitude lower than last year. Large concentrations within the Joinville Island Area, also observed last year and during the 2002 Survey A, may result from advection from the Weddell Sea. Similar proportions of furcilia stage larvae, noted across the Survey D area during 1996, 2002 and 2003 (11-15%), are modest compared to those last year (56%). Elevated proportions of furcilia larvae observed in the South Area this year were similar to those noted in the Joinville Island Area in 2002 and Elephant Island Area during 2004 suggesting variable source regions and/or advective regimes.

4.3.6.2 Salps:

Salpa thompsoni (Tables 4.7, 4.9, 4.10)

In contrast to Survey A, mean and median *S. thompsoni* abundance values in the Elephant Island Area were lower than the highs of 1993, 1997, 1998 and 2000. Substantial seasonal abundance decreases also characterized the 1994 and 2001 field seasons and preceded periods of relatively low salp concentrations. However this did not hold true for 2004 when seasonal decreases in mean (10%) and median (60%) salp concentrations coincided with a surge of overwintering solitary stage production that possibly was responsible for increased population size this year. Proportions of solitaries this year (6%) were typical for Survey D. Overall aggregate length-frequency distribution was typical for this time of year but most resembled that during 1999 (D_{MAX}=10.9 at 33 mm indicating fewer small individuals this year. While mean salp carbon biomass in the Elephant Island Area was moderate the median value was second to the maximum in 1997 and the salp:krill ratio was third after the 2002 and 1999 values. As with Survey A overall salp distributions differed from earlier February-March surveys when greatest concentrations typically were in the South and Elephant Island Areas. Elevated concentrations in the West Area starting around 2002 suggest a change in the source region and/or advective processes.

Ihlea racovitzai

As with Survey A, the frequency of occurrence of *I. racovitzai* was half of that, and mean abundance an order of magnitude smaller, than in 2004 and its representation was most similar to that in 1999. While the distribution within Bransfield Strait is similar to previous surveys the negligible presence north of the South Shetland Islands and restricted concentrations around Elephant Island are not. These differences suggest limited influence of westward flowing Polar Slope water north of the islands.

4.3.6.3 Zooplankton (Tables 4.7, 4.10, 4.11, 4.12):

The Survey D 1-2-3 copepod, *S. thompsoni,* postlarval *T. macrura* abundance relationship in the Elephant Island Area also occurred during 1994 and 1997. More equal representation of copepods and salps was shared only with 1997 and, along with similar abundance ranks of postlarval *T. macrura*, krill and *E. frigida* and chaetognaths, promoted a moderately high PSI value (79.7).

Mean and median copepod abundance values within the Elephant Island Area were among the lowest observed since 1993, both exceeding only the 1998 values. This resulted from continued low concentrations of *M. gerlachei*, *C. propinquus* and *C. acutus* all of which were at the lowest values observed over the past seven years. Only *R. gigas* appeared in average concentrations. Concentrations of larval *T. macrura* and chaetognaths were also among the lowest within the long term data sets. In contrast, mean and median abundance values for postlarval *T. macrura* were among the largest observed while those of *E. frigida* represent the long term median.

Spatially coherent and persistent zooplankton clusters obviously conforming to flow regimes during both surveys were anomalous for this typically complex and variable region and suggest a comparatively stable flow regime. The persistence of a depauperate assemblage dominated by copepods, salps and *T. macrura* that exhibited only a modest seasonal abundance increase suggests a coastally derived "East Wind Drift" assemblage lacking enrichment from seasonal southward movement of the Antarctic Circumpolar Current Southern Front (Loeb et al., ms). Similar conditions were previously observed and associated with the 1993/94 and 1998 el Niño events. However, this year differs in that faunal input appeared to be primarily from regions to the west. Despite low zooplankton concentrations this year there exist within the 1992-2005 Elephant Island data set significantly increased numbers of copepods, chaetognaths and *E. frigida* after the 1998 el Niño (Mann-Whitney U Tests, $P<0.01$). This in conjunction with decreased influence by the Weddell Sea gyre and anomalously prolonged winter sea ice extent off the Antarctic Peninsula concurrent with an el Niño event during austral spring 2004 supports an hypothesized change in large scale coupled ocean-atmosphere-sea ice processes coincidental with the North Pacific regime shift in 1998 (Loeb et al., ms).

4.4 AMLR 2005 Cruise Summary:

(1) Overall krill length-frequency distribution (predominantly 40-55 mm individuals) reflected strong recruitment success of the 2000/01 and 2001/02 year classes (respective R1 values, provided by V. Siegel 0.403 and 0.478) and minimal representation from the 2002/03 (R1=0.001) and 2003/2004 spawning seasons. Two successive years of poor recruitment success were not apparent in krill abundance or carbon biomass estimates which were similar to last years values.

(2) The presence of predominantly early calyptopis stage larvae during Survey A and a mixture of calyptopis and early furcilia stages during Survey D indicated a mid- to late December initiation of the seasonal spawning period. Proportions of advanced female maturity stages during the two surveys suggested a favorably timed spawning season that peaked in January.

(3) Poor recruitment success following the prolonged, intense and apparently successful spawning period during 2003/04 and presumably favorable extensive sea ice in the Antarctic Peninsula region during spring 2004 indicate that other factors are involved in ultimately determining localized recruitment. These factors most likely include advective processes that influence retention vs. loss to downstream areas.

(4) January 2005 abundance values of *S. thompsoni* were among the largest in the long term data set and likely result from el Niño-related conditions in 2003 and 2004 that promoted population growth and/or transport into the region. Substantially reduced salp abundance during February-March was associated with altered flow dynamics of the Shackleton Fracture Zone gyre and, based on the long term data set, may presage a period of relatively low salp abundance.

(5) Overall distribution patterns and water zone associations of *S. thompsoni* during both surveys differed markedly from those in the past and suggest input from the west via the Antarctic Circumpolar Current vs. Weddell Sea source areas to the east.

(6) Persistence of a depauperate zooplankton assemblage dominated by copepods (notably *Metridia gerlachei*), *S. thompsoni* and *T. macrura* that exhibited only a modest seasonal abundance increase reflects a coastally derived assemblage lacking enrichment by "West Wind Drift" plankton associated with the Antarctic Circumpolar Current Southern Front. These conditions also prevailed during the 1993 and 1998 El Niño periods.

4.5 Disposition of Data and Samples: All of the krill, salp and other zooplankton data have been digitized and are available upon request from Valerie Loeb. These data have been submitted to (Southwest Fisheries Science Center). Frozen krill and myctophids were provided to Mike Goebel (Southwest Fisheries Science Center) for chemical analyses. Preserved krill samples were saved for chemical analyses by Julian Ashford (Old Dominion University). Entire samples or representative subsamples from each station were preserved and shipped back to La Jolla, CA, for long term storage.

4.5 Problems and Suggestions:

(1) Additional Hydrographic Data. It has become apparent that in order to understand advective processes influencing krill recruitment success we require additional hydrographic data to those obtained from the standard survey grid. Specifically, we need to obtain finer scale information on characteristics and movement of the Southern Antarctic Circumpolar Current that can be obtained from XBT deployment during transits each field season, including those done during the fish stock assessment surveys to maximize temporal coverage.

(2) Collaboration. Collaboration among the AMLR scientists should be encouraged and supported. In the distant past the program held work sessions in order to coordinate and encourage collaborative efforts but those failed dismally, probably due to combination of personalities and the program's newness. Now with a wealth of data and insight resulting from 15 years of experience it is time to focus on data synthesis and production of publishable interdisciplinary manuscripts.

4.6 Acknowledgments: It was wonderful to once again enjoy the facilities of the R/V *Yuzhmorgeologiya*, her Captain, crew and scientists. We particularly appreciate the efforts made by Captain Igor to facilitate our scientific and logistical efforts particularly in icy and/or harsh conditions. All of us who succumbed to the flu greatly appreciated the regular attention and medical care provided by Dr. Sergey and the deep concern, commiseration and hot soup provided to us by Nina during our down times.

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Table 4.1. AMLR 2004 Large-area survey IKMT station information. Double lines denote subarea divisions.

A. SURVEY A

STATION	DATE	TIME START	TIME END (LOCAL)	DIEL	TOW DEPTH (m)	FLOW VOL. (m3)	KRILL TOTAL	KRILL ABUNDANCE N/m2	KRILL ABUNDANCE N/1000m3
WEST AREA:									
A18-12	17/01/05	0306	0333	T	171	2648.4	0	0.0	0.0
A19-11	17/01/05	0631	0702	D	180	3065.7	34	2.0	11.1
A20-10	17/01/05	0947	1014	D	170	2368.1	73	5.2	30.8
A19-09	17/01/05	1320	1346	D	170	2333.9	66	4.8	28.3
A18-10	17/01/05	1650	1721	D	168	2374.2	12	0.8	5.1
A17-11	17/01/05	1955	2012	D	112	1452.3	0	0.0	0.0
A16-10	17/01/05	2256	2321	T	170	2105.5	28	2.3	13.3
A17-09	18/01/05	0217	0246	N	174	2503.3	0	0.0	0.0
A18-08	18/01/05	0549	0614	D	169	2088.5	2	0.2	1.0
A17-07	18/01/05	0921	0946	D	169	2330.8	2	0.1	0.9
A16-08	18/01/05	1248	1315	D	170	2529.8	100	6.7	39.5
A15-09	18/01/05	1612	1640	D	167	2558.9	120	7.8	46.9
A14-10	18/01/05	1914	1925	D	69	995.3	2	0.1	2.0
A13-09	18/01/05	2154	2219	T	159	2226.5	0	0.0	0.0
A14-08	19/01/05	0106	0138	N	170	2751.8	0	0.0	0.0
A15-07	19/01/05	0436	0503	D	170	2608.8	6	0.4	2.3
A16-06	19/01/05	0753	0819	D	169	2242.5	5	0.4	2.2
A15-05	19/01/05	1117	1141	D	171	2015.1	0	0.0	0.0
A14-06	19/01/05	1436	15-6	D	169	2526.2	0	0.0	0.0
A13-07	19/01/05	1802	1830	D	170	2282.9	0	0.0	0.0
A12-08	19/01/05	2101	2126	D	170	2023.6	7	0.6	3.5
A11-07	20/01/05	0024	0051	N	170	2100.3	20	1.6	9.5
A11-05	20/01/05	0504	0533	D	170	2369.1	9	0.6	3.8
A11-03	20/01/05	0919	0945	D	167	2041.6	14	1.1	6.9
A11-01	20/01/05	1324	1354	D	172	2431.5	10	0.7	4.1
ELEPHANT ISLAND AREA:									
A09-01	20/01/05	1745	1815	D	173	4208.5	10	0.4	2.4
A09-02	20/01/05	2037	2102	D	171	1932.0	2	0.2	1.0
A09-03	20/01/05	2327	2351	N	170	2008.6	2	0.2	1.0
A09-04	21/01/05	0227	0257	N	170	2756.5	60	3.7	21.8
A09-05	21/01/05	0535	0602	D	170	2366.9	5	0.4	2.1
A09-06	21/01/05	0836	0903	D	170	1862.6	15	1.4	8.1
A09-07	21/01/05	1135	1158	D	171	1621.0	58	6.1	35.8
A09-08	21/01/05	1419	1448	D	172	2492.8	81	5.6	32.5
A08-08	21/01/05	1703	1729	D	171	2005.9	43	3.7	21.4
A08-06	21/01/05	2114	2140	D	169	2149.9	42	3.3	19.5
A08-04	22/01/05	0152	0218	N	169	2041.0	0	0.0	0.0
A08-02	22/01/05	0620	0647	D	168	2022.8	0	0.0	0.0
A07-01	22/01/05	0955	1018	D	169	1642.6	2	0.2	1.2
A07-02	22/01/05	1245	1314	D	172	2446.4	1	0.1	0.4
A07-03	22/01/05	1546	1612	D	169	2171.3	3	0.2	1.4
A07-04	22/01/05	1845	1912	D	171	2244.2	9	0.7	4.0
A07-05	22/01/05	2143	2207	T	170	1868.9	44	4.0	23.5
A07-06	23/01/05	0024	0054	N	168	2272.5	24	1.8	10.6
A07-07	23/01/05	0318	0346	T	170	2371.1	68	4.9	28.7
A07-08	23/01/05	0616	0646	D	170	2133.1	8	0.6	3.8
A05.5-08	23/01/05	0949	1014	D	169	2118.2	128	10.2	60.4
A05.5-07	23/01/05	1215	1237	D	130	1717.6	2	0.2	1.2
A05.5-06	23/01/05	1501	1516	D	101	1202.2	55	4.6	45.7
A05.5-05	23/01/05	1719	1740	D	134	1880.8	55	3.9	29.2
A05.5-04	23/01/05	2022	2045	D	171	1855.7	105	9.7	56.6
A05.5-03	23/01/05	2310	2333	N	171	1925.1	27	2.4	14.0
A05.5-02	24/01/05	0200	0227	N	171	2321.7	6	0.4	2.6
A05.5-01	24/01/05	0458	0524	D	172	2087.1	0	0.0	0.0
A04-01	24/01/05	0905	0932	D	169	2136.5	75	5.9	35.1
A04-02	24/01/05	1213	1243	D	169	2623.4	273	17.6	104.1
A04-03	24/01/05	1505	1532	D	170	2288.8	137	10.2	59.9
A04-04	24/01/05	1752	1823	D	170	2741.3	99	6.1	36.1
A04-05	24/01/05	2024	2049	D	170	2072.7	0	0.0	0.0
A04-06	25/01/05	0125	0147	N	141	1701.9	148	12.3	87.0
A04-07	25/01/05	0404	0432	D	170	2190.1	11	0.9	5.0
A04-08	25/01/05	0645	0713	D	169	2184.1	60	4.6	27.5
A03-08	25/01/05	0920	0945	D	170	2078.4	74	6.1	35.6
A03-06	25/01/05	1332	1400	D	170	2146.7	16	1.3	7.5

Table 4.1 (Contd.)

A. SURVEY A

STATION	DATE	TIME START	TIME END (LOCAL)	DIEL	TOW DEPTH (m)	FLOW VOL. (m3)	KRILL ABUNDANCE TOTAL	N/m2	N/1000m3
A03-04	25/01/05	1756	1825	D	170	2323.2	158	11.6	68.0
A03-02	25/01/05	2210	2235	T	170	2001.3	15	1.3	7.5
A02-01	26/01/05	0143	0211	N	171	2108.1	269	21.8	127.6
A02-02	26/01/05	0432	0459	D	171	2226.4	37	2.8	16.6
A02-03	26/01/05	1718	1745	D	170	2064.5	44	3.6	21.3
A02-04	26/01/05	1009	1034	D	168	2094.7	266	21.3	127.0
A02-05	26/01/05	1306	1335	D	170	2321.7	24	1.8	10.3
A02-06	26/01/05	1814	1843	D	172	2407.0	21	1.5	8.7
A02-07	26/01/05	2102	2128	D	171	2046.6	179	15.0	87.5
A02-08	26/01/05	2325	2351	N	171	2442.0	5	0.4	2.0
JOINVILLE ISLAND AREA:									
A02-09	27/01/05	0211	0242	N	170	2572.5	2	0.1	0.8
A04-09.5	27/01/05	0640	0710	D	169	2550.8	7	0.5	2.7
A04-09	27/01/05	0837	0902	D	170	1877.2	17	1.5	9.1
A06-09	27/01/05	1302	1330	D	170	2280.5	350	26.1	153.5
A06-11	27/01/05	1654	1721	D	168	2294.5	0	0.0	0.0
A06-12	27/01/05	1929	1958	D	170	2306.2	0	0.0	0.0
SOUTH AREA:									
A07-11	27/01/05	2246	2310	N	168	1912.3	2	0.2	1.0
A08-10	28/01/05	0159	0229	N	167	2565.4	172	11.2	67.0
A09-09	28/01/05	0436	0501	D	173	2018.6	326	27.9	161.5
A10-10	28/01/05	0758	0825	D	170	2102.4	2	0.2	1.0
A09-11	28/01/05	1124	1148	D	170	1970.1	11	0.9	5.6
A08-12	28/01/05	1444	1513	D	170	2537.8	0	0.0	0.0
A09-13	28/01/05	1749	1818	D	168	2508.6	0	0.0	0.0
A10-12	28/01/05	2045	2149	D	169	1798.6	0	0.0	0.0
A11-11	28/01/05	2353	0021	N	170	2518.2	3	0.2	1.2
A13-11	29/01/05	0406	0434	T	170	2383.6	8	0.6	3.4
A12-12	29/01/05	0718	0743	D	170	2126.9	6	0.5	2.8
A11-13	29/01/05	1010	1036	D	169	2213.8	8	0.6	3.6
A12-14	29/01/05	1622	1650	D	169	2241.4	48	3.6	21.4
A13-13	29/01/05	1920	1949	D	168	2339.0	1	0.1	0.4
A14-12	29/01/05	2232	2256	T	170	1945.3	0	0.0	0.0
A15-13	30/01/05	0159	0226	N	170	2556.6	2	0.1	0.8
A14-14	30/01/05	0853	0918	D	168	1993.4	0	0.0	0.0
A15-15	30/01/05	1214	1243	D	170	2419.1	4	0.3	1.7
A16-14	30/01/05	2016	2042	D	170	2147.9	1	0.1	0.5
A17-13	30/01/05	2326	2352	N	167	2031.9	1	0.1	0.5

			TOTAL	N/m2	N/1000m3
SURVEY A TOTAL:	N = 99		4247		
		MEAN		3.3	19.7
		STD		5.6	33.3
		MEDIAN		0.6	3.8
WEST AREA:	N = 25		510		
		MEAN		1.4	8.4
		STD		2.2	13.0
		MEDIAN		0.4	2.3
ELEPHANT ISLAND AREA:	N = 48		2766		
		MEAN		4.5	27.1
		STD		5.5	33.0
		MEDIAN		2.6	15.3
JOINVILLE ISLAND AREA:	N = 6		376		
		MEAN		4.7	27.7
		STD		9.6	56.3
		MEDIAN		0.3	1.8
SOUTH AREA:	N = 20		595		
		MEAN		2.3	13.6
		STD		6.4	37.0
		MEDIAN		0.2	1.0

Table 4.1 (Contd.)

B. SURVEY D

STATION	DATE	TIME START	TIME END (LOCAL)	DIEL	TOW DEPTH (m)	FLOW VOL. (m3)	KRILL ABUNDANCE TOTAL	N/m2	N/1000m3
WEST AREA:									
D18-12	22/02/05	0342	0410	N	170	2444.2	25	1.7	10.2
D19-11	23/02/05	0714	0743	D	171	2353.5	2	0.1	0.8
D20-10	23/02/05	1046	1115	D	170	2190.6	0	0.0	0.0
D19-09	23/02/05	1415	1441	D	170	2163.0	0	0.0	0.0
D18-10	23/02/05	1800	1828	D	168	2232.5	2	0.2	0.9
D17-11	23/02/05	2115	2131	T	110	1560.0	7	0.5	4.5
D16-10	24/02/05	0012	0040	N	160	2520.1	45	2.9	17.9
D17-09	24/02/05	0331	0359	N	169	2406.2	5	0.4	2.1
D18-08	24/02/05	0658	0724	D	168	2206.2	2	0.2	0.9
D17-07	24/02/05	1015	1040	D	169	1937.5	0	0.0	0.0
D16-08	24/02/05	1407	1432	D	171	1996.9	46	3.9	23.0
D15-09	24/02/05	1736	1804	D	170	2319.5	17	1.2	7.3
D14-10	24/02/05	2026	2036	D	70	804.3	0	0.0	0.0
D13-09	24/02/05	2305	2330	N	159	2155.6	145	10.7	67.3
D14-08	25/02/05	0311	0337	N	166	2535.1	103	6.7	40.6
D15-07	25/02/05	0650	0719	D	169	2274.6	1	0.1	0.4
D16-06	25/02/05	1030	1056	D	168	2142.3	0	0.0	0.0
D15-05	25/02/05	1509	1536	D	170	2206.4	3	0.2	1.4
D14-06	25/02/05	1845	1914	D	169	2188.3	6	0.5	2.7
D13-07	25/02/05	2218	2245	N	169	2159.6	12	0.9	5.6
D12-08	26/02/05	0144	0212	N	170	2478.3	4	0.3	1.6
D11-07	26/02/05	0520	0547	T	170	2153.6	13	1.0	6.0
D11-05	26/02/05	0930	0955	D	171	1972.9	0	0.0	0.0
D11-03	26/02/05	1527	1552	D	175	2078.5	1	0.1	0.5
D11-01	26/02/05	1943	2009	D	169	2203.9	0	0.0	0.0
ELEPHANT ISLAND AREA:									
D09-01	27/02/05	0013	0038	N	174	2055.8	19	1.6	9.2
D09-02	27/02/05	0253	0322	N	170	2469.2	22	1.5	8.9
D09-03	27/02/05	0547	0617	T	168	2825.8	2	0.1	0.7
D09-04	27/02/05	0826	0851	D	171	1862.5	14	1.3	7.5
D09-05	27/02/05	1110	1138	D	165	2543.2	26	1.7	10.2
D09-06	27/02/05	1358	1425	D	170	2312.2	70	5.1	30.3
D09-07	27/02/05	1637	1704	D	169	2083.7	1	0.1	0.5
D09-08	27/02/05	1901	1927	D	170	2166.5	2	0.2	0.9
D08-08	27/02/05	2144	2210	N	172	1962.6	1	0.1	0.5
D08-06	28/02/05	0225	0251	N	171	2111.5	67	5.4	31.7
D08-04	28/02/05	0647	0715	D	168	2208.4	0	0.0	0.0
D08-02	28/02/05	1127	1154	D	170	2237.1	0	0.0	0.0
D07-01	28/02/05	1508	1536	D	170	2564.3	33	2.2	12.9
D07-02	28/02/05	1814	1841	D	168	2143.2	1	0.1	0.5
D07-03	28/02/05	2054	2120	T	170	2076.5	1	0.1	0.5
D07-04	28/02/05	2338	0005	N	169	2187.7	44	3.4	20.1
D07-05	01/03/05	0233	0301	N	171	2172.2	40	3.1	18.4
D07-06	01/03/05	0532	0601	T	169	2520.3	9	0.6	3.6
D07-07	01/03/05	0818	0845	D	170	2138.0	1	0.1	0.5
D07-08	01/03/05	1112	1139	D	168	2088.5	25	2.0	12.0
D05.5-08	01/03/05	1450	1515	D	170	1988.4	1	0.1	0.5
D05.5-07	01/03/05	1719	1747	D	170	2423.0	15	1.1	6.2
D05.5-06	01/03/05	1947	2003	T	99	1315.6	3	0.2	2.3
D05.5-05	01/03/05	2205	2224	N	130	1441.2	437	39.4	303.2
D05.5-04	02/03/05	0213	0238	N	170	2128.3	1220	97.4	573.2
D05.5-03	02/03/05	0510	0535	T	170	1851.9	0	0.0	0.0
D05.5-02	02/03/05	0751	0819	D	169	2272.5	1	0.1	0.4
D05.5-01	02/03/05	1112	1137	D	169	1960.1	46	4.0	23.5
D04-01	02/03/05	1508	1538	D	169	2469.2	1	0.1	0.4
D04-02	02/03/05	1758	1826	D	169	2248.9	32	2.4	14.2
D04-03	02/03/05	2052	2118	T	169	2324.8	14	1.0	6.0
D04-04	02/03/05	2344	0009	N	170	2139.9	2380	189.1	1112.2
D04-05	03/03/05	0235	0301	N	174	2096.2	15	1.2	7.2
D04-06	03/03/05	0819	0837	D	120	1362.8	6	0.5	4.4
D04-07	03/03/05	1103	1128	D	167	2182.5	0	0.0	0.0
D04-08	03/03/05	1348	1413	D	169	2289.9	0	0.0	0.0
D03-08	03/03/05	1638	1708	D	168	2472.6	1	0.1	0.4
D03-06	03/03/05	2056	2121	N	167	2186.0	0	0.0	0.0

Table 4.1 (Contd.)

B. SURVEY D

STATION	DATE	TIME START (LOCAL)	TIME END	DIEL	TOW DEPTH (m)	FLOW VOL. (m3)	KRILL TOTAL	KRILL ABUNDANCE N/m2	KRILL ABUNDANCE N/1000m3
D03-04	04/03/05	0127	0157	N	170	2531.0	145	9.7	57.3
D03-02	04/03/05	0559	0627	T	167	2271.5	4	0.3	1.8
D02-01	04/03/05	0927	0955	D	169	2386.1	9	0.6	3.8
D02-02	04/03/05	1229	1254	D	170	2105.6	11	0.9	5.2
D02-03	04/03/05	1531	1557	D	170	2123.3	2	0.2	0.9
D02-04	04/03/05	1832	1858	D	169	2221.0	4	0.3	1.8
D02-05	04/03/05	2118	2146	N	169	2280.0	24	1.8	10.5
D02-06	05/03/05	0031	0057	N	169	2159.1	5	0.4	2.3
D02-07	05/03/05	0329	0354	N	172	2313.1	5	0.4	2.2
D02-08	05/03/05	0647	0712	T	171	1729.9	0	0.0	0.0
JOINVILLE ISLAND AREA:									
D02-09	05/03/05	1921	1951	D	169	2328.8	1	0.1	0.4
D03-10	05/03/05	2212	2239	N	170	2349.2	403	29.2	171.5
D04-10	06/03/05	0224	0249	N	171	2172.4	8	0.6	3.7
D04-09	06/03/05	0504	0532	T	168	2292.7	5	0.4	2.2
D06-09	06/03/05	0904	0932	D	168	2155.6	1	0.1	0.5
D06-11	06/03/05	1416	1439	D	171	2113.3	0	0.0	0.0
SOUTH AREA:									
D07-11	06/03/05	1637	1703	D	168	2304.3	0	0.0	0.0
D08-10	06/03/05	1940	2007	T	168	2251.2	14	1.0	6.2
D09-09	06/03/05	2244	2313	N	170	2606.6	2	0.1	0.8
D10-10	07/03/05	0300	0328	N	170	2362.3	2736	196.9	1158.2
D09-11	07/03/05	0707	0734	D	169	2305.5	3	0.2	1.3
D08-12	07/03/05	0957	1022	D	170	2050.1	7	0.6	3.4
D09-13	07/03/05	1323	1348	D	170	2132.6	7	0.6	3.3
D10-12	07/03/05	1603	1629	D	170	2139.0	1	0.1	0.5
D11-11	07/03/05	1739	2004	T	169	2101.2	0	0.0	0.0
D13-11	07/03/05	2321	2347	N	169	1974.0	2	0.2	1.0
D12-12	08/03/05	0250	0319	N	170	2483.0	258	17.7	103.9
D11-13	08/03/05	0714	0744	D	169	2797.1	1	0.1	0.4
D12-14	08/03/05	1110	1138	D	170	2281.7	800	192.8	350.6
D13-13	08/03/05	1418	1444	D	171	2218.6	4	0.3	1.8
D14-12	08/03/05	1737	1802	D	171	2109.9	204	16.5	96.7
D15-13	08/03/05	2048	2114	N	168	2169.3	2	0.2	0.9
D14-14	09/03/05	0421	0447	N	169	2150.7	37	2.9	17.2
D15-15	09/03/05	0802	0831	D	171	2721.7	3	0.2	1.1

			TOTAL	N/m2	N/1000m3
SURVEY D TOTAL:	N = 97		9697		
		MEAN		9.0	45.7
		STD		34.7	175.4
		MEDIAN		0.3	2.1
WEST AREA:	N = 25		439		
		MEAN		1.3	7.8
		STD		2.5	15.2
		MEDIAN		0.2	1.4
ELEPHANT ISLAND AREA:	N = 48		4759		
		MEAN		7.9	48.1
		STD		30.3	179.9
		MEDIAN		0.5	2.9
JOINVILLE ISLAND AREA:	N = 6		418		
		MEAN		5.1	29.7
		STD		10.8	63.4
		MEDIAN		0.2	1.3
SOUTH AREA:	N = 18		4081		
		MEAN		23.9	97.1
		STD		60.7	270.3
		MEDIAN		0.3	1.6
				1.8	10.5

Table 4.2 Maturity stage composition of krill collected in the large survey area and subareas during January-March 2005. Advanced maturity stages are proportions of mature females that are 3c-3e in January and 3d-3e in February-March.

	Euphausia superba January 2005				
Area	Survey A	West	Elephant I.	Joinville I.	South
Stage	%	%	%	%	%
Juveniles	4.1	0.4	2.6	21.7	3.1
Immature	11.3	2.7	8.7	27.2	19.9
Mature	84.6	96.9	88.7	51.1	77.0
Females:					
F2	0.6	0.0	0.9	0.0	0.0
F3a	4.9	4.9	2.0	23.1	11.6
F3b	5.9	11.7	5.2	3.2	6.5
F3c	10.1	6.5	11.8	3.9	9.2
F3d	13.1	3.3	15.8	7.9	11.1
F3e	3.6	1.3	3.5	3.3	1.2
Advanced Stages	71.3	40.2	81.2	36.4	54.2
Males:					
M2a	1.9	0.4	2.5	1.0	0.6
M2b	4.1	1.2	2.4	16.7	6.8
M2c	4.6	1.1	2.9	9.5	12.4
M3a	3.0	5.6	2.1	4.7	4.0
M3b	44.1	63.6	18.3	5.1	33.5
Male:Female	1.5	2.6	1.5	0.9	1.5
No. measured	3149	507	2189	148	305

	February 2005				
Area	Survey D	West	Elephant I.	Joinville I.	South
Stage	%	%	%	%	%
Juveniles	2.5	0.3	0.8	0.0	4.6
Immature	25.8	10.4	9.7	9.6	38.9
Mature	71.7	89.3	89.5	90.4	56.5
Females:					
F2	6.8	0.0	0.8	0.0	13.3
F3a	25.4	11.5	16.2	38.6	32.3
F3b	9.2	12.7	9.3	12.3	4.9
F3c	6.1	10.3	12.1	1.8	0.6
F3d	1.7	3.2	3.6	0.0	0.2
F3e	0.3	0.4	0.0	0.0	0.6
Advanced Stages	4.6	9.5	8.7	0.0	2.1
Males:					
M2a	3.1	0.4	1.5	0.3	5.2
M2b	4.4	3.5	0.8	4.5	6.7
M2c	11.4	6.4	6.6	4.8	13.7
M3a	10.2	8.6	13.2	3.6	8.2
M3b	18.8	42.5	35.0	34.1	9.8
Male:Female	1.0	1.6	1.4	0.9	0.8
No. measured	2054	403	1018	121	512

Table 4.3. Larval krill stage composition and abundance in (A) Large Survey Areas, 1996-2005, and (B) total and individual survey areas, 2000-2005. Only pooled calyptopis and furcilia stages provided for 1996-1999. Individual stages provided for 2000-2005 surveys.

(A) Large Survey Area

Stage %	A96	A97	A98	A99	A00	A01	A02	A03	A04	A05
Calyptopis Total	100	93	68	100	n.a.	100	70	100	95	99
Furcilia Total	---	7	32	---	n.a.	---	30	---	5	1
No. per 1000 m3										
Mean	2.7	15.4	1.0	103.1	n.a.	160.2	19.4	3.4	7.0	18.6
STD	7.5	27.1	4.5	587.4	n.a.	710.8	48.6	12.1	14.6	66.8
Med	0.0	0.8	0.0	2.6	n.a.	12.5	0.0	0.0	0.4	0.5

Stage %	D96	D97	D98	D99	D00	D01	D02	D03	D04	D05
Calyptopis Total	86	100	99	97	97	98	85	89	44	85
Furcilia Total	14	---	1	3	3	2	15	11	56	15
No. per 1000 m3										
Mean	13.9	25.0	1.6	49.8	2129.6	683.4	61.0	3.9	107.7	183.1
STD	40.2	81.4	14.1	119.3	7247.8	3607.1	220.4	10.5	523.1	840.6
Med	3.0	0.0	0.0	9.0	34.2	10.5	0.0	0.0	20.2	0.0

(B) Total, Elephant Island, West, South and Joinville Island Areas

Survey	A00				A01				A02					A03					A04					A05				
Stage %					Total	West	Eleph	South	Total	West	Eleph	South	Joinvl	Total	West	Eleph	South	Joinvl	Total	West	Eleph	South	Joinvl	Total	West	Eleph	South	Joinvl
C1					24.0	17.6	68.4	95.3	37.3	50.0	40.3	13.9	5.0	87.5	77.7	89.7	100	100	64.5	80.0	63.4	60.7	68.2	81.7	84.3	90.8	64.2	78.6
C2					66.3	72.7	22.1	---	15.8	50.0	16.3	7.0	2.9	9.6	1.9	8.8	---	---	18.5	8.3	22.1	7.6	24.9	11.2	---	6.6	22.2	10.3
C3					9.7	9.7	9.3	---	17.4	---	20.3	---	52.5	3.6	20.4	1.5	---	---	10.3	---	12.4	8.6	---	3.5	---	0.2	8.0	11.0
Unid.					---	---	0.2	4.7	---	---	---	---	---	---	---	---	---	---	1.8	4.3	2.0	0.0	---	2.0	3.7	1.4	4.2	---
Calyptopis Total					100	100	100	100	70.5	100	76.9	20.9	60.4	100	100	100	100	100	95.1	92.6	100	76.9	93.1	98.9	88.0	100	98.6	100
F1					---	---	---	---	9.6	---	6.2	35	38.2	---	---	---	---	---	3.7	---	---	19.3	6.9	1.0	12.0	---	1.4	---
F2					---	---	---	---	19.9	---	17.0	44.1	1.4	---	---	---	---	---	0.7	---	---	3.9	---	---	---	---	---	---
F3					---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Unid.					---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.6	7.4	---	---	---	0.1	---	---	---	---
Furcilia Total					---	---	---	---	29.5	---	23.1	79.1	39.6	---	---	---	---	---	4.9	7.4	---	23.1	6.9	1.1	12.0	---	1.4	---
No. per 1000 m3																												
Mean					160.2	472.6	32.8	2.9	19.4	1.5	35.8	13.4	1107.0	3.4	3.6	4.7	1.0	7.1	7.0	2.2	9.8	7.0	4.6	18.6	2.8	22.0	26.4	30.9
STD					710.8	1243.8	86.2	6.9	48.6	7.6	64.6	30.3	2602.6	12.1	7.5	16.8	3.1	6.4	14.6	6.5	18.5	9.4	6.3	66.8	8.3	78.3	79.6	40.6
Med					12.5	66.5	9.0	---	---	---	---	---	92.9	---	---	---	---	5.7	0.4	---	0.4	2.4	2.0	0.5	---	1.1	1.2	13.8

Survey	D00				D01				D02					D03					D04					D05				
Stage %	Total	West	Eleph	South	Total	West	Eleph	South	Total	West	Eleph	South	Joinvl	Total	West	Eleph	South	Joinvl	Total	West	Eleph	South	Joinvl	Total	West	Eleph	South	Joinvl
C1	46.3	48.8	46.3	32.6	57.1	37.6	58.4	17.8	18.5	3.2	42.2	50.3	---	67.7	100	63.4	78.8	100	17.0	31.6	14.2	37.5	17.8	12.2	100	22.2	2.2	0.3
C2	40.5	29.3	40.5	55.2	29.8	36.1	29.4	15.2	12.1	16.7	4.1	49.7	15.6	21.2	---	22.8	21.2	---	15.1	27.1	10.7	29.6	41.3	55.2	---	45.0	15.6	86.0
C3	9.9	21.1	9.8	12.2	11.2	18.0	10.7	67.0	49.5	70.0	23.5	---	29.5	---	---	---	---	---	11.8	40.2	8.0	14.9	13.5	15.3	---	18.1	21.7	8.7
Unid.	0.6	---	0.6	---	---	0.8	---	---	5.3	9.5	---	---	---	---	---	---	---	---	---	---	---	---	---	2.4	---	4.5	---	---
Calyptopis Total	96.9	99.2	96.9	100	98.2	92.5	98.6	100	85.5	99.3	69.8	100	45.1	88.9	100	86.2	100	100	43.9	98.9	32.9	82.0	72.6	85.1	100	89.9	39.5	95.0
F1	1.4	0.8	1.4	---	1.8	7.4	1.4	---	10.4	0.7	22.8	---	26.8	1.1	---	1.3	---	---	5.8	1.1	5.8	9.0	11.4	12.4	---	9.9	46.3	3.5
F2	1.2	---	1.2	---	---	0.1	---	---	3.4	---	7.4	---	12.1	10.0	---	12.5	---	---	24.5	---	29.3	4.7	13.4	2.2	---	---	13.9	1.1
F3	0.1	---	0.1	---	---	---	---	---	0.7	---	---	---	16.1	---	---	---	---	---	25.6	---	31.6	4.3	2.6	0.1	---	---	---	0.4
Unid.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.3	---	0.4	---	---	0.2	---	0.3	0.3	---
Furcilia Total	2.7	0.8	2.7	---	1.8	7.5	1.4	---	14.5	0.7	30.2	---	54.9	11.1	---	13.8	---	---	56.1	1.1	67.1	18.0	27.4	14.9	---	10.1	60.5	5.0
No. per 1000 m3																												
Mean	2129.6	37.8	3423.2	11.1	683.4	2119.3	71.9	4.8	61.0	133.7	49.9	0.4	29.2	3.9	0.1	6.1	2.8	4.8	107.7	41.0	177.3	23.2	87.2	183.1	0.8	194.8	127.9	1014.4
STD	7247.8	75.2	8974.1	11.2	3607.1	6328.9	176.9	9.8	220.4	380.9	140.9	1.1	38.4	10.5	0.6	13.0	9.1	7.9	523.1	79.7	741.5	31.6	86.4	840.6	3.9	969.1	511.8	1511.1
Med	34.2	9.5	248.7	9.6	10.5	42.5	5.1	---	---	---	---	---	0.0	---	---	---	---	0.4	20.2	15.1	38.9	5.2	40.7	---	---	4.6	0.4	33.2

Table 4.4. Composition and abundance of zooplankton assemblages sampled in large Survey A and D areas, January-March, 2005. F(%) is frequency of occurrence in samples. R is rank and % is percent of total mean abundance represented by each taxon. L and J denote larval and juvenile stages.

	AMLR 2005 SURVEY A (N=99)							AMLR 2005 SURVEY D (N=97)						
TAXON	F(%)	R	%	MEAN	STD	MED	MAX	F(%)	R	%	MEAN	STD	MED	MAX
Total Copepods	100	2	26.6	544.9	954.2	197.3	5628.7	100	1	43.4	1216.8	1795.0	499.3	10201.3
Metridia gerlachei	65.7		57.9	315.3	855.8	4.6	5049.1	90.7		30.6	858.0	1500.7	106.9	8605.0
Calanoides acutus	92.9		17.8	96.8	220.9	23.7	1373.7	99.0		6.1	169.8	365.7	53.7	2521.7
Other copepods	96.0		12.1	66.0	75.4	45.7	380.9	97.9		2.5	71.2	92.8	32.4	466.1
Rhincalanus gigas	70.7		4.3	23.5	75.7	5.7	720.8	87.6		1.9	53.2	70.4	25.9	357.0
Pareuchaeta spp.	32.3		2.7	14.7	45.6	0.0	342.5	70.1		1.2	34.3	68.4	6.6	466.1
Calanus propinquus	85.9		4.8	26.1	42.4	10.4	287.5	82.5		1.0	27.4	64.2	9.9	452.4
Pleuromama robusta	7.1		0.2	0.9	5.0	0.0	48.4	6.2		0.0	1.1	6.9	0.0	64.8
Pareuchaeta antarctica	13.1		0.1	0.5	2.0	0.0	17.3	26.8		0.0	0.8	2.5	0.0	17.8
Heterorhabdus sp.	0.0		0.0	0.0	0.0	0.0	0.0	5.2		0.0	0.7	3.9	0.0	36.1
Haloptilus ocellatus	3.0		0.1	0.7	7.1	0.0	71.3	2.1		0.0	0.2	1.2	0.0	9.1
Eucalanus sp.	1.0		0.0	0.2	1.6	0.0	16.5	0.0		0.0	0.0	0.0	0.0	0.0
Calanus similus	1.0		0.0	0.1	1.1	0.0	11.2	0.0		0.0	0.0	0.0	0.0	0.0
Copepodites	0.0		0.0	0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.0	0.0	0.0
Thysanoessa macrura	94.9	3	11.4	232.5	276.8	143.7	1490.8	100	3	16.9	473.3	504.2	292.9	2520.0
Themisto gaudichaudii	87.9	9	0.8	16.8	23.0	9.6	118.7	95.9	8	0.8	22.6	31.1	9.7	155.9
Salpa thompsoni	98.0	1	50.2	1028.4	1588.0	382.7	9761.0	94.8	2	25.5	715.9	954.7	329.8	5399.9
Cyllopus magellanicus	79.8	11	0.7	13.7	23.3	4.2	154.2	89.7	9	0.5	14.1	25.0	6.6	219.9
Chaetognaths	80.8	5	1.1	22.2	36.8	8.7	236.5	83.5	6	1.6	44.5	70.8	17.4	412.3
Euphausia superba	79.8	7	1.0	19.7	33.3	3.8	161.5	82.5	5	1.6	45.7	175.4	2.1	1158.2
Vibilia antarctica	74.7		0.2	3.6	5.8	1.5	32.9	75.3	14	0.1	3.4	6.5	1.4	50.7
Euphausia frigida	45.5	6	1.0	19.8	56.9	0.0	385.2	63.9	7	1.2	33.9	52.3	3.8	265.8
Euphausia superba (L)	51.5	8	0.9	18.6	66.8	0.5	521.8	48.5	4	6.5	183.1	840.6	0.0	6755.5
Amphipods (unid.)	32.3		0.1	2.4	7.8	0.0	71.3	44.3	12	0.2	6.2	12.6	0.0	72.1
Spongiobranchaea australis	51.5		0.1	1.5	3.1	0.4	20.2	42.3		0.0	1.1	2.9	0.0	20.2
Ostracods	42.4	12	0.4	8.9	32.9	0.0	299.1	41.2	11	0.3	7.4	15.9	0.0	88.6
Thysanoessa macrura (L)	51.5	4	2.1	43.0	119.9	0.5	836.0	36.1	10	0.3	8.9	26.6	0.0	202.6
Primno macropa	62.6		0.2	3.6	4.9	1.9	33.3	36.1		0.1	1.7	3.6	0.0	20.5
Cyllopus lucasii	27.3		0.0	0.5	1.2	0.0	6.7	35.1		0.0	1.0	2.1	0.0	10.2
Siphonophora	41.4	15	0.3	5.3	13.4	0.0	77.4	34.0		0.1	2.7	6.0	0.0	36.7
Sipunculids	33.3	10	0.8	16.2	45.6	0.0	269.7	32.0	13	0.1	4.2	11.2	0.0	77.3
Ihlea racovitzai	22.2		0.1	2.4	6.4	0.0	42.4	26.8		0.0	1.2	6.0	0.0	57.9
Radiolaria	32.3		0.1	2.1	8.1	0.0	71.3	24.7		0.0	0.9	2.3	0.0	12.7
Hyperiella dilatata	36.4		0.0	0.7	1.7	0.0	12.0	23.7		0.0	0.6	1.7	0.0	11.9
Euphausia spp.	17.2		0.2	3.7	17.3	0.0	146.6	19.6		0.0	1.0	3.2	0.0	19.8
Tomopteris spp.	43.4		0.1	1.1	2.6	0.0	19.4	19.6		0.0	0.6	2.0	0.0	17.3
Lepidonotothen kempi (L)	9.1		0.0	0.2	0.8	0.0	7.2	16.5		0.0	0.2	0.5	0.0	2.2
Eggs (unid.)	2.0		0.2	3.5	34.2	0.0	341.6	15.5	15	0.1	3.2	18.2	0.0	162.7
Larvaceans	20.2		0.2	3.4	11.5	0.0	72.7	15.5		0.0	1.0	2.9	0.0	14.6
Clione limacina	47.5		0.0	1.0	2.0	0.0	16.5	15.5		0.0	0.1	0.4	0.0	1.9
Limacina helicina	36.4	13	0.3	6.0	18.8	0.0	135.7	14.4		0.0	0.8	3.7	0.0	29.8
Notolepis coatsi (L)	6.1		0.0	0.1	0.3	0.0	2.3	14.4		0.0	0.2	0.8	0.0	6.9
Electrona antarctica	4.0		0.0	0.0	0.2	0.0	1.9	14.4		0.0	0.2	0.5	0.0	3.4
Euphausia crystallorophias	15.2		0.0	0.5	2.2	0.0	20.6	13.4		0.0	0.8	3.0	0.0	23.2
Hyperiids (unid.)	11.1		0.0	0.2	0.9	0.0	5.7	13.4		0.0	0.3	1.5	0.0	12.7
Calycopsis borchgrevinki	1.0		0.0	0.0	0.0	0.0	0.4	13.4		0.0	0.2	0.6	0.0	3.2
Cyllopus spp.	18.2		0.0	0.8	2.8	0.0	19.1	12.4		0.0	0.6	2.8	0.0	25.3
Lepidonotothen larseni (L)	19.2		0.0	0.3	0.8	0.0	6.2	11.3		0.0	0.1	0.2	0.0	1.3
Dimophyes arctica	7.1		0.0	0.2	1.0	0.0	8.7	10.3		0.0	0.1	0.3	0.0	2.1
Hydromedusae (unid)	14.1		0.0	0.1	0.5	0.0	2.6	10.3		0.0	0.1	0.4	0.0	3.8
Euphausia spp. (L)	23.2	14	0.3	6.0	22.7	0.0	162.6	9.3		0.1	3.0	22.8	0.0	223.1
Polychaetes (unid.)	22.2		0.1	1.4	4.9	0.0	42.3	9.3		0.0	0.4	1.6	0.0	11.3
Champsocephalus gunnari (L)	0.0		0.0	0.0	0.0	0.0	0.0	9.3		0.0	0.3	1.4	0.0	9.4
Larval Fish (unid.)	12.1		0.0	0.2	0.8	0.0	7.5	9.3		0.0	0.2	1.0	0.0	6.9
Limacina spp.	14.1		0.2	3.1	15.4	0.0	140.0	8.2		0.0	0.7	2.8	0.0	19.2
Euphausia triacantha	11.1		0.1	2.6	10.5	0.0	60.7	8.2		0.0	0.5	2.3	0.0	19.4
Diphyes antarctica	19.2		0.0	0.2	0.6	0.0	3.1	8.2		0.0	0.2	1.1	0.0	10.4
Vanadis antarctica	3.0		0.0	0.1	0.3	0.0	2.6	7.2		0.0	0.1	0.3	0.0	2.8
Isopods (unid.)	13.1		0.0	0.5	1.6	0.0	9.0	6.2		0.0	0.7	4.8	0.0	46.5
Pegantha martgon	0.0		0.0	0.0	0.0	0.0	0.0	6.2		0.0	0.2	0.8	0.0	5.9
Gymnoscopelus braueri	2.0		0.0	0.0	0.1	0.0	0.5	6.2		0.0	0.1	0.2	0.0	1.6
Spongiobranchaea sp.	10.1		0.0	0.2	1.3	0.0	12.0	5.2		0.0	0.1	0.3	0.0	2.1
Callanira antarctica	3.0		0.0	0.1	0.7	0.0	6.5	5.2		0.0	0.1	0.3	0.0	2.4
Hyperiella spp.	2.0		0.0	0.0	0.1	0.0	1.0	5.2		0.0	0.1	0.3	0.0	2.3
Ctenophora (unid.)	7.1		0.0	0.1	0.7	0.0	6.2	5.2		0.0	0.0	0.3	0.0	1.7
Orchomene plebs	10.1		0.0	0.1	0.4	0.0	2.0	5.2		0.0	0.0	0.2	0.0	1.9

Table 4.4 (contd.)

	AMLR 2005 SURVEY A													
TAXON	F(%)	R	%	MEAN	STD	MED	MAX	F(%)	R	%	MEAN	STD	MED	
Cumaceans	0.0		0.0	0.0	0.0	0.0	0.0	4.1		0.0	0.3	2.8	0.0	27.8
Pleuragramma antarcticum (L)	2.0		0.0	0.0	0.1	0.0	0.5	4.1		0.0	0.1	0.6	0.0	5.7
Electrona spp. (L)	5.1		0.0	0.1	0.4	0.0	3.2	4.1		0.0	0.0	0.2	0.0	1.8
Oediceroides calmani?	0.0		0.0	0.0	0.0	0.0	0.0	3.1		0.0	0.1	1.3	0.0	13.2
Notolepis spp. (L)	2.0		0.0	0.0	0.1	0.0	0.5	3.1		0.0	0.0	0.2	0.0	1.7
Beroe cucumis	3.0		0.0	0.0	0.1	0.0	0.5	3.1		0.0	0.0	0.2	0.0	1.8
Gymnoscopelus nicholsi	1.0		0.0	0.0	0.0	0.0	0.4	3.1		0.0	0.0	0.1	0.0	0.9
Acanthophyra pelagica	8.1		0.0	0.1	0.3	0.0	2.0	3.1		0.0	0.0	0.1	0.0	0.5
Euphausia frigida (L)	7.1		0.1	1.7	13.7	0.0	136.4	2.1		0.0	0.2	2.0	0.0	19.9
Mysids (unid)	0.0		0.0	0.0	0.0	0.0	0.0	2.1		0.0	0.2	1.3	0.0	11.5
Epimeriella macronyx	1.0		0.0	0.0	0.0	0.0	0.5	2.1		0.0	0.1	0.7	0.0	6.5
Pleuragramma antarcticum	0.0		0.0	0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.3	0.0	2.3
Beroe spp.	0.0		0.0	0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.2	0.0	1.5
Clio pyramidata spp?	1.0		0.0	0.0	0.1	0.0	0.8	2.1		0.0	0.0	0.2	0.0	1.7
Eusirus antarcticus	7.1		0.0	0.0	0.2	0.0	1.0	2.1		0.0	0.0	0.1	0.0	0.9
Chionodraco rastrospinosus (L)	1.0		0.0	0.0	0.1	0.0	0.9	2.1		0.0	0.0	0.1	0.0	0.9
Gymnoscopelus bolini	0.0		0.0	0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.9
Gammarids (unid)	0.0		0.0	0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.8
Hyperiella macronyx	2.0		0.0	0.0	0.1	0.0	0.5	2.1		0.0	0.0	0.1	0.0	0.5
Cephalopods	2.0		0.0	0.0	0.1	0.0	0.5	2.1		0.0	0.0	0.1	0.0	0.5
Trematomus scotti (L)	13.1		0.0	0.2	0.6	0.0	3.9	2.1		0.0	0.0	0.1	0.0	0.4
Pleurobrachia pileus	1.0		0.0	0.0	0.0	0.0	0.5	1.0		0.0	0.0	0.4	0.0	3.5
Gastropods (unid)	8.1		0.0	0.2	0.8	0.0	5.0	1.0		0.0	0.0	0.3	0.0	3.1
Notolepis annulata (L)	0.0		0.0	0.0	0.0	0.0	0.0	1.0		0.0	0.0	0.1	0.0	1.0
Hyperia antarctica	0.0		0.0	0.0	0.0	0.0	0.0	1.0		0.0	0.0	0.1	0.0	0.5
Clione antarctica	0.0		0.0	0.0	0.0	0.0	0.0	1.0		0.0	0.0	0.0	0.0	0.5
Schyphomedusae (unid.)	3.0		0.0	0.0	0.1	0.0	0.5	1.0		0.0	0.0	0.0	0.0	0.5
Tunicata (unid.)	1.0		0.0	0.0	0.0	0.0	0.4	1.0		0.0	0.0	0.0	0.0	0.5
Orchomene spp.	0.0		0.0	0.0	0.0	0.0	0.0	1.0		0.0	0.0	0.0	0.0	0.5
Electrona carlsbergi	4.0		0.0	0.0	0.1	0.0	0.5	1.0		0.0	0.0	0.0	0.0	0.5
Racovitzia glacialis	0.0		0.0	0.0	0.0	0.0	0.0	1.0		0.0	0.0	0.0	0.0	0.5
Nototheniops nudifrons (L)	0.0		0.0	0.0	0.0	0.0	0.0	1.0		0.0	0.0	0.0	0.0	0.4
Pasiaphaea spp. (L)	10.1		0.0	0.3	1.5	0.0	11.8	1.0		0.0	0.0	0.0	0.0	0.4
Adult Myctophids (unid.)	0.0		0.0	0.0	0.0	0.0	0.0	1.0		0.0	0.0	0.0	0.0	0.4
Clio pyramidata antarctica?	24.2		0.1	1.1	4.3	0.0	35.4	1.0		0.0	0.0	0.0	0.0	0.0
Chorismus antarcticus	5.1		0.0	0.1	0.5	0.0	4.0	0.0		0.0	0.0	0.0	0.0	0.0
Notothenidae Larvae (unid.)	4.0		0.0	0.1	0.4	0.0	3.5	0.0		0.0	0.0	0.0	0.0	0.0
Bargmannia elongata	4.0		0.0	0.0	0.1	0.0	0.8	0.0		0.0	0.0	0.0	0.0	0.0
Rhynchonereelia bongraini	2.0		0.0	0.1	0.6	0.0	5.6	0.0		0.0	0.0	0.0	0.0	0.0
Pelagobia longicirrata	2.0		0.0	0.0	0.4	0.0	4.2	0.0		0.0	0.0	0.0	0.0	0.0
Ephyra Larvae (unid.)	2.0		0.0	0.0	0.4	0.0	3.9	0.0		0.0	0.0	0.0	0.0	0.0
Hyperoche medusarum	2.0		0.0	0.0	0.4	0.0	3.6	0.0		0.0	0.0	0.0	0.0	0.0
Clio pyramidata sulcata?	2.0		0.0	0.0	0.2	0.0	1.3	0.0		0.0	0.0	0.0	0.0	0.0
Halitholus spp.	2.0		0.0	0.0	0.1	0.0	0.8	0.0		0.0	0.0	0.0	0.0	0.0
Beroe forskalii	2.0		0.0	0.0	0.1	0.0	0.5	0.0		0.0	0.0	0.0	0.0	0.0
Bolinopsis sp.	2.0		0.0	0.0	0.1	0.0	0.5	0.0		0.0	0.0	0.0	0.0	0.0
Cryodraco antarctica (J)	2.0		0.0	0.0	0.1	0.0	0.5	0.0		0.0	0.0	0.0	0.0	0.0
Krefftichthys anderssoni	2.0		0.0	0.0	0.1	0.0	0.4	0.0		0.0	0.0	0.0	0.0	0.0
Orchomene rossi	2.0		0.0	0.0	0.1	0.0	0.4	0.0		0.0	0.0	0.0	0.0	0.0
Modeeria rotunda?	2.0		0.0	0.0	0.1	0.0	0.4	0.0		0.0	0.0	0.0	0.0	0.0
Euphausia crystallorophias(L)	1.0		0.0	0.5	4.8	0.0	48.1	0.0		0.0	0.0	0.0	0.0	0.0
Euphausia triacantha (L)	1.0		0.0	0.0	0.2	0.0	2.1	0.0		0.0	0.0	0.0	0.0	0.0
Scina spp.	1.0		0.0	0.0	0.1	0.0	1.3	0.0		0.0	0.0	0.0	0.0	0.0
Leusia spp.	1.0		0.0	0.0	0.1	0.0	1.2	0.0		0.0	0.0	0.0	0.0	0.0
Harpagifer antarcticus (L)	1.0		0.0	0.0	0.1	0.0	1.0	0.0		0.0	0.0	0.0	0.0	0.0
Eusirus properdentatus	1.0		0.0	0.0	0.1	0.0	0.5	0.0		0.0	0.0	0.0	0.0	0.0
Arctopodema ampla	1.0		0.0	0.0	0.0	0.0	0.5	0.0		0.0	0.0	0.0	0.0	0.0
Decapods (unid.)	1.0		0.0	0.0	0.0	0.0	0.5	0.0		0.0	0.0	0.0	0.0	0.0
Electrona subaspera	1.0		0.0	0.0	0.0	0.0	0.4	0.0		0.0	0.0	0.0	0.0	0.0
Mitrocomella brownei?	1.0		0.0	0.0	0.0	0.0	0.4	0.0		0.0	0.0	0.0	0.0	0.0
Laodicea undulata	1.0		0.0	0.0	0.0	0.0	0.4	0.0		0.0	0.0	0.0	0.0	0.0
Chromatonema rubra?	1.0		0.0	0.0	0.0	0.0	0.4	0.0		0.0	0.0	0.0	0.0	0.0
Eusirus perdentatus	1.0		0.0	0.0	0.0	0.0	0.4	0.0		0.0	0.0	0.0	0.0	0.0
Channychthidae Larvae (unid.)	1.0		0.0	0.0	0.0	0.0	0.4	0.0		0.0	0.0	0.0	0.0	0.0
Cyphocaris richardi	1.0		0.0	0.0	0.0	0.0	0.4	0.0		0.0	0.0	0.0	0.0	0.0
TOTAL				2047.0	2008.2	1416.9	11497.1				2806.5	2768.6	1563.2	14130.0
TAXA	104			18.1	2.9	16.7	34	88			16.3	4.2	16.0	35

Table 4.5. Composition and abundance of zooplankton assemblages sampled in four subareas, during (A) January and (B) February 2005. F% is frequency of occurrence in samples. R is rank and % is proportion of total mean abundance represented by each taxon. (L) and (J) denote larval and juvenile stages.

A. SURVEY A

	WEST AREA (N=25)						ELEPHANT ISLAND AREA (N=48)						JOINVILLE ISLAND AREA (N=6)						SOUTH AREA (N=20)					
TAXON	F(%)	R	%	MEAN	STD	MED	F(%)	R	%	MEAN	STD	MED	F(%)	R	%	MEAN	STD	MED	F(%)	R	%	MEAN	STD	MED
Salpa thompsoni	100	1	68.7	1578.0	2377.0	424.0	100	1	61.5	1208.7	1274.7	670.8	66.7	4	4.5	106.7	208.1	18.9	95.2	3	10.1	185.4	294.1	37.8
Total Copepods	100	2	14.9	342.9	642.8	122.6	100	2	18.5	364.6	687.3	126.4	100	1	66.1	1568.6	1893.0	901.9	95.2	1	50.4	922.7	1093.3	785.6
Metridia gerlachei	56.0		7.9	181.9	625.9	0.0	66.7		11.2	220.0	614.4	3.9	50.0		36.3	862.0	1873.0	0.8	76.2		29.9	546.9	994.8	172.1
Other copepods	92.0		2.4	54.5	56.0	44.9	95.8		2.5	49.1	57.9	35.2	100		7.7	182.0	117.4	184.9	95.2		4.7	86.2	82.2	56.4
Rhincalanus gigas	68.0		2.1	48.8	143.1	5.7	60.4		0.6	12.6	21.0	4.7	83.3		0.5	11.4	11.8	5.7	90.5		1.2	21.5	23.1	12.9
Calanoides acutus	80.0		1.4	31.9	36.8	15.1	95.8		2.0	39.0	62.7	16.1	100		18.0	426.8	514.1	149.1	95.2		11.9	217.7	301.1	60.1
Calanus propinquus	84.0		1.0	22.2	55.5	5.3	83.3		1.3	26.4	41.8	9.5	83.3		1.7	41.0	33.9	26.0	90.5		1.4	25.9	20.9	22.5
Haloptilus ocellatus	8.0		0.1	2.9	14.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.0	0.1	0.3	0.0
Calanus similus	4.0		0.0	0.4	2.2	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Pleuromama robusta	4.0		0.0	0.3	1.3	0.0	8.3		0.1	1.4	7.0	0.0	0.0		0.0	0.0	0.0	0.0	9.5		0.0	0.6	2.1	0.0
Pareuchaeta antarctica	8.0		0.0	0.1	0.3	0.0	12.5		0.0	0.6	2.6	0.0	16.7		0.0	0.8	1.9	0.0	19.0		0.0	0.8	1.8	0.0
Pareuchaeta spp.	0.0		0.0	0.0	0.0	0.0	31.3		0.8	15.2	53.8	0.0	50.0		1.9	44.6	58.3	11.0	66.7		1.2	22.9	41.3	7.6
Eucalanus sp.	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.3	2.3	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Thysanoessa macrura	92.0	3	7.8	178.7	191.0	116.0	93.8	3	8.7	171.4	247.1	109.6	100	2	8.3	197.9	166.7	185.8	95.2	2	24.9	456.6	340.0	461.9
Themisto gaudichaudii	100	4	1.7	39.0	30.4	27.7	93.8	10	0.6	12.6	15.0	10.1	33.3		0.0	0.2	0.2	0.0	71.4		0.2	4.1	5.1	2.0
Chaetognaths	80.0	5	1.4	32.0	45.3	12.9	72.9	9	0.8	15.8	37.3	2.9	100		1.9	45.8	25.4	43.0	90.5	8	1.0	18.5	13.7	14.6
Thysanoessa macrura (L)	24.0	6	0.9	20.8	85.0	0.0	50.0	4	2.2	43.0	139.9	0.5	100	3	6.3	148.8	155.0	81.6	71.4	5	2.1	39.3	62.7	14.1
Cyllopus magellanicus	84.0	7	0.8	18.4	34.8	6.2	87.5	8	0.9	17.3	19.3	6.0	33.3		0.0	0.7	1.4	0.0	66.7		0.2	3.0	6.6	0.8
Euphausia frigida	12.0	8	0.6	13.2	43.4	0.0	45.8	5	1.4	28.5	73.7	0.0	50.0		0.6	14.2	24.6	1.5	81.0		0.5	8.8	10.0	4.9
Euphausia spp. (L)	24.0	9	0.4	8.5	32.2	0.0	22.9		0.3	6.7	22.3	0.0	16.7		0.1	1.3	2.9	0.0	23.8		0.1	2.7	6.8	0.0
Euphausia superba	68.0	10	0.4	8.4	13.0	2.3	91.7	6	1.4	27.1	33.0	15.3	66.7		1.2	27.7	56.3	1.8	66.7	10	0.7	13.6	37.0	1.0
Ostracods	48.0		0.3	6.4	15.9	0.0	29.2		0.1	1.6	3.8	0.0	33.3		0.2	4.1	8.6	0.0	66.7	6	1.7	31.0	65.9	4.2
Vibilia antarctica	76.0		0.3	5.9	9.3	2.2	83.3		0.2	3.6	3.9	2.2	50.0		0.0	0.9	1.0	0.4	57.1		0.1	1.3	2.2	0.5
Euphausia spp.	4.0		0.3	5.9	28.7	0.0	29.2		0.2	4.4	13.3	0.0	0.0		0.0	0.0	0.0	0.0	9.5		0.0	0.2	0.7	0.0
Primno macropa	68.0		0.2	5.6	7.3	4.0	66.7		0.2	3.3	3.8	2.0	66.7		0.2	4.1	3.6	4.5	42.9		0.1	1.7	2.6	0.0
Siphonophora (unid.)	28.0		0.2	5.4	14.9	0.0	33.3		0.2	3.8	12.4	0.0	66.7		0.3	6.9	8.5	4.5	66.7		0.5	8.3	14.5	3.7
Euphausia triacantha	20.0		0.2	4.9	15.3	0.0	12.5		0.1	2.9	10.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Amphipods (unid.)	32.0		0.2	3.9	14.1	0.0	39.6		0.1	2.3	4.1	0.0	33.3		0.1	1.9	3.0	0.0	14.3		0.0	0.9	2.5	0.0
Radiolaria	36.0		0.2	3.6	13.9	0.0	25.0		0.0	0.9	3.2	0.0	66.7		0.3	8.3	9.9	2.8	33.3		0.1	1.4	2.9	0.0
Euphausia superba (L)	28.0		0.1	2.8	8.3	0.0	56.3	7	1.1	22.0	78.3	1.1	100.0		1.3	30.9	40.6	13.8	90.5	7	1.4	26.4	79.6	1.2
Spongiobranchaea australis	48.0		0.1	2.6	5.1	0.0	41.7		0.0	1.0	1.8	0.0	50.0		0.0	0.7	0.8	0.4	76.2		0.1	1.6	2.1	0.7
Clio pyramidata antarctica?	48.0		0.1	2.4	7.0	0.0	20.8		0.0	0.9	3.3	0.0	0.0		0.0	0.0	0.0	0.0	9.5		0.0	0.1	0.4	0.0
Clione limacina	40.0		0.0	1.1	3.3	0.0	29.2		0.0	0.3	0.7	0.0	100.0		0.1	1.5	1.2	1.2	81.0		0.1	2.1	1.8	1.8
Tomopteris spp.	44.0		0.0	1.1	2.3	0.0	31.3		0.1	1.0	3.1	0.0	83.3		0.1	3.2	2.7	2.9	57.1		0.0	0.6	0.9	0.5
Hyperiella dilatata	28.0		0.0	0.9	2.6	0.0	33.3		0.0	0.7	1.3	0.0	66.7		0.0	0.8	0.9	0.5	42.9		0.0	0.3	0.5	0.0
Cyllopus spp.	12.0		0.0	0.8	3.0	0.0	27.1		0.1	1.2	3.2	0.0	0.0		0.0	0.0	0.0	0.0	9.5		0.0	0.1	0.2	0.0
Cyllopus lucasii	24.0		0.0	0.7	1.6	0.0	37.5		0.0	0.6	1.2	0.0	33.3		0.0	0.4	0.6	0.0	4.8		0.0	0.0	0.1	0.0
Ihlea racovitzai	8.0		0.0	0.6	2.1	0.0	22.9		0.2	3.2	8.3	0.0	66.7		0.2	4.2	6.4	2.0	23.8		0.1	1.9	3.7	0.0
Lepidonotothen kempi (L)	8.0		0.0	0.3	1.4	0.0	8.3		0.0	0.1	0.4	0.0	33.3		0.0	0.7	1.3	0.0	4.8		0.0	0.0	0.1	0.0
Euphausia crystallorophias	16.0		0.0	0.3	1.0	0.0	8.3		0.0	0.6	3.1	0.0	0.0		0.0	0.0	0.0	0.0	33.3		0.0	0.4	0.7	0.0
Larval Fish (unid.)	20.0		0.0	0.3	0.7	0.0	2.1		0.0	0.0	0.1	0.0	16.7		0.1	1.2	2.8	0.0	23.8		0.0	0.2	0.3	0.0
Limacina helicina	8.0		0.0	0.3	1.0	0.0	22.9		0.0	0.9	3.0	0.0	100.0		1.8	42.4	48.0	26.2	81.0	9	0.8	14.6	21.6	2.5
Spongiobranchaea sp.	12.0		0.0	0.2	0.6	0.0	10.4		0.0	0.1	0.3	0.0	0.0		0.0	0.0	0.0	0.0	9.5		0.0	0.6	2.6	0.0
Electrona spp. (L)	8.0		0.0	0.2	0.7	0.0	0.0		0.0	0.0	0.0	0.0	16.7		0.0	0.2	0.5	0.0	9.5		0.0	0.1	0.2	0.0
Polychaetes (unid.)	4.0		0.0	0.2	0.9	0.0	14.6		0.0	0.3	0.7	0.0	66.7		0.1	2.7	3.6	0.4	47.6		0.3	5.1	9.6	0.3
Lepidonotothen larseni (L)	16.0		0.0	0.1	0.3	0.0	8.3		0.0	0.1	0.4	0.0	33.3		0.0	0.5	0.7	0.0	42.9		0.0	0.8	1.5	0.0
Electrona antarctica	4.0		0.0	0.1	0.4	0.0	4.2		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.0	0.0	0.1	0.0
Hyperiids (unid.)	8.0		0.0	0.1	0.2	0.0	12.5		0.0	0.3	1.1	0.0	0.0		0.0	0.0	0.0	0.0	14.3		0.0	0.4	1.1	0.0
Notolepis coatsi (L)	8.0		0.0	0.1	0.2	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	14.3		0.0	0.2	0.5	0.0
Scina spp.	4.0		0.0	0.1	0.3	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Harpagifer antarcticus (L)	4.0		0.0	0.0	0.2	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Cephalopods	8.0		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Krefftichthys anderssoni	8.0		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Sipunculids	4.0		0.0	0.0	0.1	0.0	20.8		0.1	1.7	7.3	0.0	100.0	5	3.2	75.3	94.6	34.0	76.2	4	2.9	53.6	64.9	19.7
Diphyes antarctica	4.0		0.0	0.0	0.1	0.0	20.8		0.0	0.2	0.5	0.0	33.3		0.0	0.7	1.2	0.0	28.6		0.0	0.3	0.6	0.0
Bargmannia elongata	4.0		0.0	0.0	0.1	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	9.5		0.0	0.1	0.2	0.0
Gymnoscopelus braueri	4.0		0.0	0.0	0.1	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Notolepis spp. (L)	4.0		0.0	0.0	0.1	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Euphausia frigida (L)	4.0		0.0	0.0	0.1	0.0	8.3		0.2	3.3	19.6	0.0	16.7		0.1	1.2	2.8	0.0	4.8		0.0	0.0	0.1	0.0
Bolinopsis sp.	4.0		0.0	0.0	0.1	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Beroe forskalii	4.0		0.0	0.0	0.1	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Isopods (unid.)	4.0		0.0	0.0	0.1	0.0	10.4		0.0	0.3	1.2	0.0	33.3		0.0	0.7	1.0	0.0	23.8		0.1	1.3	2.7	0.0

Table 4.5 (contd.)

A. SURVEY A

	WEST AREA						ELEPHANT ISLAND AREA						JOINVILLE ISLAND AREA						SOUTH AREA					
TAXON	F(%)	R	%	MEAN	STD	MED	F(%)	R	%	MEAN	STD	MED	F(%)	R	%	MEAN	STD	MED	F(%)	R	%	MEAN	STD	MED
Calycopsis borchgrevinki	4.0		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Eggs (unid.)	0.0		0.0	0.0	0.0	0.0	4.2		0.4	7.2	48.8	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Dimophyes arctica	0.0		0.0	0.0	0.0	0.0	10.4		0.0	0.3	1.5	0.0	0.0		0.0	0.0	0.0	0.0	9.5		0.0	0.1	0.2	0.0
Limacina spp.	0.0		0.0	0.0	0.0	0.0	8.3		0.0	0.3	1.3	0.0	50.0		1.4	33.0	51.4	2.7	33.3		0.3	4.7	8.3	0.0
Larvaceans	0.0		0.0	0.0	0.0	0.0	4.2		0.0	0.2	1.3	0.0	66.7		1.0	23.3	25.5	12.0	66.7		0.5	9.5	16.3	4.1
Ctenophora (unid.)	0.0		0.0	0.0	0.0	0.0	6.3		0.0	0.1	0.9	0.0	0.0		0.0	0.0	0.0	0.0	19.0		0.0	0.3	0.8	0.0
Callanira antarctica	0.0		0.0	0.0	0.0	0.0	4.2		0.0	0.1	0.9	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.0	0.0	0.2	0.0
Gastropods (unid.)	0.0		0.0	0.0	0.0	0.0	6.3		0.0	0.1	0.4	0.0	16.7		0.0	0.1	0.1	0.0	19.0		0.0	0.7	1.6	0.0
Trematomus scotti (L)	0.0		0.0	0.0	0.0	0.0	10.4		0.0	0.1	0.4	0.0	50.0		0.0	1.0	1.4	0.2	23.8		0.0	0.3	0.6	0.0
Hydromedusae (unid.)	0.0		0.0	0.0	0.0	0.0	8.3		0.0	0.1	0.3	0.0	33.3		0.0	0.2	0.3	0.0	38.1		0.0	0.5	0.8	0.0
Clio pyramidata sulcata?	0.0		0.0	0.0	0.0	0.0	4.2		0.0	0.0	0.2	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Euphausia triacantha (L)	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.3	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Electrona carlsbergi	0.0		0.0	0.0	0.0	0.0	8.3		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Acanthophyra pelagica	0.0		0.0	0.0	0.0	0.0	4.2		0.0	0.0	0.1	0.0	50.0		0.0	0.4	0.5	0.3	14.3		0.0	0.1	0.4	0.0
Eusirus antarcticus	0.0		0.0	0.0	0.0	0.0	6.3		0.0	0.0	0.1	0.0	33.3		0.0	0.1	0.2	0.0	9.5		0.0	0.1	0.3	0.0
Orchomene plebs	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.2	0.0	16.7		0.0	0.3	0.7	0.0	38.1		0.0	0.3	0.5	0.0
Leusia spp.	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.2	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Hyperiella spp.	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.0	0.0	0.1	0.0
Pleuragramma antarcticum (L)	0.0		0.0	0.0	0.0	0.0	4.2		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Hyperiella macronyx	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.0	0.0	0.1	0.0
Epimeriella macronyx	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Arctopodema ampla	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Decapods (unid.)	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Pleurobrachia pileus	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Electrona subaspera	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Vanadis antarctica	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	16.7		0.0	0.4	1.0	0.0	4.8		0.0	0.1	0.4	0.0
Chromatonema rubra?	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Orchomene rossi	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.0	0.0	0.1	0.0
Modeeria rotunda?	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.0	0.0	0.1	0.0
Euphausia crystallorophias(L)	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.1	2.4	10.5	0.0
Pasiaphaea spp. (L)	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	33.3		0.1	2.2	4.3	0.0	38.1		0.0	0.8	1.9	0.0
Rhynchonereelia bongraini	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	9.5		0.0	0.3	1.2	0.0
Chorismus antarcticus	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	16.7		0.0	0.4	0.8	0.0	19.0		0.0	0.3	0.9	0.0
Pelagobia longicirrata	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	9.5		0.0	0.2	0.9	0.0
Hyperoche medusarum	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	9.5		0.0	0.2	0.8	0.0
Notothenidae (unid.)	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	33.3		0.0	0.7	1.3	0.0	9.5		0.0	0.1	0.3	0.0
Beroe cucumis	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	14.3		0.0	0.1	0.2	0.0
Halitholus spp.	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	9.5		0.0	0.1	0.2	0.0
Chionodraco rastrospinosus (L)	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.0	0.0	0.2	0.0
Cryodraco antarctica (J)	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	9.5		0.0	0.0	0.1	0.0
Ephyra Larvae (unid.)	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	16.7		0.0	0.7	1.5	0.0	4.8		0.0	0.0	0.1	0.0
Schyphomedusae (unid.)	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.0	0.0	16.7		0.0	0.1	0.2	0.0	4.8		0.0	0.0	0.1	0.0
Eusirus properdentatus	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.0	0.0	0.1	0.0
Gymnoscopelus nicholsi	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.0	0.0	0.1	0.0
Tunicata (unid.)	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.0	0.0	0.1	0.0
Eusirus perdentatus	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.0	0.0	0.1	0.0
Channychthidae fam.	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.0	0.0	0.1	0.0
Cyphocaris richardi	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	4.8		0.0	0.0	0.1	0.0
Clio pyramidata spp?	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	16.7		0.0	0.1	0.3	0.0	0.0		0.0	0.0	0.0	0.0
Mitrocomella brownei?	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	16.7		0.0	0.1	0.2	0.0	0.0		0.0	0.0	0.0	0.0
Laodicea undulata	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	16.7		0.0	0.1	0.2	0.0	0.0		0.0	0.0	0.0	0.0
TOTAL				2297.0	2853.6	1224.8				1966.4	1601.6	1133.6				2368.3	2206.1	1507.4				1831.6	1413.0	1786.7
TAXA	52			14.5	2.3	15.0	75			16.6	2.7	17.0	50			24.3	1.6	23.5	77			24.3	2.2	24.0

Table 4.5 (contd.)

B. SURVEY D

	WEST AREA (N=25)						ELEPHANT ISLAND AREA (N=48)						JOINVILLE ISLAND AREA (N=6)						SOUTH AREA (N=18)					
TAXON	F(%)	R	%	MEAN	STD	MED	F(%)	R	%	MEAN	STD	MED	F(%)	R	%	MEAN	STD	MED	F(%)	R	%	MEAN	STD	MED
Salpa thompsoni	100	1	34.5	819.3	776.1	635.0	100	2	31.5	861.0	1109.7	493.1	66.7	4	2.0	94.9	132.0	20.1	83.3	3	13.5	392.5	693.5	6.6
Total Copepods	100	2	33.8	804.1	953.0	336.7	100	1	37.3	1022.1	1254.5	344.3	100	1	67.1	3261.8	3404.3	1408.8	100	1	56.1	1627.8	2478.0	642.5
Rhincalanus gigas	100		3.5	83.4	105.5	39.4	87.5		2.0	54.0	54.2	31.6	33.3		0.1	6.4	10.6	0.0	88.9		0.9	25.0	24.4	18.7
Calanoides acutus	100		2.3	54.8	50.6	34.6	97.9		5.3	144.2	385.5	47.8	100		12.9	628.1	667.5	371.2	100		8.4	245.1	276.6	104.4
Other copepods	96.0		1.9	46.0	53.8	23.7	97.9		2.0	54.2	64.7	32.3	100		4.6	223.8	194.7	211.6	100		3.5	100.8	90.8	63.3
Metridia gerlachei	92.0		24.8	589.1	847.8	106.9	87.5		25.9	708.9	1075.7	76.7	100		44.2	2147.3	2526.2	766.9	94.4		41.3	1199.0	2257.2	162.6
Calanus propinquus	68.0		0.3	8.2	10.5	4.2	81.3		0.8	22.6	45.1	9.9	100		2.3	111.2	102.1	79.5	100		1.3	38.9	100.7	13.2
Pareuchaeta spp.	56.0		0.9	20.7	41.9	6.6	77.1		1.2	33.6	43.3	8.8	83.3		3.0	144.8	191.6	22.2	66.7		0.6	18.2	30.1	4.2
Pareuchaeta antarctica	16.0		0.0	0.5	1.5	0.0	33.3		0.0	1.1	3.0	0.0	16.7		0.0	0.2	0.5	0.0	27.8		0.0	0.8	2.3	0.0
Heterorhabdus sp.	8.0		0.0	0.7	2.4	0.0	6.3		0.0	0.9	5.2	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Haloptilus ocellatus	4.0		0.0	0.4	1.8	0.0	2.1		0.0	0.2	1.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Pleuromama robusta	4.0		0.0	0.0	0.0	0.0	10.4		0.1	2.2	9.7	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Copepodites	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	11.1		0.0	0.0	0.0	0.0
Thysanoessa macrura	100	3	23.8	566.3	550.9	398.4	100	3	16.1	441.1	511.4	275.0	100	3	4.7	227.1	259.5	131.8	100	2	17.6	512.1	438.5	312.8
Cyllopus magellanicus	100	7	0.6	15.0	12.4	9.1	95.8	9	0.6	17.7	33.1	9.8	66.7		0.1	3.8	5.9	0.9	66.7		0.2	6.6	9.6	1.1
Themisto gaudichaudii	96.0	5	2.1	49.8	41.5	38.0	97.9	8	0.7	17.8	21.6	10.7	66.7		0.0	0.7	0.9	0.4	100		0.2	4.8	4.9	3.4
Vibilia antarctica	88.0		0.1	3.0	2.9	1.9	83.3		0.2	4.8	8.5	1.8	33.3		0.0	0.4	0.6	0.0	50.0		0.1	1.5	2.6	0.2
Chaetognaths	84.0	4	2.3	54.4	99.3	16.4	79.2	6	1.8	47.9	66.1	16.4	66.7	10	0.4	17.1	18.7	13.3	100	7	1.1	30.8	30.7	18.6
Euphausia superba	72.0	8	0.3	7.8	15.2	1.4	85.4	5	1.8	48.1	179.9	2.9	83.3	8	0.6	29.7	63.4	1.3	88.9	5	3.3	97.1	270.3	1.6
Primno macropa	60.0	10	0.2	3.8	5.5	1.0	31.3		0.0	1.1	2.5	0.0	33.3		0.0	1.6	3.1	0.0	16.7		0.0	0.3	0.6	0.0
Euphausia frigida	52.0	6	1.3	29.9	44.3	1.8	64.6	7	1.3	34.9	50.6	6.7	83.3	6	1.1	52.2	57.0	29.2	72.2	6	1.1	30.9	62.9	4.2
Amphipods (unid.)	40.0		0.1	2.8	7.1	0.0	60.4	10	0.4	9.7	15.1	2.1	0.0		0.0	0.0	0.0	0.0	22.2		0.1	4.0	10.9	0.0
Cyllopus lucasi	40.0		0.1	1.2	2.3	0.0	41.7		0.0	1.2	2.4	0.0	66.7		0.0	0.9	0.9	0.5	0.0		0.0	0.0	0.0	0.0
Ostracods	36.0	9	0.2	4.5	7.7	0.0	37.5		0.2	4.2	10.7	0.0	66.7	9	0.4	18.9	24.8	3.2	50.0	9	0.5	15.8	24.8	2.4
Radiolaria	36.0		0.0	0.8	1.3	0.0	27.1		0.1	1.4	3.0	0.0	0.0		0.0	0.0	0.0	0.0	11.1		0.0	0.2	0.5	0.0
Siphonophora (unid.)	32.0		0.1	2.7	5.7	0.0	43.8		0.1	3.9	7.1	0.0	16.7		0.0	0.1	0.2	0.0	16.7		0.0	0.7	2.0	0.0
Spongiobranchaea australis	28.0		0.1	1.5	2.9	0.0	47.9		0.0	1.1	3.0	0.0	50.0		0.0	2.2	4.6	0.2	44.4		0.0	0.5	0.9	0.0
Euphausia spp.	24.0		0.1	2.4	5.2	0.0	16.7		0.0	0.4	1.2	0.0	33.3		0.0	2.3	4.7	0.0	16.7		0.0	0.5	1.4	0.0
Euphausia crystallorophias	24.0		0.1	2.3	5.4	0.0	8.3		0.0	0.2	0.7	0.0	0.0		0.0	0.0	0.0	0.0	16.7		0.0	0.5	1.3	0.0
Hyperiids (unid.)	24.0		0.0	0.4	0.9	0.0	12.5		0.0	0.4	1.8	0.0	0.0		0.0	0.0	0.0	0.0	5.6		0.0	0.3	1.4	0.0
Dimophyes arctica	20.0		0.0	0.2	0.5	0.0	6.3		0.0	0.1	0.3	0.0	0.0		0.0	0.0	0.0	0.0	11.1		0.0	0.1	0.2	0.0
Sipunculids	16.0		0.0	0.2	0.5	0.0	27.1		0.1	1.9	4.9	0.0	50.0		0.3	12.2	12.6	10.0	61.1	10	0.5	13.3	20.4	6.1
Electrona antarctica	12.0		0.0	0.2	0.7	0.0	20.8		0.0	0.1	0.3	0.0	16.7		0.0	0.6	1.3	0.0	0.0		0.0	0.0	0.0	0.0
Hyperiella dilatata	12.0		0.0	0.1	0.3	0.0	20.8		0.0	0.8	2.2	0.0	50.0		0.0	0.6	1.0	0.2	38.9		0.0	0.5	1.0	0.0
Ctenophora (unid.)	12.0		0.0	0.1	0.3	0.0	4.2		0.0	0.0	0.3	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Thysanoessa macrura (L)	8.0		0.1	1.7	6.9	0.0	31.3		0.0	1.2	2.7	0.0	83.3	5	1.4	69.0	74.5	39.2	72.2	8	0.7	19.5	18.2	15.3
Euphausia superba (L)	8.0		0.0	0.8	3.9	0.0	64.6	4	7.1	194.8	969.1	4.6	83.3	2	20.9	1014.4	1511.1	33.2	50.0	4	4.4	127.9	511.8	0.4
Mysids (unid.)	8.0		0.0	0.7	2.5	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Polychaetes (unid.)	8.0		0.0	0.5	1.8	0.0	8.3		0.0	0.2	0.7	0.0	16.7		0.0	0.7	1.6	0.0	11.1		0.0	0.7	2.6	0.0
Cyllopus spp.	8.0		0.0	0.4	1.4	0.0	20.8		0.0	1.1	3.8	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Tomopteris spp.	8.0		0.0	0.2	0.6	0.0	20.8		0.0	0.9	2.8	0.0	33.3		0.0	0.1	0.2	0.0	27.8		0.0	0.4	0.8	0.0
Lepidonotothen kempi (L)	8.0		0.0	0.2	0.5	0.0	18.8		0.0	0.2	0.5	0.0	0.0		0.0	0.0	0.0	0.0	27.8		0.0	0.2	0.5	0.0
Pleuragramma antarcticum	8.0		0.0	0.1	0.5	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Orchomene plebs	8.0		0.0	0.1	0.4	0.0	0.0		0.0	0.0	0.0	0.0	16.7		0.0	0.1	0.2	0.0	11.1		0.0	0.0	0.1	0.0
Larval Fish (unid.)	8.0		0.0	0.1	0.3	0.0	8.3		0.0	0.4	1.4	0.0	0.0		0.0	0.0	0.0	0.0	16.7		0.0	0.1	0.2	0.0
Electrona spp. (L)	8.0		0.0	0.1	0.4	0.0	4.2		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Gymnoscopelus braueri	8.0		0.0	0.1	0.3	0.0	6.3		0.0	0.1	0.2	0.0	0.0		0.0	0.0	0.0	0.0	5.6		0.0	0.0	0.1	0.0
Gymnoscopelus bolini	8.0		0.0	0.1	0.2	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Oediceroides calmani?	8.0		0.0	0.1	0.2	0.0	2.1		0.0	0.3	1.9	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Notolepis coatsi (L)	8.0		0.0	0.1	0.2	0.0	25.0		0.0	0.3	1.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Gammarids (unid)	8.0		0.0	0.1	0.2	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Cumaceans	8.0		0.0	0.0	0.2	0.0	2.1		0.0	0.6	4.0	0.0	0.0		0.0	0.0	0.0	0.0	5.6		0.0	0.1	0.4	0.0
Hydromedusae (unid.)	4.0		0.0	0.1	0.3	0.0	10.4		0.0	0.1	0.2	0.0	16.7		0.0	0.6	1.4	0.0	16.7		0.0	0.1	0.2	0.0
Beroe spp.	4.0		0.0	0.1	0.3	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Callanira antarctica	4.0		0.0	0.1	0.3	0.0	4.2		0.0	0.1	0.4	0.0	0.0		0.0	0.0	0.0	0.0	11.1		0.0	0.0	0.1	0.0
Beroe cucumis	4.0		0.0	0.0	0.2	0.0	4.2		0.0	0.0	0.3	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Clione limacina	4.0		0.0	0.0	0.2	0.0	12.5		0.0	0.1	0.3	0.0	33.3		0.0	0.4	0.6	0.0	33.3		0.0	0.3	0.6	0.0
Spongiobranchaea sp.	4.0		0.0	0.0	0.1	0.0	4.2		0.0	0.1	0.4	0.0	0.0		0.0	0.0	0.0	0.0	11.1		0.0	0.1	0.4	0.0
Orchomene spp.	4.0		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Tunicata (unid.)	4.0		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Calycopsis borchgrevinki	4.0		0.0	0.0	0.1	0.0	25.0		0.0	0.4	0.8	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Ihlea racovitzai	4.0		0.0	0.0	0.1	0.0	29.2		0.1	2.0	8.4	0.0	66.7		0.0	1.0	1.0	0.9	38.9		0.0	0.7	1.1	0.0

Table 4.5 (contd.)

B. SURVEY D

	WEST AREA (N=25)						ELEPHANT ISLAND AREA (N=48)						JOINVILLE ISLAND AREA (N=6)						SOUTH AREA (N=18)					
TAXON	F(%)	R	%	MEAN	STD	MED	F(%)	R	%	MEAN	STD	MED	F(%)	R	%	MEAN	STD	MED	F(%)	R	%	MEAN	STD	MED
Lepidonotothen larseni (L)	4.0		0.0	0.0	0.1	0.0	6.3		0.0	0.0	0.2	0.0	50.0		0.0	0.4	0.5	0.2	22.2		0.0	0.1	0.2	0.0
Gymnoscopelus nicholsi	4.0		0.0	0.0	0.1	0.0	4.2		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Limacina helicina	0.0		0.0	0.0	0.0	0.0	10.4		0.0	0.6	2.8	0.0	66.7		0.1	5.9	10.8	0.9	27.8		0.0	0.7	2.0	0.0
Larvaceans	0.0		0.0	0.0	0.0	0.0	22.9		0.1	1.4	3.2	0.0	33.3		0.1	4.0	5.7	0.0	11.1		0.0	0.1	0.3	0.0
Vanadis antarctica	0.0		0.0	0.0	0.0	0.0	8.3		0.0	0.0	0.1	0.0	33.3		0.0	0.3	0.5	0.0	5.6		0.0	0.2	0.6	0.0
Pleuragramma antarcticum (L)	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	33.3		0.0	0.1	0.2	0.0	11.1		0.0	0.4	1.3	0.0
Euphausia spp. (L)	0.0		0.0	0.0	0.0	0.0	12.5		0.0	1.0	5.0	0.0	16.7	7	0.8	37.2	83.1	0.0	11.1		0.0	0.8	2.6	0.0
Diphyes antarctica	0.0		0.0	0.0	0.0	0.0	8.3		0.0	0.3	1.5	0.0	16.7		0.0	0.2	0.3	0.0	16.7		0.0	0.1	0.2	0.0
Epimeriella macronyx	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.1	0.9	0.0	16.7		0.0	0.1	0.2	0.0	0.0		0.0	0.0	0.0	0.0
Eusirus antarcticus	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	16.7		0.0	0.2	0.4	0.0	0.0		0.0	0.0	0.0	0.0
Acanthophyra pelagica (L)	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	16.7		0.0	0.1	0.2	0.0	5.6		0.0	0.0	0.1	0.0
Chionodraco rastrospinosus (L)	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	16.7		0.0	0.1	0.2	0.0	5.6		0.0	0.0	0.2	0.0
Trematomus scotti (L)	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	16.7		0.0	0.1	0.2	0.0	5.6		0.0	0.0	0.1	0.0
Racovitzia glacialis	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	16.7		0.0	0.1	0.2	0.0	0.0		0.0	0.0	0.0	0.0
Eggs (unid.)	0.0		0.0	0.0	0.0	0.0	18.8		0.2	5.9	25.5	0.0	0.0		0.0	0.0	0.0	0.0	33.3		0.1	1.7	3.2	0.0
Euphausia triacantha	0.0		0.0	0.0	0.0	0.0	16.7		0.0	1.0	3.3	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Euphausia frigida (L)	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.4	2.8	0.0	0.0		0.0	0.0	0.0	0.0	5.6		0.0	0.0	0.0	0.0
Pegantha martgon	0.0		0.0	0.0	0.0	0.0	12.5		0.0	0.4	1.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Limacina spp.	0.0		0.0	0.0	0.0	0.0	4.2		0.0	0.3	1.6	0.0	0.0		0.0	0.0	0.0	0.0	33.3		0.1	2.6	5.4	0.0
Isopods (unid.)	0.0		0.0	0.0	0.0	0.0	4.2		0.0	0.2	1.2	0.0	0.0		0.0	0.0	0.0	0.0	22.2		0.1	2.9	10.6	0.0
Champsocephalus gunnari (L)	0.0		0.0	0.0	0.0	0.0	4.2		0.0	0.2	1.3	0.0	0.0		0.0	0.0	0.0	0.0	38.9		0.0	1.1	2.2	0.0
Pleurobrachia pileus	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.1	0.5	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Notolepis spp. (L)	0.0		0.0	0.0	0.0	0.0	6.3		0.0	0.1	0.3	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Clio pyramidata spp?	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.2	0.0	0.0		0.0	0.0	0.0	0.0	5.6		0.0	0.0	0.1	0.0
Hyperiella spp.	0.0		0.0	0.0	0.0	0.0	4.2		0.0	0.0	0.2	0.0	0.0		0.0	0.0	0.0	0.0	16.7		0.0	0.2	0.5	0.0
Notolepis annulata (L)	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Hyperia antarctica	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Schyphomedusae (unid.)	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Electrona carlsbergi	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Adult Myctophids (unid.)	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Cephalopods	0.0		0.0	0.0	0.0	0.0	2.1		0.0	0.0	0.1	0.0	0.0		0.0	0.0	0.0	0.0	5.6		0.0	0.0	0.1	0.0
Nototheniops nudifrons (L)	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	5.6		0.0	0.0	0.1	0.0
Pasiaphaea spp. (L)	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	5.6		0.0	0.0	0.1	0.0
Hyperiella macronyx	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	11.1		0.0	0.0	0.1	0.0
Gastropods (unid.)	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	5.6		0.0	0.2	0.7	0.0
Clio pyramidata antarctica?	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	5.6		0.0	0.0	0.0	0.0
Clione antarctica	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	5.6		0.0	0.0	0.1	0.0
TOTAL				2378.3	1643.2	1617.4				2736.8	2409.0	1506.2				4861.9	5203.4	1860.8				2902.1	3372.3	1256.1
TAXA	53			14.0	3.9	14.0	71			16.9	4.1	16.0	39			16.0	3.2	17.0	59			17.8	3.6	19.0

Table 4.6. Taxonomic composition of zooplankton clusters during (A) January and (B) February-March, 2005.
R and % are rank and proportions of total abundance represented by each taxon.

A. SURVEY A

JANUARY 2005	CLUSTER 1 (COASTAL) N = 19					CLUSTER 2 (INTERMEDIATE) N = 35					CLUSTER 3 (OFFSHORE) N = 45				
TAXON	R	%	MEAN	STD	MED	R	%	MEAN	STD	MED	R	%	MEAN	STD	MED
Salpa thompsoni	5	3.5	56.5	135.5	7.5	2	33.0	684.6	1342.4	189.4	1	79.6	1706.2	1785.6	1071.1
Copepods	1	57.3	922.4	1228.7	396.4	1	40.3	836.0	1152.6	288.9	2	7.4	159.1	239.5	64.0
Thysanoessa macrura	2	15.6	251.7	322.6	119.4	3	18.9	392.9	283.1	325.4	3	4.6	99.5	156.3	39.3
Thysanoessa macrura (L)	3	6.1	98.1	108.2	58.6		0.1	2.0	4.4	0.0	4	2.4	51.7	154.9	0.0
Themisto gaudichaudii		0.0	0.6	1.2	0.0		0.6	12.8	16.0	6.7	5	1.2	26.7	27.3	16.1
Cyllopus magellanicus		0.0	0.3	0.9	0.0		0.3	6.3	10.5	2.8	6	1.2	25.0	29.3	14.6
Euphausia superba		1.2	19.0	39.4	2.0	6	1.0	20.8	36.2	5.1		0.9	19.2	27.6	4.1
Chaetognaths		1.8	29.4	22.7	32.5	5	1.4	29.6	52.3	11.8		0.6	13.5	22.1	3.1
Euphausia frigida		0.9	14.3	21.7	2.1	4	1.7	34.6	74.7	7.1		0.5	10.5	48.2	0.0
Euphausia superba (L)	6	3.0	48.9	84.7	20.2		0.8	16.1	86.8	0.0		0.4	7.7	20.3	0.0
Vibilia antarctica		0.0	0.3	0.5	0.0		0.1	2.4	2.7	1.4		0.3	5.8	7.5	3.3
Primno macropa		0.2	3.1	3.1	2.1		0.1	3.1	6.2	0.0		0.2	4.2	4.4	3.1
Ostracods		1.1	18.2	66.4	0.0		0.6	11.5	20.5	2.4		0.1	2.9	10.3	0.0
Radiolaria		0.3	4.7	7.6	0.4		0.0	0.6	2.1	0.0		0.1	2.2	10.5	0.0
Siphonophora		0.3	4.6	6.2	2.6		0.5	9.9	17.6	0.5		0.1	2.0	10.6	0.0
Tomopteris spp.		0.1	1.6	2.0	0.8		0.0	0.3	0.7	0.0		0.1	1.5	3.5	0.0
Clio pyramidata antarctica?		0.0	0.0	0.0	0.0		0.1	1.5	3.8	0.0		0.1	1.2	5.3	0.0
Spongiobranchaea australis		0.1	0.9	1.2	0.5		0.1	2.2	3.2	1.3		0.1	1.2	3.5	0.0
Hyperiella dilatata		0.1	1.0	1.1	0.4		0.0	0.3	0.5	0.0		0.0	0.9	2.3	0.0
Clione limacina		0.1	2.2	1.8	1.7		0.0	0.7	0.9	0.4		0.0	0.6	2.5	0.0
Cyllopus lucasi		0.0	0.4	0.8	0.0		0.0	0.4	1.2	0.0		0.0	0.6	1.3	0.0
Limacina helicina		1.8	29.1	34.4	8.8		0.0	1.0	2.1	0.0		0.0	0.2	0.8	0.0
Ihlea racovitzai		0.5	7.4	11.1	1.3		0.1	2.5	5.4	0.0		0.0	0.2	1.0	0.0
Sipunculids	4	4.9	78.8	76.3	58.4		0.1	3.1	9.4	0.0		0.0	0.0	0.1	0.0
Larvaceans		1.0	16.7	21.7	7.2		0.0	0.6	1.7	0.0		0.0	0.0	0.0	0.0
TOTAL			1610.3	1526.9	1108.2			2075.8	2246.5	1087.9			2142.7	1910.0	1709.9

B. SURVEY D

FEBRUARY-MARCH 2005	CLUSTER 1 (COASTAL) N=16					CLUSTER 2 (INTERMEDIATE) N = 53					CLUSTER 3 (OFFSHORE) N = 28				
TAXON	R	%	MEAN	STD	MED	R	%	MEAN	STD	MED	R	%	MEAN	STD	MED
Salpa thompsoni		0.4	4.0	5.6	1.0	2	20.9	838.6	971.9	357.2	1	63.7	890.5	1010.3	642.8
Thysanoessa macrura	2	29.4	302.8	229.2	237.5	3	16.3	654.0	594.4	521.4	2	16.3	228.7	209.4	183.3
Copepods	1	55.2	569.0	475.5	339.0	1	49.1	1969.1	2130.6	1296.6	3	11.7	163.1	134.4	107.7
Themisto gaudichaudii		0.2	2.1	1.7	1.7		0.4	16.6	21.3	7.9	4	3.3	45.6	40.8	30.2
Cyllopus magellanicus		0.0	0.4	0.6	0.0		0.3	11.4	10.3	9.1	5	1.9	27.2	40.8	17.4
Chaetognaths	3	4.7	48.8	53.6	18.7	6	1.6	62.9	84.7	31.3	6	0.5	7.1	8.7	3.3
Vibelia antarctica		0.0	0.1	0.2	0.0		0.1	3.2	4.6	1.5		0.4	5.9	9.6	2.5
Euphausia superba	5	2.3	23.8	84.4	0.8	5	1.8	73.6	228.8	3.7		0.4	5.2	8.1	0.9
Primno macropa		0.1	0.8	2.1	0.0		0.0	0.9	2.8	0.0		0.3	3.6	4.8	1.6
Cyllopus lucasi		0.0	0.0	0.1	0.0		0.0	0.8	1.9	0.0		0.1	1.8	2.7	0.4
Thysanoessa macrura (L)	4	2.3	24.2	21.0	16.1		0.2	8.2	32.3	0.0		0.1	1.7	6.5	0.0
Radiolaria		0.1	0.6	1.1	0.0		0.0	0.8	2.5	0.0		0.1	1.4	2.1	0.0
Sihponophores		0.4	4.3	9.2	0.0		0.1	3.2	5.9	0.0		0.1	1.1	2.6	0.0
Euphausia superba (L)		0.6	6.3	10.9	1.2	4	6.4	258.0	996.5	7.6		0.1	0.9	1.7	0.0
Spongiobranchia australis		0.1	0.6	0.9	0.5		0.0	1.6	3.7	0.0		0.0	0.6	1.1	0.0
Euphausia frigida		0.3	3.0	5.8	0.2		1.5	61.0	58.2	40.7		0.0	0.4	0.9	0.0
Hyperia dilitata		0.0	0.4	0.8	0.0		0.0	0.7	2.1	0.0		0.0	0.3	0.8	0.0
Ostracods		0.4	4.2	11.0	0.0		0.3	12.0	19.3	3.3		0.0	0.3	0.7	0.0
Sipunculids	6	1.6	16.0	13.6	15.6		0.1	2.7	11.0	0.0		0.0	0.2	0.6	0.0
Clione limacina		0.0	0.2	0.4	0.0		0.0	0.1	0.4	0.0		0.0	0.1	0.2	0.0
Tomopteris spp.		0.1	0.9	1.4	0.0		0.0	0.7	2.6	0.0		0.0	0.0	0.2	0.0
Larvaceans		0.2	2.4	4.6	0.0		0.0	1.0	2.7	0.0		0.0	0.0	0.1	0.0
Ihlea racovitzai		0.0	0.3	0.7	0.0		0.1	2.1	8.0	0.0		0.0	0.0	0.0	0.0
Leptonotothen kempi (L)		0.0	0.2	0.3	0.0		0.0	0.3	0.7	0.0		0.0	0.0	0.0	0.0
TOTAL			1030.9	411.0	948.8			4011.5	2915.3	3452.2			1399.0	1095.7	1170.7

Table 4.7. Abundance of krill and other dominant zooplankton taxa collected in the Elephant Island Area during January-February and February-March surveys, 1992-2004. Zooplankton data are not available for February-March 1992 or January 2000.

	Euphausia superba													
	January-February													
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
N	63	70	63	71	72	71	61	40	n.a.	60	44	38	46	48
Mean	23.7	28.8	34.5	9.5	82.1	29.6	27.1	5.3	---	18.9	39.0	318.8	59.8	27.1
SD	78.0	64.4	94.2	20.6	245.1	80.5	42.3	8.1	---	32.7	93.3	1386.0	170.5	33.0
Med	5.7	8.2	3.1	3.6	11.4	5.6	10.2	1.7	---	6.0	7.5	30.9	3.1	15.3
Max	594.1	438.9	495.9	146.1	1500.6	483.2	175.0	35.1	---	217.7	458.6	8683.2	852.2	127.6
	February-March													
N	67	67	70	71	72	16	61	39	60	57	44	48	47	48
Mean	38.0	35.0	17.1	5.2	133.2	30.4	162.6	35.5	14.4	80.5	10.1	94.9	50.9	48.1
SD	77.4	89.7	63.5	12.0	867.7	56.4	768.3	155.7	35.3	374.0	25.4	240.2	91.0	179.9
Med	7.1	3.0	0.4	1.2	4.1	4.6	4.5	0.8	3.3	4.6	0.4	8.7	10.4	2.9
Max	389.9	542.0	371.1	90.0	7385.4	204.2	5667.0	978.6	253.5	2817.0	112.1	1309.1	425.2	1112.2

	Salpa thompsoni													
	January-February													
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
N	63	70	63	71	72	71	61	40	n.a.	60	44	38	46	48
Mean	94.3	1213.4	931.9	20.2	25.5	223.2	939.7	197.5	---	622.8	410.0	61.9	176.6	1208.7
SD	192.3	2536.7	950.2	46.5	36.3	336.4	1556.3	191.6	---	576.4	614.6	132.7	166.7	1274.7
Med	14.0	245.8	582.3	1.6	10.5	87.1	348.9	159.1	---	449.3	85.8	8.7	134.1	670.8
Max	1231.1	16078.8	4781.7	239.9	161.6	2006.3	8030.4	873.4	---	3512.4	2816.8	709.2	754.8	5022.5
	February-March													
N	n.a.	67	70	71	72	16	61	39	60	57	44	48	47	48
Mean	---	1585.9	495.1	20.6	33.2	1245.5	977.3	309.1	912.8	452.4	570.4	60.7	159.1	861.0
SD	---	2725.5	579.4	66.5	85.7	1224.6	1496.5	376	3395.1	501.2	782.3	119.7	252.2	1109.7
Med	---	605.9	242.6	0.7	5.6	521.0	553.8	160.7	262.9	312.1	250.9	7.0	45.5	493.1
Max	---	16662.5	2377.5	391.9	659.4	4348.3	10712.9	1550.2	24031.9	2416.8	2903.7	475.4	1216.3	5399.9

	Thysanoessa macrura													
	January-February													
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
N	63	70	63	71	72	71	61	40	n.a.	60	44	38	46	48
Mean	48.1	48.6	74.6	104.1	103.4	101.0	135.3	46.6	---	46.2	200.9	239.0	108.2	171.4
SD	57.0	60.1	144.3	231.9	118.1	127.2	150.8	54.1	---	49.2	784.8	405.3	161.5	247.1
Med	22.5	27.5	25.4	36.1	52.3	52.8	98.0	23.2	---	32.2	33.1	103.9	55.4	109.6
Max	233.7	307.1	901.6	1859.0	500.1	616.2	992.3	215.8	---	251.7	5302.0	2134.8	971.4	1490.8
	February-March													
N	n.a.	67	70	71	72	16	61	39	60	57	44	48	47	48
Mean	---	128.9	77.1	79.7	116.1	181.3	140.6	95.2	35.1	1040.9	56.4	232.6	138.9	441.1
SD	---	235.1	132.6	138.5	147.4	168.0	232.3	131.9	61.5	7262.6	132.5	271.3	205.7	511.4
Med	---	22.1	23.8	22.2	53.6	122.6	70.0	18.0	14.0	44.1	3.5	156.0	59.8	275.0
Max	---	1141.5	815.9	664.9	679.4	538.9	1638.5	589.2	291.6	55381.1	662.7	1441.5	963.6	2520.0

Table 4.7 (Contd.)

	Copepods													
	January-February													
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
N	n.a.	70	63	71	72	71	61	40	n.a.	60	44	38	46	48
Mean	---	73.5	32.4	741.0	897.5	656.4	41.2	928.2	---	1003.2	5484.3	541.0	494.5	364.6
SD	---	302.7	92.2	1061.3	1726.4	799.1	55.1	1590.8	---	1582.4	14585.6	798.6	796.1	687.3
Med	---	0.0	0.0	346.0	338.2	399.7	21.5	333.0	---	252.2	2174.9	317.0	208.7	126.4
Max	---	2312.6	465.3	7047.5	10598.0	4090.0	276.0	7524.8	---	6909.7	96514.5	4390.2	3554.4	3502.6
	February-March													
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Mean	---	---	3453.3	3707.3	1483.7	1267.8	110.4	1558.4	8019.1	4501.5	17473.4	1674.3	6303.1	1022.1
SD	---	---	8190.8	5750.3	2209.2	1755.6	170.3	2337.5	11824.4	8072.4	20036.9	2593.6	17739.5	1254.5
Med	---	---	172.4	1630.9	970.2	659.8	50.9	621.6	3478.0	1518.0	7563.8	737.5	2233.5	344.3
Max	---	---	37987.2	40998.5	16621.0	7289.2	901.1	10786.6	57498.5	39800.7	90224.5	15990.9	120411.5	5508.1

	Euphausia superba Larvae													
	January-February													
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
N	n.a.	n.a.	n.a.	71	72	71	61	40	n.a.	60	44	38	46	48
Mean	---	---	---	172.1	3.4	19.3	0.4	175.1	---	32.8	35.8	4.7	9.8	22.0
SD	---	---	---	969.4	8.3	27.0	1.6	795.5	---	86.2	64.6	16.8	18.5	78.3
Med	---	---	---	0.0	0.0	6.4	0.0	4.3	---	9.0	0.0	0.0	0.4	1.1
Max	---	---	---	8076.1	42.7	96.5	11.4	5083.2	---	654.0	356.3	95.5	95.7	521.8
	February-March													
N	n.a.	n.a.	n.a.	71	72	16	61	39	60	57	44	48	47	48
Mean	---	---	---	4593.4	14.1	25.0	2.5	67.2	3423.2	71.9	49.9	6.1	177.3	194.8
SD	---	---	---	20117.0	44.0	81.4	18.3	146.0	8974.1	176.9	140.9	13.0	741.5	969.1
Med	---	---	---	268.6	3.3	0.0	0.0	12.3	248.7	5.1	0.0	0.0	38.9	4.6
Max	---	---	---	167575.6	368.5	339.0	144.1	692.5	44478.2	1197.7	728.6	56.1	5160.5	6755.5

	Euphausia frigida													
	January-February													
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
N	63	70	63	71	72	71	61	40	n.a.	60	44	38	46	48
Mean	5.4	4.2	4.7	12.1	2.0	9.6	0.3	15.9	---	23.4	28.0	10.6	19.2	28.5
SD	14.9	18.4	14.9	32.1	4.5	21.4	1.4	29.1	---	55.9	56.1	27.3	44.5	73.7
Med	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	---	0.0	0.4	0.0	0.0	0.0
Max	76.7	143.0	76.7	175.6	22.5	91.4	10.0	116.0	---	315.6	256.1	135.2	223.7	385.2
	February-March													
N	n.a.	67	70	71	72	16	61	39	60	57	44	48	47	48
Mean	---	1.0	28.9	19.7	9.5	44.8	9.0	23.0	43.1	37.7	78.4	50.9	26.8	34.9
SD	---	4.7	62.0	36.7	12.7	54.2	26.0	38.7	73.0	82.0	192.3	92.0	45.8	50.6
Med	---	0.0	5.5	2.9	1.2	21.0	0.0	7.6	6.8	0.0	5.1	11.5	0.6	6.7
Max	---	32.6	439.7	216.1	48.8	176.2	178.4	159.1	307.2	319.2	1149.9	478.7	162.7	223.2

Table. 4.7 (Contd.)

	Thysanoessa macrura larvae													
	January-February													
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
N	n.a.	n.a.	n.a.	71	72	71	61	40	n.a.	60	44	38	46	48
Mean	---	---	---	20.2	372.0	21.5	0.0	116.5	---	269.3	773.3	1.2	6.7	43.0
SD	---	---	---	75.2	858.1	38.4	0.0	348.8	---	608.8	1379.1	2.7	11.0	139.9
Med	---	---	---	0.0	32.1	1.5	0.0	2.8	---	42.7	181.7	0.0	2.1	0.5
Max	---	---	---	441.5	4961.8	159.9	0.0	1519.6	---	3621.0	8984.2	14.5	45.3	836.0
	February-March													
N	n.a.	n.a.	70	71	72	16	61	39	60	57	44	48	47	48
Mean	---	---	31.7	344.3	511.5	10.8	0.5	185.9	1084.8	613.3	1444.9	1.3	386.8	1.2
SD	---	---	111.1	594.2	1432.5	24.9	2.0	535.7	4147.3	1009.5	2665.1	3.0	989.5	2.7
Med	---	---	0.0	79.9	36.1	1.0	0.0	10.0	26.8	265.3	364.0	0.0	0.0	0.0
Max	---	---	809.1	3735.5	10875.0	104.7	12.1	2990.8	31132.5	5461.9	12270.6	18.1	4637.7	12.9

	Chaetognaths													
	January-February													
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
N	n.a.	70	63	71	72	71	61	40	n.a.	60	44	38	46	48
Mean	---	3.1	0.2	84.7	11.9	20.1	3.3	63.9	---	57.4	139.8	119.3	35.3	15.8
SD	---	7.9	0.5	159.5	25.1	26.1	5.2	159.1	---	110.9	221.1	33.6	78.5	37.3
Med	---	0.0	0.0	30.0	4.2	10.3	0.9	14.7	---	11.3	76.6	5.3	9.3	2.9
Max	---	41.3	2.2	781.8	184.9	120.4	24.7	960.2	---	660.7	1283.4	130.2	385.3	236.5
	February-March													
N	n.a.	67	70	71	72	16	61	39	60	57	44	48	47	48
Mean	---	0.7	21.8	330.2	58.4	18.4	8.9	147.4	792.3	93.5	1073.1	103.2	446.8	47.9
SD	---	4.2	87.7	404.6	72.3	23.9	23.3	261.4	1543.7	173.4	1210.4	130.6	1114.1	66.1
Med	---	0.0	0.0	161.0	31.8	5.5	1.0	48.7	229.4	10.5	435.6	56.3	127.3	16.4
Max	---	34.9	578.9	1769.9	383.8	77.9	124.7	1146.6	8221.0	836.9	5052.6	579.9	7568.7	262.9

Table 4.8. Maturity stage composition of krill collected in the Elephant Island Area during 2005 compared to 1992-2004. Advanced maturity stages are proportions of mature females that are (A) 3c-3e in January-February and (B) 3d-3e in Febr
Data are not available for January-February, 2000.

A. SURVEY A	*Euphausia superba* JANUARY-FEBRUARY													
Stage	1992 %	1993 %	1994 %	1995 %	1996 %	1997 %	1998 %	1999 %	2000 n.a.	2001 %	2002 %	2003 %	2004 %	2005 %
Juveniles	37.1	7.2	4.0	4.6	55.0	15.2	18.4	0.4	---	9.7	46.3	42.4	1.8	2.6
Immature	19.1	30.7	18.8	4.0	18.3	30.6	31.7	11.7	---	6.2	9.0	39.1	38.5	8.7
Mature	43.9	62.2	77.2	91.4	26.7	54.2	49.9	87.9	---	84.1	44.7	18.5	59.7	88.7
Females:														
F2	0.8	7.8	2.3	0.1	1.1	6.3	9.1	1.6	---	0.2	0.4	12.3	4.3	0.9
F3a	0.6	11.7	18.0	0.2	0.0	3.5	21.4	1.7	---	0.9	0.5	11.7	18.1	2.0
F3b	12.3	14.3	19.3	1.2	0.2	0.6	9.0	1.8	---	14.6	2.3	1.3	7.5	5.2
F3c	9.2	5.1	20.1	15.3	1.9	6.9	1.0	14.7	---	13.2	13.7	1.6	11.2	11.8
F3d	0.4	1.2	2.3	17.7	0.7	6.1	0.3	23.9	---	7.4	10.0	0.0	0.1	15.8
F3e	0.0	0.0	0.0	3.7	11.6	7.4	0.7	9.2	---	1.3	6.2	0.0	0.6	3.5
Advanced Stages	42.7	19.5	37.5	96.3	98.3	83.2	6.2	93.2	---	58.5	91.6	11.2	11.8	81.2
Males:														
M2a	8.7	6.8	0.3	0.9	14.6	14.6	8.5	2.2	---	2.1	3.0	13.6	7.4	2.5
M2b	7.3	11.9	9.4	1.5	2.1	8.2	8.4	3.9	---	2.1	4.0	10.2	14.7	2.4
M2c	2.3	4.2	6.8	1.5	0.5	1.5	5.7	4.1	---	1.7	1.5	3.1	12.2	2.9
M3a	2.8	3.7	4.3	4.4	1.4	1.5	3.1	1.7	---	2.1	1.7	1.1	11.5	2.1
M3b	18.7	26.2	13.2	48.9	10.9	28.1	14.4	34.9	---	44.6	10.4	2.9	10.8	18.3
Male:Female ratio	1.7	1.3	0.5	1.5	1.9	1.8	1.0	0.9	---	1.4	0.6	1.2	1.4	1.5
No. measured	2472	4283	2078	2294	4296	3209	3600	751	---	2063	1437	2466	1410	2189

B. SURVEY D	FEBRUARY-MARCH													
Stage	1992 %	1993 %	1994 %	1995 %	1996 %	1997 %	1998 %	1999 %	2000 %	2001 %	2002 %	2003 %	2004 %	2005 %
Juveniles	33.6	3.5	3.7	1.1	20.8	8.0	3.6	0.0	0.1	13.4	38.9	20.6	0.1	0.8
Immature	27.1	51.4	6.2	2.5	9.9	19.7	25.4	1.3	2.3	14.7	17.3	52.4	16.3	9.7
Mature	39.2	45.1	90.1	96.4	69.3	72.3	71.0	98.7	97.5	71.9	43.8	27.0	83.6	89.5
Females:														
F2	0.8	21.8	0.7	0.3	0.6	1.1	6.9	0.0	0.2	0.7	3.3	21.4	2.9	0.8
F3a	10.3	12.4	3.5	0.0	0.0	0.1	10.9	0.4	1.0	2.4	0.9	13.4	3.7	16.2
F3b	10.2	6.2	7.8	0.0	0.0	0.0	11.8	0.0	0.7	0.2	0.2	2.5	0.3	9.3
F3c	4.3	3.7	4.3	2.0	5.0	1.8	3.0	11.1	6.5	1.5	2.2	2.3	2.2	12.1
F3d	1.2	1.1	4.6	21.8	10.9	29.1	1.3	47.3	21.9	3.8	14.7	0.3	17.0	3.6
F3e	<0.01	1.2	0.9	20.4	4.9	7.3	0.1	4.8	22.0	42.6	3.6	0.6	13.0	0.0
Advanced Stages	4.6	9.3	26.1	95.5	76.0	95.0	5.2	81.8	84.2	91.8	85.2	4.7	82.9	8.7
Males:														
M2a	4.3	6.9	0.2	0.7	6.5	8.6	1.9	0.0	0.1	4.1	8.8	12.0	2.4	1.5
M2b	19.8	19.1	1.2	0.4	1.2	8.8	6.6	0.7	0.7	2.7	3.6	14.9	7.3	0.8
M2c	2.2	3.6	4.2	1.1	1.6	1.2	10.0	0.6	1.3	7.3	1.6	4.2	3.7	6.6
M3a	2.5	2.1	24.1	4.4	5.3	3.7	17.5	2.6	7.4	2.2	0.3	2.0	4.8	13.2
M3b	10.7	18.4	44.7	47.8	43.2	30.3	26.2	32.4	38.0	19.2	22.1	5.8	42.7	35.0
Male:Female ratio	1.5	1.1	3.4	1.2	2.7	1.3	1.9	0.6	0.9	0.7	1.5	0.9	1.6	1.4
No. measured	3646	3669	1155	1271	2984	560	3153	1176	1371	1739	558	1936	2081	1018

Table 4.9. Salp and krill carbon biomass (mg C per m^2) in the Elephant Island area during 1995-2005 surveys. N is number of samples. Salp:Krill ratio is based on median values.

Survey A	January-February																					
	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
Biomass	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill
Mean	7.8	242.3	20.2	337.3	334.5	229.0	430.8	173.1	151.8	48.6	---	---	334.5	248.5	287.4	218.6	35.9	1426.0	120.5	472.7	707.6	295.2
SD	16.1	201.1	30.9	756.1	1115.6	522.1	565.3	290.6	166.1	66.1	---	---	272.8	425.3	418.3	552.0	69.8	6818.3	135.8	1403.2	770.3	371.9
Median	1.3	43.5	10.0	72.2	108.9	45.1	187.0	46.7	93.2	14.5	---	---	251.7	81.0	127.0	37.6	4.5	137.7	84.9	28.2	411.7	169.9
Maximum	75.3	1545.2	134.2	4721.0	9434.6	3115.5	2699.0	1488.4	882.7	304.4	---	---	1395.1	2561.2	1855.4	3509.2	388.6	42745.4	628.0	7254.5	3121.1	1680.6
N	57	71	72	72	71	71	61	60	40	40	---	---	60	60	44	44	38	38	46	46	48	48
Salp:Krill Ratio	0.03		0.1		2.4		4.0		6.4		n.a.		3.1		3.4		0.03		3.0		2.4	

Survey D	February-March																					
	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
Biomass	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill	Salps	Krill
Mean	13.1	59.2	50.7	1702.3	1139.7	313.1	694.6	1555.8	321.9	451.0	741.2	204.4	333.9	890.3	738.4	62.3	62.0	451.9	123.7	559.1	674.3	510.3
SD	47.3	149.1	146.5	12441.6	1269.8	655.2	1121.2	8218.7	335.1	2082.6	2314.9	507.6	352.4	4116.8	2129.0	179.5	122.9	1082.7	219.1	1037.1	831.0	1957.6
Median	0.7	13.1	4.6	40.7	504.8	50.0	379.4	31.6	193.5	6.9	239.0	42.8	216.3	45.9	327.1	2.7	6.2	27.4	42.5	82.9	466.0	24.2
Maximum	325.2	1107.1	954.0	106458.5	4645.4	2638.7	8543.0	62155.8	1698.1	13133.1	16400.1	3634.6	1702.8	30967.9	14362.1	1062.6	550.4	5165.6	1201.3	5221.1	5458.6	12312.4
N	71	71	72	72	16	16	61	60	39	39	60	60	57	57	44	44	48	48	47	47	48	48
Salp:Krill Ratio	0.1		0.1		10.1		12.0		28.0		5.6		4.7		121.1		0.2		0.5		19.3	

Table 4.10. Zooplankton and nekton taxa present in the large survey area samples during (A) January 2005 and (B) February-March 2005 compared to 1995-2004 surveys. F is the frequency of occurrence (%) in (N) tows. Mean is number per 1000 m^3. Dashes indicate that taxa were not yet identified and/or enumerated. (L) and (J) denote larval and juvenile stages.

A. SURVEY A	JANUARY-FEBRUARY																					
	2005		2004		2003		2002		2001		2000		1999		1998		1997		1996		1995	
	N=99		N=91		N=83		N=95		N=101		n.a.		N=75		N=105		N=105		N=91		N=90	
TAXON	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean			F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean
Salpa thompsoni	98.0	1028.4	93.4	179.1	81.9	63.0	88.4	267.7	100.0	520.7	-----	-----	100.0	163.3	100.0	808.2	97.1	181.4	64.8	20.4	66.7	16.0
Copepods	100.0	544.9	98.9	479.9	100.0	609.2	100.0	7536.2	100.0	2247.1	-----	-----	100.0	711.6	94.2	56.5	100.0	582.6	100.0	794.4	98.9	652.7
Thysanoessa macrura	94.9	232.5	95.6	156.4	100.0	243.5	92.6	222.6	93.1	73.5	-----	-----	93.3	135.1	100.0	180.8	97.1	104.4	98.9	106.9	91.1	96.4
Thysanoessa macrura (L)	51.5	43.0	57.1	13.3	21.7	1.0	90.5	1428.1	85.1	458.0	-----	-----	69.3	72.5	1.9	0.0	44.8	17.0	90.1	308.5	36.7	15.9
Chaetognaths	80.8	22.2	84.6	36.1	94.0	31.3	81.1	170.9	84.2	174.2	-----	-----	49.3	47.8	42.3	8.9	74.3	22.9	68.1	12.5	98.9	79.7
Euphausia frigida	45.5	19.8	36.3	16.1	39.8	10.9	42.1	20.5	45.5	28.8	-----	-----	32.0	9.0	5.8	0.2	41.9	14.8	30.8	1.9	50.0	9.8
Euphausia superba	79.8	19.7	83.5	44.7	92.8	193.0	74.7	65.5	89.1	27.7	-----	-----	60.0	6.1	92.3	36.8	93.3	40.4	96.7	112.5	87.8	14.5
Euphausia superba (L)	51.5	18.6	50.5	7.0	32.5	3.4	28.4	19.4	68.3	160.2	-----	-----	65.3	103.1	11.5	1.0	55.2	15.2	22.0	2.7	22.2	135.8
Themisto gaudichaudii	87.9	16.8	72.5	2.9	74.7	7.8	86.3	32.5	66.3	4.0	-----	-----	32.0	0.3	31.7	0.3	92.4	3.6	92.3	4.9	76.7	4.9
Sipunculids	33.3	16.2	19.8	0.3	26.5	0.2	3.2	0.0	3.0	0.0	-----	-----	10.7	0.0	11.5	0.1	10.5	0.1	7.7	0.0	24.4	0.1
Cyllopus magellanicus	79.8	13.7	35.2	0.4	37.3	0.5	44.2	3.3	30.7	0.5	-----	-----	78.7	2.0	64.4	1.9	76.2	3.8	41.8	1.6	24.4	0.2
Ostracods	42.4	8.9	63.7	14.6	45.8	6.8	28.4	111.0	37.6	6.7	-----	-----	49.3	2.8	51.0	4.8	41.0	5.5	53.8	4.9	56.7	9.7
Limacina helicina	36.4	6.0	83.5	22.1	68.7	31.9	12.6	0.8	51.5	4.9	-----	-----	61.3	2.4	73.1	8.1	47.6	2.9	74.7	33.7	43.3	1.9
Euphausia spp. (L)	23.2	6.0	0.0	0.0	0.0	0.0	11.6	93.5	0.0	0.0	-----	-----	10.7	11.1	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----
Siphonophora	41.4	5.3	4.4	0.1	3.6	0.1	2.1	0.0	3.0	0.3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Primno macropa	62.6	3.6	67.0	5.4	85.5	5.2	52.6	6.3	7.9	0.1	-----	-----	69.3	2.5	26.0	0.7	63.8	4.3	20.9	0.1	20.0	0.1
Vibilia antarctica	74.7	3.6	54.9	0.7	74.7	2.3	66.3	3.9	98.0	16.3	-----	-----	94.7	3.8	96.2	13.2	70.5	2.5	48.4	0.5	22.2	0.2
Larvacean	20.2	3.4	3.3	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Limacina spp.	14.1	3.1	2.2	0.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Euphausia triacantha	11.1	2.6	15.4	0.7	10.8	0.7	7.4	0.8	13.9	1.6	-----	-----	17.3	0.4	7.7	0.3	18.1	1.4	15.4	0.5	33.3	1.5
Ihlea racovitzai	22.2	2.4	42.9	37.0	13.3	0.2	12.6	1.1	12.9	1.1	-----	-----	25.3	3.3	5.8	41.5	n.a	n.a	n.a	n.a	n.a	n.a
Radiolaria	32.3	2.1	65.9	3.6	47.0	2.2	42.1	1030.2	19.8	46.1	-----	-----	40.0	8.9	27.9	0.7	41.0	1.8	12.1	0.1	-----	-----
Euphausia frigida (L)	7.1	1.7	2.2	0.2	8.4	0.4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Spongiobranchaea australis	51.5	1.5	79.1	2.5	57.8	1.4	69.5	1.9	68.3	2.1	-----	-----	69.3	1.4	45.2	0.9	67.6	2.2	47.3	1.8	64.4	0.5
Polychaetes	22.2	1.4	8.8	0.1	0.0	0.0	15.8	6.7	7.9	0.7	-----	-----	20.0	0.6	28.8	1.5	1.0	0.0	1.1	0.0	-----	-----
Tomopteris spp.	43.4	1.1	53.8	1.4	74.7	3.4	46.3	3.0	45.5	1.9	-----	-----	56.0	2.0	31.7	1.3	54.3	1.9	60.4	0.9	84.4	4.2
Clio pyramidata antarctica	24.2	1.1	11.0	0.1	15.7	1.7	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Clione limacina	47.5	1.0	33.0	0.6	54.2	2.9	40.0	2.3	26.7	0.9	-----	-----	17.3	0.1	38.5	0.9	21.9	0.3	56.0	2.1	41.1	0.5
Cyllopus spp.	18.2	0.8	0.0	0.0	10.8	0.2	3.2	0.0	2.0	0.0	-----	-----	28.0	0.4	1.0	0.0	1.0	0.0	-----	-----	-----	-----
Hyperiella dilatata	36.4	0.7	47.3	0.4	65.1	0.8	53.7	1.3	24.8	0.4	-----	-----	52.0	0.5	39.4	0.4	56.2	2.2	41.8	0.6	54.4	0.3
Cyllopus lucasii	27.3	0.5	78.0	3.0	31.3	0.5	34.7	1.4	87.1	22.4	-----	-----	6.7	0.0	20.2	0.5	49.5	0.4	11.0	0.1	22.2	0.5
Euphausia crystallorophias (L)	1.0	0.5	3.3	0.0	4.8	0.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Euphausia crystallorophias	15.2	0.5	11.0	0.3	30.1	29.7	12.6	16.5	1.0	0.0	-----	-----	9.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0
Pasiphaea sp. (L)	10.1	0.3	1.1	0.0	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Lepidonotothen larseni (L)	19.2	0.3	36.3	0.9	48.2	1.5	18.9	3.8	10.9	0.7	-----	-----	20.0	0.2	23.1	0.5	27.6	1.8	22.0	0.2	40.0	1.1
Hyperiids	11.1	0.2	1.1	0.0	6.0	0.1	4.2	0.5	12.9	0.7	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Diphyes antarctica	19.2	0.2	23.1	0.3	33.7	0.5	15.8	0.4	23.8	0.5	-----	-----	34.7	0.5	37.5	1.1	9.5	0.2	17.6	0.1	58.9	1.0
Spongiobranchaea sp.	10.1	0.2	2.2	0.0	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Gastropods	8.1	0.2	0.0	0.0	3.6	0.1	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Larval Fish	12.1	0.2	0.0	0.0	12.0	0.4	8.4	3.3	18.8	0.6	-----	-----	9.3	0.1	8.7	0.1	0.0	0.0	1.1	0.0	0.0	0.0
Lepidonotothen kempi (L)	9.1	0.2	11.0	0.3	15.7	0.2	8.4	0.3	7.9	0.4	-----	-----	6.7	0.0	13.5	0.3	32.4	0.6	30.8	0.3	20.0	0.1
Dimophyes arctica	7.1	0.2	9.9	0.2	16.9	0.1	13.7	0.6	10.9	0.2	-----	-----	6.7	0.1	2.9	0.1	19.0	0.3	15.4	0.1	25.6	0.8
Lepidonotothen nudifrons (L)	13.1	0.2	4.4	0.1	0.0	0.0	5.3	0.1	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	8.9	0.1
Hydromedusae	14.1	0.1	6.6	0.0	0.0	0.0	15.8	0.4	14.9	0.4	-----	-----	37.3	0.2	0.0	0.0	20.0	0.1	4.4	0.0	6.7	0.1
Ctenophora	7.1	0.1	2.2	0.0	3.6	0.0	1.1	0.0	5.0	0.1	-----	-----	6.7	0.0	3.8	0.1	16.2	0.1	-----	-----	6.7	0.0
Orchomene plebs	10.1	0.1	2.2	0.0	2.4	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	1.0	0.0	2.9	0.0	1.1	0.0	4.4	0.0
Callianira antarctica	3.0	0.1	0.0	0.0	14.5	0.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Chorismus antarcticus (L)	5.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----
Electrona spp. (L)	5.1	0.1	16.5	0.3	44.6	1.5	3.2	0.0	10.9	0.4	-----	-----	24.0	0.2	10.6	0.2	37.1	1.4	27.5	0.7	61.1	2.5
Acanthophyra pelagica (L)	8.1	0.1	5.5	0.0	10.8	0.1	2.1	1.5	0.0	0.0	-----	-----	17.3	0.2	3.8	0.0	9.5	0.1	0.0	0.0	22.2	0.1
Notothenia spp. (L)	4.0	0.1	0.0	0.0	0.0	0.0	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rhynchonereella bongraini	2.0	0.1	9.9	0.2	18.1	0.5	0.0	0.0	1.0	0.0	-----	-----	33.3	0.8	9.6	0.2	4.8	0.1	2.2	0.0	3.3	0.1
Notolepis coatsi (L)	6.1	0.1	18.7	0.2	16.9	0.1	4.2	0.0	1.0	0.0	-----	-----	5.3	0.0	3.8	0.0	6.7	0.0	8.8	0.0	27.8	0.1
Vanadis antarctica	3.0	0.1	0.0	0.0	0.0	0.0	2.1	0.0	5.0	0.1	-----	-----	5.3	0.1	4.8	0.1	1.0	0.0	4.4	0.0	15.6	0.1
Pelagobia longicirrata	2.0	0.0	2.2	0.0	0.0	0.0	1.1	0.0	3.0	0.0	-----	-----	0.0	0.0	0.0	0.0	1.0	0.0	1.1	0.0	-----	-----
Ephyra Larva	2.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Hyperoche medusarum	2.0	0.0	2.2	0.0	6.0	0.0	1.1	0.0	5.0	0.1	-----	-----	5.3	0.0	1.0	0.0	1.0	0.0	3.3	0.0	18.9	0.0
Eusirus antarcticus	7.1	0.0	13.2	0.1	4.8	0.0	1.1	0.0	-----	-----	-----	-----	0.0	0.0	1.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0
Electrona antarctica	4.0	0.0	8.8	0.1	1.2	0.0	3.2	0.0	5.9	0.0	-----	-----	1.3	0.0	3.8	0.1	9.5	0.0	13.2	0.0	13.3	0.1
Bargmannia elongata	4.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Euphausia triacantha (L)	1.0	0.0	0.0	0.0	4.8	2.8	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Electrona carlsbergi	4.0	0.0	0.0	0.0	1.2	0.0	2.1	0.0	2.0	0.0	-----	-----	2.7	0.0	1.0	0.0	10.5	0.1	-----	-----	-----	-----
Hyperiella spp.	2.0	0.0	1.1	0.0	6.0	0.0	11.6	0.1	5.9	0.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Scina spp.	1.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	1.0	0.1	-----	-----	0.0	0.0	0.0	0.0	4.8	0.1	-----	-----	-----	-----
Beroe cucumis	3.0	0.0	5.5	0.0	8.4	0.1	2.1	0.0	20.8	0.3	-----	-----	4.0	0.0	3.8	0.0	15.2	0.1	7.7	0.0	12.2	0.0
Halitholus spp.	2.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Leusia sp.	1.0	0.0	0.0	0.0	1.2	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Harpagifer antarcticus (L)	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----
Notolepis spp. (L)	2.0	0.0	1.1	0.0	2.4	0.0	0.0	0.0	2.0	0.0	-----	-----	0.0	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----
Schyphomedusae	3.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	2.0	0.0	-----	-----	1.3	0.0	1.9	0.0	1.0	0.0	13.2	0.1	-----	-----
Hyperiella macronyx	2.0	0.0	1.1	0.0	6.0	0.1	3.2	0.0	-----	-----	-----	-----	2.7	0.0	2.9	0.1	8.6	0.1	5.5	0.0	23.3	0.1
Pleuragramma antarcticum (L)	2.0	0.0	0.0	0.0	15.7	0.4	1.1	0.0	4.0	0.1	-----	-----	1.3	0.1	4.8	0.0	2.9	0.0	1.1	0.0	2.2	0.0
Beroe forskalii	2.0	0.0	18.7	0.2	30.1	0.4	0.0	0.0	17.8	0.2	-----	-----	2.7	0.0	1.0	0.0	0.0	0.0	1.1	0.0	-----	-----
Bolinopsis sp.	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----
Gymnoscopelus braueri	2.0	0.0	1.1	0.0	1.2	0.0	1.1	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Table 4.10 (Cont.)

A. SURVEY A	JANUARY-FEBRUARY																					
	2005		2004		2003		2002		2001		2000		1999		1998		1997		1996		1995	
TAXON	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean			F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean
Chionodraco rastrospinosus (L)	1.0	0.0	5.5	0.0	4.8	0.0	2.1	0.0	-----	-----	-----	-----	1.3	0.0	1.9	0.0	1.0	0.0	-----	-----	-----	-----
Cephalopods	2.0	0.0	1.1	0.0	1.2	0.0	0.0	0.0	1.0	0.0	-----	-----	1.3	0.0	1.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0
Cryodraco antarctica (L)	2.0	0.0	1.1	0.0	1.2	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----
Krefftichthys anderssoni	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	-----	-----
Orchomene rossi	2.0	0.0	1.1	0.0	6.0	0.0	0.0	0.0	1.0	0.0	-----	-----	4.0	0.0	0.0	0.0	8.6	0.0	0.0	0.0	5.6	0.0
Clio pyramidata sulcata	1.0	0.0	2.2	0.1	7.2	0.1	75.8	53.4	32.7	5.9	-----	-----	9.3	0.1	4.8	0.3	2.9	0.0	6.6	0.1	72.2	5.3
Modeeria rotunda	2.0	0.0	0.0	0.0	1.2	0.0	2.1	0.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Eusirus properdentatus	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Epimeriella macronyx	1.0	0.0	4.4	0.0	1.2	0.0	0.0	0.0	1.0	0.0	-----	-----	0.0	0.0	5.8	0.2	1.9	1.4	1.1	0.0	8.9	0.0
Arctapodema ampla	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----
Decapods (L)	1.0	0.0	2.2	0.0	2.4	0.0	3.2	1.7	0.0	0.0	-----	-----	1.3	0.0	2.9	0.0	0.0	0.0	2.2	0.2	-----	-----
Pleurobrachia pileus	1.0	0.0	0.0	0.0	2.4	0.0	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Electrona subaspera	1.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Mitrocomella brownei	1.0	0.0	0.0	0.0	1.2	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Laodicea undulata	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Gymnoscopelus nicholsi	1.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	1.9	0.0	1.1	0.0	1.1	0.0
Chromatonema rubra	1.0	0.0	0.0	0.0	0.0	0.0	2.1	0.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Eusirus perdentatus	1.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	1.0	0.0	-----	-----	1.3	0.0	0.0	0.0	0.0	0.0	1.1	0.0	22.2	0.1
Cyphocaris richardi	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	4.4	0.0
Calycopsis borchgrevinki	1.0	0.0	3.3	0.0	2.4	0.0	1.1	0.0	4.0	0.2	-----	-----	2.7	0.0	1.0	0.0	2.9	0.0	2.2	0.0	1.1	0.0
Pegantha martagon	0.0	0.0	8.8	0.2	7.2	0.0	1.1	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Clione antarctica	0.0	0.0	13.2	0.1	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Cumaceans	0.0	0.0	3.3	0.1	2.4	0.3	2.1	2.7	1.0	0.0	-----	-----	-----	-----	-----	-----	3.8	0.4	1.1	0.0	-----	-----
Gammarids	0.0	0.0	7.7	0.1	3.6	0.4	1.1	0.0	0.0	0.0	-----	-----	2.7	0.0	1.0	0.0	0.0	0.0	1.1	0.0	-----	-----
Lepidonotothen larseni (J)	0.0	0.0	3.3	0.0	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Artedidraco mirus (L)	0.0	0.0	2.2	0.0	1.2	0.0	1.1	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Hyperiella antarctica	0.0	0.0	1.1	0.0	0.0	0.0	1.1	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	2.2	0.0
Bolinopsis infundibulus	0.0	0.0	2.2	0.0	4.8	0.0	1.1	0.0	-----	-----	-----	-----	5.3	0.0	1.9	0.0	-----	-----	-----	-----	-----	-----
Travisiopsis coniceps	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	1.0	0.0	-----	-----	-----	-----
Notolepis annulata (L)	0.0	0.0	1.1	0.0	2.4	0.0	0.0	0.0	0.0	0.0	-----	-----	2.7	0.0	0.0	0.0	1.0	0.0	0.0	0.0	13.3	0.0
Trematomus lepidorhinus (L)	0.0	0.0	1.1	0.0	0.0	0.0	1.1	0.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Trematomus scotti (L)	0.0	0.0	1.1	0.0	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Periphylla periphylla	0.0	0.0	1.1	0.0	1.2	0.0	0.0	0.0	0.0	0.0	-----	-----	1.3	0.0	0.0	0.0	0.0	0.0	1.1	0.0	1.1	0.0
Travisiopsis levinseni	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Clio pyramidata martensi?	0.0	0.0	1.1	0.0	0.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pleurobranchia pileus	0.0	0.0	1.1	0.0	0.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Notocrangon antarcticus(?)	0.0	0.0	0.0	0.0	3.6	0.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Orchomene spp.	0.0	0.0	0.0	0.0	2.4	0.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Fish Eggs	0.0	0.0	0.0	0.0	3.6	0.1	0.0	0.0	0.0	0.0	-----	-----	1.3	0.0	1.0	0.0	2.9	0.1	1.1	0.0	4.4	0.0
Atolla wyvillei	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	2.9	0.0	1.1	0.0	7.8	0.0
Krefftichthys anderssoni (L)	0.0	0.0	0.0	0.0	1.2	0.0	1.1	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	1.9	0.0	-----	-----	-----	-----
Eusirus spp.	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----
Hyperia antarctica	0.0	0.0	0.0	0.0	1.2	0.0	1.1	0.0	1.0	0.0	-----	-----	0.0	0.0	0.0	0.0	1.9	0.0	-----	-----	-----	-----
Maupasia coeca	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	1.0	0.0	-----	-----	1.3	0.0	0.0	0.0	1.9	0.0	1.1	0.0	-----	-----
Atolla sp.	0.0	0.0	0.0	0.0	1.2	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Vogtia serrata	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	-----	-----	1.3	0.0	0.0	0.0	3.8	0.1	-----	-----	-----	-----
Staurophora mertensi ?	0.0	0.0	0.0	0.0	1.2	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Russelia mirabilis	0.0	0.0	0.0	0.0	1.2	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Bathylagus sp. (L)	0.0	0.0	0.0	0.0	1.2	0.0	3.2	0.3	0.0	0.0	-----	-----	0.0	0.0	1.0	0.0	1.0	0.0	2.2	0.0	8.9	0.0
Crustacean larvae	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.8	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Zanclonia weldoni	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Trematomus newnesi (L)	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Chaenodraco wilsoni (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Prionodraco evansii (J)	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Parachaenechthys charcoti (L)	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Schizobrachium polycotylum	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Botrynema brucei	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.1	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Mysids	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.1	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Artededraco sp. B (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	1.0	0.0	-----	-----	-----	-----
Artededraco skottsbergi (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	1.0	0.0	1.0	0.0	-----	-----	-----	-----
Bylgides pelagica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	1.3	0.0	0.0	0.0	2.9	0.1	0.0	0.0	5.6	0.0
Chaenocephalus aceratus (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	3.8	0.0	-----	-----	-----	-----	-----	-----
Notothenia coriiceps (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Hyperia macrocephala	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	1.0	0.1	1.0	0.0	0.0	0.0	3.3	0.0
Gymnoscopelus opisthopteris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	3.8	0.0	2.2	0.0	7.8	0.0
Phalacrophorus pictus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----
Patagonitothen b. guntheri (J)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	1.3	0.0	-----	-----	-----	-----	-----	-----	-----	-----
Oediceroides calmani	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	1.0	0.0	-----	-----	-----	-----
Eusirus microps	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0
Euphysora gigantea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0
Thyphloscolex muelleri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	1.0	0.0	4.4	0.0	-----	-----
Gymnodraco acuticeps (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Gosea brachyura	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-----	-----	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0
Gobionotothen gibberifrons (L)	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	-----	-----	1.3	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
TOTAL		2037.0		1033.1		1264.9		11143.1		3812.2		---		1293.9		1172.7		1015.2		1408.9		1052.2
TAXA	95		89		88		89		63		---		65		63		70		66		68	

Table 4.10 (Contd.)

B. SURVEY D	FEBRUARY-MARCH																					
	2005 N=97		2004 N=97		2003 N=95		2002 N=94		2001 N=97		2000 N=97		1999 N=67		1998 N=104		1997 N=16		1996 N=91		1995 N=89	
TAXON	F (%)	Mean	F (%)	Mean	F (%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean
Copepods	100.0	1216.8	100.0	4412.5	100.0	1533.7	100.0	15904.8	99.0	5915.7	99.0	7038.7	100.0	1454.5	97.1	119.0	100.0	1267.8	98.9	1387.0	100.0	3189.1
Thysanoessa macrura	100.0	473.3	95.9	209.4	100.0	293.3	79.8	112.8	86.5	639.0	92.8	41.5	98.5	93.1	100.0	177.4	100.0	181.3	91.2	143.3	93.3	161.3
Themisto gaudichaudii	95.9	22.6	87.6	4.5	93.7	6.4	97.9	30.2	79.2	4.3	83.5	7.2	32.8	0.2	32.7	0.3	87.5	2.9	91.2	2.5	74.2	3.6
Salpa thompsoni	94.8	715.9	90.7	123.4	76.8	77.8	80.9	621.6	100.0	392.1	96.9	726.2	100.0	248.1	98.1	689.1	100.0	1245.5	62.6	28.2	59.6	16.5
Cyllopus magellanicus	89.7	14.1	59.8	0.9	45.3	2.2	34.0	2.8	70.8	2.9	87.6	10.0	95.5	4.8	81.7	5.6	93.8	3.3	46.2	2.1	25.8	0.7
Chaetognaths	83.5	44.5	96.9	332.7	96.8	83.1	97.9	880.1	77.1	164.5	91.8	632.8	91.0	127.4	61.5	10.7	75.0	18.2	93.4	64.1	100.0	296.4
Euphausia superba	82.5	45.7	76.3	73.5	90.5	151.5	57.4	281.6	79.2	59.0	77.3	21.0	61.2	24.4	89.4	133.5	68.8	30.4	86.8	106.7	78.7	5.7
Vibilia antarctica	75.3	3.4	42.3	1.0	63.2	1.9	46.8	22.2	99.0	10.9	95.9	20.2	98.5	3.6	96.2	8.0	81.3	8.1	48.4	1.0	23.6	0.2
Euphausia frigida	63.9	33.9	59.8	35.3	58.9	31.3	66.0	80.0	50.0	42.0	67.0	49.9	64.2	20.0	29.8	9.3	68.8	44.8	54.9	9.0	60.7	16.7
Euphausia superba (L)	48.5	183.1	87.6	107.7	27.4	3.9	28.7	61.0	64.6	683.4	80.4	2129.6	80.6	49.8	12.5	1.6	37.5	25.0	62.6	13.9	93.3	3690.0
Amphipods (unid)	44.3	6.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Spongiobranchaea australis	42.3	1.1	71.1	5.9	54.7	1.3	47.9	1.3	70.8	4.1	68.0	2.7	65.7	1.0	38.5	0.8	43.8	2.8	68.1	1.4	60.7	0.4
Ostracods	41.2	7.4	52.6	26.9	48.4	9.0	22.3	42.6	20.8	10.1	45.4	25.1	80.6	14.0	43.3	5.4	56.3	4.8	47.3	10.1	75.3	43.4
Thysanoessa macrura (L)	36.1	8.9	68.0	315.1	25.3	1.1	96.8	1111.5	91.7	718.3	82.5	883.9	74.6	137.4	13.5	2.6	50.0	10.8	87.9	414.4	79.8	276.9
Primno macropa	36.1	1.7	76.3	16.1	73.7	6.7	57.4	28.2	28.1	1.5	44.3	3.2	65.7	2.6	49.0	1.9	18.8	0.5	63.7	3.5	31.5	0.4
Cyllopus lucasi	35.1	1.0	76.3	3.4	17.9	0.2	30.9	3.0	96.9	26.6	4.1	0.0	29.9	0.2	57.7	1.6	93.8	2.4	34.1	0.2	23.6	0.5
Siphonophora	34.0	2.7	6.2	0.6	1.1	0.0	0.0	0.0	2.1	0.0	10.3	2.3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Sipunculids	32.0	4.2	28.9	1.3	15.8	0.1	4.3	1.5	12.5	0.3	12.4	0.1	11.9	0.0	4.8	0.1	6.3	0.0	8.8	0.1	9.0	0.0
Ihlea racovitzai	26.8	1.2	52.6	22.3	10.5	0.5	5.3	0.3	3.1	0.3	13.4	0.6	26.9	5.1	61.5	51.5	-----	-----	-----	-----	-----	-----
Radiolaria	24.7	0.9	46.4	362.1	46.3	2.3	36.2	7918.3	32.3	216.2	40.2	531.4	40.3	6.3	28.8	1.0	12.5	0.7	34.1	0.9	27.0	0.4
Hyperiella dilatata	23.7	0.6	47.4	3.5	37.9	0.4	38.3	2.6	30.2	0.4	22.7	0.4	56.7	1.2	34.6	0.4	25.0	0.2	52.7	0.8	24.7	0.1
Euphausia spp.	19.6	1.0	0.0	0.0	4.2	0.2	0.0	0.0	0.0	0.0	4.1	0.7	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Tomopteris spp.	19.6	0.6	36.1	1.6	49.5	1.9	18.1	1.1	19.8	0.4	23.7	2.3	55.2	2.8	8.7	0.0	31.3	0.5	38.5	0.9	57.3	1.3
Lepidonotothen kempi (L)	16.5	0.2	28.9	0.8	35.8	0.6	18.1	0.3	19.8	0.2	29.9	0.3	16.4	0.1	22.1	0.2	6.3	0.2	39.6	0.4	48.3	0.4
Eggs (unid.)	15.5	3.2	0.0	0.0	0.0	0.0	0.0	0.0	19.8	9.3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Larvaceans	15.5	1.0	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Clione limacina	15.5	0.1	28.9	0.5	18.9	0.3	4.3	0.1	16.7	0.9	5.2	0.0	3.0	0.0	10.6	0.1	12.5	0.0	15.4	0.2	-----	-----
Limacina helicina	14.4	0.8	73.2	42.6	36.8	1.5	5.3	0.6	33.3	1.8	45.4	205.4	26.9	1.9	37.5	0.8	0.0	0.0	24.2	1.9	4.5	0.0
Notolepis coatsi (L)	14.4	0.2	12.4	0.1	23.2	0.2	12.8	0.2	2.1	0.0	6.2	0.0	0.0	0.0	4.8	0.0	0.0	0.0	18.7	0.1	36.0	0.2
Electrona antarctica	14.4	0.2	12.4	0.1	9.5	0.1	12.8	0.1	5.2	0.0	15.5	0.1	6.0	0.0	8.7	0.0	31.3	0.2	20.9	0.2	15.7	0.1
Euphausia crystallorophorias	13.4	0.8	6.2	2.4	31.6	4.9	11.7	65.3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Hyperiids	13.4	0.3	2.1	0.0	1.1	0.0	0.0	0.0	5.2	0.3	8.2	2.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Calycopsis borchgrevinki	13.4	0.2	8.2	0.0	6.3	0.0	4.3	0.0	6.3	0.0	13.4	0.2	19.4	0.4	4.8	0.0	6.3	0.0	6.6	0.0	11.2	0.0
Cyllopus spp.	12.4	0.6	7.2	0.0	9.5	0.4	13.8	0.9	0.0	0.0	25.8	2.9	0.0	0.0	24.0	0.7	24.0	0.7	-----	-----	-----	-----
Lepidonotothen larseni (L)	11.3	0.1	24.7	0.5	15.8	0.5	11.7	1.8	14.6	0.2	3.1	0.0	11.9	0.0	13.5	0.1	0.0	0.0	13.2	0.3	10.1	0.0
Dimophyes arctica	10.3	0.1	12.4	0.5	9.5	0.1	8.5	0.1	15.6	0.2	15.5	0.6	0.0	0.0	16.3	0.4	12.5	0.1	13.2	0.1	13.5	0.3
Hydromedusae	10.3	0.1	0.0	0.0	5.3	0.1	5.3	0.0	4.2	0.0	23.7	0.5	40.3	0.3	12.5	0.2	12.5	0.2	3.3	0.1	5.6	0.0
Euphausia spp. (L)	9.3	3.0	0.0	0.0	5.3	0.1	3.2	4.4	1.0	0.4	11.3	4.3	13.4	1.5	-----	-----	-----	-----	-----	-----	-----	-----
Polychaetes	9.3	0.4	4.1	0.4	5.3	0.3	1.1	0.0	6.3	0.6	18.6	2.6	7.5	0.3	13.5	0.3	0.0	0.0	3.3	0.1	2.2	0.0
Champsocephalus gunnari (L)	9.3	0.3	0.0	0.0	2.1	0.0	1.1	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Larval Fish (unid.)	9.3	0.2	1.0	0.0	17.9	0.7	1.1	0.0	1.0	0.0	6.2	0.6	14.9	0.7	1.9	0.1	0.0	0.0	1.1	0.0	-----	-----
Limacina spp.	8.2	0.7	5.2	1.0	0.0	0.0	1.1	0.2	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Euphausia triacantha	8.2	0.5	20.6	1.3	30.5	1.8	22.3	2.2	16.7	1.2	25.8	1.9	22.4	1.8	11.5	0.6	43.8	0.9	22.0	0.8	28.1	1.6
Diphyes antarctica	8.2	0.2	29.9	0.2	29.5	0.4	8.5	0.2	20.8	0.2	21.6	0.4	31.3	0.3	29.8	0.4	6.3	0.3	7.7	0.1	23.6	0.4
Vanadis antarctica	7.2	0.1	4.1	0.0	0.0	0.0	2.1	0.0	1.0	0.0	4.1	0.1	1.5	0.0	3.8	0.1	0.0	0.0	1.1	0.0	6.7	0.0
Pegantha margaton	6.2	0.2	3.1	0.0	8.4	0.1	3.2	0.1	27.1	0.3	13.4	0.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pleuragramma antarcticum (L)	6.2	0.2	1.0	0.0	15.8	0.2	5.3	0.2	5.2	0.1	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	1.1	0.0	2.2	0.0
Gymnoscopelus braueri	6.2	0.1	6.2	0.0	7.4	0.1	6.4	0.1	7.3	0.0	8.2	0.1	7.5	0.1	-----	-----	-----	-----	-----	-----	-----	-----
Spongiobranchaea sp.	5.2	0.1	3.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----		
Callianira antarctica	5.2	0.1	0.0	0.0	13.7	0.3	0.0	0.0	5.2	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Hyperiella spp.	5.2	0.1	5.2	0.0	5.3	0.2	12.8	0.2	0.0	0.0	9.3	0.3	9.0	0.1	1.0	0.0	-----	-----	-----	-----	-----	-----
Ctenophora	5.2	0.0	4.1	0.1	4.2	0.0	0.0	0.0	5.2	0.0	6.2	0.1	4.5	0.0	0.0	0.0	6.3	0.0	1.1	0.0	3.4	0.0
Orchomene plebs	5.2	0.0	15.5	0.1	3.2	0.0	2.1	0.0	1.0	0.0	2.1	0.8	0.0	0.0	1.9	0.0	0.0	0.0	2.2	0.0	3.4	0.0
Cumaceans	4.1	0.3	3.1	0.0	0.0	0.0	1.1	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----
Electrona spp. (L)	4.1	0.0	36.1	1.2	55.8	2.5	20.2	2.2	12.5	0.8	43.3	4.0	20.9	0.3	10.6	0.2	12.5	0.1	38.5	0.9	62.9	5.2
Oediceroides calmani?	3.1	0.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Notolepis spp. (L)	3.1	0.0	0.0	0.0	6.3	0.1	1.1	0.0	1.0	0.2	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0
Beroe cucumis	3.1	0.0	4.1	0.0	4.2	0.0	1.1	0.0	7.3	0.1	2.1	0.0	9.0	0.0	4.8	0.0	0.0	0.0	11.0	0.1	4.5	0.0
Gymnoscopelus nicholsi	3.1	0.0	4.1	0.0	1.1	0.0	2.1	0.0	3.1	0.0	1.0	0.0	1.5	0.0	1.0	0.0	12.5	0.1	3.3	0.0	1.1	0.0
Acanthophyra pelagica	3.1	0.0	3.1	0.0	3.2	0.1	1.1	0.0	0.0	0.0	0.0	0.0	3.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0
Euphausia frigida (L)	2.1	0.2	24.7	5.7	18.9	1.0	19.1	53.4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Mysids	2.1	0.2	0.0	0.0	1.1	0.0	2.1	0.1	1.0	0.1	1.0	0.0	1.5	0.0	-----	-----	-----	-----	-----	-----	-----	-----
Epimeriella macronyx	2.1	0.1	1.0	0.0	2.1	0.1	0.0	0.0	0.0	0.0	2.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	5.6	0.6
Beroe spp.	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Clio pyramidata spp.	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Eusirus antarcticus	2.1	0.0	5.2	0.1	3.2	0.0	2.1	0.0	5.2	0.1	1.0	0.0	1.5	0.0	1.9	0.0	-----	-----	-----	-----	-----	-----
Chionodraco rastrospinosus (L)	2.1	0.0	0.0	0.0	1.1	0.0	0.0	0.0	1.0	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Gymnoscopelus bolini	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Gammarids	2.1	0.0	4.1	0.2	1.1	0.1	4.3	2.3	4.2	0.4	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Hyperiella macronyx	2.1	0.0	2.1	0.0	1.1	0.0	1.1	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	6.3	0.0	6.6	0.1	13.5	0.0
Cephalopods	2.1	0.0	3.1	0.0	2.1	0.0	2.1	0.0	1.0	0.0	2.1	0.0	4.5	0.0	1.9	0.0	0.0	0.0	9.9	0.0	-----	-----
Trematomus scotti (L)	2.1	0.0	1.0	0.0	0.0	0.0	4.3	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pleurobrachia pileus	1.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	5.2	0.0	0.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Gastropods	1.0	0.0	1.0	0.0	2.1	0.2	0.0	0.0	0.0	0.0	4.1	17.6	6.0	0.5	1.9	0.0	-----	-----	-----	-----	-----	-----
Notolepis annulata (L)	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	5.5	0.0	3.4	0.0
Hyperia antarctica	1.0	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Clione antarctica	1.0	0.0	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----		
Schyphomedusae	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	12.5	0.0	19.8	0.1	13.5	0.1
Orchomene spp.	1.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	1.0	1.3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Electrona carlsbergi	1.0	0.0	2.1	0.0	0.0	0.0	1.1	0.0	6.3	0.0	1.0	0.0	4.5	0.0	1.9	0.0	-----	-----	-----	-----	-----	-----
Racovitzia glacialis	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Nototheniops nudifrons (L)	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pasiaphaea sp. (L)	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.8	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Adult Myctophids (unid.)	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Table 4.10 (Contd.)

B. SURVEY D	FEBRUARY-MARCH																					
	2005		2004		2003		2002		2001		2000		1999		1998		1997		1996		1995	
TAXON	F (%)	Mean	F (%)	Mean	F (%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean	F(%)	Mean
Clio pyramidata antarctica?	1.0	0.0	3.1	0.0	6.3	0.2	4.3	0.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rhynchonereella bongraini	0.0	0.0	10.3	1.0	16.8	1.0	0.0	0.0	2.1	0.0	5.2	0.6	31.3	2.3	1.0	0.0	0.0	0.0	5.5	0.1	20.2	0.1
Beroe forskalii	0.0	0.0	10.3	0.1	3.2	0.0	0.0	0.0	10.4	0.0	13.4	0.1	9.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Scina spp.	0.0	0.0	5.2	0.3	4.2	0.1	1.1	0.0	0.0	0.0	1.0	0.0	1.5	0.0	0.0	0.0	6.3	0.5	2.2	0.0	1.1	0.0
Euphausia triacantha (L)	0.0	0.0	5.2	0.3	2.1	0.0	1.1	0.8	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Bathylagus sp. (L)	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	1.1	0.0	14.6	0.0
Clio pyramidata sulcata	0.0	0.0	3.1	0.0	1.1	0.0	5.3	0.2	10.4	0.4	5.2	0.0	13.4	0.1	0.0	0.0	0.0	0.0	3.3	0.0	12.4	0.0
Leusia spp.	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Staurophora mertensi ?	0.0	0.0	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----		
Orchomene rossi	0.0	0.0	2.1	0.0	4.2	0.2	1.1	0.0	0.0	0.0	0.0	0.0	1.5	0.0	1.0	0.0	0.0	0.0	5.5	0.5	6.7	0.0
Euphausia crystallorophorias (L)	0.0	0.0	2.1	0.7	2.1	0.0	6.4	14.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Krefftichthys anderssoni (L)	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----
Thyphloscolex muelleri	0.0	0.0	1.0	0.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----		
Clio pyramidata martensi?	0.0	0.0	1.0	3.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----		
Macrourid (L)	0.0	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Hyperoche medusarum	0.0	0.0	1.0	0.0	4.2	0.0	3.2	0.0	10.4	0.1	3.1	0.0	4.5	0.0	0.0	0.0	12.5	0.3	2.2	0.0	12.4	0.0
Atolla wyvillei	0.0	0.0	1.0	0.0	4.2	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----
Cyphocaris richardi	0.0	0.0	1.0	0.0	3.2	0.0	2.1	0.0	1.0	0.0	3.1	0.0	1.5	0.0	0.0	0.0	0.0	0.0	1.1	0.0	3.4	0.1
Chromatonema rubra?	0.0	0.0	1.0	0.0	0.0	0.0	3.2	0.3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pelagobia longicirrata	0.0	0.0	1.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	5.2	0.6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Periphylla periphylla	0.0	0.0	1.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	1.1	0.0	1.1	0.0
Hyperia macrocephala	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	1.1	0.0	5.6	0.0
Lepidonotothen larseni (J)	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Gobionotothen gibberifrons (L)	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Eusirus perdentatus	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	2.2	0.0	6.7	0.1
Hyperiella antarctica	0.0	0.0	0.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Fish Eggs	0.0	0.0	0.0	0.0	5.3	0.2	0.0	0.0	3.1	0.0	0.0	0.0	1.5	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Harpagifer antarcticus (L)	0.0	0.0	0.0	0.0	3.2	0.0	2.1	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----
Eusirus properdentatus	0.0	0.0	0.0	0.0	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Protomyctophum bolini	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Cryodraco antarctica (L)	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pseudochaenichthys georgianus (J)	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Botrynema brucei	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	1.0	0.0	0.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Bylgides pelagica	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0
Zanclonia weldoni?	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Clytia sp.?	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Modeeria rotunda?	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Bolinopsis spp.	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Lepidonotothen nudifrons (L)	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	3.4	0.0
Mitrocomella brownei?	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Bathydraco antarcticus (L)	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	3.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----
Trematomus newnesi (L)	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Parachaenechthys charcoti (L)	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Trematomus centronotus (L)	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Arctapodema ampla	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Gerlachea australis (L)	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pyrasoma atlanticum	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Decapods (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	-----	-----
Artedidraco skottsbergi (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----
Electrona subaspera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Travisiopsis coniceps	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	1.1	0.0
Chorismus antarcticus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	-----	-----	-----	-----	-----	-----	-----	-----
Hyperia spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.1	-----	-----
Pagetopsis macropterus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Chaenodraco wilsoni (J)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----
Laodicea undulata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Notothenia coriiceps (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pagothenia brachysoma	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	-----	-----	-----	-----	-----	-----
Rhynchonereella sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----
Eusirus microps	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	-----	-----
Solomondella spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Gymnoscopelus sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	-----	-----	-----	-----	-----	-----
Gymnoscopelus opisthopteris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	10.1	0.0
Bolinopsis infundibulus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
TOTAL		2806.5		6124.5		2228.5		27260.8		8910.2		12378.9		2207.6		1224.4		2854.0		2196.4		7713.3
TAXA	88	16.3	89		82		84		72		72		58		60		37		63		62	

Table 4.11. Abundance of biomass dominant copepod species in the Elephant Island Area during various cruises 1981-2005. 1981-1990 data provided by John Wormuth. Dashes indicate that data are not available.

SURVEY PERIOD	TAXON N/1000 m^3	*Calanoides acutus*	*Calanus propinquus*	*Metridia gerlachei*	*Rhincalanus gigas*	*Pleuromamma robusta*	*Paraeuchaeta antarctica*	*Haloptilus ocellatus*	*Heterorhabdus austrinus*	Copepodites	Other Copepods	Total Copepods
Jan-Feb 89	Mean	429.7	93.6	1639.0	---	---	---	---	---	---	---	---
N=48	STD	676.8	104.3	3488.0	---	---	---	---	---	---	---	---
	Median	80.5	45.5	57.0	---	---	---	---	---	---	---	---
Jan 90	Mean	302.5	354.4	981.3	---	---	---	---	---	---	---	1700.2
N=23	STD	405.8	365.8	1620.7	---	---	---	---	---	---	---	2003.7
	Median	170.1	243.6	192.3	---	---	---	---	---	---	---	656.7
Jan 99	Mean	335.4	109.1	340.5	---	---	---	---	---	---	---	927.0
N=40	STD	1009.5	161.9	512.7	---	---	---	---	---	---	---	1590.8
	Median	28.9	52.0	66.0	---	---	---	---	---	---	---	332.9
Jan 01	Mean	241.0	50.4	488.4	20.2	5.5	0.2	0.0	---	---	197.5	1003.2
N=60	STD	392.0	85.9	1103.3	74.8	21.0	0.6	0.0	---	---	527.3	1582.4
	Median	117.7	12.5	45.5	0.0	0.0	0.0	0.0	---	---	41.8	252.2
Jan 02	Mean	2931.3	1862.2	350.8	141.6	1.4	122.7	0.0	---	30.2	44.2	5484.3
N=44	STD	8293.0	5659.2	467.6	381.0	6.3	185.6	0.0	---	154.1	89.0	14585.6
	Median	876.4	502.7	130.3	16.4	0.0	57.7	0.0	---	0.0	11.0	2174.9
Jan 03	Mean	75.6	80.1	241.2	11.1	1.8	0.0	0.2	---	0.1	41.0	541.0
N=38	STD	67.9	65.0	639.3	23.4	10.9	0.0	1.0	---	0.9	34.9	798.6
	Median	52.0	55.1	6.7	1.9	0.0	0.0	0.0	---	0.0	27.8	317.0
Jan 04	Mean	77.4	73.2	293.6	9.7	24.1	16.4	0.0	---	0.1	0.0	494.5
N=46	STD	97.2	63.8	706.6	19.0	41.0	25.0	0.0	---	0.9	0.0	796.1
	Median	42.7	57.1	25.4	0.2	7.8	7.6	0.0	---	0.0	0.0	208.7
Jan 05	Mean	39.0	26.4	220.0	12.6	1.4	0.6	0.0	0.0	0.0	49.1	364.6
N=48	STD	62.7	41.8	614.4	21.0	7.0	2.6	0.0	0.0	0.0	57.9	687.3
	Median	16.1	9.5	3.9	4.7	0.0	0.0	0.0	0.0	0.0	35.2	126.4

SURVEY PERIOD	TAXON N/1000 m^3	*Calanoides acutus*	*Calanus propinquus*	*Metridia gerlachei*	*Rhincalanus gigas*	*Pleuromama robusta*	*Pareuchaeta antarctica*	*Haloptilus ocellatus*	*Heterorhabdus austrinus*	Copepodites	Other Copepods	Total Copepods
Mar 81	Mean	4786.9	5925.8	2402.5	---	---	---	---	---	---	---	---
N=10	STD	5482.2	6451.6	3321.4	---	---	---	---	---	---	---	---
	Median	2197.7	2048.7	609.5	---	---	---	---	---	---	---	---
Feb-Mar 84	Mean	25.5	121.7	1154.4	---	---	---	---	---	---	---	---
N=13	STD	29.6	134.4	2999.9	---	---	---	---	---	---	---	---
	Median	16.2	51.4	23.1	---	---	---	---	---	---	---	---
Feb 89	Mean	161.4	194.9	3189.3	---	---	---	---	---	---	---	---
N=25	STD	240.9	151.5	4017.2	---	---	---	---	---	---	---	---
	Median	88.0	162.0	1051.0	---	---	---	---	---	---	---	---
Feb 99	Mean	511.8	300.9	521.1	---	---	---	---	---	---	---	1557.9
N=39	STD	1395.6	630.6	699.0	---	---	---	---	---	---	---	2337.8
	Median	70.7	70.8	216.9	---	---	---	---	---	---	---	621.6
Feb 00	Mean	1846.3	741.8	3051.7	1089.0	100.0	107.3	1.5	---	---	1171.4	8019.1
N=60	STD	3177.2	1546.5	4783.5	2456.5	34.7	249.1	7.8	---	---	28232.0	11824.4
	Median	225.2	193.3	1249.7	79.9	0.0	11.0	0.0	---	---	297.6	3478.0
Feb-Mar 01	Mean	2540.2	247.1	1450.0	32.4	3.7	74.7	0.4	---	116.1	37.0	4501.5
N=57	STD	6921.6	402.9	2966.0	129.1	13.6	137.9	2.7	---	343.8	188.4	8072.4
	Median	111.5	122.2	140.1	0.0	0.0	20.8	0.0	---	23.2	0.0	1518.0
Feb-Mar 02	Mean	9569.2	3827.4	2515.1	1226.4	30.0	169.3	14.8	---	5.2	116.0	17473.4
N=44	STD	12553.1	4288.9	3124.5	1952.7	97.2	269.2	66.0	---	22.5	337.2	20036.9
	Median	4855.6	2037.2	1183.6	346.2	0.0	52.5	0.0	---	0.0	0.0	7563.8
Feb 03	Mean	138.1	68.2	1092.8	39.0	5.9	3.8	0.5	---	0.0	205.0	1674.3
N=48	STD	114.2	70.2	2239.6	45.9	17.5	10.0	1.7	---	0.0	235.4	2593.6
	Median	119.3	47.9	197.3	17.9	0.0	0.0	0.0	---	0.0	130.2	737.5
Feb-Mar 04	Mean	1821.7	1113.3	1791.8	1209.3	7.7	168.9	15.1	88.2	0.3	89.7	6303.1
N=47	STD	7439.2	3524.0	3902.9	5315.2	25.3	195.3	53.6	552.6	2.2	195.0	17739.5
	Median	277.0	324.3	368.9	117.3	0.0	68.4	0.0	0.0	0.0	5.9	2233.5
Feb-Mar 05	Mean	144.2	22.6	708.9	54.0	2.2	1.1	0.2	0.9	0.0	54.2	1022.1
N=48	STD	385.5	45.1	1075.7	54.2	9.7	3.0	1.1	5.2	0.0	64.7	1254.5
	Median	47.8	9.9	76.7	31.6	0.0	0.0	0.0	0.0	0.0	32.3	344.3

Table 4.12. Percent contribution and abundance rank (R) of numerically dominant zooplankton and nekton taxa in the Elephant Island Area during (A) January-February and (B) February-March surveys, 1994-2004. Includes the 10 most abundant taxa each year. Radiolaria excluded as a taxonomic category. No samples were collected January-February 2000. Dashes indicate that the taxon was not enumerated during that survey.

A.	JANUARY-FEBRUARY																						
	2005		2004		2003		2002		2001		2000		1999		1998		1997		1996		1995		1994	
TAXON	%	R	%	R	%	R	%	R	%	R	n.a.		%	R	%	R	%	R	%	R	%	R	%	R
Salpa thompsoni	61.45	1	17.94	2	4.87	4	5.66	3	29.03	2	---	---	12.35	2	68.76	1	17.79	2	1.45	6	1.51	5	80.83	1
Copepods	18.54	2	50.37	1	42.52	1	75.69	1	46.76	1	---	---	58.05	1	4.80	3	57.16	1	56.18	1	61.54	1	4.08	3
Thysanoessa macrura	8.71	3	11.02	3	18.79	3	2.77	4	2.15	5	---	---	2.92	6	15.38	2	10.24	3	7.56	4	9.09	3	7.87	2
Thysanoessa macrura (L)	2.19	4	0.69		0.09		10.67	2	12.55	3	---	---	7.29	4	0.00		1.67	6	21.82	2	1.50	6	---	
Euphausia frigida	1.45	5	1.96	6	0.84	7	0.39	9	1.09	7	---	---	1.00	7	0.02		1.45	8	0.14		0.92	8	0.38	9
Euphausia superba	1.38	6	6.10	4	25.06	2	0.54	6	0.88	10	---	---	0.33	8	3.13	5	3.96	4	7.95	3	1.37	7	2.68	4
Euphausia superba (L)	1.12	7	0.99	10	0.37	10	0.49	7	1.53	6	---	---	10.95	3	0.09		1.49	7	0.19	10	12.80	2	---	
Cyllopus magellanicus	0.88	8	0.07		0.04		0.09		0.01		---	---	0.15		0.21		0.45		0.13		0.02		0.63	
Chaetognaths	0.80	9	3.60	5	1.51	6	1.93	5	2.68	4	---	---	4.00	5	0.92	7	2.28	5	0.90	7	7.84	4	0.04	
Themisto gaudichaudii	0.64	10	0.24		0.35		0.32	10	0.17		---	---	0.02		0.03		0.35		0.34	9	0.46		1.05	6
Vibilia antarctica	0.18		0.07		0.19		0.06		0.98	8	---	---	0.32	9	1.12	6	0.24		0.04		0.02		1.17	5
Primno macropa	0.17		0.40		0.44	9	0.12		0.10		---	---	0.13		0.06		0.42	10	0.01		0.01		0.05	
Ihlea racovitzai	0.16		1.63	8	0.03		0.02		0.02		---	---	0.15		3.53	4	---		---		---		---	
Euphausia triacantha	0.15		0.10		0.05		0.02		0.10		---	---	0.03		0.02		0.14		0.04		0.14		0.12	
Ostracods	0.08		1.74	7	0.53	8	0.09		0.25		---	---	0.13		0.41	9	0.54	9	0.35	8	0.91	9	---	
Tomopteris spp.	0.05		0.11		0.20		0.03		0.11		---	---	0.15	10	0.11		0.19		0.06		0.40		0.25	10
Spongiobranchaea australis	0.05		0.29		0.15		0.02		0.09		---	---	0.09		0.07		0.22		0.13		0.05		0.01	
Limacina helicina	0.05		1.30	9	2.55	5	0.03		0.14		---	---	0.07		0.69	8	0.28		2.38	5	0.18		0.03	
Clio pyramidata	0.05		0.01		0.01		0.46	8	0.08		---	---	0.01		0.02		0.00		0.01		0.50	10	0.53	8
Cyllopus lucasii	0.03		0.38		0.06		0.02		0.98	9	---	---	0.15		0.16	10	0.37		0.11		0.02		0.62	7
TOTAL	98.13		98.94		98.65		99.43		99.68		---		98.15		99.32		98.79		99.64		99.26		99.69	

B.	FEBRUARY-MARCH																						
	2005		2004		2003		2002		2001		2000		1999		1998		1997		1996		1995		1994	
TAXON	%	R	%	R	%	R	%	R	%	R	%	R	%	R	%	R	%	R	%	R	%	R	%	R
Copepods	37.34	1	80.19	1	73.70	1	83.13	1	64.68	1	54.20	1	62.77	1	7.38	4	44.46	1	62.07	1	40.49	2	82.15	1
Salpa thompsoni	31.46	2	2.02	5	2.67	5	2.71	4	6.50	4	6.17	4	12.46	2	65.31	1	43.62	2	1.39	6	0.22	7	11.78	2
Thysanoessa macrura	16.12	3	1.77	6	10.24	2	0.27	7	14.96	2	0.24	8	3.84	5	9.40	3	6.36	3	4.86	4	0.87	5	1.83	3
Euphausia superba (L)	7.12	4	2.26	4	0.27	8	0.20	8	1.03	7	23.14	2	2.71	6	0.16		0.88	6	0.59	7	50.16	1	---	
Euphausia superba	1.76	5	0.65	7	4.18	4	0.05		1.15	6	0.10		1.43	7	10.87	2	1.07	5	5.57	3	0.06	10	0.41	7
Chaetognaths	1.75	6	5.68	2	4.54	3	5.11	3	1.34	5	5.35	5	5.94	4	0.60	8	0.65	7	2.43	5	3.61	4	0.47	6
Euphausia frigida	1.27	7	0.34		2.24	6	0.37	6	0.54	8	0.29	7	1.00	8	0.60	7	1.57	4	0.40	8	0.21	8	0.69	5
Themisto gaudichaudii	0.65	8	0.03		0.20	10	0.12		0.07		0.02		0.01		0.01		0.10		0.09		0.01		0.27	8
Cyllopus magellanicus	0.65	9	0.01		0.09		0.02		0.02		0.07		0.17		0.55	9	0.12		0.10		0.01		0.12	
Vibilia antarctica	0.18	10	0.01		0.07		0.16	10	0.21	10	0.18	10	0.15		0.71	6	0.28	9	0.05		0.00		0.16	9
Ostracods	0.15		0.43	9	0.24	9	0.06		0.03		0.20	9	0.65	9	0.35	10	0.17	10	0.38	9	0.43	6	---	
Ihlea racovitzai	0.07		0.41	10	0.01		0.00		0.00		0.00		0.34	10	2.77	5	---		---		---		---	
Thysanoessa macrura (L)	0.05		4.92	3	0.06		6.87	2	8.81	3	7.33	3	7.49	3	0.03		0.38	8	21.40	2	3.76	3	---	
Cyllopus lucasii	0.04		0.06		0.01		0.01		0.43	9	0.00		0.01		0.14		0.08		0.01		0.01		0.14	10
Primno macropa	0.04		0.13		0.35	7	0.21	9	0.03		0.02		0.08		0.11		0.02		0.15	10	0.00		0.00	
Euphausia spp. (L)	0.04		---	---	0.01		0.00		0.01		0.04		0.10		0.00		0.00		0.00		0.00		---	
Euphausia triacantha	0.04		0.03		0.09		0.01		0.02		0.01		0.06		0.04		0.03		0.03		0.02		0.03	
Limacina helicina	0.02		0.63	8	0.06		0.00		0.00		2.21	6	0.00		0.03		0.00		0.01		0.00		0.00	
Euphausia frigida (L)	0.02		0.12		0.07		0.40	5	---		---		---		---		---		---		---		---	
Electrona spp. (L)	0.00		0.01		0.18		0.02		0.02		0.03		0.01		0.01		0.01		0.04		0.07	9	0.75	4
TOTAL	98.77		99.69		99.11		99.70		99.84		99.58		99.20		99.04		99.78		99.52		99.87		98.04	

Table 4.13. Percent Similarity Index (PSI) values from comparisons of overall zooplankton composition in the Elephant Island area during Surveys (A) A and (B) D, 1994-2005.

A.	JANUARY-FEBRUARY PSI VALUES										
Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1994	16.7	16.6	34.2	85.0	20.9	n.a	38.7	14.5	20.9	34.0	76.4
1995	xxxxx	70.3	76.8	18.7	80.7	n.a.	58.9	71.7	58.7	70.2	35.4
1996		xxxxx	73.4	19.3	70.0	n.a.	65.9	73.4	64.2	69.7	32.9
1997			xxxxx	38.4	80.2	n.a.	75.7	71.3	66.6	90.1	52.6
1998				xxxxx	22.6	n.a.	39.8	15.2	30.9	41.2	78.0
1999					xxxxx	n.a.	75.1	77.4	54.4	73.2	40.0
2000						xxxxx	n.a.	n.a.	n.a.	n.a.	n.a.
2001							xxxxx	69.2	54.4	74.6	56.7
2002								xxxxx	53.8	63.5	32.2
2003									xxxxx	70.3	36.7
2004										xxxxx	51.5

B.	FEBRUARY-MARCH PSI VALUES										
Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1994	42.4	66.9	60.1	22.9	78.4	61.8	74.9	86.4	80.4	85.4	53.1
1995	xxxxx	49.1	44.0	10.0	52.4	72.0	48.1	48.9	46.2	52.0	47.8
1996		xxxxx	54.3	21.1	80.3	67.0	80.9	74.1	76.4	74.8	48.6
1997			xxxxx	60.5	65.2	53.6	61.3	49.5	57.6	51.5	79.7
1998				xxxxx	27.7	15.5	26.2	12.0	25.6	14.0	52.5
1999					xxxxx	76.9	85.0	78.7	77.2	62.8	61.3
2000						xxxxx	71.0	70.0	62.9	54.2	53.6
2001							xxxxx	76.8	81.2	64.7	63.3
2002								xxxxx	82.5	80.2	43.2
2003									xxxxx	73.7	56.0
2004										xxxxx	46.6

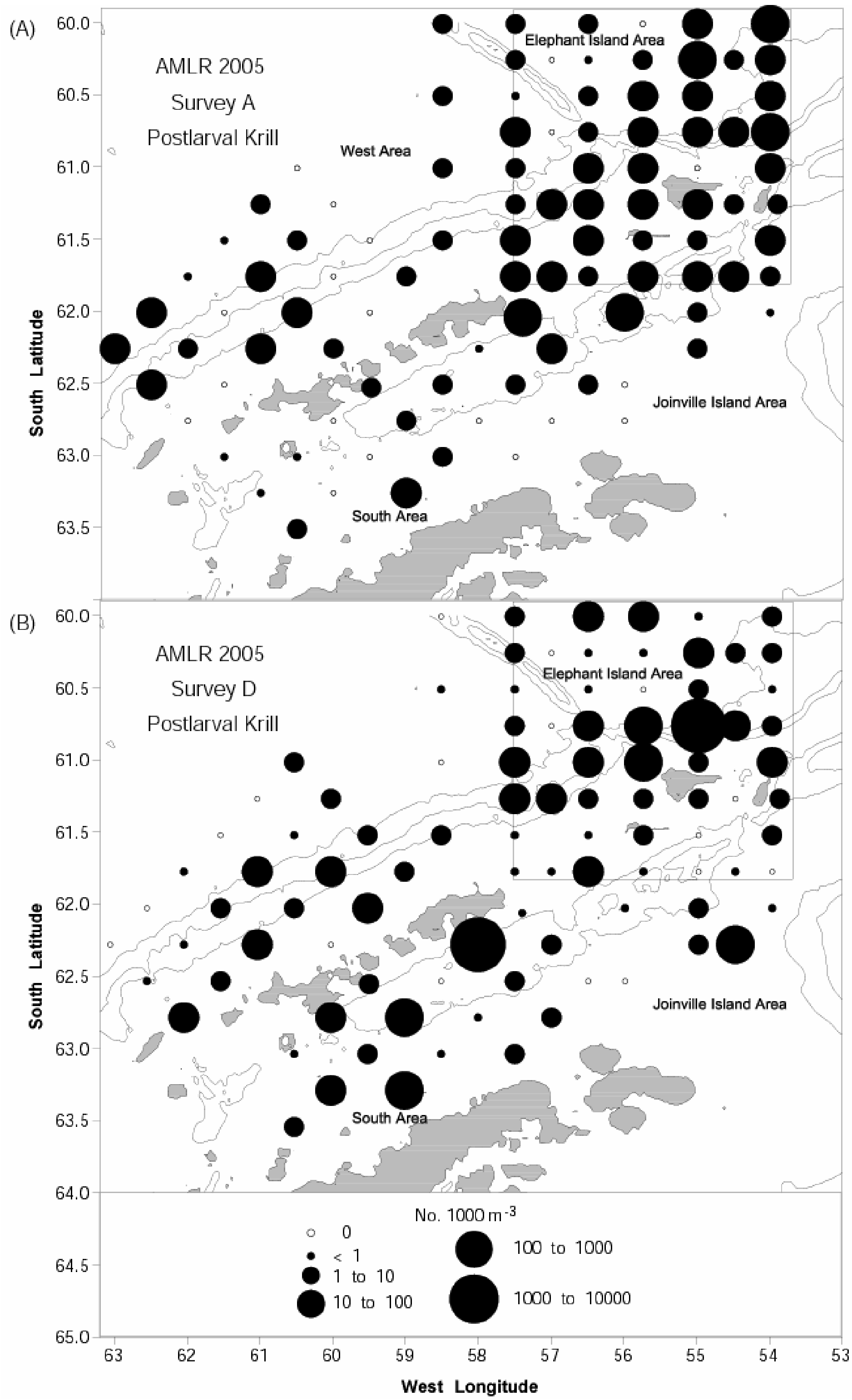

Figure 4.1. Postlarval krill abundance in IKMT tows collected during (A) January Survey A and (B) February-March Survey D, 2005. The outlined stations included in the Elephant Island Area are used for between-year comparisons. West, South and Joinville Island Area stations are indicated.

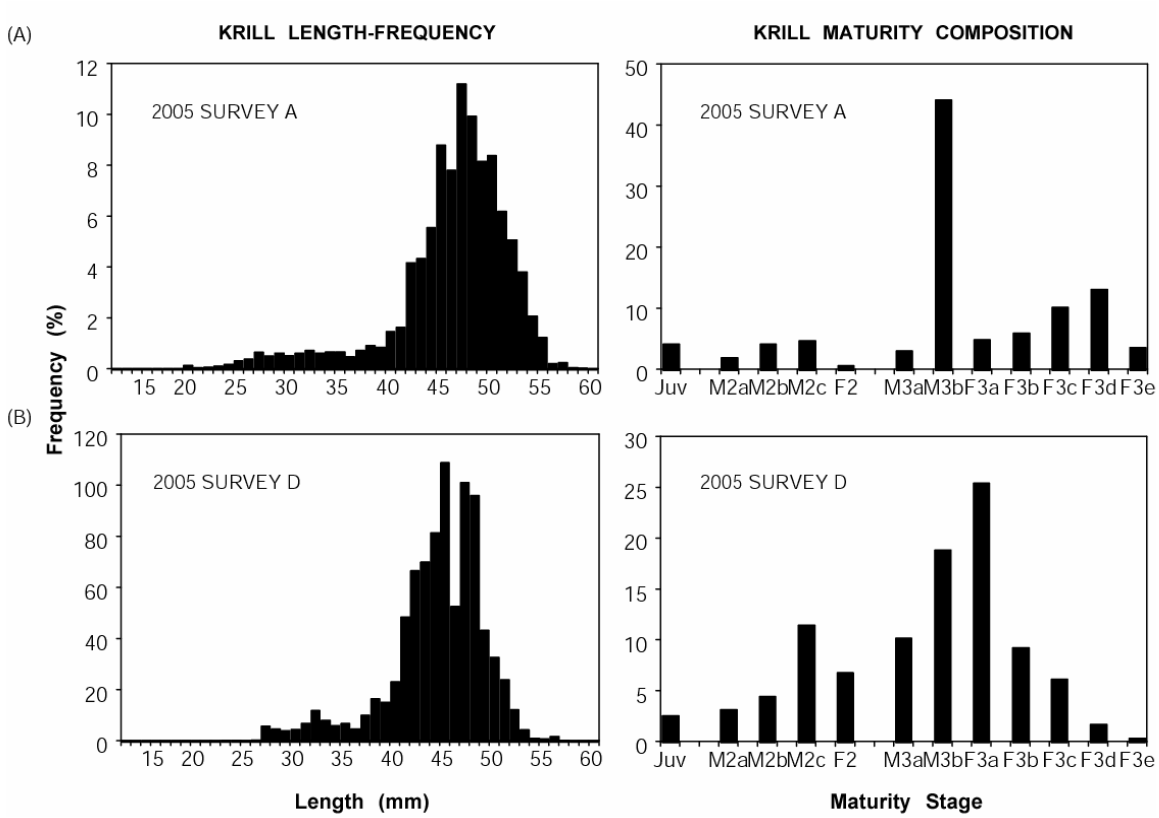

Figure 4.2. Krill length- frequency distribution and maturity stage composition during (A) Survey A and (B) Survey D.

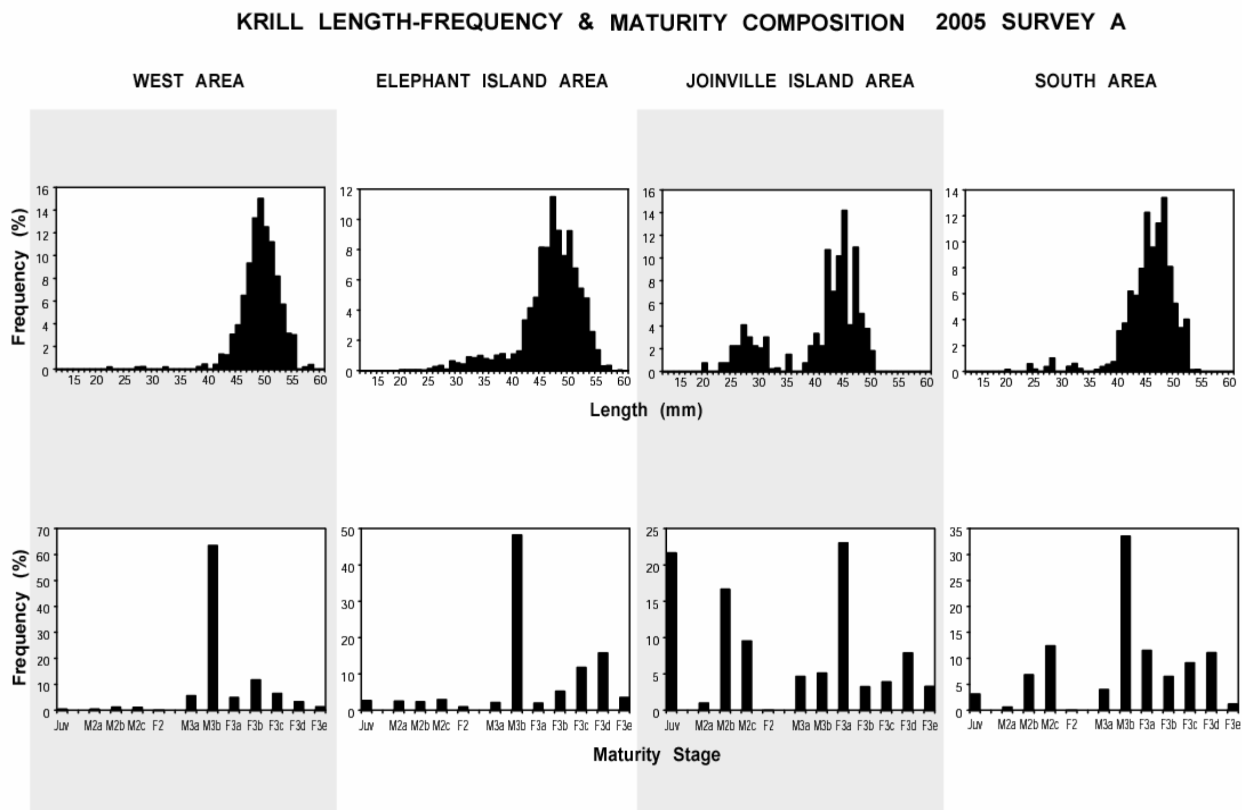

Figure 4.3a. Krill length- frequency distribution and maturity stage composition in the West, Elephant Island, South and Joinville Island Areas during the Survey A.

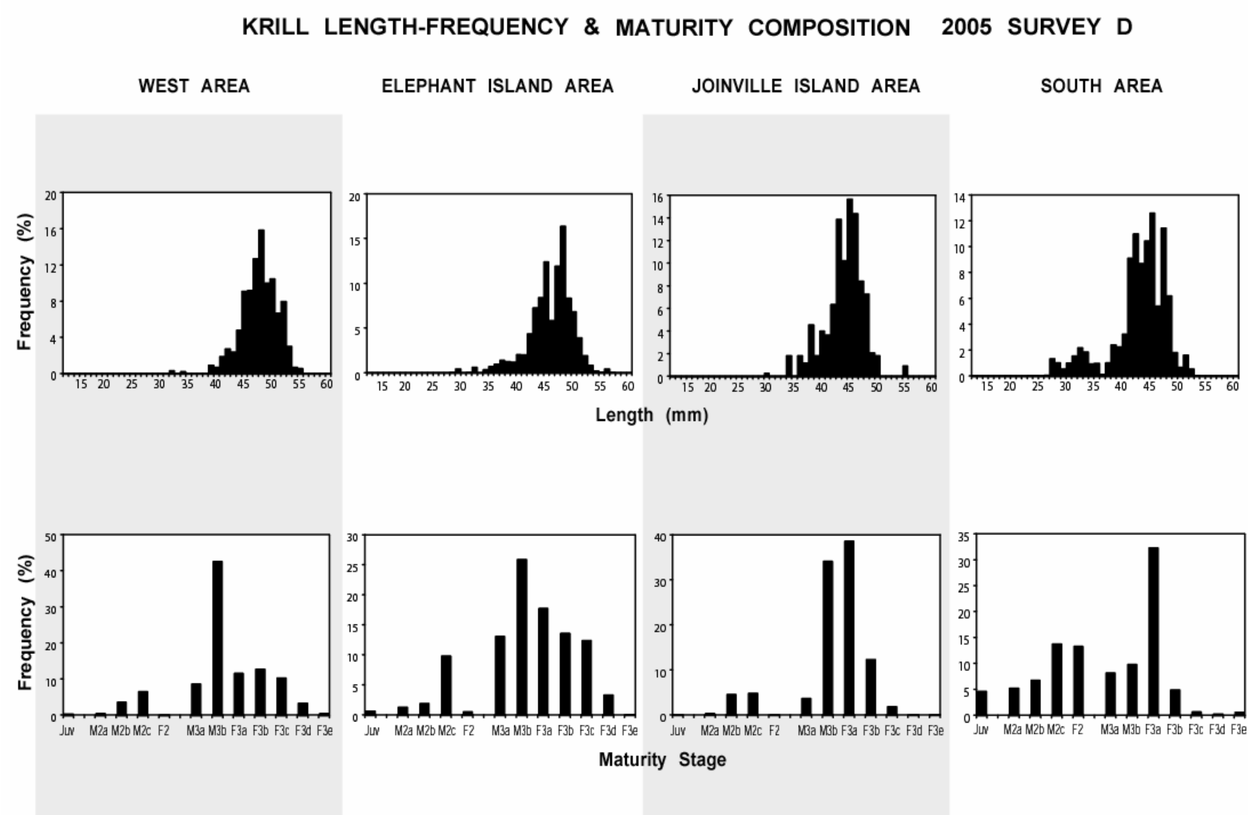

Figure 4.3b. Krill length- frequency distribution and maturity stage composition in the West, Elephant Island, South and Joinville Island Areas during the Survey D.

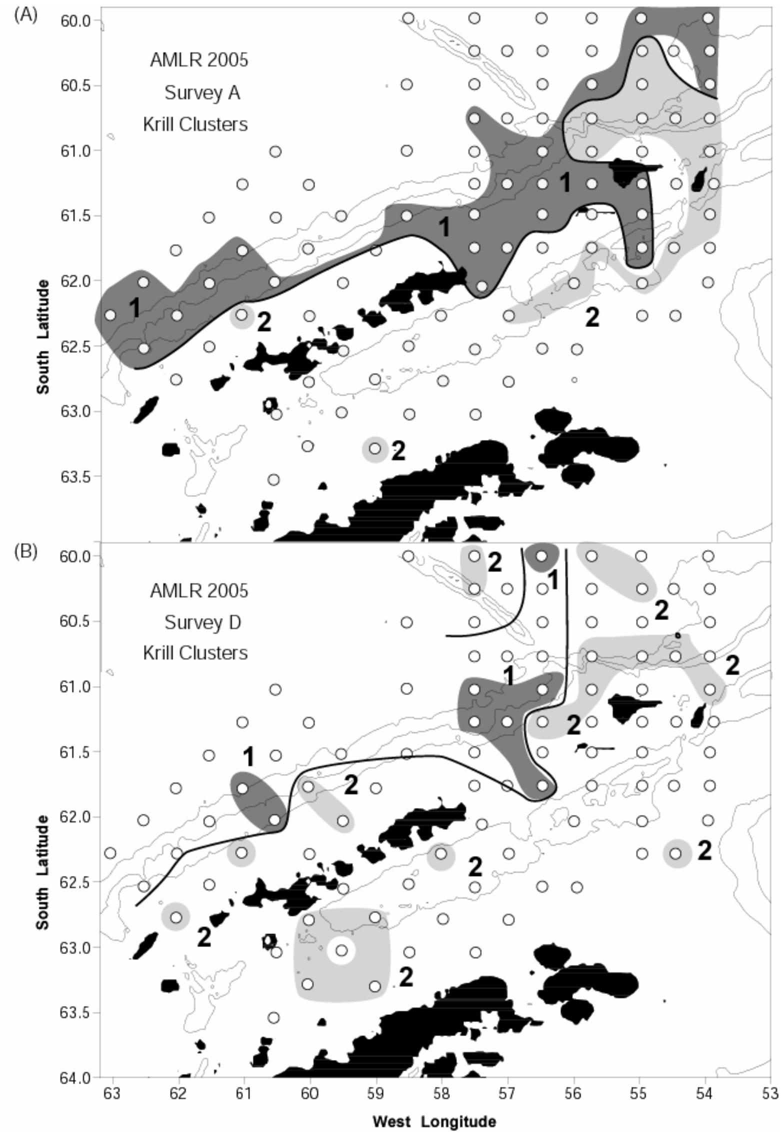

Figure 4.4. Distribution patterns of krill belonging to three length categories (Clusters) during the (A) January Survey A and (B) February-March Survey D.

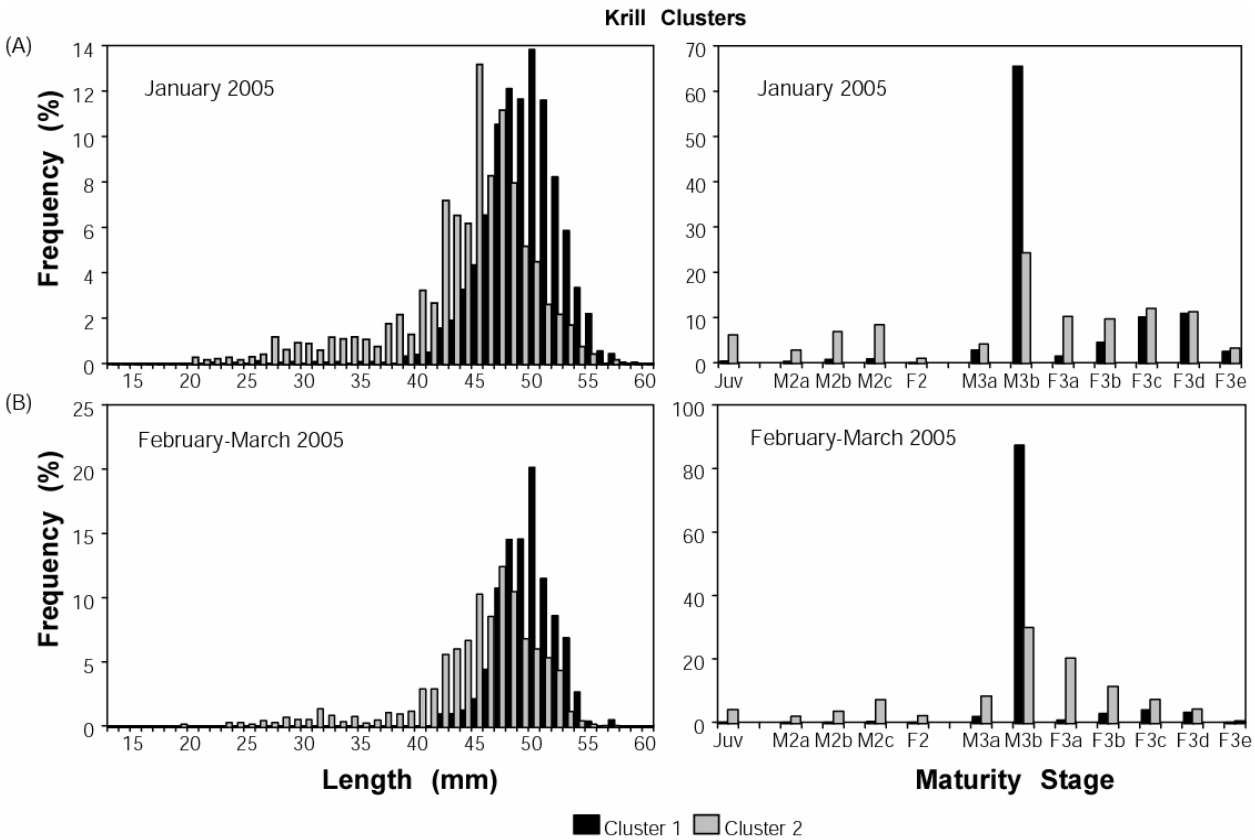

Figure 4.5. Length-frequency distribution and maturity stage composition of krill belonging to Clusters 1-3 during the (A) January Survey A and (B) February-March Survey D.

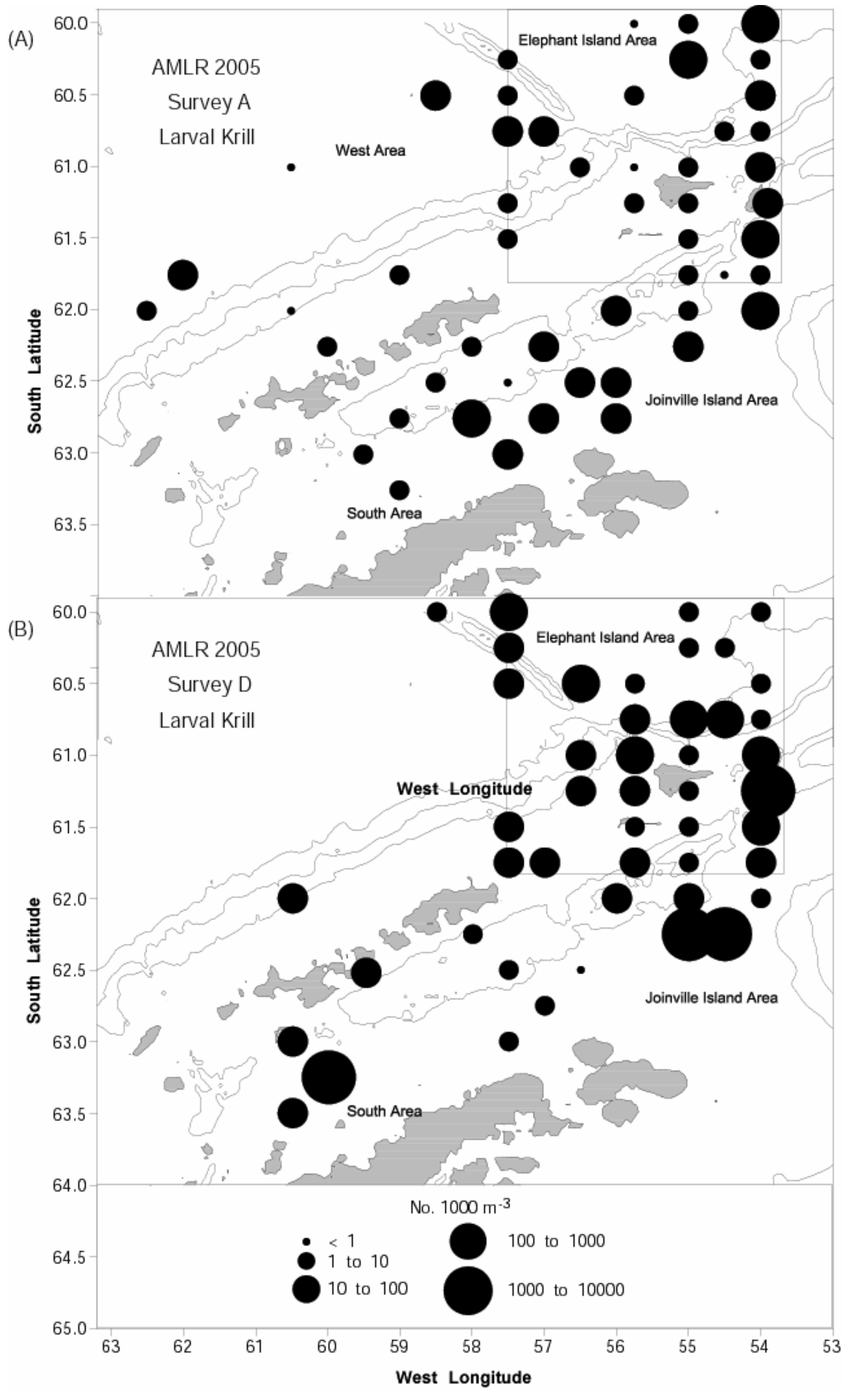

Figure 4.6. Distribution and abundance of Calyptopis and Furcilia stage krill larvae during the (A) Survey A and the (B) Survey D.

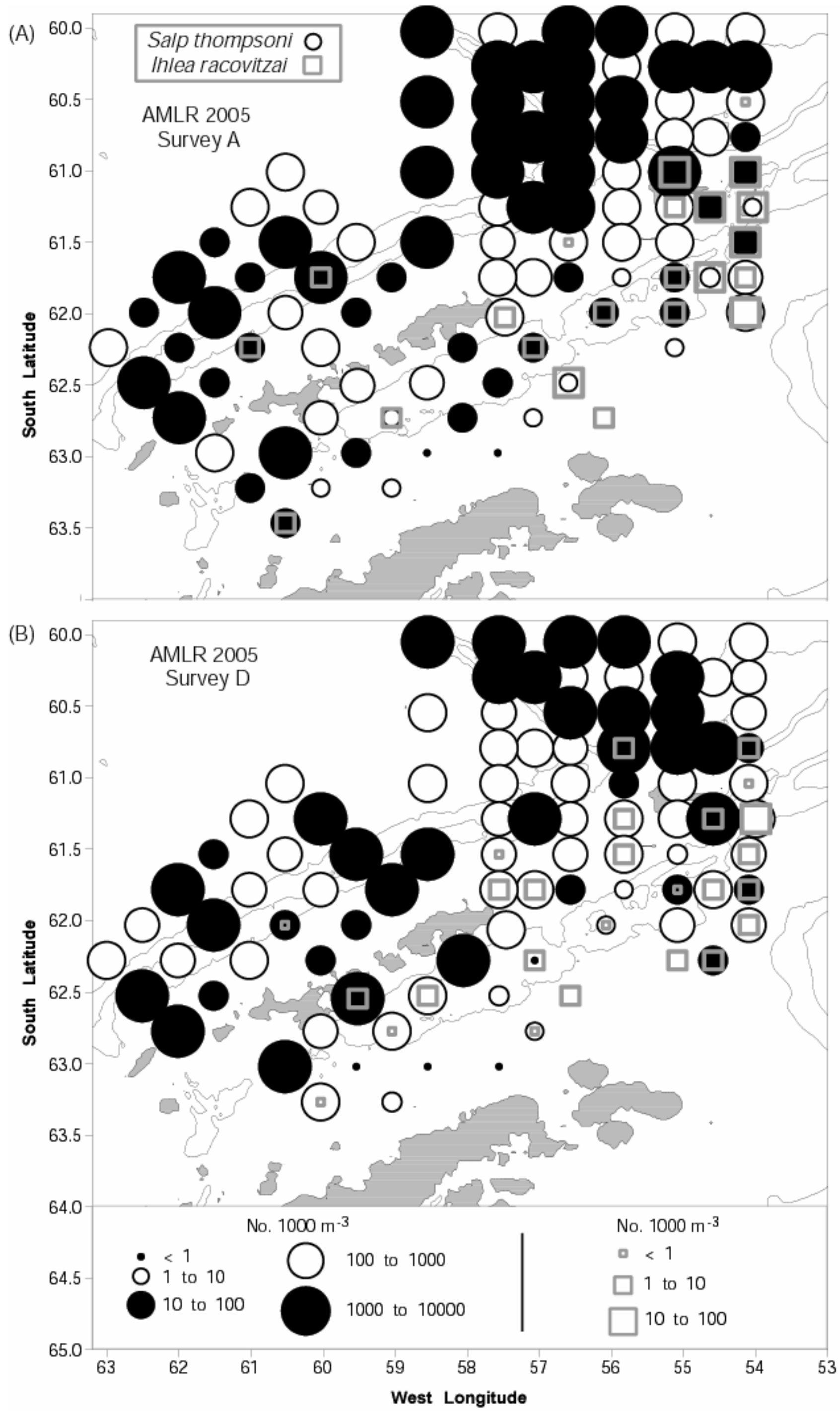

Figure 4.7. Distribution and abundance of *Salpa thompsoni* and *Ihlea racovitzai* during the (A) Survey A and the (B) Survey D.

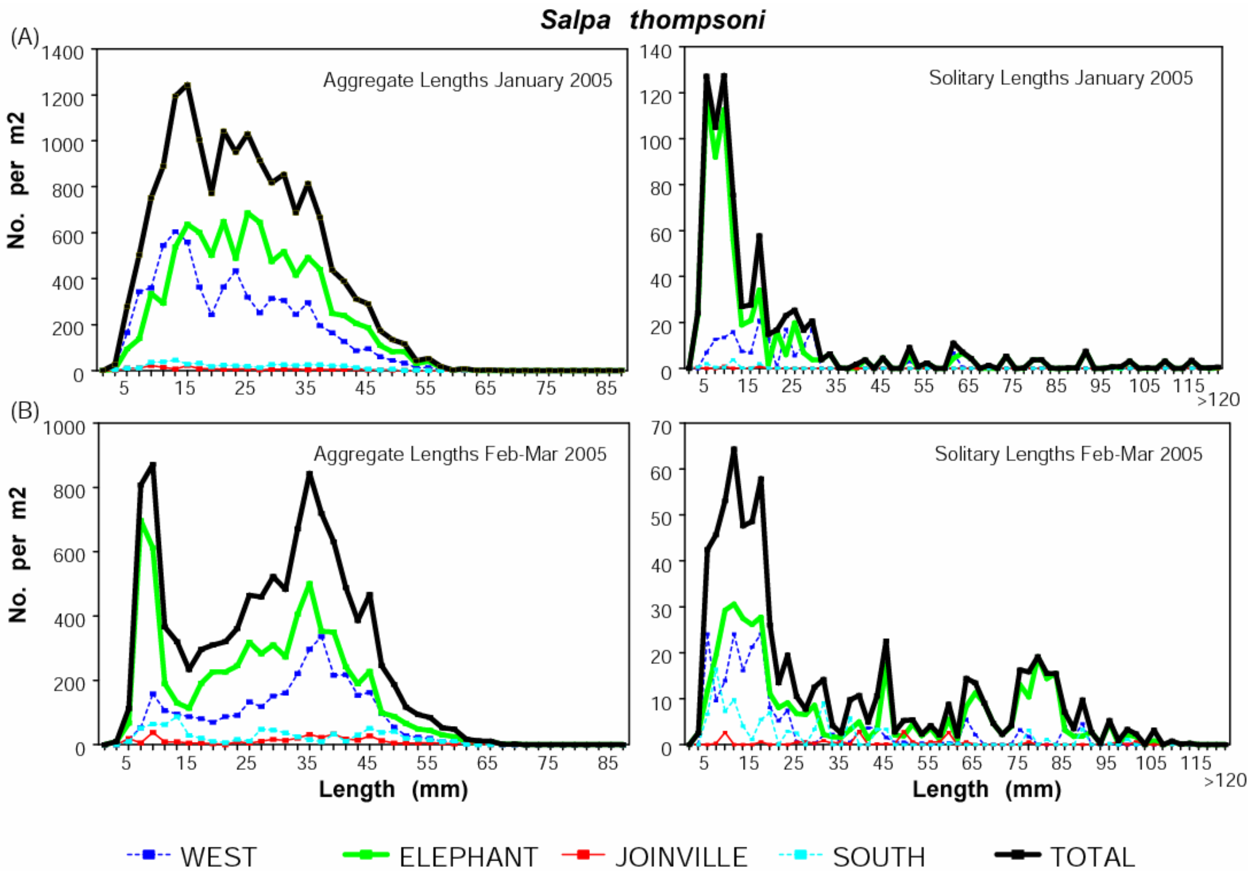

Figure 4.8. Length-frequency distributions of aggregate and solitary stage Salpa thompsoni in the large area survey and four subareas during the (A, B) January Survey A and the (C, D) February-March Survey D.

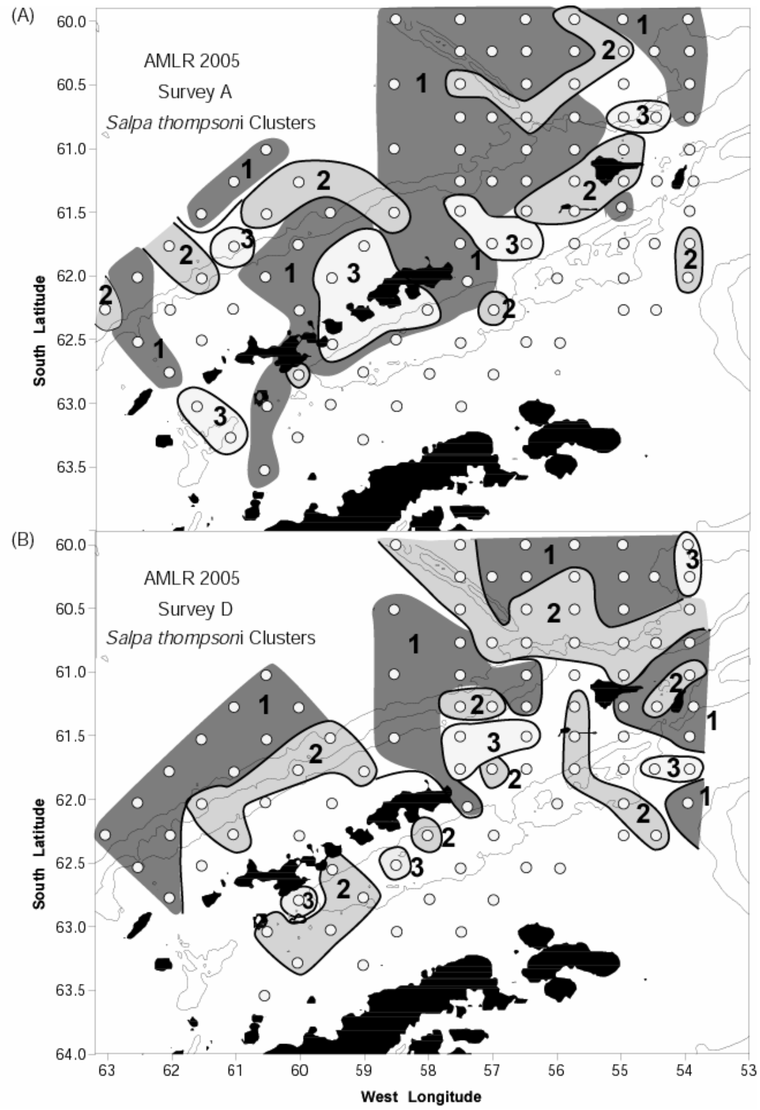

Figure 4.9. Distribution of aggregate salps belonging to two length clusters during the (A) Survey A and the (B) Survey D.

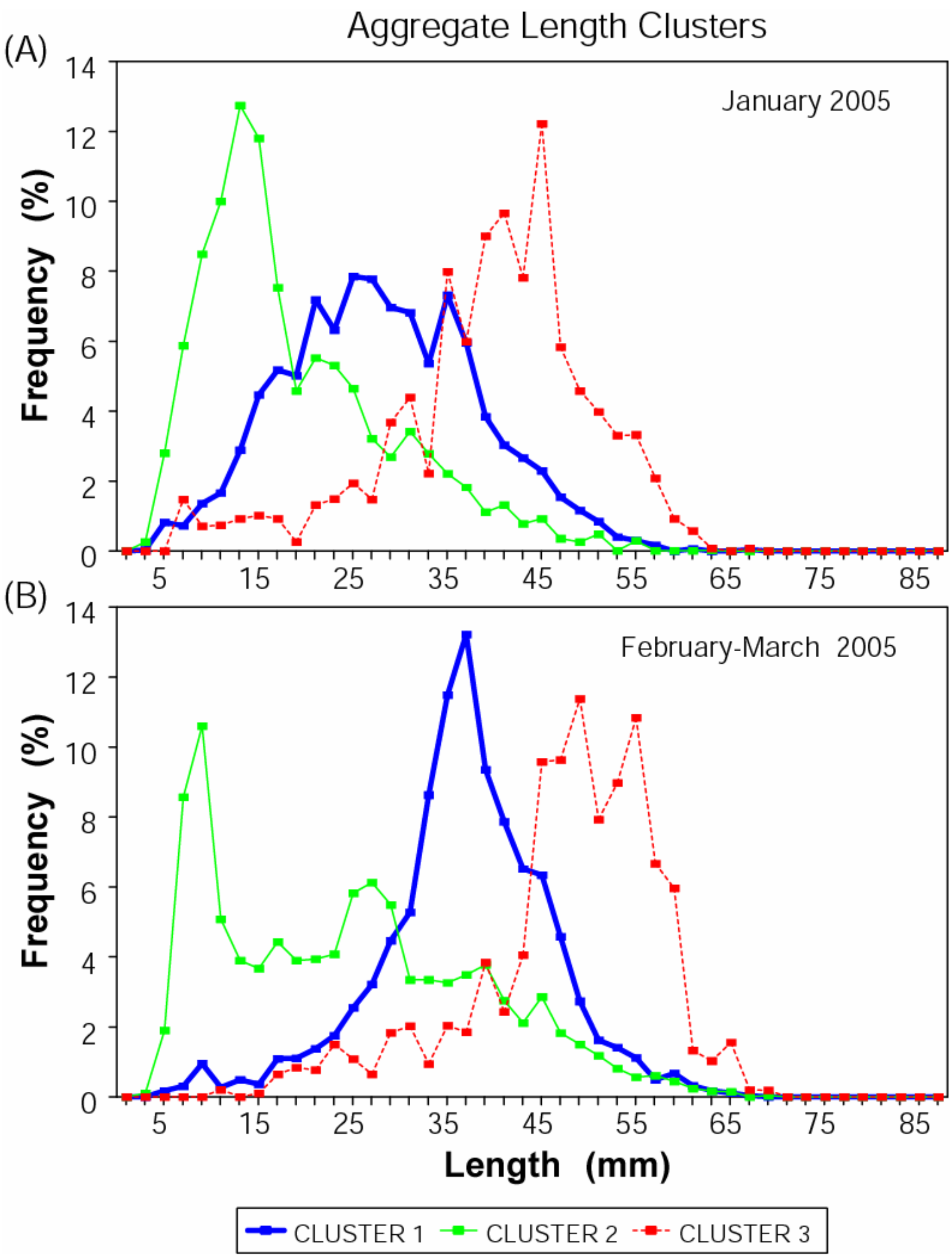

Figure 4.10. Length-frequency distribution of aggregate *salpa thompsoni* comprising three Clusters during the (A) Survey A and the (B) Survey D.

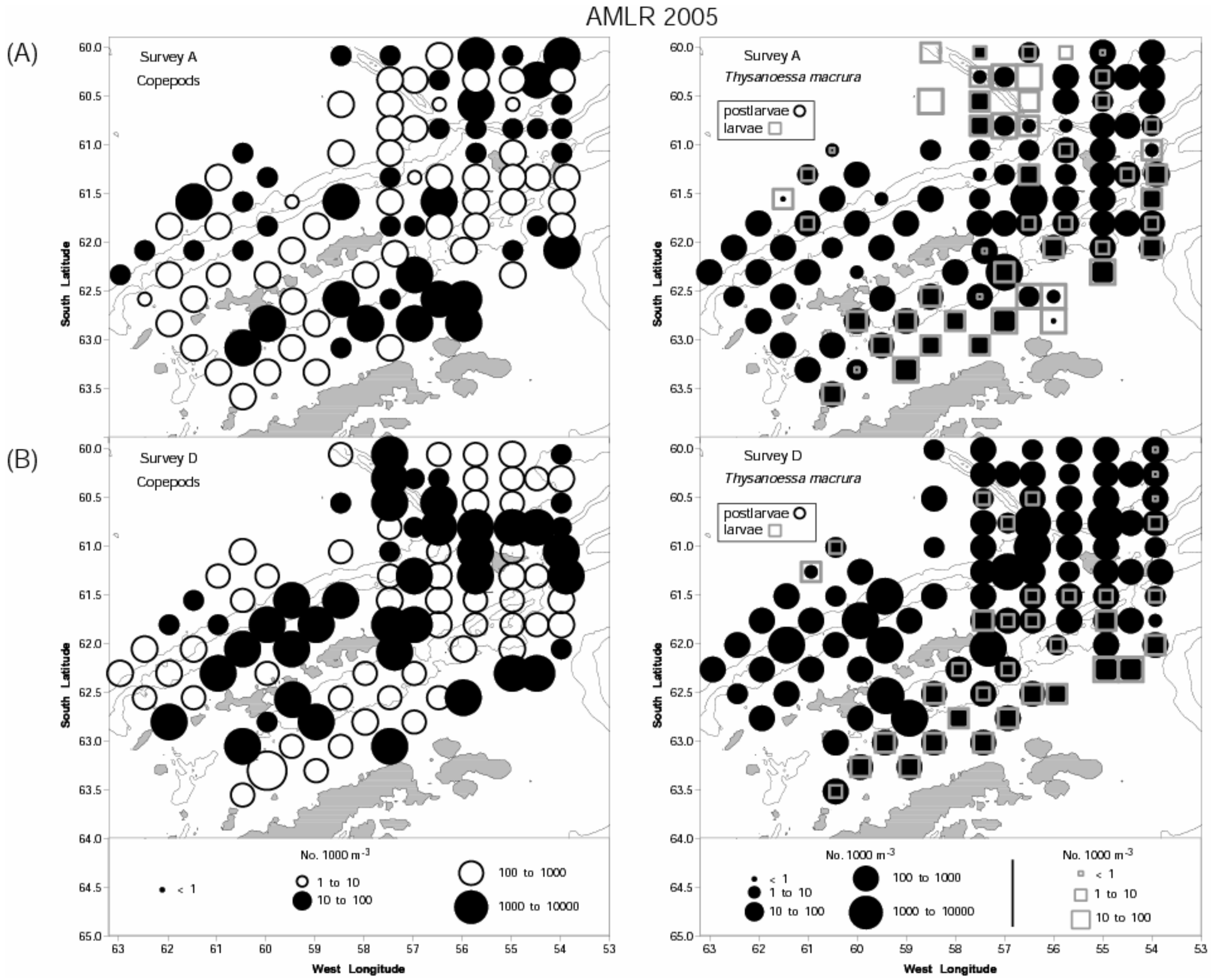

Figure 4.11. Distribution and abundance of copepods and postlarval and larval *Thysanoessa macrura* during the (A) Survey A and the (B) Survey D.

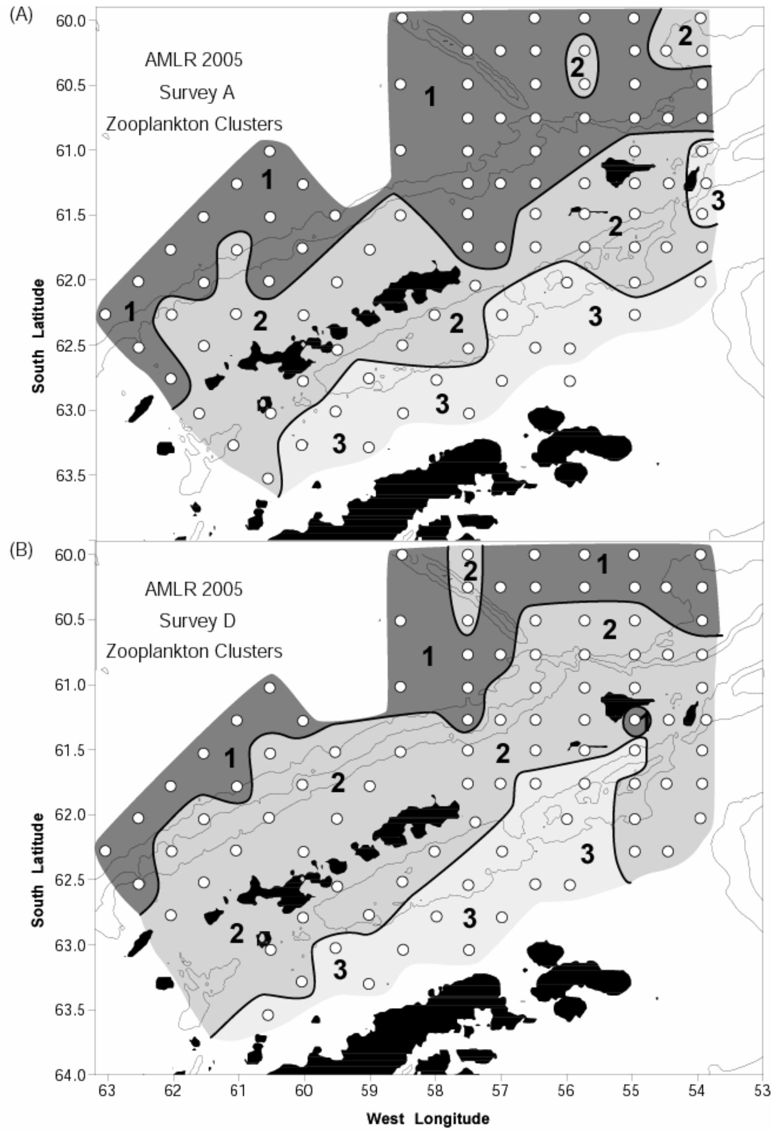

Figure 4.12. Distribution patterns of zooplankton taxa belonging to different station groupings (Clusters 1-3) during the (A) January Survey A and the (B) February-March Survey D.

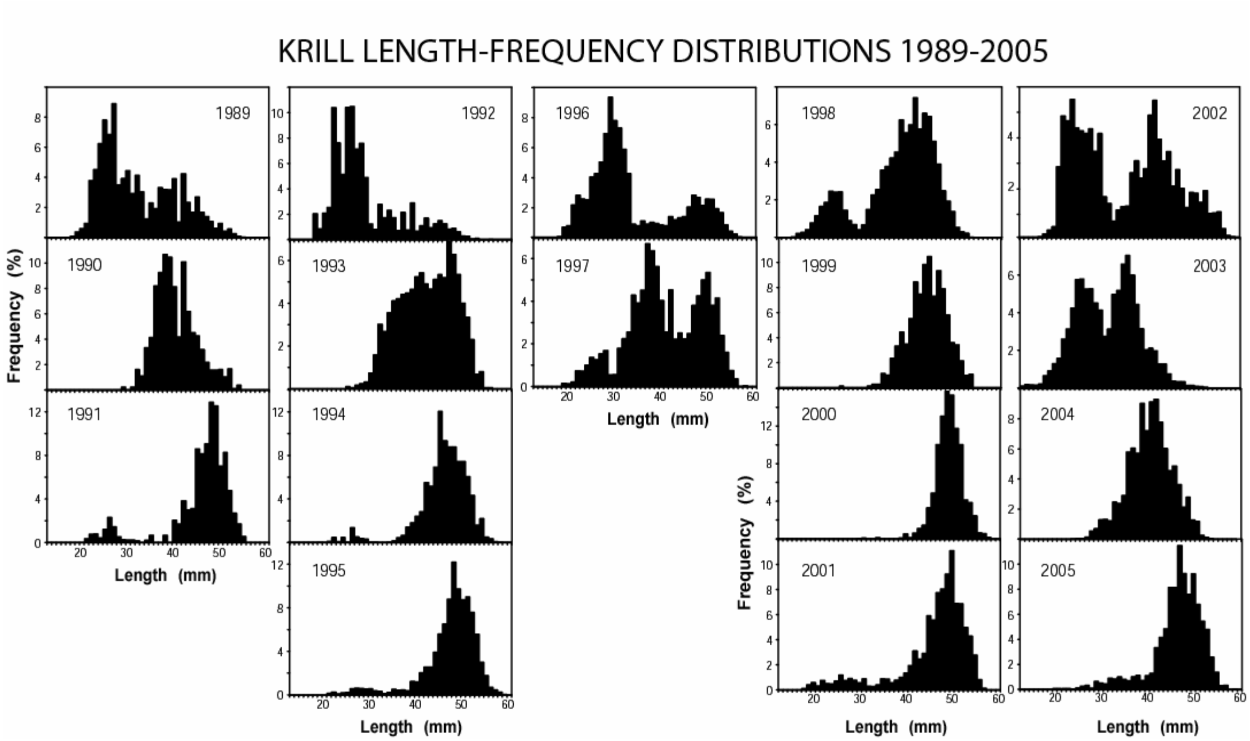

Figure 4.13. Krill length-frequency distributions represented in the Elephant Island Area during 1989-2005 showing temporal sequences of good and poor recruitment success. January-February surveys are used for all years except in 2000.

5. Nearshore Acoustical Survey Near Cape Shirreff, Livingston Island; submitted by Joseph D. Warren (Leg I), Steve Sessions (Leg I), Mark Patterson (Leg I), Adam Jenkins (Leg I), Derek Needham (Leg I), and David A. Demer.

5.1 Objectives: The nearshore area around Cape Shirreff serves as the main feeding ground for the seasonally resident fur seal and penguin populations at Cape Shirreff. These animals feed primarily on Antarctic krill, which aggregates in large swarms and layers in the waters just offshore of the island. Shallow and highly variable bathymetry makes this area unsuitable for study from large ships. Using a specially modified 19-ft Zodiac (R/V *Ernest* II), the near-shore region was surveyed, collecting acoustical backscatter, hydrographic and meteorological data. During this time, the R/V *Yuzhmorgeologiya* conducted a complementary survey of the shelf-break and eastern canyon areas (Figure 5.1). This survey overlapped coverage with that of *Ernest* and collected multiple frequency acoustic backscatter, hydrographic, meteorologic, and net tow data. All of these data sets were analyzed to study the relationships between the oceanography and biology of the area. It is believed that the two submarine canyons flanking Cape Shirreff serve as a source of deep, nutrient-rich water which increases the productivity of this nearshore area. Additionally, several instrumented buoys were deployed in the area near the mouth of the eastern canyon however technical complications resulted in the buoys being retrieved the same day they were deployed. An Autonomous Underwater Vehicle (AUV, Fetch 2, Sias-Patterson) was also deployed from a zodiac several times during the nearshore survey as a field test for more extensive deployments in future field seasons.

5.2 Methods and Accomplishments: Over 275 nautical miles were surveyed using *Ernest* from 1 to 10 February 2005 (Figure 5.1). *Ernest* is a Mark V 19-ft Zodiac powered by a 55-hp Johnson (Figure 5.2). She is equipped with multiple GPS, EPIRB, VHF radio, a WeatherPak 2000 meteorological station (measuring temperature, humidity, barometric pressure, bearing and apparent and true wind speed and direction), and a 38 and 200 kHz Simrad ES60 echosounder. GPS and meteorological data were recorded on a laptop computer on board the vessel. A surface temperature and conductivity sensor (SeaBird MicroCAT) was mounted to the transducer arm and collected measurements at a depth of roughly 1 m while *Ernest* was underway. The *Ernest* is also capable of deploying small nets or a video camera system for ground truthing the acoustic data. Two modified waterproof cases were used to protect and house data acquisition and processing systems (Figure 5.3). One case contained a battery bank supplying all power for the boat (2 12 V marine batteries), the ES60 echosounder processing unit, a DC/AC power inverter, and a 802.11g wireless network access point. The other case contained a 15” LCD screen, laptop computer with wireless card, GPS receiver, and a power inverter. Power was supplied from the battery case to the other case with weatherproof connectors, while all acoustic data was transferred to the laptop via the wireless network.

A stainless steel insert with a canvas and vinyl cover is mounted to the Zodiac floorboards to protect the equipment and personnel from the elements. The boat is also equipped with survival and tool kits, manual and automatic bilge pumps, three survival suits, four fuel tanks, binoculars, and anchorage equipment. The acoustic transducer is on a transom mount which locates the transducer approximately 1 m below the water line. The transducer can also be raised out of the water for quicker transit or rough sea state.

Ernest was deployed from *Yuzhmorgeologiya* on 1 February 2005 at approximately 1300 GMT. *Ernest* was taken into the Cape Shirreff cove anchorage location where mooring tackle was set-up, the WeatherPak installed and data acquisition systems tested. Around 1730, the boat was taken out of the anchorage location and the acoustic system was calibrated in 50 m of water using a 38.1 mm Tungsten Carbide sphere. We were able to acquire strong target returns from the sphere on the echosounder unit, however it was difficult to ascertain whether the sphere was centered in the acoustic beam given the nature of the calibration technique (lowering the sphere on a monofilament line from the side of the boat). After the calibration, the vessel began to proceed to one of the station locations to determine the amount of engine noise present on the echogram at various survey speeds. These operations were concluded and the vessel was anchored by 1930.

Subsequent operations were based from the field camp on Cape Shirreff. Surveys were conducted 2-9 February 2005 with the exception of 8 Feb 2005 when no *Ernest* operations occurred due to fog and concerns about remaining fuel. Boat operations began each day between 1000 and 1200 and concluded at 1800. Sea states were generally 1-2 m when close to shore or in the lee of Cape Shirreff, however offshore survey tracks regularly encountered sea states of 3-4 m. When seas reached 4 m, tracklines were adjusted so that the vessel was in more protected waters. Due to sea state and fog, the western canyon was again not surveyed this year, however two full surveys were completed of the eastern canyon. The new canvas/vinyl dodger on the *Ernest* made ship operations much more comfortable for the boat personnel.

On 10 Feb 2005, the *Ernest* was again taken into approximately 50 m of water and another acoustic calibration was conducted. The calibration sphere produced more numerous echoes than the pre-survey calibration, but again the location of the sphere in the beam pattern was somewhat unknown. The *Ernest* was brought aboard the *Yuzhmorgeologiya* around 1400.

The survey operations for both vessels were as follows:

Date	***Ernest Tracklines***	***Yuzhmo. Tracklines***
1 Feb 2005	Deployment, Calibration	Deployment, Calibration
2 Feb 2005	E5-6, Western part of East Canyon	East Canyon
3 Feb 2005	E7-8, Eastern part of East Canyon	East Canyon
4 Feb 2005	4 East-West transects	West Canyon
5 Feb 2005	2 E-W transects, video	Weathered Out
6 Feb 2005	E7-8, weathered out	West Canyon
7 Feb 2005	E5-6, Joint Yuzhmo ops	East Canyon
8 Feb 2005	Fogged In	East Canyon
9 Feb 2005	E7-8, AUV ops	West Canyon
10 Feb 2005	Calibration, Return to Yuzhmo	West Canyon, Recover *Ernest*

During the nearshore survey, the *Yuzhmorgeologiya* conducted forty CTD casts and 38 Isaacs-Kidd Midwater Trawls to collect zooplankton samples. The survey effort this year yielded the best coverage (by both boats) of the nearshore waters of Livingston Island with minimal time lost to sea state and weather conditions and no survey time was lost due equipment failures or malfunctions.

For the first time ever, the nearshore waters of the Southern Ocean were surveyed by a small autonomous underwater vehicle. The Fetch I AUV from Sias-Patterson, Inc. was deployed from the ship, zodiac, and shore. The 1.96 m long, 73 kg, seal-shaped AUV is equipped with a 600 kHz side-scan sonar, color video camera, CTD with oxygen sensor, and GPS. The AUV was used to conduct feasibility studies in the nearshore region of Cape Shirreff including: 1) use of side-scan sonar to survey epipelagic krill swarms; 2) use of color video to document the natural orientation distributions of krill; 3) use of side-scan sonar and an AUV to characterize possible avoidance reaction of krill to the survey vessels; and 4) use of a CTD and side-scan sonar to relate fine-scale physical oceanographic conditions to krill dispersion.

AUV operations were commenced in the vicinity of Livingston Island, South Shetlands, on 1 February, with the last day of AUV operations on 9 February. AUV operations were conducted every day during this period except Sunday, 6 February, when a weather window opened up and Derek Needham and Mark Patterson took advantage of sunny dry conditions to open up the vehicle, retrieve and replace the analog Hi 8 mm videotape, and recharge the Li-Ion battery for the internal Sony VTR.

The AUV dove 55 dives to depths as great as 70 m, and traveled an estimated 12.1 nm, while collecting 260 Mb of 600 kHz side scan sonar data, 4 hours of underwater video, and simultaneously logging conductivity, temperature, depth, bathymetry, and dissolved oxygen data at 2 Hz. AUV operations generally lasted 4 hours per day because of battery life limitations of the vehicle. AUV operations were conducted from the zodiac under varying conditions of rain, fog, high winds, and high waves.

The vehicle carried tags transmitting on 38 and 50 kHz, and locating the vehicle using the pinger locator proved essential on several occasions when visibility was reduced to 40 yards by fog, and when whitecaps rendered visual location problematic. It was also necessary to determine when the vehicle fins were knocked around during deployments, when the vehicle inadvertently hit the bottom in uncharted areas (the altimeter onboard cannot avoid collisions with vertical cliffs), and when marine algae had fouled the AUV’s propeller. It was also necessary to stay vigilant of leopard seals becoming overly interested in AUV operations and operators.

The AUV operations were conducted as follows:

Date	AUV Activities
1 Feb 2005	Loaded supplies onshore. Set up robot and charged it. AUV too buoyant. Practiced deploying AUV. AUV did not turn it on.
2 Feb 2005	Replaced the 18 VDC battery. Broke video power connector. Repaired same. Bent fins during launch and recovery. Four failed dive attempts due to positive buoyancy.
3 Feb 2005	Added 6 pounds of ballast, split between the stern and nose cone. In the

	morning, five failed dive attempts due to positive buoyancy. The sixth dive attempt was aborted due to a low voltage alarm (11.8 VDC) in the AUV and a low battery warning in Dell Inspiron 8100. In the afternoon, the first dive was aborted early due to altimeter dysfunction. Problem remedied by rebooting the AUV computer. Two short successful dives, then two dives aborted early due to low AUV voltage. Verified CTD, O2, and sidescan sensors functioning. Depth holding appeared to be OK in long-period one-meter swell conditions.
4 Feb 2005	Added 38 kHz pinger. Eight short dives; 82 minutes of video recorded during seven dives. Altimeter failed and system rebooted, again. Used 10 m setting on sonar.
5 Feb 2005	Added light sensor to the front of Fetch. First dive in the afternoon failed because the altimeter was reading the default value of 0.55 m. Seven short dives including straight legs and squares; some to 20 m. Some dives took longer than 30 seconds to surface. Serial/USB converter failed and prevented the use of Fugawi to track the surfaced AUV relative to the zodiac.
6 Feb 2005	AUV disassembled to retrieve video tape. Tape showed occasional single krill, salps, salp chairs, siphonophores, a brief view of dense krill swarm, and a dramatic crash into an uncharted seamount. Charged battery and replaced tape. Broke large ground connector on flight computer. Derek and Mark made repairs. AUV opened and closed three times due to various problems seating serial connectors.
7 Feb 2005	Followed *Ernest* out to rendezvous with *Yuzhmo* several miles offshore near east canyon in about 240 m of water. *Ernest* saw krill from 50-100 m. Two AUV dives attempted to 50 m, but AUV surfaced early due to sonar interpreting krill layer as bottom closer than 7 m. Real bottom circa 140 m. After adjusting the algorithms, dove the AUV 5 more times to about 50 m using different sonar settings. Saw lots of whale spouts and penguins in the vicinity.
8 Feb 2005	Swam the AUV in the cove under surface control with video on, then dove the robot very shallowly coming out of cove to document benthos with video camera. Then, offshore, did more regular dives with video and side scan until batteries ran low.
9 Feb 2005	The AUV did not charge overnight. Charged the AUV in the afternoon and then went offshore in a fog. Rendezvoused with RV *Ernest* to investigate possible boat avoidance behavior of krill. Four runs were attempted where the AUV lead and RV *Ernest* followed. On one attempt, the AUV was fouled with arborescent kelp and could not dive. On the third attempt, the lower rudder malfunctioned and sent the AUV off course. The second video tape was completely blank due to an undetermined malfunction.

It was also necessary to develop a scheme for launch and recovery of the AUV from the Zodiac. Ultimately, this consisted of dead-lifting the vehicle onto the Zodiac pontoon while avoiding damage to the rear rudders and stabilizers, and then artfully sliding the vehicle backward into the water in such a way as to avoid deranging control surfaces. The vehicle would sink to a depth of

5-7 m, and then float back to the surface. During this period, Jenkins would move the Zodiac so that the AUV didn't skewer the boat. Recovery consisted of backing down on the AUV, using a boat hook to draw it along side, Patterson then would grab it by the side scan transducer, and tilt it tail down, head up, and all would hoist it back up on pontoon, followed by a rotation and twist lift back onto its carrying frame. Transits were generally accomplished with the AUV not secured, except by its considerable weight, to the frame. However on two occasions, wave conditions and transit distance required that the AUV be secured with boat straps.

5.3 Results and Tentative Conclusions: Initial results from the 2005 nearshore survey are similar to previous years. There were many large aggregations of scatterers at the edges of the canyons often in waters between 100 and 150 m in depth. From video observations from the *Ernest*, net tow data from the *Yuzhmorgeologiya*, and multiple frequency acoustic discrimination from both vessels, these scatterers are identified as krill. The presence of these patches was often coincident during the survey with observations of penguins, fur seals, and humpback whales from the *Ernest*.

Integrated acoustic backscatter from the 200 kHz echosounder from the RV *Ernest* shows similar spatial patterns as the results from the 120 kHz backscatter surveys during 2000 and 2002 (Figure 5.4). Volume backscattering coefficients at 200 kHz were integrated over the upper water column from 5 m below the surface to the shallower of 3 m above the bottom or 100 m. Furthermore, the 200 kHz data was only integrated in areas where the relationship between backscatter at 38 and 200 kHz was indicative of krill (Brierley *et al*., 1998, *Deep Sea Research II* 45, pp. 1155-1173). Backscattering was averaged over 0.1-nautical miles of survey distance to produce NASC (Nautical Area Scattering Coefficient) values which are proportional to the density of krill. As was seen in the 2000 and 2002 surveys, the highest concentrations of scatterers were found in the near-shore region southeast and east of Cape Shirreff. High levels of scattering were also found along the canyon walls. Scattering level magnitude was smaller than previous years, but this is likely due to the lower noise levels in the 200 kHz data than the 120 kHz echosounder in 2002 and 2004.

The acoustic backscatter data from the *Yuzhmorgeologiya* was processed in a similar manner; although the integration was done over 1 km horizontal bins and the 120 kHz NASC data are shown (Figure 5.5). The *Yuzhmorgeologiya* survey showed the presence of large amounts of scattering in the nearshore waters, particularly on either side of Cape Shirreff. Patches of scatterers were abundant both within the canyon heads and along the shallower nearshore waters.

From the 2005 nearshore survey net tow data from *Yuzhmorgeologiya*, the acoustical targets are dominated by the euphausiids *Euphausia superba*, *Thysanoessa macrura* and *Euphausia frigida*. Additional contributors to the acoustic backscatter include: salps, siphonophores, larval fish, myctophids, and amphipods.

CTD casts taken by the R/V *Yuzhmorgeologiya* covered the entire survey area with multiple casts at each station location over the course of the week (Figure 5.1). Potential temperature (Θ) and salinity are plotted for all stations to determine if Circumpolar Deep Water was present. Previous cruises had shown evidence of deep water intrusions moving up the canyons towards the nearshore waters and surface upwelling of Upper Circumpolar Deep Water has been linked to increased productivity by other studies (Prezelin *et al*., 2000, *Journal of Marine Research* 58, pp.165-202). The CTD data had hydrographic characteristics of Circumpolar Deep Water as defined by Klinck *et al*. (2004, *Deep-Sea Research II* 51, pp. 1925-1946) (Figure 5.6). However it should be noted that all the hydrographic profiles that showed evidence of CDW were from the furthest off-shore stations of each transect (near the 500 m isobath). Therefore if the CDW water is migrating up the canyons to the nearshore area, it is most likely mixing as it moves and in the process loses the Θ–S characteristics. The hydrographic data from the *Ernest* was collected from a depth of 1m and given the wind and sea conditions during the nearshore survey; this portion of the water column is definitely well-mixed as well as being strongly affected by air temperatures. The nearshore waters of the eastern canyon had temperatures that varied greatly, however surface salinities showed the presence of freshwater in the southeast corner of the survey area which is likely the result of glacial runoff.

IKMT net tow data were collected at almost all stations along the western, middle, and eastern canyon transects (Figure 5.1). As expected, euphausiids, copepods, salps, and larval fish were the most common animals found (Figure 5.7) and occurred in numerical densities up to several animals per cubic meter (copepods, krill, and salps). The most common species for various zooplankton types were: krill (*E. superba, T. macrura, and E. frigida)*, copepods (*M. gerlachei, C. acutus, C. propinquus*, *R. gigas* and *Pareuchaeta spp.)*, salps (*S. thompsoni*), amphipods (*C. lucasii, P. macropa, and T. gaudichaudii*), chaetognaths, siphonophores, larval fish (*L. larseni, N. coatsi*, and *T. scotti*), and gastropods (*S. australis*, and *C. limacina*). Adult krill (*E. superba*) were nearly 5 cm in length, while salps (*S. thompsoni*) were typically between 3 and 6 cm in length.

Euphausiids, salps, and larval fish were found in higher densities in the offshore waters, while copepods had slightly higher densities in the nearshore areas. It is important to note though that these differences may be a result of the net tow sampling occurring continuously through the day and night so animals that vertically migrate during the day would be more likely to be found in the deeper waters.

Weather conditions were fair during the 1 – 10 February 2005 survey period (Figure 5.8). The meteorological data collected by the WeatherPak 2000 system aboard the *Ernest* shows that wind speeds were generally in excess of 5 m/s. Wind direction was variably but most often from the northwest and southwest. True wind speed and direction were calculated from the apparent wind speed and direction and the speed and course of the R/V *Ernest*. The humidity sensor often gave readings > 100% and is believed to have a 10-15% offset. Temperature was generally between 2^{o} C and 4^{o} C. The sea state was typically 2-3 m and occasionally up to 4-6 m. Typical survey speeds were 5-kts and an average of 8 hours per day were spent on the water.

Most AUV surveys were conducted within 1-2 nm of the cove near the Cape Shirreff camp in 50 –85 m of water, in areas of dramatically changing topography. Penguins and seals and whales were observed diving in these areas, and one krill swarm was successfully imaged during the first 2 hours of video, along with some salps. The AUV also filmed a kelp covered underwater pinnacle that it collided with inadvertently, as the AUV altimeter did not detect the change in bathymetry until it was too late!

On 7 February, the AUV team rendezvoused with the *Ernest* Zodiac offshore in 240 m of water during the simultaneous runs with the R/V *Yuzhmorgeologiya*. The *Ernest* located a putative large krill swarm at a depth of 50-100 m. Upon arrival, it was determined that the AUV altimeter was actually seeing the krill layer as a false bottom, as the real bottom lay beyond the range of its altimeter (approximately 170 m). This proved valuable during these dives, as the krill layer appeared to successfully shallow as the team surveyed in a NW direction, with the krill layer coming as shallow as 20 m. The AUV was dived repeatedly through the krill layer, with the side scan sonar on 5, 10, 20, and 50 m range (each side) settings.

The video made concurrent with sidescan sonar observations provided a view of the krill swarm (identified by Dr. Valerie Loeb, pers. comm.). The sidescan data showed many “swarm like” patches. At different times, the camera also recorded salps, salp chains, and an unintended collision with the bottom. A detailed analysis of side scan imagery correlated with video imagery is still ongoing, but it appears that krill are seen as patches in the side scan images. They appear in a manner similar to swarms of smaller fishes seen in other ecosystems and thus it appears that krill can be detected at 600 kHz using side scan from an AUV.

On the last day of AUV operations, the *Ernest* again rendezvoused with Zodiac I, in the fog, and we conducted several runs where the AUV was sent on a heading for 8 minutes, and shortly after the AUV left the surface, the *Ernest* followed behind. These runs are an initial attempt to see whether there is any avoidance reaction to the ER60 echosounder and small boat, vs. the passage of the AUV.

Plans for data analysis include volumetric graphing of the water column temperature, salinity and oxygen, and examination of krill abundance as detected by side scan and Hi 8 mm video, and whether there is any evidence for avoidance behavior. On the second to last day of ops, several dives where devoted inshore to attempts to make usable images of the bottom, that is, benthic mapping, using the underwater camera. But as noted above, the video camera failed in some way.

Finally, it was determined that the Chilean map made in the 1950’s has positional errors approaching 1/4 nm. An offset was measured using the Fetch1 and Zodiac I GPS units, so that latitude and longitude offsets can be applied to future AUV missions near the Cape Shirreff coastline.

5.4 Disposition of Data: Data are available from David A. Demer, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA 92037, USA; phone/fax +1 (858) 546-5603/5608; email: david.demer@noaa.gov or Joseph D. Warren, Southampton College, 239 Montauk Hwy, Southampton, NY 11968, phone/fax +1 (631) 287-8390/287-8419; email: joe.warren@liu.edu.

5.5 Acknowledgments: We are indebted to the scientists and crew aboard R/V *Yuzhmorgeologiya* for keeping a watchful eye over R/V *Ernest* and crew, and for collecting CTD, acoustical, and net tow data during the survey. We would also like to thank the personnel of the Cape Shirreff field camp for their hospitality during our stay at their home. Additional support for this project was provided by NSF Office of Polar Programs Grant 03-38196.

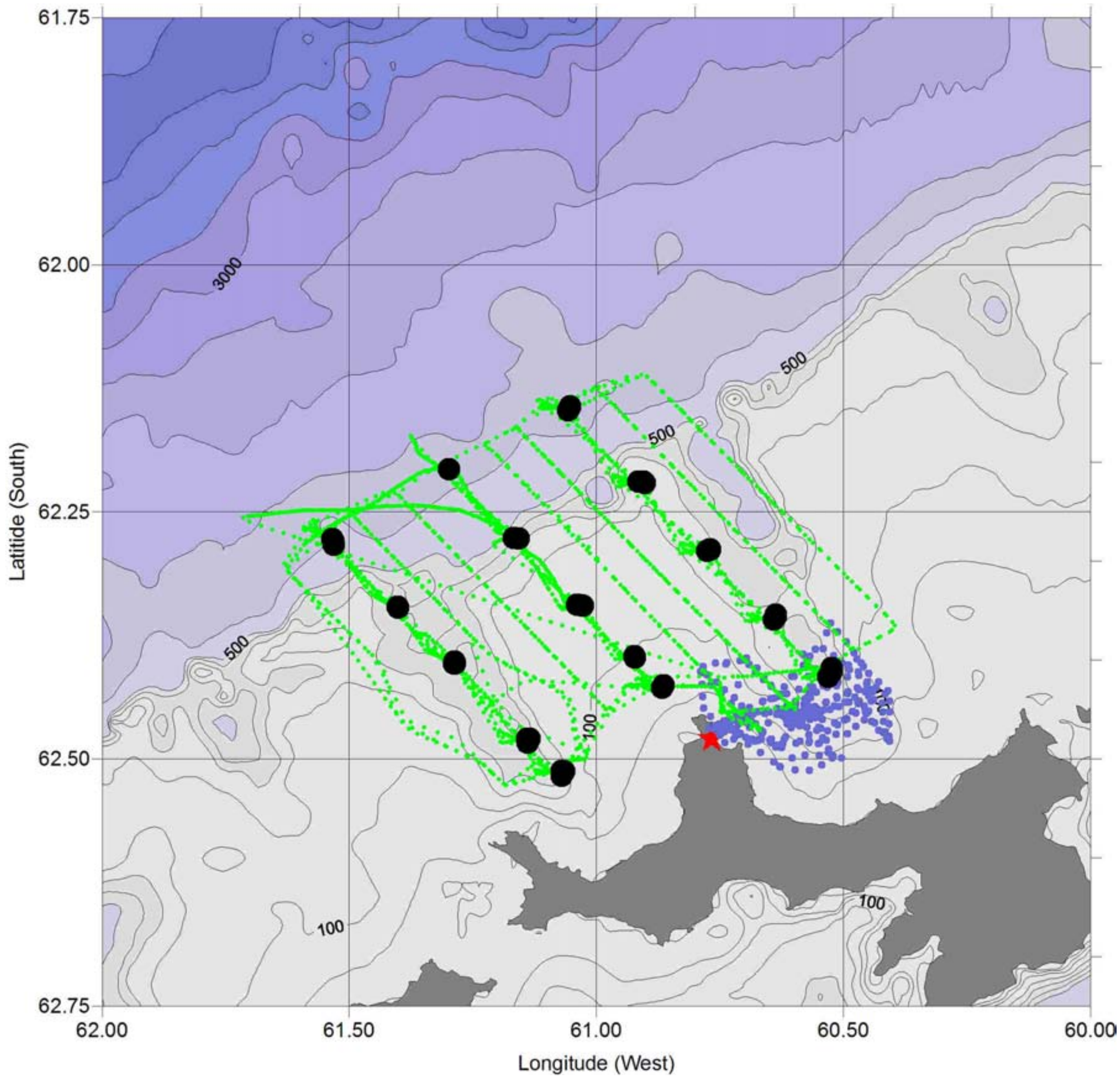

Figure 5.1 Completed track lines of the R/V *Yuzhmorgeologiya* (green) and R/V *Ernest* (purple) during the 01-10 February 2005 AMLR Nearshore Survey of Cape Shirreff. Black circles indicate the locations of CTD and IKMT stations.

Figure 5.2 R/V *Ernest* moored at the protected beach immediately north of the Cape Shirreff field camp. (Photo by Steve Sessions)

Figure 5.3 The two waterproof cases containing all of the equipment necessary to power (left), view (middle), collect and process (right) the acoustic, meteorologic, and hydrologic data from the RV *Ernest*.

Figure 5.4. Fetch1 AUV off of Livingston Island, South Shetland Islands, Antarctica. (Photo by Steve Sessions)

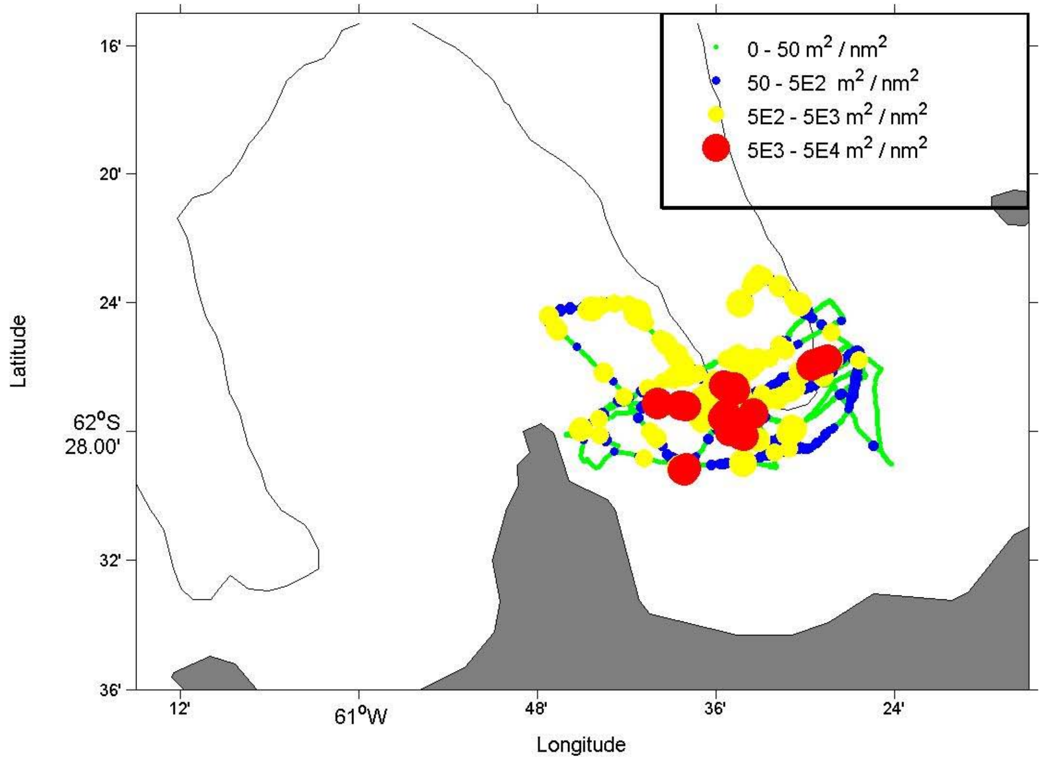

Figure 5.5 Volume backscattering coefficients at 200 kHz integrated from 5 m depth to either 3 m above the bottom or 500 m if no bottom present and averaged over 0.1 nautical mile bins (Sa). Elevated backscatter (indicative of the presence of krill) occurred in the areas immediately east and southeast of Cape Shirreff and throughout the canyon region particularly along the canyon boundaries. The 200 m isobath is shown in black. Scatterers were identified as krill by video data collected by the *Ernest*, multiple frequency acoustic discrimination, and net samples from the *Yuzhmorgeologiya*.

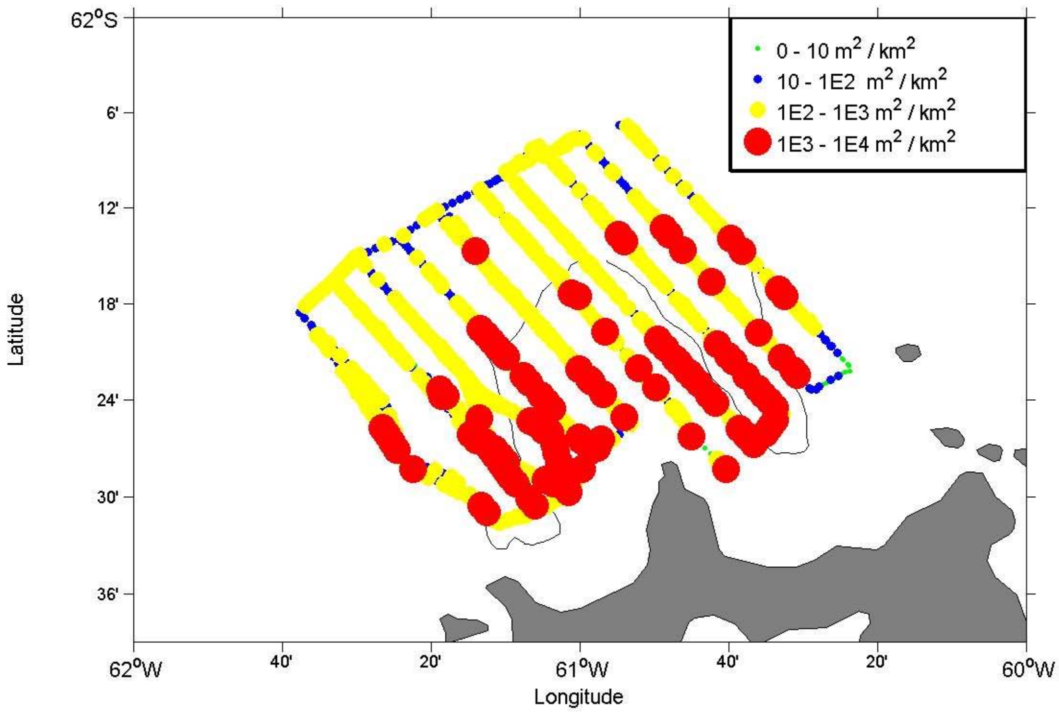

Figure 5.6 Volume backscattering coefficients at 120 kHz integrated from 5 m depth to either just above the bottom or 500 m if no bottom present and averaged over 1 km bins (Sa). Elevated backscatter (indicative of the presence of krill) occurred in the areas immediately east and west of Cape Shirreff and throughout the canyon region particularly along the canyon boundaries. The 200 m isobath is shown in black. Scatterers were identified as krill by multiple frequency acoustic methodologies and net samples from the *Yuzhmorgeologiya*.

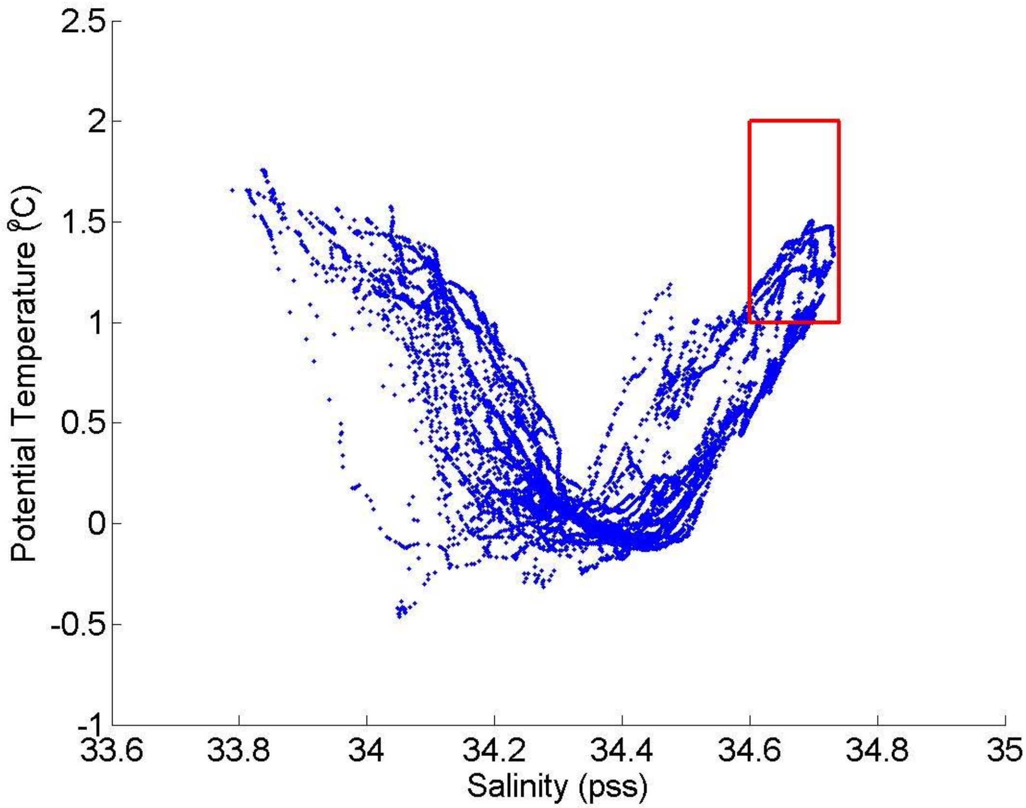

Figure 5.7 Theta-S plot for the CTD casts from the RV *Yuzhmorgeologiya* during the nearshore survey. The box indicates water that meets the criteria of Circumpolar Deep Water (CDW) as specified by Klinck *et al*., 2004, *Deep-Sea Research II* 51, pp. 1925-1946. CDW was only found at the CTD stations furthest from the island, along the 500 m isobath.

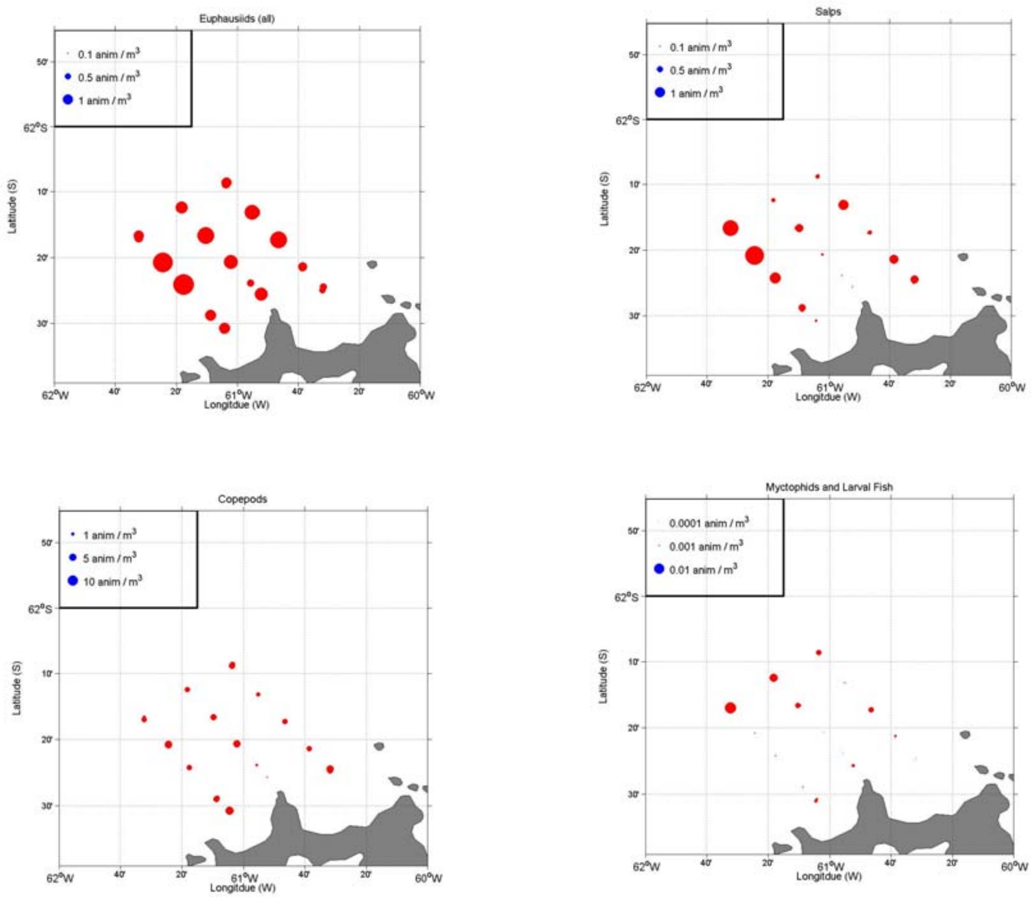

Figure 5.8 Distribution of euphausiids (upper left), salps (upper right), copepods (lower left), and fish (lower right) from IKMT new samples collected by the RV *Yuzhmorgeologiya* during the 2005 nearshore survey. The diameter of the circles correspond to numerical densities of animals per m^3, but are different for each image. Salps, euphausiids, and fish were found in higher densities off-shore, while copepods had slightly higher densities in the nearshore waters. A complicating factor is that the net surveys are likely biased since the net tows occurred during both day and night during the nearshore survey.

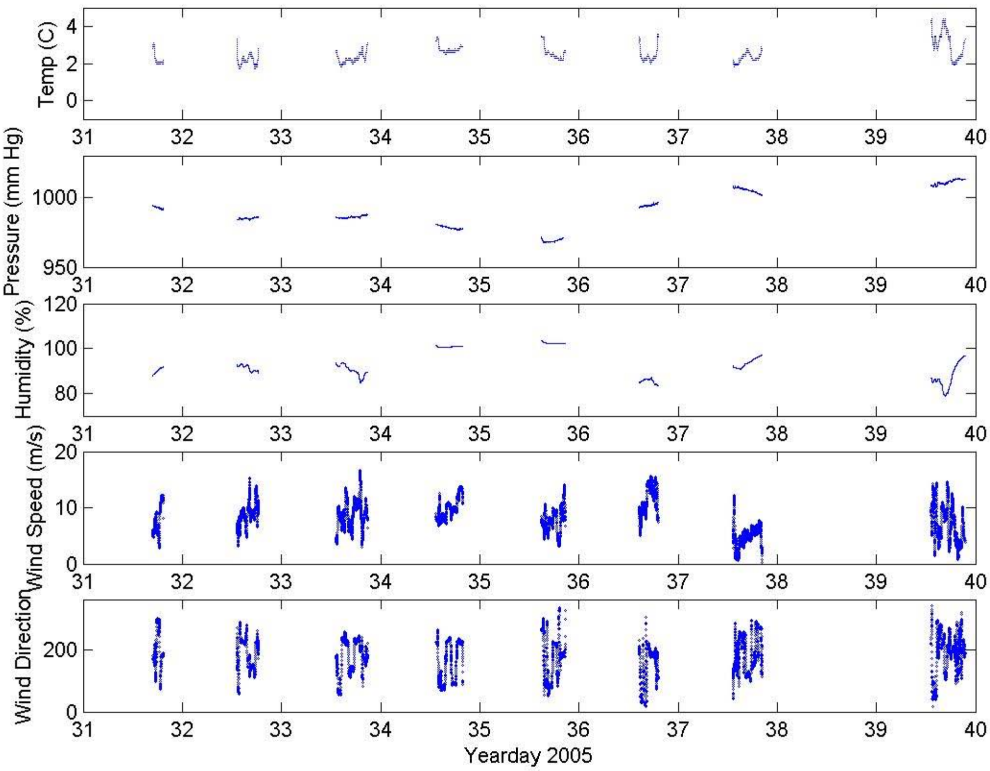

Figure 5.9 Meteorological data from R/V *Ernest* during the nearshore survey. The humidity sensor readings are likely offset 10-15% high. Mean wind speed was 8 m/s with a peak gust recorded of 17 m/s. Most frequent wind direction was from the SW and NW.

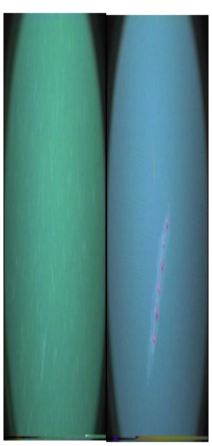

Figure 5.10. Dense krill swarm (*Euphausia superba*) at 20 m depth off of Cape Shirreff (a), and aggregate salps (*Salpa thompsoni*).

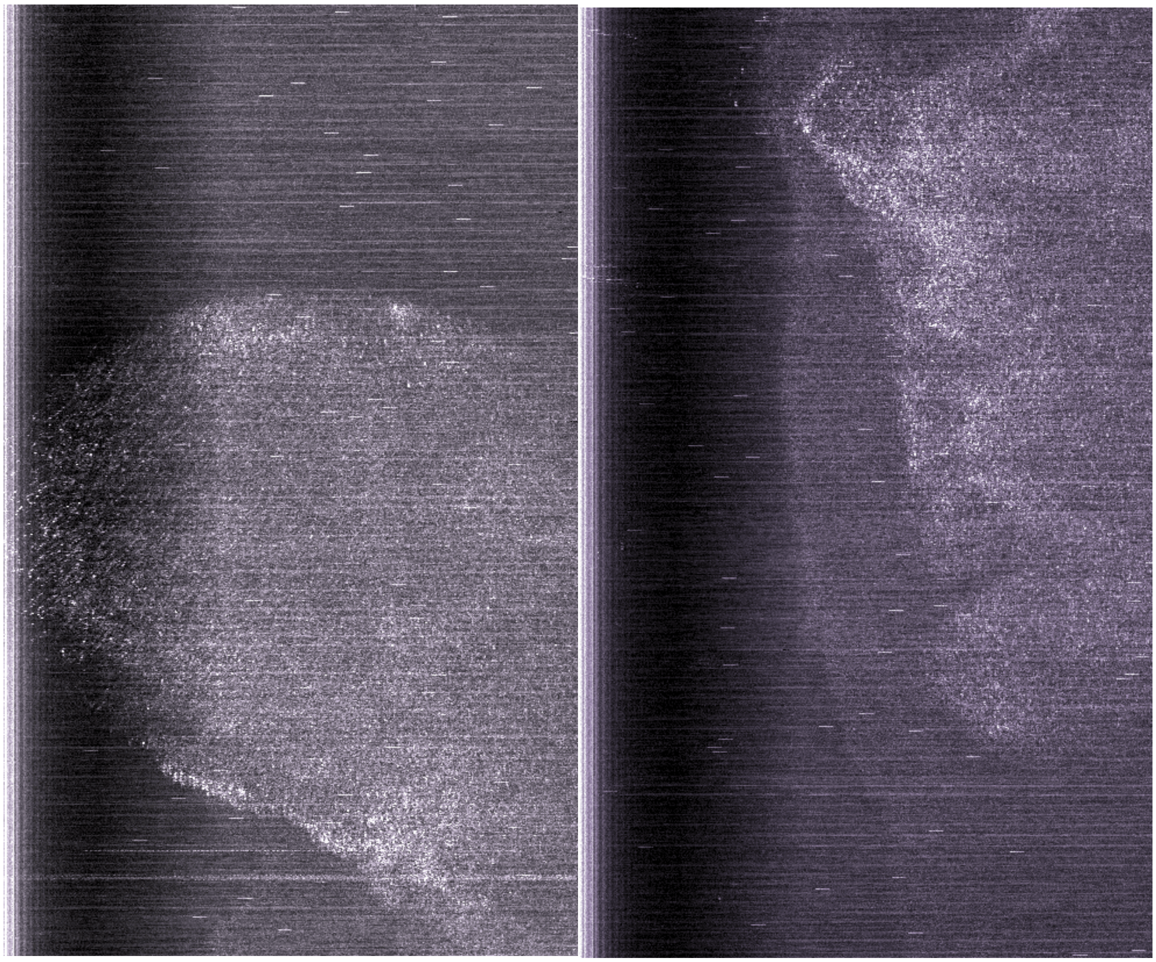

Figure 5.11. Putative krill aggregation observed with a 10 m sidescan sonar swath in approximately 80 m of water, close to the beach at Cape Shirreff, 4 February, 2005.

6. Pinniped research at Cape Shirreff, Livingston Island, Antarctica, 2004/05; submitted by Michael E. Goebel, Birgitte I. McDonald, Yann Tremblay, Douglas J. Krause, Jessica D. Lipsky, Margaret H. Cooper, and Rennie S. Holt.

6.1 Objectives: As upper trophic level predators, pinnipeds are a conspicuous component of the marine ecosystem around the South Shetland Islands. They respond to spatio-temporal changes in physical and biological oceanography and are directly dependent upon availability of krill (*Euphausia superba*) for maintenance, growth, and reproduction during the austral summer. Because of their current numbers and their pre-exploitation biomass in the Antarctic Peninsula region and Scotia Sea, Antarctic fur seals, are recognized to be an important "krill-dependent" upper trophic level predator. The general objectives for U.S. AMLR pinniped research at Cape Shirreff (62^{o}28'S, 60^{o}46'W) are to monitor population demography and trends, reproductive success, and status of pinnipeds throughout the summer months. The Antarctic fur seal, *Arctocephalus gazella*, is the most abundant pinniped at Cape Shirreff and our studies are focused to a large degree on this species. Our studies focus on foraging ecology, diving, foraging range, energetics, diet, and reproductive success of fur seals rearing offspring.

The 2004/05 field season began with the arrival at Cape Shirreff of a five person field team via the R/V *Laurence M. Gould* on 10 November 2004. Research activities were initiated soon after and continued until closure of the camp on 11 March 2005. Our specific research objectives for the 2004/05 field season were to:

A. Monitor Antarctic fur seal female attendance behavior (time at sea foraging and time ashore attending a pup);

B. Monitor pup growth in cooperation with Chilean researchers collecting mass measures for a random sample of 100 fur seal pups every two weeks throughout the research period beginning 30 days after the median date of births;

C. Document fur seal pup production at designated rookeries on Cape Shirreff and assist when necessary Chilean colleagues in censuses of fur seal pups for the entire Cape and the San Telmo Islands;

D. Collect and analyze fur seal scat contents on a weekly basis for diet studies;

E. Collect a milk sample at each adult female fur seal capture for fatty acid signature analysis for diet studies;

F. Deploy time-depth recorders on adult female fur seals for diving studies;

G. Record at-sea foraging locations for adult female fur seals using ARGOS satellite-linked transmitters (with most deployments coinciding with the U.S.-AMLR Oceanographic Survey cruises);

H. Tag 500 fur seal pups for future demographic studies;

I. Re-sight animals tagged as pups in previous years for population demography studies;

J. Monitor survival and natality of the tagged adult female population of fur seals;

K. Extract a lower post-canine tooth from tagged adult female fur seals for aging studies;

L. Deploy a weather station for continuous recording of wind speed, wind direction, ambient temperature, humidity and barometric pressure during the study period;

M. Record any pinnipeds carrying marine debris (i.e., entanglement); and

N. Record any other tagged pinnipeds observed on the Cape.

6.2 Methods, Accomplishments, and Results (by objective):

A. Female Fur Seal Attendance Behavior: Lactation in otariid females is characterized by a cyclical series of trips to sea and visits to shore to suckle their offspring. The sequential sea/shore cycles are commonly referred to as attendance behavior. Measuring changes in attendance behavior (especially the duration of trips to sea) is one of the standard indicators of a change in the foraging environment and availability of prey resources. Generally, the shorter the duration of trips to sea, the more resources a female can deliver to her pup during the period from birth to weaning.

We instrumented 30 lactating females from 4-16 December 2004. The study was conducted according to CCAMLR protocol (CCAMLR Standard Method C1.2 Procedure A) using VHF radio transmitters (Advanced Telemetry Systems, Inc., Model 7PN with a pulse rate of 40ppm). Standard Method C1.2 calls for monitoring of trip durations for the first six trips to sea. All females were instrumented 0-2 days post-partum (determined by the presence of a newborn with an umbilicus) and were left undisturbed for at least their first six trips to sea. Pups were captured at the same time as their mothers, and were weighed, measured, and marked with an identifying bleach mark. The general health and condition of the pups was monitored throughout the study by making daily visual observations. Presence or absence on shore was monitored for each female every 30 minutes for 30 seconds for the first six trips to sea using a remote VHF receiving station with an automated data collection and storage device. Data were downloaded weekly. Daily visual observations of instrumented females were conducted to confirm proper functioning of the remote system.

The first female in our study to begin her foraging cycles did so on 10 December and the last female to complete six trips to sea did so on 8 February. Only one female (3.1%) failed to complete six trips before losing her pup. She was, thus, removed from our attendance study. The pup was never observed (live or dead) after the second visit to shore, ~26 December (the pup was observed limping prior to its disappearance.) Of the remaining 29 females, none lost their pups to leopard seal predation before completion of six trips to sea.

The mean trip duration for the combined first six trips to sea this year was 3.91 days (±0.21, $N_{Females}$=29, N_{Trips}=174, range: 0.52-9.50), similar to the long-term mean of 3.92 days (based on eight years of trip duration data) (Table 6.1, Figure 6.1; ANOVA, $F_{7,217}$=45.94, P<0.0005).

Bonferroni probabilities indicate mean trip duration this year was no different than 2003/04, 1999/00 and 1997/98 trip durations (*P*-values by year: 97/98, 1.000; 98/99, 0.033; 99/00, 0.951; 00/01-01/02, <0.0005; 03/04, 1.000).

Mean duration for the first six, non-perinatal visits was 1.45 days (±0.05, $N_{Females}$=29, N_{Visits}=174, range: 0.96-2.19) (Table 6.1, Figure 6.1; ANOVA, $F_{7,217}$=14.31, P<0.0005). Bonferroni probabilities indicate mean visit duration this year was no different than previous years except for 1999/00 which had a greater mean visit duration (P=0.013) and 2002/03, which had shorter visits (P<0.0005).

We use female post-partum mass as an index of condition at the start of the breeding season. Arrival condition was similar to last year and better than years previous to 2003/04. Mean post-partum mass was 48.9kg (±0.74, N=30). There was no difference in the postpartum mass of females at arrival from 1998/99 to 2002/03 (ANOVA, $F_{4,138}$, P=0.34). However, females in 2003/04 and 2004/05 had a greater mass at arrival than females in the previous four years (ANOVA, $F_{6,194}$, P=0.001; (Figure 6.2a). Females from 1997/98, the first year of our studies, were excluded from this analysis because they had a later mean date of parturition (22 Dec, ±0.60; range: 15-28 Dec) than females in subsequent years. This was due to late arrival of researchers in the first year of monitoring studies. Females in all other years did not differ in their mean date of parturition (8 Dec, ±0.21, range: 3-16 Dec; ANOVA, $F_{6,194}$, P=0.28).

The mass-to-length ratio (arc-sin transformed), a better measure of condition, did not change from 1998/99-2002/03 (ANOVA, $F_{4,138}$=0.702, P=0.592; **98/99:** Mean=0.346 ±0.007, N=34; **99/00:** Mean=0.345 ±0.007, N=24; **00/01:** Mean=0.346 ±0.005, N=29; **01/02:** Mean=0.341 ±0.008, N=28; **02/03:** Mean=0.334 ±0.005, N=28). However, females at arrival in 2003/04 and 2004/05 had a greater mass-to-length ratio, **03/04:** 0.366 ±0.007, **04/05:** 0.372 ±0.004 (ANOVA, $F_{6,194}$=4.84, P<0.0005; Figure 6.2b).

B. Fur Seal Pup Growth: Measures of fur seal pup growth were a collaborative effort between the U.S. research team and Chilean researchers. Data on pup weights and measures were collected every two weeks beginning 30 days after the median date of pupping (8 Dec 2004) and ending 23 February (four bi-weekly samples; collection dates: 8 Jan, 23 Jan, 7 Feb, and 23 Feb). Data were collected as directed in CCAMLR Standard Method C2.2 Procedure B. The results will be submitted to CCAMLR by Chilean researchers.

C. Fur Seal Pup Production: Fur seal pups (live and dead) and females were counted by U.S. researchers at four main breeding beaches (Copihue, Maderas, Cachorros, and Chungungo) on the east side of the Cape. Censuses were conducted every other day from 17 November 2004 through 10 January 2005. The maximum number counted (live plus cumulative dead) at the combined four beaches in 2004/05 was 2,284 on 31 December 2004 (Figure 6.3), one pup less than the maximum count for the same area last year (**03/04:** 2285 on 4 January 2004; **02/03**: 2157 on 8 January 2003; **01/02:** 2,435 on 6 January 2002; **00/01:** 2,248 on 29 December 2000; **99/00:** 2,104 on 3 January 2000).

The median date of parturition was 8 December, a day earlier than last year. Since 1997/98 the median date of parturition has varied by four days (7-10 Dec).

Neonate mortality was lower than in the previous three years. We recorded the number of new pup carcasses on our census beaches at each count and calculated a cumulative mortality every other day (i.e. at each census) from around the start of births (17 November this year) until the last of pupping (10 January this year). Pup mortality for 2004/05 was 4.5%; last year's pup mortality was 4.9 percent. The long-term average (based on eight years of data is 4.25% ±0.82). Pup mortality for the same time period for past years was: **97/98:** 1.8%; **98/99:** 2.5%; **99/00:** 2.8%; **00/01:** 3.0%; and **01/02:** 5.5%; **02/03:** 9.0% and **03/04:** 4.9%.

Our measures of neonate mortality extend only to the end of the pupping (10 January). In most years, neonate mortality experiences a peak during the perinatal period or soon after females begin their trips to sea. However, another peak in pup mortality occurs later when young inexperienced pups enter the water for the first time around one month of age and become vulnerable to leopard seal predation. Since remains are rare, evidence of this type of mortality is more difficult to quantify. Leopard seal predation is significant and may be a factor controlling recovery of South Shetland populations of fur seals (Boveng *et al*. 1998). To estimate the extent of leopard seal predation on neonates we calculated the loss of pups from our tagged population of females. We assumed that once pups survived to one month of age that their disappearance was due to leopard seal predation. We included only females whose pup status could be confirmed excluding female/pup pairs whose status was uncertain. Our estimate of pup mortality due to leopard seal predation, calculated 23 February, 77 days after the median date of pupping, was based on daily tag resights of adult females. By that date 63.2% of pups were lost to leopard seals.

D. Diet Studies: Information on fur seal diet was collected using three different sampling methods: collection of scats, enemas, and fatty acid signature analysis of milk. In addition to scats and enemas, an occasional regurgitation is found in female suckling areas. Regurgitations often provide whole prey that is only minimally digested. Scats are collected from around suckling sites of females or from captured animals that defecate while captive. All females that are captured to remove a time-depth recorder or satellite-linked transmitter (PTT) are given an enema to collect fecal material containing dietary information. In addition to diet information from captive animals, ten scats were collected opportunistically from female suckling sites every week beginning 20 December. The weekly scat samples are collected by systematically walking transects of female suckling areas and collecting any fresh scats within a short range of the observer. This method prevents any bias associated with the difference in visibility between krill laden scats, which are bright pink, and fish laden scats, which are gray to brown, and blend in with the substrate more easily.

In total, we collected and processed 113 scats from 23 December 2004-3 March 2005. Diet samples that could not be processed within 24 hours of collection were frozen. All samples were processed by 5 March. Up to 25 krill carapaces were measured from each sample that contained krill. Otoliths were sorted, dried, identified to species. The number of squid beaks were counted and preserved in 70% alcohol for later identification. A total of 2,675 krill carapaces were measured. Most scats, 95.6% (108/113) collected contained krill. In addition, 3,390 otoliths were collected from 49.6% of the scats collected (in contrast 6,424 otoliths were collected from 58.9% of the scats collected in 2003/04). Most (97.1%, 3,293 otoliths) were from two species of myctophid fish (*Electrona antarctica*, n=580 and *Gymnoscopelus nicholsi*, n=2,713; plus an additional 97 (2.9%) eroded and unidentified otoliths). No *Electrona carlsbergi* otoliths were found in 2004/05. A total of 20 squid beaks (*Brachioteuthis picta*) were collected from 11.5% of the scats.

The proportions of krill, fish and squid were different every year (X^2=31.7, d.f.=8, P<0.0005). Results for 2004/05 showed similar trends to past years in regards to an increasing proportion of fish and squid from December through February (Figure 6.4). For the past two years (2002/03 and 2003/04) the percent occurrence of fish was greater than krill in February. This year showed results similar to those prior to 2002/03 with a greater proportion of krill in the diet regardless of month. The weekly occurrence of five primary prey species in fur seal diet varies inter-annually and intra-seasonally (Figure 6.5).

The length and width of krill carapaces found in fur seal scats were measured in order to determine length distribution of krill consumed. Up to twenty-five carapaces from each scat were randomly selected and measured according to Hill (1990). The following linear discriminant function (Reid and Measures 1998) was applied to the carapace length (CL) and width (CW) to determine sex of individual krill:

$$D = -1.04 - 0.146(CL) + 0.265(CW)$$

Positive discriminant function values were identified as female and negative values male. Once the sex for each krill was determined the following regression equations from Reid and Measures (1998) were applied to calculate total length (TL) from the carapace length:

$$\text{Females: } TL = 15.3 + 2.09(CL)$$

$$\text{Males: } TL = 13.9 + 2.29(CL)$$

A total of 2,675 carapaces were measured from 107 scats in 2004/05. Summary statistics are presented in Table 6.2. Data from 1999/00 through 2003/04 are also presented for comparison. Krill consumed by fur seals in 2004/05 was on average no larger than last year (Table 6.2; ANOVA, $F_{1,5010}$ = 0.001, P=0.98). The length distributions (in 2mm increments) for the last four years are presented in Figure 6.6. As in previous years, weekly comparisons showed changes in length frequency distributions (Figure 6.7) and in the overall mean length of krill (Figure 6.8). No consistent intra-seasonal trends were evident (Figure 6.8).

E. Fatty Acid Signature Analysis of Milk: In addition to scats, we collected 71 milk samples from 56 female fur seals. Each time a female was captured (either to instrument or to remove instruments), =30mL of milk was collected by manual expression. Prior to collection of the milk sample, an intra-muscular injection of oxytocin (0.25mL, 10 UI/mL) was administered. Milk was returned (within several hours) to the lab where two 0.25mL aliquots were collected and each stored in a solvent-rinsed glass tube with 2mL of chloroform with 0.01% butylated hydroxytoluene (BHT, an antioxidant). Samples were flushed with nitrogen, sealed, and stored frozen until later extraction of lipid and trans-esterification of fatty acids. Of the 71 samples, 29 were collected from perinatal females and 27 were collected from females that had dive data for the foraging trip prior to milk collection.

F. Diving Studies: Twelve of our 29 females transmittered for attendance studies also received a time-depth recorder (TDR, Wildlife Computers Inc., Mark 9s, 66 x 18 x 18mm, 31g) on their first visit to shore. All carried their TDR for at least their first six trips to sea. In addition, all other females captured for studies of at-sea foraging locations also received a TDR. A total of 28 dive records were collected from 26 females in 2004/05.

G. Adult Female Foraging Locations: We instrumented 16 females with satellite-linked transmitters (ARGOS-linked Platform Terminal Transmitters or PTTs) from 16 December – 20 February. Twelve of the 16 were deployed to coincide with the U.S. AMLR large- and small-scale oceanographic surveys. Two females carried a PTT for a single trip, six more carried a PTT for two trips, six for three trips, and one each for four and five trips to sea. Results of fur seal foraging location data analysis and interannual comparisons are pending.

H-J. Demography and Tagging: Together Chilean and U.S. researchers tagged 497 fur seal pups (265 females, 231 males, 1 sex unknown) from 23 January – 8 March 2005. All tags placed at Cape Shirreff were Dalton Jumbo Roto tags with white tops and orange bottoms. Each pup was tagged on both fore-flippers with identical numbers. Series numbers for 2004/05 were 4000-4500. All pups were tagged on study beaches on the east side of the Cape from Playa Marko to Ballena Norte beach. No pups were tagged at Loberia beach on the northwest side of the Cape in 2004/05.

In addition to the 497 pups tagged, we also tagged 31 adult lactating females (30 had been previously untagged [348-375, 377-378] and 1 that had previously been tagged but had lost one tag [376, whose former ID was 303]). Two of the newly tagged females (348 & 357) later lost one of their tags and were retagged 379 and 380 (respectively).   All tags were placed on females with parturition sites on east side beaches (Copihue, Maderas, Cachorros, and Chungungo beaches).

Last year we added 26 adult females to our tagged population. These 26, when added to the females that returned in the previous season (N=207) plus two that returned to Cape Shirreff but were not sighted in 2003/04) gave an expected known tagged population of 235 for 2004/05 (Table 6.3). Of these, 211 (89.8%) returned in 2004/05 to Cape Shirreff and 179 (84.8%) returned pregnant (Figure 6.9). The return rate was lower than last year and slightly (0.6%) below the long-term mean (mean for seven years, 1998/99-2004/05: 90.4% ±1.8). The natality rate was only slightly (0.3%) below the long-term mean (89.0% ±1.2). (Return rates by year: **98/99:** 83.8%, **99/00:** 94.0%, **00/01:** 90.4%, **01/02:** 97.9%, **02/03:** 85.8%, **03/04:** 92.0%; Natality rates: **98/99:** 90.3%, **99/00:** 92.3%, **00/01:** 87.2%, **01/02:** 93.1%, **02/03:** 86.6%, **03/04:** 89.0%; (Figure 6.9).

Our tagged population of females returned on average 2.0 (±0.50) days earlier than last year. In 2003/04 the mean date of pupping for tagged females (which had a pup in both years, 2003/04 and 2004/05) was 9 December (±0.60, N=156) and in 2004/05, for the same females, it was 7 December (±0.50, N=156).

This year we observed nine yearlings tagged as pups (four males, five females; 1.8% return rate) compared to 12 last year (four males and eight females; 2.4% return) and 23 in 2002/03 (12 males and 11 females, 4.6%; Table 6.4). The yearling return rate declined this year over that of last year. The 7-year mean was 2.4% (±0.58). Table 6.4 presents observed tag returns for four cohorts in their first year. Tag deployment, the total number placed and re-sighting effort for all six cohorts were similar and the variance is likely due to differences in the post-weaning physical and/or biological environment. The differences in return rates are not necessarily due to survival alone but may be due to other factors (e.g. physical oceanography of the region, over-winter prey availability or other factors) that influence whether animals return to natal rookeries in their first year.

We calculated the minimum percent survival for year one based upon tag re-sights for the first two years following tagging (Table 6.5). The survival values are adjusted based upon the probability that an individual would lose both tags. Tag loss (right or left) was assumed to be independent. The results presented are for the minimum percent survival because animals return for the first time to natal rookeries at different ages and the probability of returning at age 1, age 2, *etcetera* may vary for different cohorts. Given similar re-sighting effort the six cohorts presented have return rates in the first two years that are very different (Figure 6.10). Most notable is that the 1999/00 cohort appears exceptional in its rate of return in both its first year and its second. The minimum survival to age-1 for the 1999/00 cohort was 25.0%. If the transition to nutritional independence and foraging conditions their first winter are critical to juvenile otariid survival (as suggested by York, 1994) then 1999/00 cohort experienced exceptionally good conditions at weaning and for their first winter at sea. The observed cohort differences are important whether due to survival or differences in dispersal that result in a different rate of return. This year's tag returns were again dominated by the 99/00 cohort and to a lesser degree by the 2001/02 cohort which had 16.1% minimum survival in its first year.

K. Age Determination Studies: We began an effort of tooth extraction from adult female fur seals for age determination in 1999/00. Tooth extractions are made using gas anesthesia (isoflurane, 2.5-5.0%), oxygen (4-10 liters/min), and midazolam hydrochloride (1cc). A detailed description of the procedure was presented in the 1999/00 annual report (NOAA-TM-NMFS-SWFSC-302). This year we took a single post-canine tooth from only 1 previously tagged female and 14 untagged females during their perinatal visit. The mean age of the sample was 10.9 years (± 1.23, N=15).

L. Weather at Cape Shirreff: A weather data recorder (Davis Weather Monitor II) was set up at the U.S.-AMLR field camp at Cape Shirreff from 12 November 2004 to 6 March 2005. The recorder archived wind speed and direction, barometric pressure, temperature, humidity, and rainfall at 15-minute intervals. The sampling rate for wind speed, temperature, and humidity was every eight seconds; the averaged value for each 15-minute interval was stored in memory. Barometric pressure was measured once at each 15-minute interval and stored. When wind speed was greater than 0, the wind direction for each 8-second interval was stored in one of 16 bins corresponding to the 16 compass points. At the end of the 15-minute archive interval, the most frequent wind direction was stored in memory.

M. Entangled pinnipeds: Three female fur seals were observed this season with entanglements around their neck. All three carried pack bands. One female was an adult female with a pup. She was captured and the packing band was removed. The second female was also an adult but not observed with a pup. The third female was a juvenile and was captured to have her entanglement removed.

N. Other pinnipeds: Southern elephant seals. No tagged elephant seals were recorded this year. However, US-AMLR in collaboration with University of California researchers tagged eight elephant seal pups (2 males, 6 females) and six adult females. The adult females were captured post-molt and were also instrumented with satellite-linked transmitters.

6.3 Preliminary Conclusions: Fur seal pup production in 2004/05 at U.S. AMLR study beaches was the second highest on record since our studies began in 1997/98. Neonate mortality (4.5%), only slightly less than last year, was close to the eight year mean of 4.25%. The median date of pupping based on pup counts was one day earlier than last year and our tag returns of adult females confirm a 2d change in the parturition date. Over winter survival for adult females, however, was lower than last year (89.8 vs. 92.1%) as was the natality rate (84.8 vs. 89.0%). Foraging trip durations (3.91d ±0.12) and visits to shore (1.45d ±0.05) were average (the long-term means; trips: 3.92d ±0.09 visits: 1.47d ±0.02). The 1999/00 and the 2001/02 cohorts continued to dominate tag returns as in previous years and the 2003/04 cohort had modest (1.8%) first year return rates. Fur seal diet studies recorded for the first time a total absence of *Electrona carlsbergi*.

6.4 Disposition of Data: All raw and summarized data are archived by the Antarctic Ecosystem Research Division of the National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, CA.

6.5 Problems and Suggestions: The monitoring program at Cape Shirreff is confined to measuring parameters during the first three months of fur seal pup rearing. Only a few of the summer-measured parameters (e.g. adult female over-winter survival, pregnancy rates, and cohort survival) reflect ecological processes over a broader temporal spatial scale. Yet these data show that post-weaning environments are crucial for survival, recruitment, and sustainability of pinniped and seabird populations. The dominance of the 99/00 cohort in tag return data and differential cohort strength (Table 6.5, Figure 6.10) offer one of the best examples of this. Recent technology in miniaturization and programmability of satellite-linked transmitters provide the means by which to develop an understanding of post-weaning environments, dispersal of females and pups post-weaning. These instruments can not only provide information on dispersal but can measure the physical environment encountered by individuals. Future studies should use this technology to measure dispersal, survival and various parameters of the physical environment in order to identify factors leading to increased survival and recruitment of juvenile pinnipeds and seabirds.

6.6 Acknowledgements: The National Science Foundation provided support and transportation to the Cape Shirreff field site for the opening camp crew. We thank the captain, Mike Terminal, the crew and science staff of the November cruise of the R/V *Laurence M. Gould*. We are grateful to our Chilean colleagues: Romeo Vargas, Max Bello, Claudio Vero, Daniel Torres Jr., and Cesar Cifuentes, for their assistance in the field and for sharing their considerable knowledge and experience of Cape Shirreff. Some of the tag re-sight data used in this report were provided by our Chilean colleagues. Thanks to Aileen Miller, Elaine Leung, and Jefferson Hinke for their help with pinniped studies. We are, likewise, grateful to Adam Jenkins, the AMLR personnel, and the Russian crew of the R/V *Yuzhmorgeologiya* for their invaluable support and assistance to the land-based AMLR personnel. All pinniped research at Cape Shirreff was conducted under Marine Mammal Protection Act Permit No. 774-1649 granted by the Office of Protected Resources, National Marine Fisheries Service.

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Table 6.1. Summary statistics for the first six trips and visits (non-perinatal) for female Antarctic fur seals rearing pups at Cape Shirreff, Livingston Island, 1997/98 – 2004/05.

Year	Female N	Trip/Visit N	Min.	Max.	Median	Mean	St.Dev.	Skewness (SE)
Trip Durations								
1997/98	30	180	0.50	9.08	4.07	4.19	1.352	0.083 (0.181)
1998/99	31	186	0.48	11.59	4.23	4.65	1.823	0.850 (0.178)
1999/00	23	138	0.60	8.25	3.25	3.47	0.997	1.245 (0.206)
2000/01	28	168	0.75	5.66	2.69	2.71	0.828	0.874 (0.187)
2001/02	28	166	0.50	7.85	2.87	3.18	1.207	0.740 (0.188)
2002/03	15	90	2.83	10.78	6.89	6.83	0.731	-0.072 (0.254)
2003/04	28	166	0.58	6.97	3.60	3.61	1.241	0.365 (0.188)
2004/05	29	174	0.40	9.50	3.90	3.91	1.565	0.764 (0.184)
Visit Durations								
1997/98	30	179	0.46	2.68	1.25	1.35	0.462	0.609 (0.182)
1998/99	31	186	0.21	3.49	1.27	1.33	0.535	0.947 (0.178)
1999/00	23	138	0.10	4.25	1.51	1.72	0.635	1.088 (0.206)
2000/01	28	168	0.44	3.15	1.52	1.68	0.525	0.485 (0.187)
2001/02	28	166	0.19	4.84	1.43	1.55	0.621	1.328 (0.188)
2002/03	15	82	0.23	2.18	0.98	0.98	0.051	0.447 (0.266)
2003/04	28	163	0.23	3.99	1.43	1.55	0.579	0.870 (0.190)
2004/05	29	174	0.15	3.86	1.28	1.45	0.614	1.439 (0.184)

Table 6.2. Krill length (mm) in fur seal diet from 1999/00 - 2004/05. Data are derived from measuring length and width of krill carapaces found in fur seal scats and applying a discriminant function to first determine sex before applying independent regression equations to calculate total length.

Krill Length (mm)	**1999/00:**	**2000/01:**	**2001/02:**	**2002/03**	**2003/04**	**2004/05**
N:	2521	2942	2827	2091	2337	2675
Median:	50.8	52.9	52.9	43.7	48.3	48.3
Mean:	50.7	53.1	52.8	43.8	47.0	47.2
St.Dev.:	4.03	3.82	3.97	3.90	4.48	3.19
Minimum:	36.8	39.1	36.8	34.3	34.3	34.3
Maximum:	59.7	64.3	64.3	57.1	59.2	57.4
Kurtosis:	-0.58	-0.27	1.43	0.15	-0.62	-0.14
Skewness:	-0.30	-0.12	-0.93	0.28	-0.19	0.02
Sex Ratio (M:F):	1:1.8	1:1.2	1:3.2	1:0.1	1:0.7	1:0.6
% Juveniles:	0.00	0.00	0.00	1.20	0.04	0.04

Table 6.3. Tag returns and natality rates for adult female fur seals at Cape Shirreff, Livingston Island, 1998/99 – 2004/05.

Year	Known Tagged Population[1]	Returned	Pregnant	% Return	% Natality	Tags Placed	Primaparous females tagged as pups
1997/98						**37**[2]	**0**
1998/99	**37**	**31**	**28**	**83.8**	**90.3**	**52**	**0**
1999/00	**83**	**78**	**72**	**94.0**	**92.3**	**100**	**0**
2000/01	**173**	**156**	**136**	**90.4**	**87.2**	**35**	**0**
2001/02	**195**[3]	**191**	**174**	**97.9**	**91.1**	**42**	**2**
2002/03	**226**	**194**	**168**	**85.8**	**86.6**	**28**	**6**
2003/04	**227**	**209**	**186**	**92.1**	**89.0**	**26**	**14**
2004/05	**235**	**211**	**179**	**89.8**	**84.8**	**30**	**11**

[1]Females tagged and present on Cape Shirreff beaches the previous year.

[2]Includes one female present prior to the initiation of current tag studies.

[3]Includes one female tagged as an adult with a pup in 1998/99, which was present in 1999/00 but was never observed in 2000/01.

Table 6.4. A comparison of first year tag returns for seven cohorts: 1997/98 – 2003/04. Values in parentheses are percent total tagged.

Cohort	**Total Tags Placed**	**Tag Returns in Year 1 (%)** Total	Males	Females
1997/98	500	22 (4.4)	10 (2.0)	12 (2.4)
1998/99	500	6 (1.2)	5 (2.0)	1 (0.4)
1999/00	500	26 (5.2)	15 (3.0)	11 (2.2)
2000/01	499	9 (1.8)	6 (2.6)	3 (1.1)
2001/02	499	23 (4.6)	12 (4.8)	11 (4.0)
2002/03	498	12 (2.4)	4 (1.7)	8 (3.0)
2003/04	499	9 (1.8)	4 (1.6)	5 (2.4)

Table 6.5. Tag returns and minimum percent survival for six cohorts, 1997/98 – 2002/03 using only the first two years of re-sight data for each cohort. Assuming cohort return rates correlate with survival and are similar for each cohort, our data show survival to age-1 varies considerably.

	1997/98			1998/99			1999/00			2000/01			2001/02			2002/03		
	?	?	Total	?	?	Total	?	?	Total	?	?	Total	?	?	Total	?	?	Total
Sightings:																		
Sighted in Year 1:	12	10	22	1	5	6	11	15	26	3	6	9	12	11	23	9	4	13
Additional Tags Sighted in Year 2:	20	10	32	6	7	13	53	40	93	13	2	15	28	26	54	13	9	22
Minimum survival in year 1:	32	20	54[1]	7	12	19	64	55	119	16	8	24	40	37	77	22	13	35
Tag loss:																		
Unknown tag status:	2	1	3	0	2	2	1	3	4	0	1	1	4	2	6	1	0	1
Both tags present:	14	13	29	6	6	12	48	42	90	11	5	16	29	27	56	9	4	13
Missing 1 tag:	16	6	22	3	2	5	15	10	25	5	2	7	7	8	15	4	4	8
Probability of missing one tag:	0.53	0.32	0.43	0.33	0.25	0.29	0.24	0.19	0.22	0.29	0.29	0.30	0.19	0.23	0.21	0.31	0.50	0.38
Probability of missing both tags[2]:	0.28	0.10	0.19	0.11	0.06	0.09	0.06	0.04	0.05	0.08	0.08	0.09	0.04	0.05	0.04	0.09	0.25	0.15
Survival estimates:																		
Minimum % Survival 1st year:	12.80	8.00	10.8	2.8	4.8	3.8	27.6	20.6	23.8	6.0	3.4	4.8	15.3	15.5	15.4	8.4	5.5	7.0
Adj. Min. % Survival for year 1[3]:	16.44	8.80	**12.8**	3.1	5.1	**4.1**	29.2	21.4	**25.0**	6.6	3.8	**5.3**	15.9	16.4	**16.1**	9.2	6.8	**8.0**

[1]Includes two sightings of seals of unknown sex.

[2]Assumes tag loss is independent for right and left tags.

[3]Minimum percent survival adjusted for double tag loss.

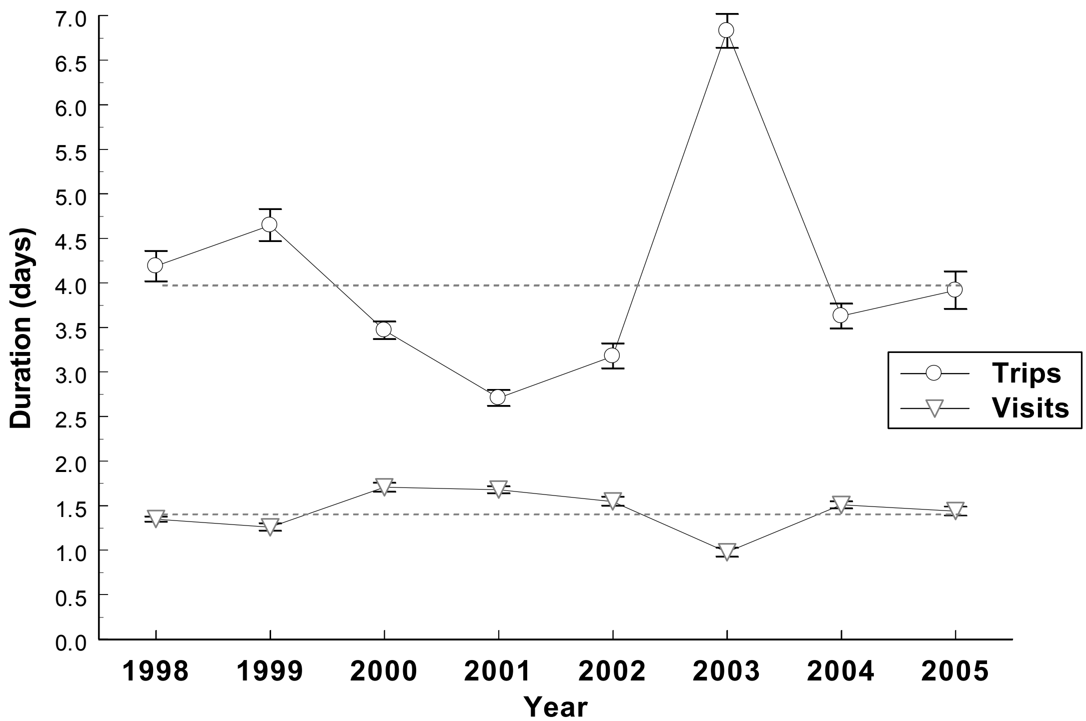


Figure 6.1. Antarctic fur seal mean trip and visit durations (with standard error) for females rearing pups at Cape Shirreff, Livingston Island. Data plotted are for the first six trips to sea and the first six non-perinatal visits following parturition for eight years (See Table 6.1 for sample sizes). Long-term means are plotted as dashed gray lines (8-year means: Trips: 3.92 days (±0.09); Visits: 1.47 days (±0.02)).

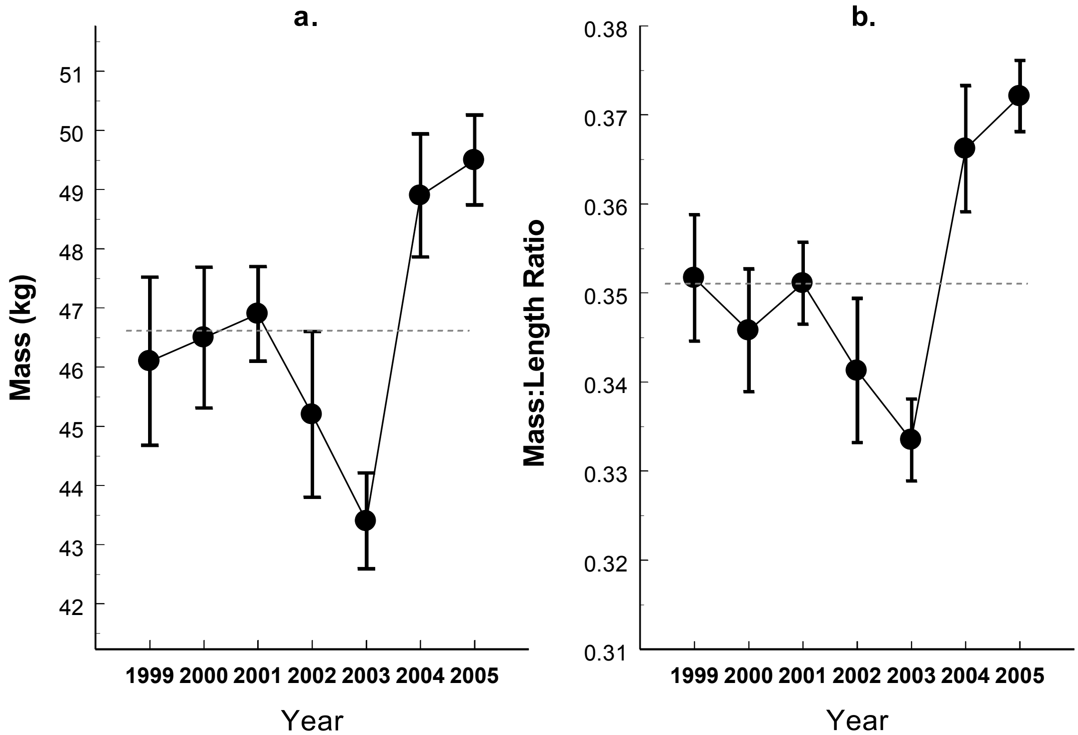


Figure 6.3. The mean mass (a.) and mass:length ratio (b.) for females at parturition 1998/99 – 2004/05 **(98/99**: N=32, **99/00**: N=23, **00/01**: N=29, **01/02-03/04**: N=28 for each year, **04/05:** N=29). Long-term average is plotted as a gray dashed line, mass: 45.4 ±0.42; mass:length ratio: 0.348 ±0.002.

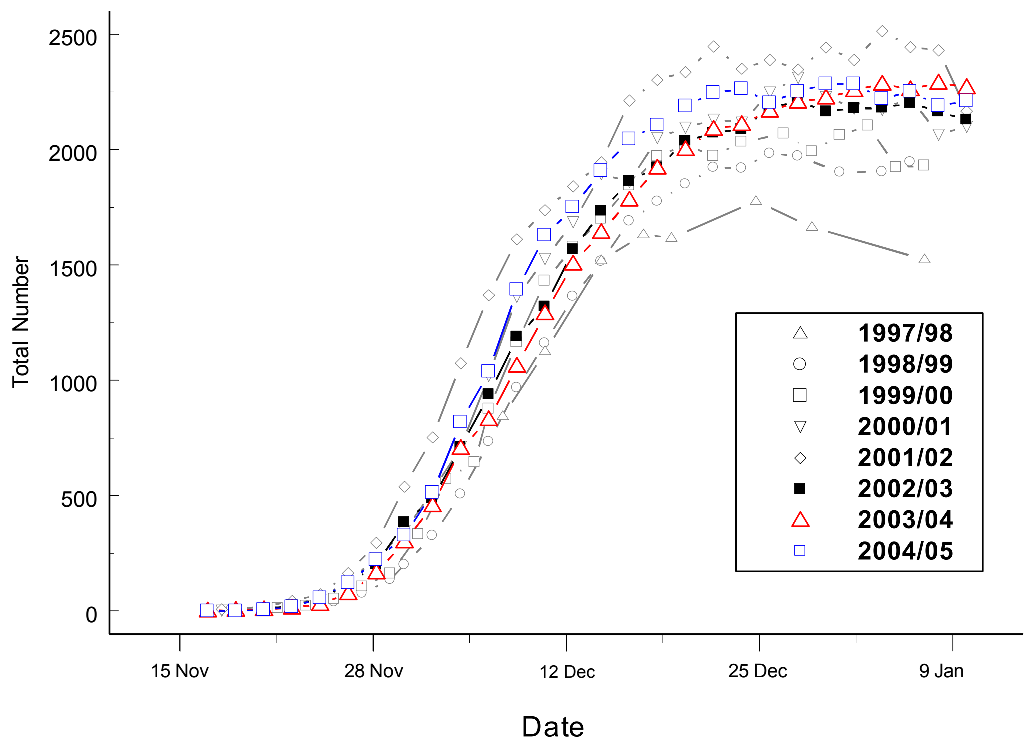


Figure 6.3. Antarctic fur seal pup production at U.S.-AMLR study beaches, Cape Shirreff, Livingston Island, 1997/98-2004/05.

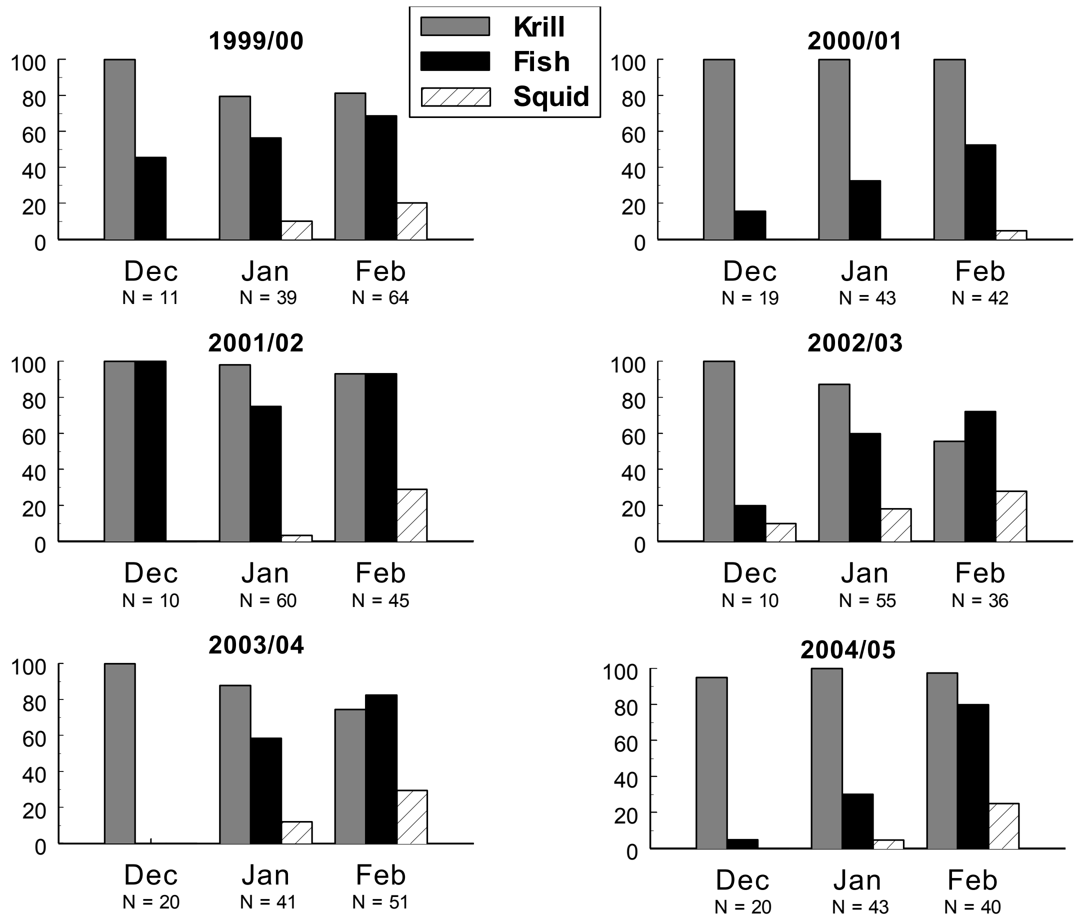


Figure 6.4. The percent occurrence of primary prey types (krill, fish, and squid) from December through February for Antarctic fur seal scats collected from female suckling areas and enemas from females carrying time-depth recorders at Cape Shirreff, Livingston Island for 1999/00 through 2004/05.

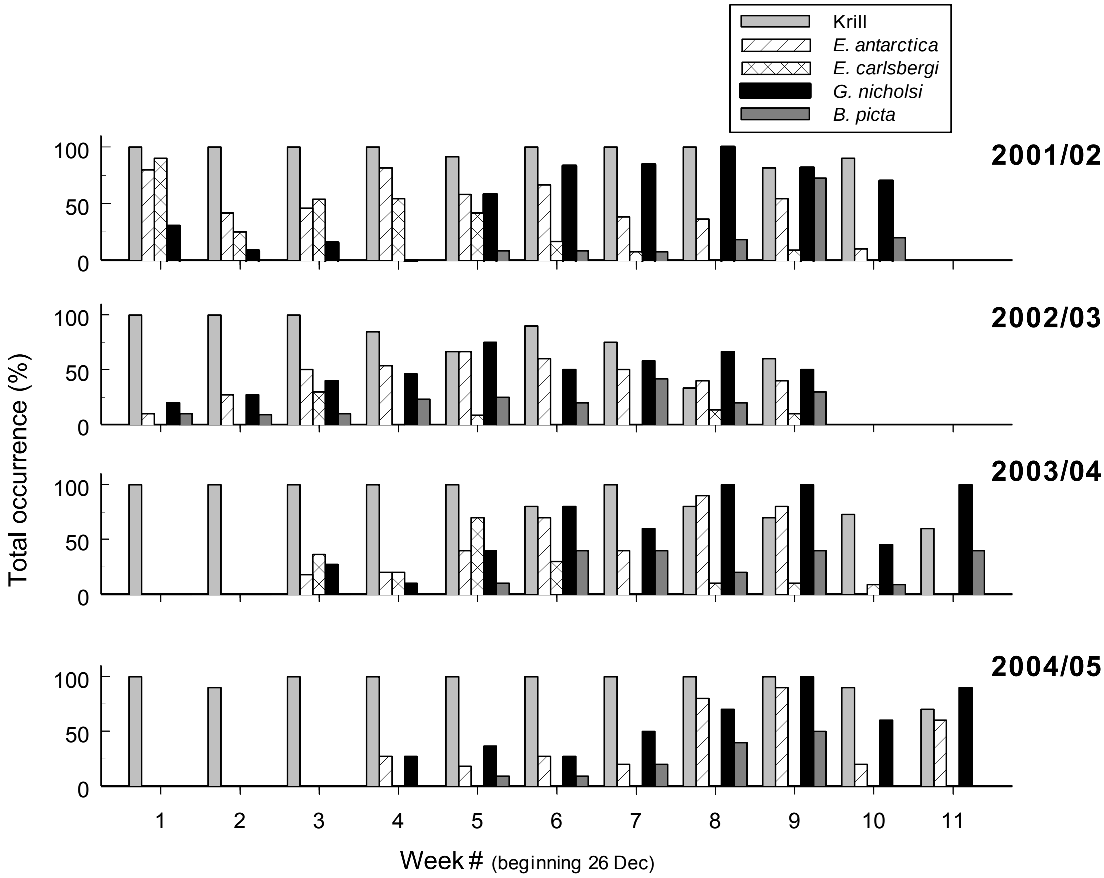


Figure 6.5. The weekly percent occurrence of five primary prey species found in fur seal diets at Cape Shirreff, Livingston Island from 2001/02-2004/05. The five species are krill (*Euphausia superba*), *Electrona antarctica*, *Electrona carlsbergi*, *Gymnoscopelus nicholsi*, and *Brachioteuthis picta*. The first three non-krill species are myctophid fish (lantern fish) and the fourth species is a cephalopod (squid).

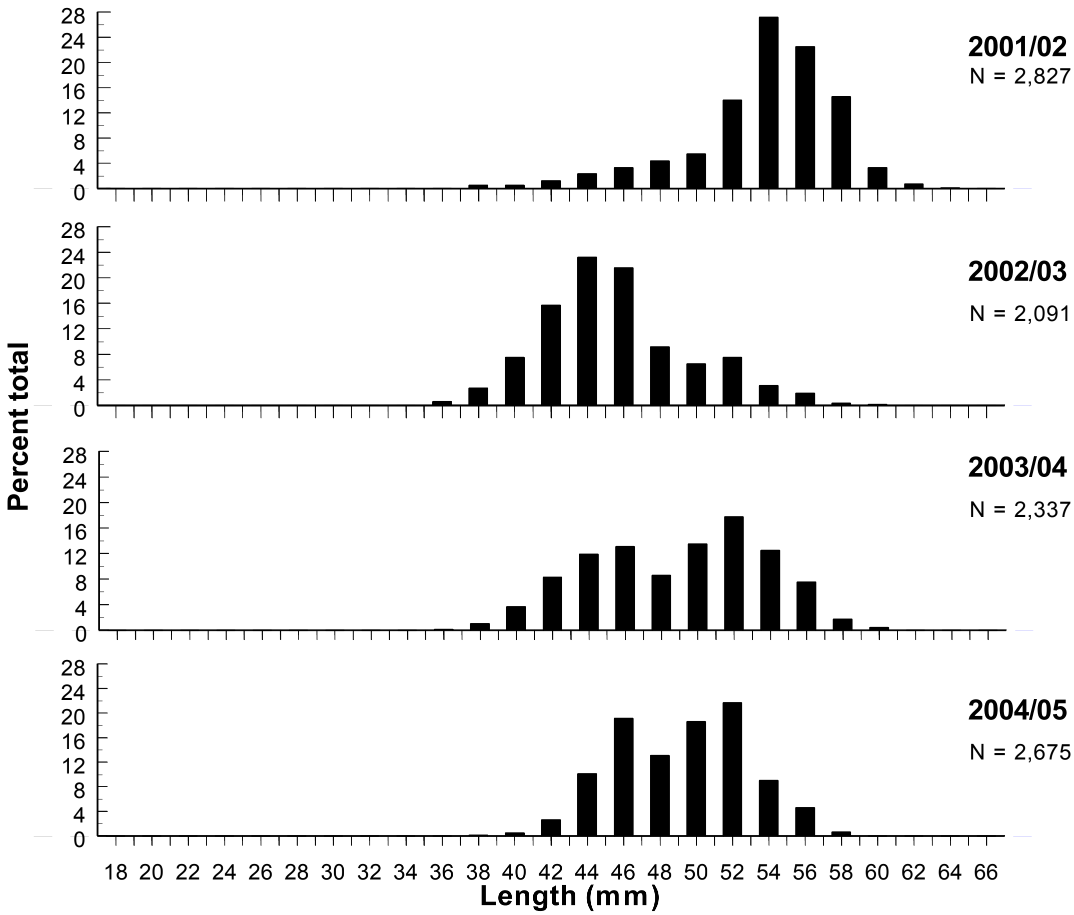


Figure 6.6. The size distribution of krill in Antarctic fur seal diet at Cape Shirreff, Livingston Island from 2001/02 through 2004/05.

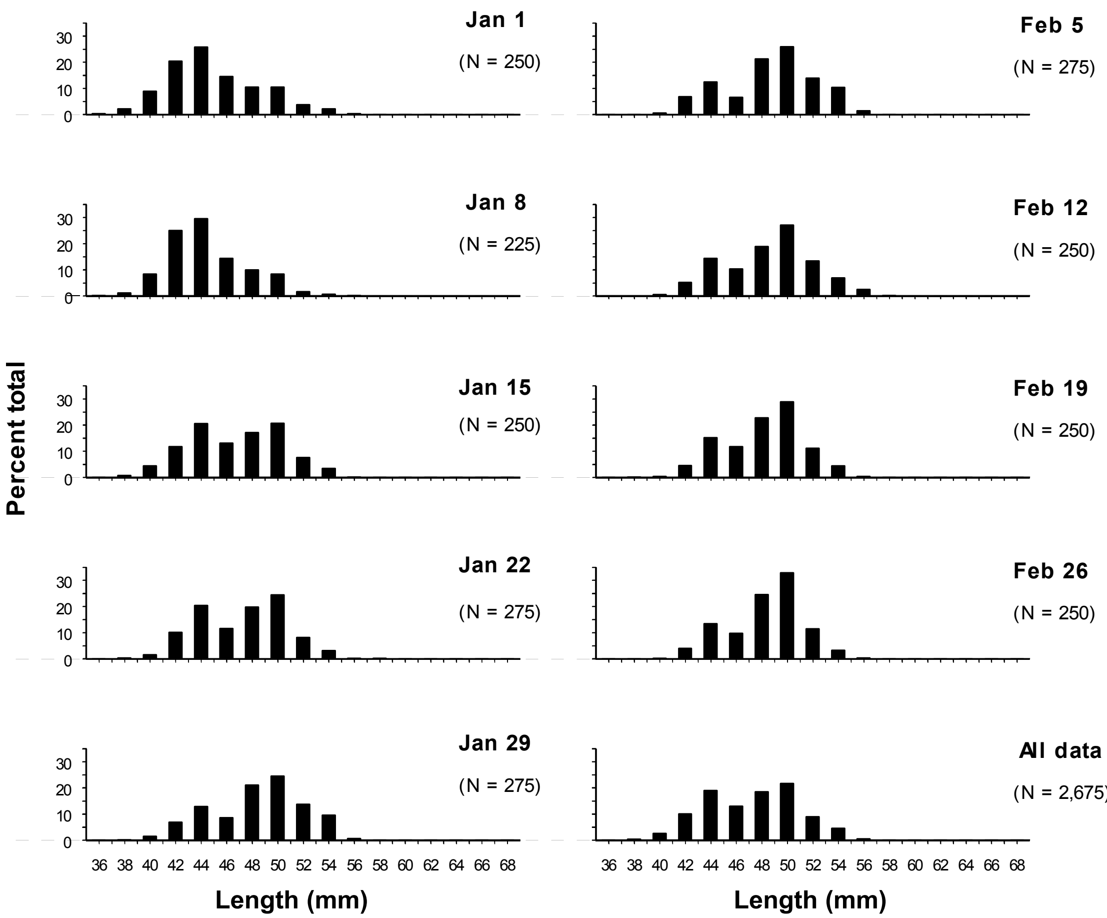


Figure 6.7. Weekly size distribution of krill (*Euphausia superba*) in Antarctic fur seal diet at Cape Shirreff, Livingston Island in 2004/05. Each plot represents one week of krill carapace measurements. The date on each plot is the last day of the week (e.g. Jan 1: the week 26 Dec 2004-1 Jan 2005). The number of krill carapaces measured for each week is given in parentheses.

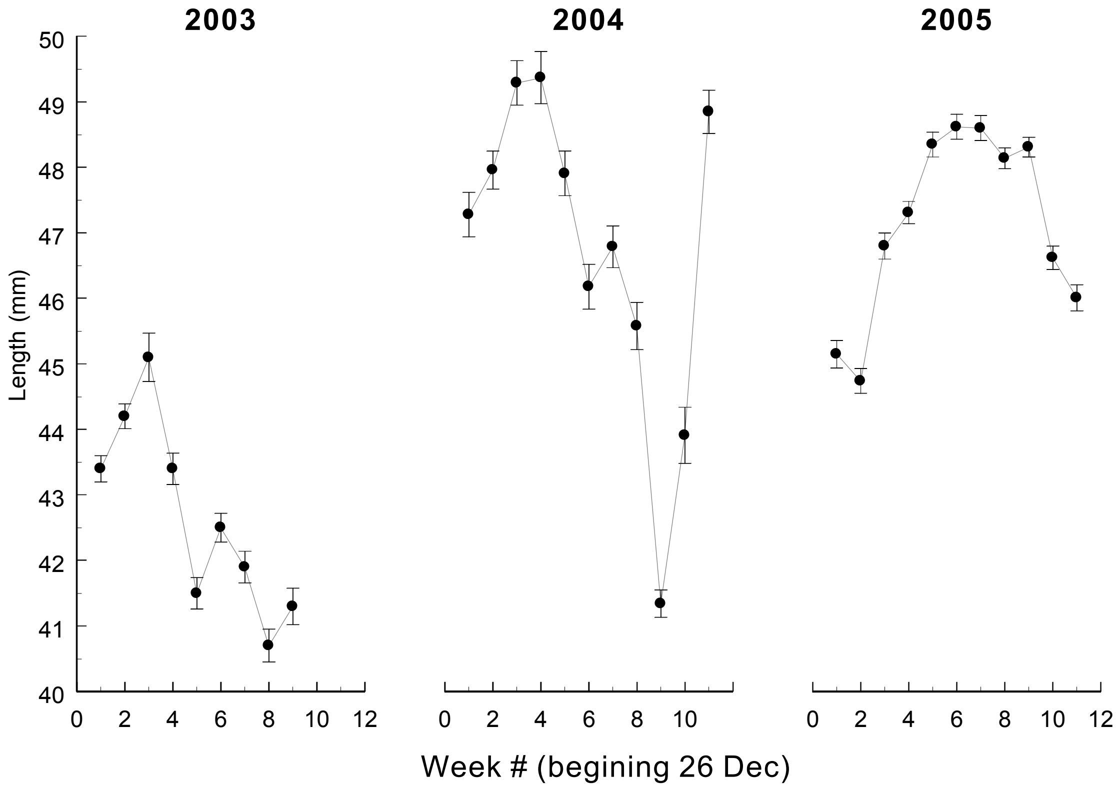


Figure 6.8. Weekly mean length of krill (*Euphausia superba*) in Antarctic fur seal diet at Cape Shirreff, Livingston Island from 2002/03 through 2004/05.

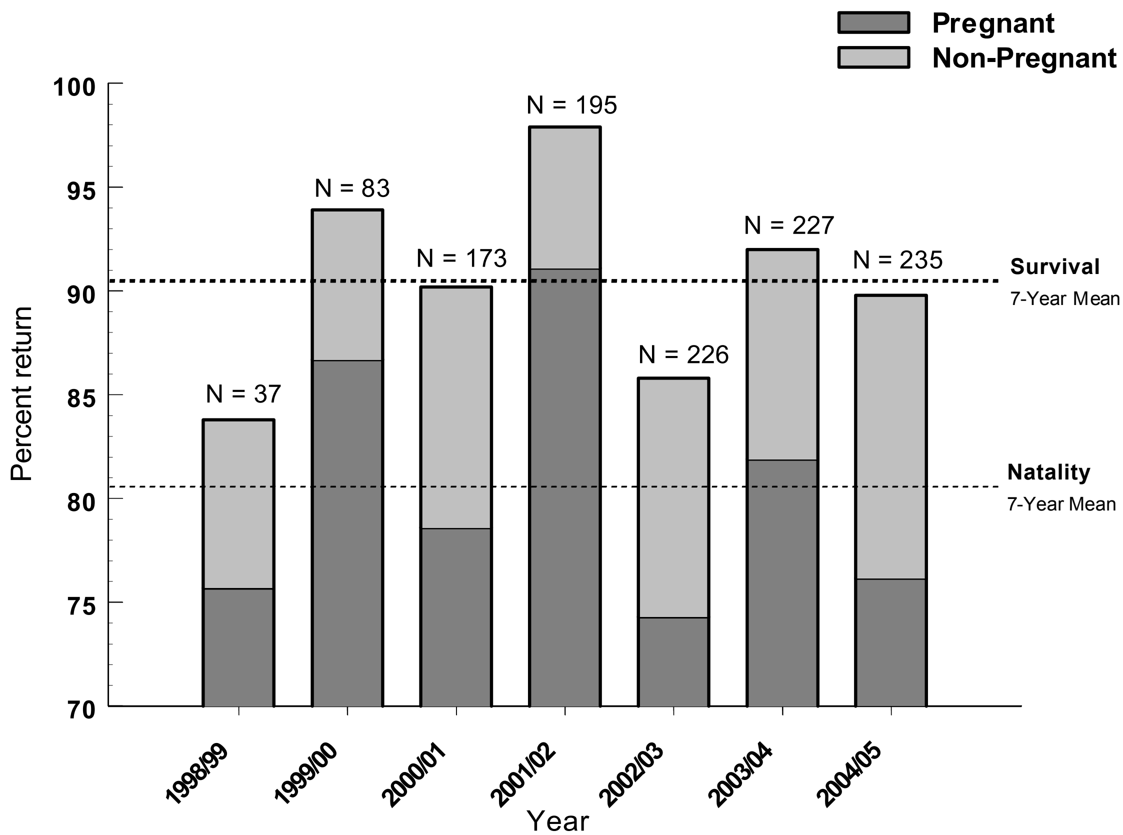


Figure 6.9. Adult female Antarctic fur seal tag returns for seven years (1998/99-2004/05) of study at Cape Shirreff, Livingston Island.

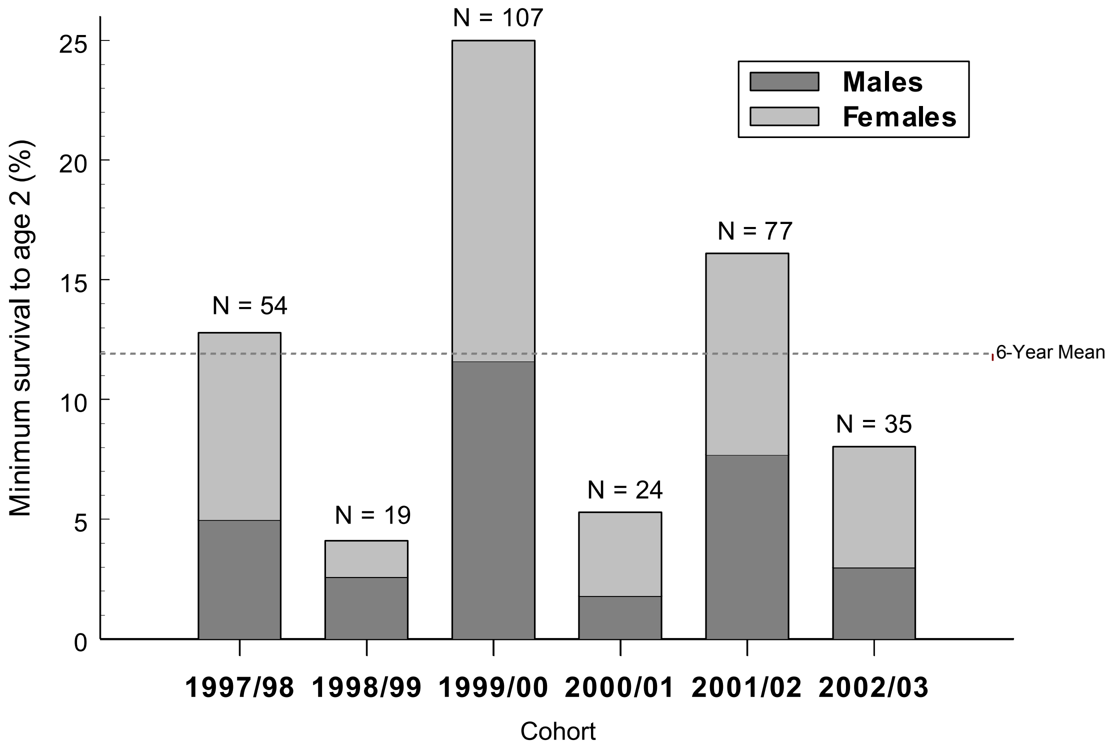


Figure 6.10. Minimum survival to age-1 based on tag returns for the first two years for four cohorts (97/98-02/03) of fur seals tagged as pups at Cape Shirreff, Livingston Island. Not all pups that survive their first year return as yearlings or two year olds, thus our estimates represent a minimum survival. There were no differences in tag re-sight effort among years.

7. Seabird research at Cape Shirreff, Livingston Island, Antarctica, 2004/2005; submitted by Aileen K. Miller, Elaine S. W. Leung and W.Z. Trivelpiece.

7.1 Objectives: The U.S. Antarctic Marine Living Resources (AMLR) program conducted its eighth complete field season of land-based seabird research at the Cape Shirreff field camp on Livingston Island, Antarctica (62º 28'S, 60º 46'W), during the austral summer of 2004-2005. Cape Shirreff is a Site of Special Scientific Interest and long-term monitoring of predator populations are conducted in support of US participation in CCAMLR (Convention for the Conservation of Antarctic Marine Living Resources).

Research for the 2004/05 field season began upon arrival at Cape Shirreff on 10 November 2004 via the National Science Foundation vessel R/V *Laurence M. Gould*. Research continued until camp closure on 12 March 2005. The U.S. AMLR chartered vessel R/V *Yuzhmorgeologiya* provided logistical support and transit back to Punta Arenas, Chile, at the field season's conclusion. The objectives of the seabird research for the 2004/05 season were to collect the following long-term monitoring data:

1. To estimate chinstrap (*Pygoscelis antarctica)* and gentoo penguin (*P. papua)* breeding population size (Standard Method A3);
2. To band 500 chinstrap and 200 gentoo penguin chicks for future demography studies (Std. Method A4);
3. To determine chinstrap penguin foraging trip durations during the chick rearing stage of the reproductive cycle (Std. Method A5);
4. To determine chinstrap and gentoo penguin breeding success (Std. Methods 6a, b & c);
5. To determine chinstrap and gentoo penguin chick weights at fledging (Std. Method 7c);
6. To determine chinstrap and gentoo penguin diet composition, meal size, and krill length-frequency distributions (Std. Methods 8a,b&c); and
7. To determine chinstrap and gentoo penguin breeding chronologies (Std. Method 9).

7.2 Results:

7.2.1 Breeding biology studies: The Cape Shirreff penguin rookery consisted of 23 breeding sub-colonies of chinstrap and gentoo penguins during the 2004/05 breeding season. Chinstrap penguin nests were censused on 2 and 3 December 2004, and gentoo penguin nests on 1 December 2004, approximately one week after the peak of clutch initiation in each species. All colonies were counted in their entirety. Total breeding numbers during the 2004/05 breeding season were determined to be 4,907 chinstrap penguin pairs and 818 gentoo penguin pairs. The number of chinstrap breeding pairs declined 13% from the 2003-04 breeding season, marking the sixth consecutive year of decline. The chinstrap penguin breeding population is at its lowest size in eight years of study at Cape Shirreff (Figure 7.1). The number of gentoo breeding pairs increased 9% from the 2003/04 breeding season. The gentoo breeding population is currently just 3% below the mean of the previous seven years of study on the Cape (Figure 7.2).

We conducted the annual penguin chick census for chinstrap penguins on 8 February 2005, and the chick census for gentoo penguins on 3 February 2005. We counted a total of 4,323 chinstrap penguin chicks and 933 gentoo penguin chicks. The chinstrap penguin count was 23% lower than the 2003/04 season, the lowest number of chinstrap penguin chicks in the nine years of study. The total number of gentoo penguin chicks was comparable to the 2003-04 breeding season (Figures 7.1 and 7.2).

Based on census data, chinstraps fledged 0.88 chicks per nest, and gentoo penguins fledged 1.14 chicks per nest. Compared to the seven-year (1997/98 and 2003/04) mean, chinstrap penguin fledging success was 19% lower and gentoo penguin fledging success 3% lower in 2004/05. We also measured penguin reproductive success by following a sample of 97 breeding pairs of chinstrap penguins and 50 pairs of gentoo penguins from clutch initiation through crèche formation (Std. Methods 6a, b & c). Chinstrap penguins fledged 0.69 chicks per nest; gentoo penguins fledged 1.16 chicks per nest during 2004/05.

We banded a sample of 500 chinstrap and 200 gentoo penguin chicks for future demographic studies. Banded chicks that survive and return to the colony as adults will be observed for age-specific survival and reproductive success in future years.

We collected fledging weights for chinstrap and gentoo penguin chicks and found that average fledge weights were the lowest seen in nine years for both species. We weighed fledging chinstrap chicks between 19 February and 2 March 2005, during the peak fledging period. We captured and weighed 171 chinstrap fledglings on the beaches surrounding the penguin rookery, as fledglings departed to sea (Standard Method 7c). Mean chinstrap fledging weight during the 2004/05 season was 2,887 g (S.D. = 406), 8% lower than the nine-year mean. We also collected a sample of gentoo penguin chick weights. Because gentoo chicks continue to be provisioned by their parents after they begin making trips to sea, it is not possible to get a definitive fledging weight by the same method used for chinstrap fledglings. Instead, a sample of chicks are captured and weighed at 85 days after average gentoo clutch initiation date. This approximates the age at which other *Pygoscelis* penguin chicks fledge. We collected 188 gentoo chick weights on 14 February; mean gentoo chick weight was 3,957 g (S.D. = 606). This average weight was 7% lower than the nine-year mean.

7.2.2 Foraging ecology studies: We conducted diet studies of chinstrap and gentoo penguins rearing chicks between 9 January and 9 February 2005. The majority of the sampling coincided with the AMLR oceanographic survey. Forty chinstrap and 20 gentoo breeding adults were captured at their nest sites upon returning from foraging trips, and total stomach contents were collected using the wet-offloading technique. Antarctic krill (*Euphausia superba*) was present in all samples, and comprised the majority of the diet in 95% of samples. Fish comprised the next largest component of the diet; < 1% of the diet was comprised of squid and other marine invertebrates.

The chinstrap penguin diet samples consisted of <1% fish by mass during the 2004/05 breeding season, similar to the past eight years of study. The gentoo penguin diet consisted of 18% fish by mass during the 2004-05 breeding season; below the seven-year average of 27% fish, but significantly higher than last year's average of 4% fish. During the 2004/05 breeding season, 38% of the chinstrap diet samples and 55% of the gentoo diet samples contained some evidence of fish. This compares to a mean frequency of occurrence of fish over eight years of 29% for chinstraps and 75% for gentoos. Average total chick meal mass was 661 g for chinstraps. Compared to the eight-year mean, chinstrap chick meals were 7% larger during the 2004/05 breeding season due to a large increase in the weight of digested material. The average weight of the digested portions of the samples was 19% greater than the mean of all eight years of study, while the average weight of the fresh portions of the samples was 5% lower than the eight-year mean. Only partial samples, from the upper (fresh) portion of the stomach, were collected from gentoo penguins so meal mass could not be evaluated.

A sub-sample of 50 individual Antarctic krill from each diet sample were measured and sexed in order to determine krill sex ratios and length distribution in penguin diets. Krill found in penguin diets during the 2004/05 breeding season consisted of 21% males, 79% females, and <1% juveniles. This distribution represents the third year of increasing proportions of females and decreasing proportions of male and juvenile krill, similar to the pattern observed over the first four years of diet study (Figure 7.3). The majority of the krill in both chinstrap and gentoo diets were in the 46-50 mm range, the third year of increasingly larger krill seen in the diet (Figure 7.4).

We attached 19 radio transmitters to adult chinstrap penguins during the chick-provisioning period on 4, 5 and 12 January and logged their signals until 4 March using a remote receiver and data collection computer at our observation blind. Detections of penguins on-shore were used to calculate foraging trip durations. The majority of foraging trips (62%) were between 6 and 14 hours long, and average trip duration was 12.4 h (N = 710, S.D. = 7.2 h). This compares to mean trip durations in 2003/04 of 18.6 hours.

Time-depth recorders (TDRs) were attached to chinstrap and gentoo penguins in two deployments in early and mid-January to collect penguin diving behavior data during the chick-rearing period. The second deployment coincided with the AMLR oceanographic survey. During each deployment, five TDRs were placed on chinstrap penguins and four on gentoo penguins; all TDRs remained on for 7-10 days before being removed and downloaded. Dive data are awaiting analysis.

PTTs (satellite-linked transmitters) were also deployed on chinstrap and gentoo penguins during the chick-rearing phase in order to provide geographic data on penguin foraging locations during this period. A small deployment was completed in early January with 4 PTTs on chinstrap penguins and 3 PTTs on gentoo penguins. Two larger deployments of PTTs were completed in mid-January and in early February; the first to coincide with the AMLR oceanographic survey, the second to coincide with the AMLR in-shore hydroacoustic survey. For both of these two deployments PTTs were placed on eight chinstrap penguins and seven gentoo penguins.

7.2.3 Other seabirds: We monitored reproductive success of all breeding brown skuas (*Catharacta lonnbergi*) on Cape Shirreff, as well as at an additional breeding site on Punta Oeste. A total of 17 brown skua pairs initiated nests during the 2004/05 season; overall fledging success was 0.41 fledglings/pair, a 37% decrease in fledging success from both the 2003/04 breeding season and the eight-year mean. Reproductive performance of kelp gulls (*Larus dominicanus*) was followed opportunistically throughout the season. Twenty-two nests were initiated on the cape, and 9 nests were initiated on Punta Oeste. Overall fledging success could not be confirmed.

7.3 Conclusions: The eighth complete consecutive season of data collection at Cape Shirreff has enabled us to examine trends in penguin population dynamics, as well as inter-annual variation in penguin diet, and foraging behavior. The chinstrap breeding population at Cape Shirreff has continued to decline over the past six years, and is at its lowest size in the past eight years of study, and fledging success was poor compared to earlier years of study. The gentoo breeding population, in contrast, has remained relatively stable and had similar fledging success in 2004/05 as the long-term mean. Fledging weights of both species decreased from last year, and were the lowest average weights seen over nine years. The diet of both chinstrap and gentoo penguins contained primarily adult female Antarctic krill, peaking in the 46-50 mm range, continuing a four year trend of increasing proportions of female krill and increasingly larger krill. The diet of both species contained less fish than in other years on average. Total chick meal mass was larger for chinstrap penguins compared to the past seven years of study, primarily in the digested portion of the meal. The interpretation of these diet patterns may be aided by analysis of foraging location and diving behavior data.

7.4 Acknowledgements: We would like to sincerely thank the efforts of Mike Goebel, Gitte Macdonald, Yann Tremblay, Douglas Krause, and Rennie Holt for their invaluable assistance and guidance in the field. We would also like to thank the Chilean research team; Romeo Vargas, Max Bello, Claudio Vero, Daniel Torres Jr., and the Chilean logistics team, Cesar Cifuentes, for their assistance in the field, as well as their personal camaraderie. We are grateful to the crew of the NSF research vessel R/V *Laurence M. Gould* for our smooth transit to Cape Shirreff and for their help with camp opening, and to the crew of the AMLR chartered research vessel R/V *Yuzhmorgeologiya* for their efforts in resupplying our camp and for providing transit back to Punta Arenas, Chile.

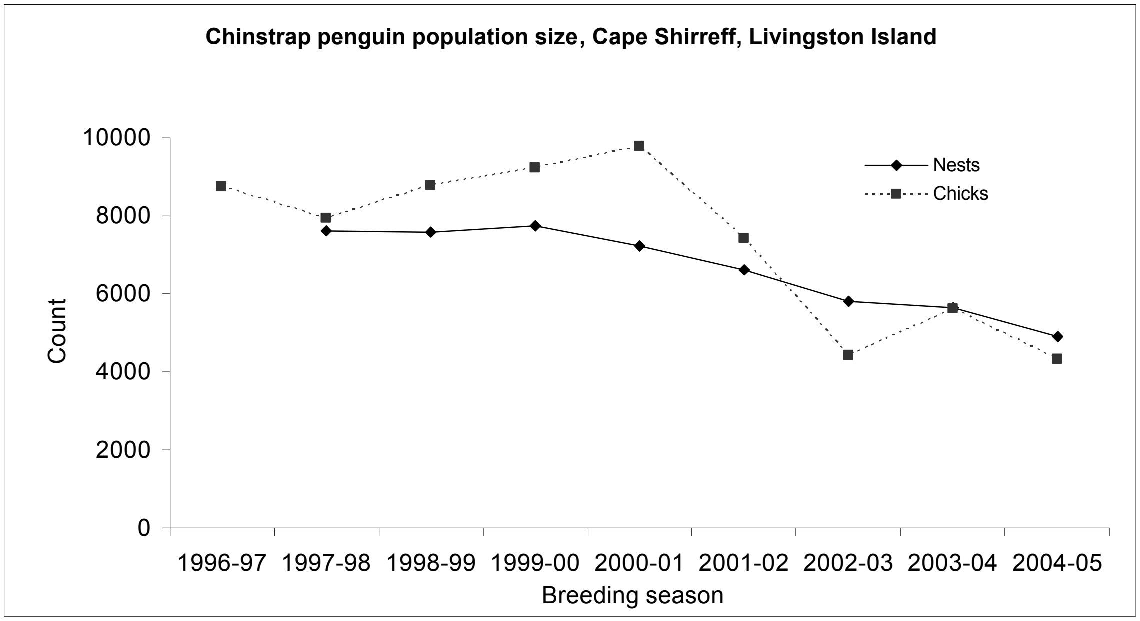


Figure 7.1. Chinstrap penguin population size based on census data at Cape Shirreff, Livingston Island, Antarctica, 1996-2005.

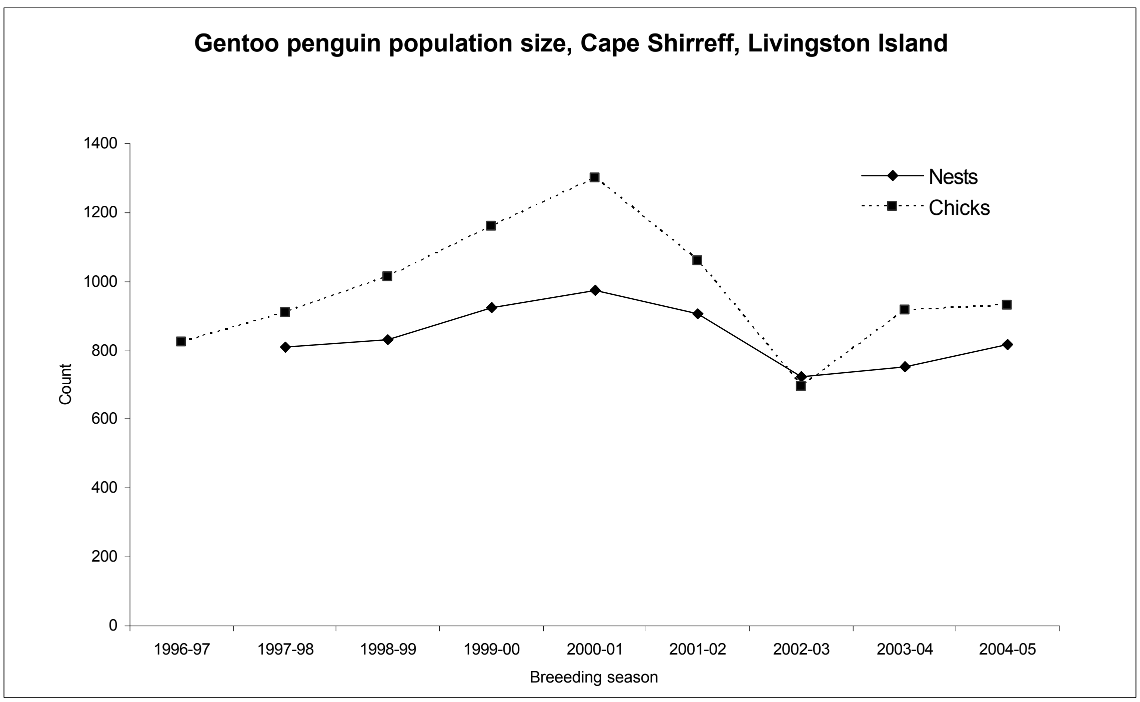


Figure 7.2. Gentoo penguin population size based on census data at Cape Shirreff, Livingston Island, Antarctica, 1996-2005.

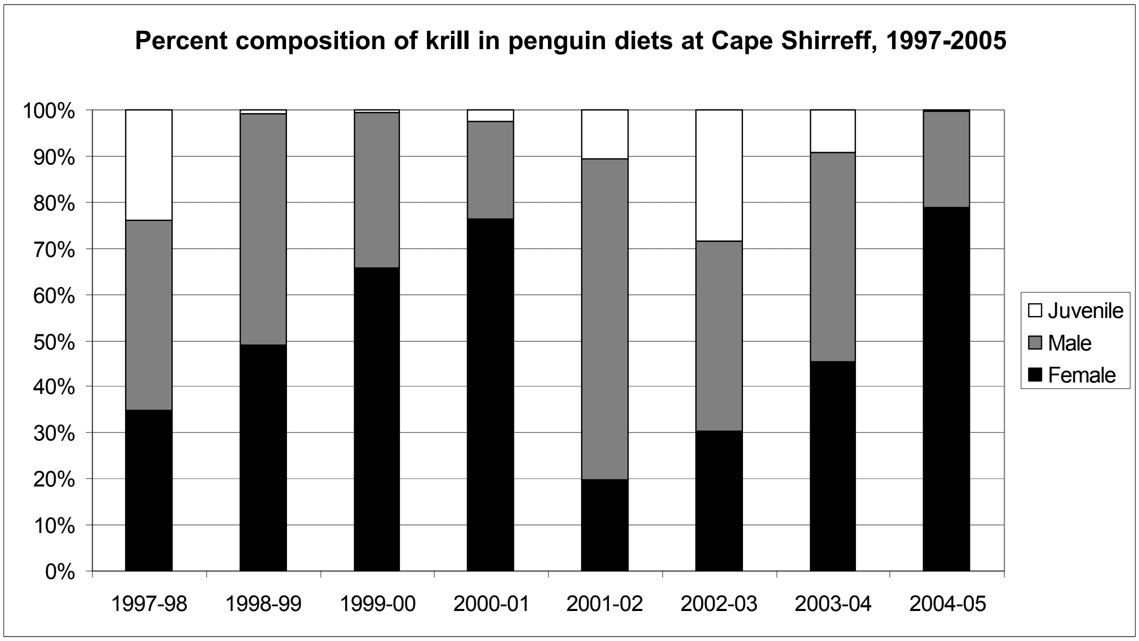


Figure 7.3. Percent composition of Antarctic krill (*E. superba*) in penguin diets at Cape Shirreff, Livingston Island, Antarctica, 1997/98 – 2004/05.

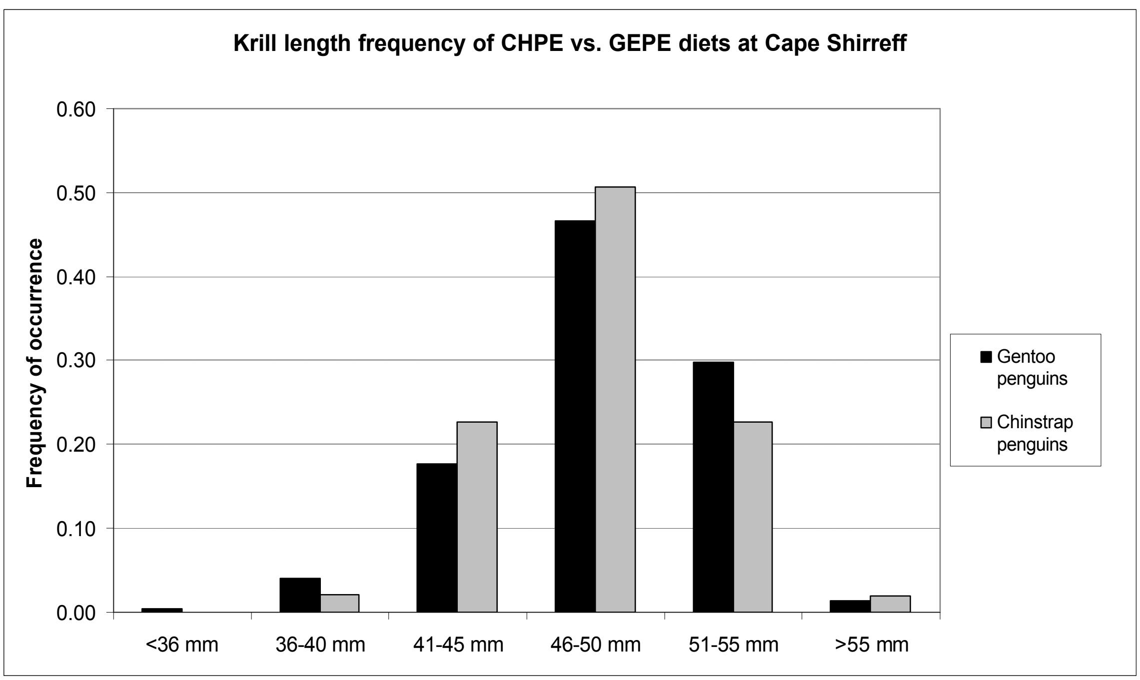


Figure 7.4. Krill length-frequency distribution in penguin diet samples at Cape Shirreff, Livingston Island, Antarctica, 2004/05.

8. Distribution, Abundance, and Behavior of Seabirds and Mammals at sea, during the 2004/05 AMLR Survey; submitted by Jarrod A. Santora (Leg I), Douglas J. Futuyma (Leg I), Michael Force (Leg II), Richard S. Heil (Leg II), and Blair J. Nikula (Leg II).

8.1 Objectives: Understanding how seabirds and their prey form aggregations at sea is crucial to the design and implementation of conservation policy. Furthermore, deciphering the complex relationship of environmental warming and fluctuations of seabird populations is difficult to accomplish with solely one type of census. This report describes a survey of predator abundance and foraging behavior at sea near the South Shetland Islands and Antarctic Peninsula. This investigation focuses on the at sea abundance and behavior of pelagic predators in collaboration with other marine operations. The primary objectives were to map the behavior and abundance of seabirds and mammals at sea during Legs I and II, and use the resulting data set to investigate:

a) Foraging behavior of Antarctic seabirds and the scale (100m to 1000's of km) at which feeding predators and krill aggregations occur.
b) Patterns of predator behavior and abundance in response to krill swarms of different size.
c) Community structure and habitat selection by predator groups.
d) Annual and seasonal change in dispersion of foraging seabirds at sea.

Here we report the amount of data collected for each Leg, species density, seabird community members in each area or strata, spatial dispersion of total bird abundance, and spatial dispersion of feeding aggregations.

8.2 Methods:

8.2.1 Seabird and Mammal Observations: Data on predator abundance and behavior were collected using binoculars while underway between stations during daylight hours. Surveys followed strip transect methods (Tasker *et al*., 1984) and counts were made within an arc of 300m directly ahead and to one side of the ship. In this report, transects are referred to as the duration of travel time and space coverage while the vessel was underway between stations. Data were entered into a computer program designed for mapping observations in space and in real time. Each record was immediately assigned a time and a position directly fed by the ships navigational computer. The computer clock was synchronized with the ships data acquisition computer and the hydro-acoustic system used to collect krill biomass estimates. Individual birds, or flocks of birds, were assigned a behavioral code. The behaviors were: flying, sitting on water, milling (circling), feeding, porpoising (penguins, seals, and dolphins), and ship following. Ship-followers were entered when encountered and were ignored thereafter. Predators, which were flying, or porpoising were assigned a direction. Data recorded for mammals included traveling direction, distance from ship and behavior. Observations were collected during transit between Punta Arenas, Chile, and the South Shetland Islands during Leg II by Michael Force, and summarized as the Drake Passage sample in section 8.4.5.

8.3 Accomplishments: The amount of area surveyed (km²) and number of transects collected in each AMLR study area is presented in table 8.1. In total, 73 transects were collected during Leg I and representing approximately 3,885 km. In total, 26 seabird species and 9 species of marine mammals were recorded during Leg I, and each species is presented in Table 8.2 as estimates of densities calculated by the dividing the total abundance, by the total kilometers surveyed in each area (i.e. Elephant Island). Overall, 201 one hour blocks (˜ 10 nm), of observation effort were collected. Mean seabird abundance per block was 87.4 birds/hour with a standard deviation of 153.42 birds/hour, with a maximum of 1,108 birds (Figure 8.1 a). 55 transects were collected during Leg II representing approximately 1,935.34 km. In total, 27 seabird species and 9 species of marine mammals were recorded during Leg II, and each species is also presented in Table 8.3 as estimates of densities calculated by the dividing the total abundance, by the total kilometers surveyed in each area. Overall, 155 one hour blocks (˜ 10 nm), of observation effort were collected. Mean seabird abundance per block was 95.4 birds/hour with a standard deviation of 337.82 birds/hour, with a maximum of 3,545 birds (Figure 8.1b).

The spatial dispersion of (a) total seabird abundance and (b) feeding aggregation abundance of seabirds recorded during each Leg for AMLR 2004/05 is presented in Figures 8.2 and 8.3 respectively. The survey effort mapped here represents observations collected during daylight hours between hydrographic stations, and therefore is an incomplete representation of the dispersion patterns of predators for the entire AMLR area; due to lack of spatial replication and missed transects during dark hours. Nevertheless, considering the total amount of hours surveyed (356) and total amount of kilometers surveyed (5820.45), these figures provide a good approximation to the probable dispersion patterns of predators during AMLR 2004/05 season. Figure 8.4 illustrates (A) humpback whale (*Megaptera novaeangliae*), and (B) Antarctic fur seal (*Arctocephalus gazella*) dispersion in the study area, represented by the abundance of animals encountered during a one-hour period. Dispersion and abundance patterns of seabirds and marine mammals will be discussed for each area in the following sections.

8.4 Results and Tentative Conclusions:

8.4.1 Elephant Island Area: The seabird community in the Elephant Island Area was represented by the following group of species in descending abundance (see Tables 8.2 and 8.3): cape petrel (*Daption capense*), southern fulmar (*Fulmarus glacialoides*), chinstrap penguin (*Pygocelis antarctica*), black-bellied storm petrel (*Fregetta tropica*), prions (*Pachyptila species*), hite-chinned petrel (*Procellaria aequinoctialis*), black-browed albatross (*Thalassarche mwelanophrys*), and Wilson’s storm petrel (*Oceanites oceanicus*).

During Leg I, 36 transects were sampled representing approximately 1,185.2 km of survey effort (Table 8.1). As in past cruises (Santora and Mitra 2003, Santora 2004), the largest aggregations of seabirds were located north of Elephant Island near the shelf break (Figure 8.2a). These aggregations (800 to 1000’s of individuals per hour) were primarily composed of feeding flocks of cape petrels, southern fulmars, black-browed albatrosses, and white-chinned petrels. Subsequently the dispersion of feeding aggregations (all species combined) coincided with the elevated seabird abundance mapped at the shelf break (Figure 8.2b). Soft-plumaged petrels (*Pterodroma mollis*), were very conspicuous in the pelagic waters at the northern edge of the Elephant Island Area. Also of note, numbers of white-chinned petrels were greater in AMLR 2004/05 than in the past two years (Santora and Mitra 2003, Santora 2004). This species was frequently (n=15) observed feeding in groups of up to 25 individuals surface-seizing prey during daylight hours. The greatest number (9 to 12 per hour) of humpback whales was located to the southwest of Elephant Island (Figure 8.4a). Antarctic fur seals were mapped along the shelf break, and between Elephant and Clarence Islands (Figure 8.4b).

During Leg II, 27 transects were sampled representing approximately 842.66 km of survey effort (Table 8.1). The largest aggregations (300 to 600 individuals per hour) were found to the southwest of Elephant Island and consisted primarily of southern fulmars. This pattern was previously detected during Leg II AMLR 2003/04 in late March and is likely related to post breeding dispersal from nearby southern fulmar colonies. Unfortunately, poor coverage of the shelf-break zone north of Elephant Island during Leg II may have lead to reduced observations of feeding birds (Figure 8.3b). However, the number of feeding aggregations was reduced in number in contrast to Leg I (Figure 8.3 a and b). The largest feeding aggregations (20 to 40 birds/hour) were located to the west of Elephant Island. No humpback whales were mapped in the Elephant Island Area. A pod of about 60 long-finned pilot whales (*Globicephala melas*) was recorded during Leg II.

8.4.2 Joinville Island Area: The seabird community in the Joinville Island Area was represented by the following group of species in descending abundance (see tables 8.2 and 8.3): southern fulmar (*Fulmarus glacialoides*), Wilson's storm petrel (*Oceanites oceanicus*), cape petrel (*Daption capense*), black-bellied Storm petrel (*Fregetta tropica*), chinstrap penguin (*Pygocelis antarctica*), and black-browed albatross (*Thalassarche melanophrys*).

During Leg I, 6 transects were sampled representing approximately 250.02 km of survey effort (Table 8.1). During Leg II, 4 transects were sampled representing approximately 166.68 km of survey effort (Table 8.1). This area is poorly under represented in the AMLR survey due to the inclusion of iceberg fields along transects. Nonetheless, the largest aggregations (2,400 to 3,500 birds per hour) of seabirds encountered during AMLR 2004/05 occurred during Leg II (Figure 8.1b), and consisted entirely of Southern Fulmars sitting on the water (Figure 8.3a). Similar aggregations were found here during the past two years (Santora and Mitra 2003, Santora 2004).

8.4.3 South Area: The seabird community in the South Area was represented by the following group of species in descending abundance (see Tables 8.2 and 8.3): southern fulmar (*Fulmarus glacialoides*), cape petrel (*Daption capense*), chinstrap penguin (*Pygocelis antarctica*), Wilson's storm petrel (*Oceanites oceanicus*), gentoo penguin (*Pygocelis papua*), Adélie penguin (*Pygocelis adelie*), black-bellied storm petrel (*Fregetta tropica*), black-browed albatross (*Thalassarche melanophrys*), southern giant petrel (*Macronectes giganteus*), and Antarctic tern (*Sterna vittata*).

During Leg I, 13 transects were sampled representing approximately 500.04 km of survey effort (Table 8.1). The greatest aggregation of seabirds (800 to 1200 birds/hour) recorded in the South Area coincided with the largest series of feeding aggregations (n=4, 150 to 300 birds/hour) encountered during AMLR 2004/05 (Figures 8.2a & b). These aggregations were located at the most southwest corner of the AMLR survey in the Bransfield Strait. As in the past two years of AMLR surveys, the greatest numbers of humpback whales were recorded in the South Area (Figure 8.4a), (Santora and Mitra 2003, Santora 2004).

During Leg II, 9 transects were sampled representing approximately 333.36 km of survey effort (Table 8.1). A series of seabird aggregations (n=7, 100 to 400 birds/hour) were recorded during the South Area during Leg II. These aggregations consisted primarily of southern fulmars sitting on the water. Feeding aggregations (n=2, 10 to 20 birds/hour) recorded in this area consisted of southern giant petrels (*Macronectes giganteus*), Wilson's storm petrels and black-browed albatrosses feeding on the remains of dead penguins (Figure 8.3b). Antarctic fur seals were more abundant and spatially distributed in the South Area during Leg II than in Leg I (Figure 8.4b).

8.4.4 West Area: The seabird community in the West Area was represented by the following group of species in descending abundance (see tables 8.2 and 8.3): cape petrel (*Daption capense*), chinstrap penguin (*Pygocelis antarctica*), Wilson's storm petrel (*Oceanites oceanicus*), black-bellied storm petrel (*Fregetta tropica*), black-browed albatross (*Thalassarche melanophrys*), white-chinned petrel (*Procellaria aequinoctialis*), prions (*Pachyptila species*), and blue petrel (*Halobaena caerulea*).

During Leg I, 18 transects were sampled representing approximately 740.8 km of survey effort (Table 8.1). One of the largest aggregations (1200 birds/hour) of seabirds recorded during AMLR 2004/05 was found during transit in Nelson Passage (see Figures 8.1a, and 8.2a). This aggregation consisted primarily of chinstrap penguins, observed actively porpoising in all directions. A series of large feeding aggregations (n=5, 80 to 160 birds/hour) were recorded on lines 1 and 2 in the West Area (Figure 8.3b). The largest aggregation of Antarctic fur seals recorded was west of Cape Sherriff, Livingston Island on line two on the shelf break, and consisted of 18 animals (Figure 8.4b). There were only two observations of humpback whales in the West Area during Leg I.

During Leg II, 15 transects were sampled representing approximately 592.64 km of survey effort (Table 8.1). The largest aggregations (n=4, 100-200 birds/hour) of total seabirds were mapped offshore in pelagic waters, and consisted primarily of soft-plumage petrels. This was largest density recorded for this species in the past two years (Santora and Mitra 2003, Santora 2004). Only one substantial feeding aggregation (80 to 120 birds/hour) was recorded during Leg II in the West Area (Figure 8.3b). Antarctic fur seals were more abundant and spatially distributed during Leg II than Leg I (Figure 8.4b), and was recorded on every hour sample (6 to 12 per hour). No humpback whales were recorded in the West Area during Leg II (Figure 8.4a). A pod of about 38 hourglass dolphins (*Lagenorhychus cruciger*) were observed in the West Area.

8.4.5 Drake Passage - Summary of underway bird and mammal observations: Standardized seabird observations were conducted during Leg II transits between the east end of the Strait of Magellan and the South Shetland Islands. There was no coverage during Leg I, resulting in reduced observation effort compared with previous years. Observations were conducted from the bow (weather permitting) or from one of the bridge wings and consisted of continuous 30 minute transects using a 300 meter 90° arc on one side of the bow. Table 8.4 summarizes observation effort by area. Table 8.5 provides perspective on relative abundance, summarizing totals by species arranged in descending order of relative abundance.

Despite the relative lack of coverage, this was an interesting year with several notable occurrences. After being entirely absent for several years, Kerguelen petrel (*Aphrodroma* *brevirostris)* was fairly common northbound in March with numbers being in the double digits (there were many more recorded off-transect and are not included in the total). In years when it does occur, there are usually 5 or less. Likewise, soft-plumaged petrel (*Pterodroma mollis*) was also widespread, numbering in the hundreds if one were to include birds off-transect. Two adult king penguins were the first ever recorded on these transects, spanning 10 years of observation effort. Another first for the AMLR crossing was a gray petrel *(Procellaria cinerea)* seen off effort by Richard Heil. Several mottled petrels (*Pterodroma inexpectata*) were seen, only the second time this western Pacific species has been recorded on an AMLR cruise. Surprising was the complete absence of blue petrel *(Halobaena caerulea)* and paucity of prions *(Pachyptila sp.)*. On the northbound Drake Passage transit after Leg I, Santora and Futuyma recorded one Salvin's albatross (*Thalassarche salvini*) approximately 100 nautical miles east of Cape Horn.

8.5 Disposition of Data: After all data have been thoroughly proofed, a copy will be retained and available from Jarrod Santora, College of Staten Island, Biology Department, 2800 Victory Boulevard, Staten Island, NY, 10314; phone: +1 (718) 982-3862; email: jasantora@yahoo.com

8.6 Acknowledgements: Mike Force assisted in data collection while at stations and during crossing of the Drake Passage. Michael Force would like to thank members of the AMLR scientific team who directly or indirectly supported the underway bird and mammal effort. This includes Derek Needham and Marcel Van den Berg who kindly provided the SCS data and to the AMLR bird observers Rick Heil and Blair Nikula for their assistance. Heartfelt thanks to Valerie Loeb (krill demographics), Adam Jenkins (cruise leader) and members of the zooplankton team for their support and understanding. Jessica Lipsky assisted in data collection of marine mammals during the Nearshore Survey. Richard R. Veit provided financial assistance and use of a laptop computer for data collection. Anthony Cossio and Christian Reiss provided excellent assistance in sequencing krill series to be aligned with predator abundance. Thank you to the crew of the R/V *Yuzhmorgeologiya* for assistance in the bridge and supplying a GPS feed.

8.7 Reference:

Santora, J.A., and Mitra, S.M. 2003. Distribution, abundance, and behavior of seabirds and mammals at sea, in response to variability of Antarctic krill and physical oceanography during the 2003 AMLR marine survey. Lipsky, J. (ed.) NOAA-TM-NMFS-SWFSC-355. pp 204-217.

Santora, J.A. 2004. Distribution, abundance, and behavior of seabirds and mammals at sea, during the 2003/04 AMLR survey. Lipsky, J. (ed.) NOAA-TM-NMFS-SWFSC-367. pp 158-165.

Tasker, M.L., Jones, P.H., Dixon, T., and Blake, B.F. 1984. Counting seabirds at sea from ships: A review of methods employed and a suggestion for a standardized approach. *Auk* 101: 567-577.

Table 8.1. Survey effort for seabird and mammal observations during AMLR 2004/05 presented here in kilometers; Parentheses is n number of sampled transects between hydrographic stations. Survey effort is separated into AMLR survey divisions.

Survey Area	Leg I	Leg II	Total
Elephant Island	1185.2 (n=36)	842.66 (n=27)	2027.94 (n=63)
West	740.8 (n=18)	592.64 (n=15)	1333.44 (n=33)
South	500.04 (n=13)	333.36 (n=9)	833.4 (n=22)
Joinville Island	250.02 (n=6)	166.68 (n=4)	416.7 (n=10)
Nearshore	1209	N/A	1209
Total	3885.14 (n=73)	1935.34 (n=55)	5820.48 (n=128)

Table 8.2. Seabird-Mammal densities recorded for Leg I AMLR 2004/05. Densities are presented as # / Km per survey (see Table 8.1 Kilometers per survey).

Common Name	Latin Name	Elephant	West	South	Joinville	Total
Gentoo Penguin	*Pygocelis papua*	0	0.0121	0.164	0	0.034
Adelie Penguin	*Pygocelis adelie*	0.0008	0	0.118	0.02	0.0243
Chinstrap Penguin	*Pygocelis antarctica*	1.1011	1.331	0.8279	0.196	1.0291
Macaroni Penguin	*Eudyptes chrysolophus*	0.0008	0	0	0	0.0004
Wandering Albatross	*Diomedea exulans*	0.0067	0.0027	0	0	0.0037
Royal Albatross	*Diomedea epomorpha*	0.0008	0	0	0	0.0004
Black-browed Albatross	*Thalassarche melanophrys*	0.3645	0.2605	0.06	0.1	0.2541
Gray-headed Albatross	*Thalassarche chrysostoma*	0.0616	0.0148	0.004	0.012	0.0333
Light-mantled Sooty Albatross	*Phoebetria palpebrata*	0.0219	0	0	0	0.0097
Southern Giant Petrel	*Macronectes giganteus*	0.0717	0.0459	0.038	0.028	0.0542
Northern Giant Petrel	*Macronectes halli*	0.0093	0	0	0	0.0041
Southern Fulmar	*Fulmarus glacialoides*	1.5634	0.0405	3.8017	1.3119	1.5366
Antarctic Petrel	*Thalassoica antarctica*	0	0	0.002	0	0.0004
Cape Petrel	*Daption capense*	1.9288	1.8912	1.7379	0.576	1.7563
Soft-plumaged Petrel	*Pterodroma mollis*	0.0793	0	0	0	0.0351
White-chinned Petrel	*Procellaria aequinoctialis*	0.3915	0.1309	0	0.008	0.2104
Antarctic Prion	*Pachyptila desolata*	0.3966	0.0648	0	0	0.1936
Slender-billed Prion	*Pachyptila belcheri*	0.0886	0.004	0	0	0.0404
Unknown Prion	*Pachyptila species*	0.4312	0.0364	0	0	0.201
Blue Petrel	*Halobaena caerulea*	0.0177	0.0594	0.002	0	0.0247
Wilson's Storm Petrel	*Oceanites oceanicus*	0.1021	0.3105	0.306	0.6319	0.2474
Black-bellied Storm Petrel	*Fregetta tropica*	0.6826	0.2808	0.084	0.372	0.4305
Brown Skua	*Catharacta antarctica*	0.0017	0.0013	0.014	0	0.0037
South Polar Skua	*Catharacta maccormicki*	0.0051	0.0135	0.028	0.008	0.012
Kelp Gull	*Larus dominicanus*	0	0.004	0.008	0	0.0026
Arctic Tern	*Sterna paradisaea*	0.0008	0	0	0	0.0004
Antarctic Tern	*Sterna vittata*	0.0101	0.0243	0.034	0	0.0176
Antarctic Fur Seal	*Arctocephalus gazella*	0.0447	0.0418	0.02	0.048	0.0396
Elephant Seal	*Mioungq leonina*	0.0008	0	0	0	0.0004
Leopard Seal	*Hydrurga leptonyx*	0.0008	0	0	0.004	0.0007
Southern Bottlenose Whale	*Hyperoodon planifrons*	0.0034	0.0013	0	0	0.0019
Antarctic Minke Whale	*Balaenoptera bonaerensis*	0.0025	0.0094	0.004	0	0.0045
Fin Whale	*Balaenoptera physalus*	0.0143	0.004	0	0	0.0075
Humpback Whale	*Megaptera novaeangliae*	0.0143	0.0081	0.088	0.112	0.0355
Long-finned Pilot Whale	*Globicephala melas*	0.0008	0	0	0	0.0004
Killer Whale	*Orcinus orca*	0	0.0054	0	0	0.0015
Un-identified Whale	*Balaenoptera species*	0.011	0	0.004	0	0.0056

Table 8.3. Seabird-Mammal densities recorded for Leg II AMLR 2004/05. Densities are presented as # / Km per survey (see Table 8.1 Kilometers per survey).

Common Name	Latin Name	Elephant	West	South	Joinville	Total
Gentoo Penguin	*Pygocelis papua*	0.0047	0	0	0	0.0021
Chinstrap Penguin	*Pygocelis antarctica*	0.2599	1.2014	0.03	0.144	0.4986
Macaroni Penguin	*Eudyptes chrysolophus*	0.0012	0	0	0	0.0005
Wandering Albatross	*Diomedea exulans*	0.0024	0.0084	0.003	0	0.0041
Black-browed Albatross	*Thalassarche melanophrys*	0.0866	0.1468	0.465	0.216	0.1814
Gray-headed Albatross	*Thalassarche chrysostoma*	0.0712	0.0624	0.12	0.06	0.076
Light-mantled Sooty Albatross	*Phoebetria palpebrata*	0.0047	0.0017	0.015	0.012	0.0062
Southern Giant Petrel	*Macronectes giganteus*	0.0641	0.0135	0.18	0.066	0.0687
Northern Giant Petrel	*Macronectes halli*	0.0047	0	0.018	0.024	0.0072
Southern Fulmar	*Fulmarus glacialoides*	1.589	0.0034	1.8179	36.0451	4.1104
Snow Petrel	*Pagodroma nivea*	0.0012	0	0.003	0	0.001
Cape Petrel	*Daption capense*	0.2718	0.0354	0.123	0.096	0.1586
Mottled Petrel	*Pterodroma inexpectata*	0	0.0067	0	0	0.0021
Kerguelen Petrel	*Aphrodroma brevirostris*	0.0059	0.0034	0	0.006	0.0041
Soft-plumaged Petrel	*Pterodroma mollis*	0.3026	0.7441	0	0	0.3596
White-chinned Petrel	*Procellaria aequinoctialis*	0.0142	0.1249	0.003	0.006	0.0455
Antarctic Prion	*Pachyptila desolata*	0.4652	0.2244	0	0.006	0.2718
Unknown Prion	*Pachyptila species*	0.2385	0	0	0	0.1039
Blue Petrel	*Halobaena caerulea*	0.0024	0.0186	0	0	0.0067
Wilson's Storm Petrel	*Oceanites oceanicus*	0.1483	0.4539	0.474	0.288	0.31
Black-bellied Storm Petrel	*Fregetta tropica*	0.9873	0.7036	0.7229	0.6599	0.8267
Common Diving Petrel	*Pelacanoides urinatrix*	0.0012	0.0051	0	0	0.0021
Brown Skua	*Catharacta antarctica*	0.0071	0	0.018	0.012	0.0072
South Polar Skua	*Catharacta maccormicki*	0	0	0.027	0	0.0047
Pale-faced Sheathbill	*Chionis alba*	0.0012	0	0	0	0.0005
Kelp Gull	*Larus dominicanus*	0	0	0.027	0	0.0047
Arctic Tern	*Sterna paradisaea*	0.0059	0	0.057	0	0.0124
Antarctic Tern	*Sterna vittata*	0.0036	0.0017	0.057	0	0.0119
Unknown Tern	*Sterna species*	0.1804	0	1.6019	0	0.3545
Crabeater Seal	*Lobodon carcinophagus*	0	0	0	0.006	0.0005
Antarctic Fur Seal	*Arctocephalus gazella*	0.0297	0.0861	0.189	0.06	0.077
Southern Bottlenose Whale	*Hyperoodon planifrons*	0.0024	0	0	0	0.001
Antarctic Minke Whale	*Balaenoptera bonaerensis*	0	0.0067	0	0	0.0021
Fin Whale	*Balaenoptera physalus*	0.0593	0.0557	0.003	0.042	0.047
Humpback Whale	*Megaptera novaeangliae*	0	0	0.081	0.018	0.0155
Long-finned Pilot Whale	*Globicephala melas*	0.0712	0	0	0	0.031
Killer Whale	*Orcinus orca*	0	0	0.009	0	0.0016
Hourglass Dolphin	*Lagenorhynchus cruciger*	0	0.0641	0	0	0.0196
Un-identified Whale	*Balaenoptera species*	0.0131	0.0017	0.054	0.042	0.0191

Table 8.4 Observation Effort Summary, Drake Passage transit.

	Stratum 1	**Stratum 2**	**Stratum 3**
# of transects (n=65)	16	26	23
Minutes of effort (n=1950)	480	780	690
Total birds	2312	337	747
km of trackline surveyed (n=436.5)	91.6	201.1	143.7
Area surveyed (km^2)	50.9	111.7	79.9
Density (birds/km^2)*	45.4	3.0	7.7
Mean SST (°C)	10.1	5.7	2.7
Mean surface salinity (PPT)	32.83	33.93	33.78
Mean sea state (Beaufort)	3	5	7

Notes:

* includes flying birds

Stratum 1: Neritic waters off the east side of Isla Grande de Tierra del Fuego south to approximately 55°30’ South; the surface water is relatively warm with low salinity.

Stratum 2: Northern Drake Passage, pelagic waters from about Latitude 55°30’ South to roughly the northern edge of the Polar Front. The surface water is colder than Stratum 1 with a higher salinity.

Stratum 3: Southern Drake Passage includes the cold, lower salinity pelagic waters of the Polar front south to the AMLR study area.

Table 8.5 Summary of birds seen during the Drake Passage transits.

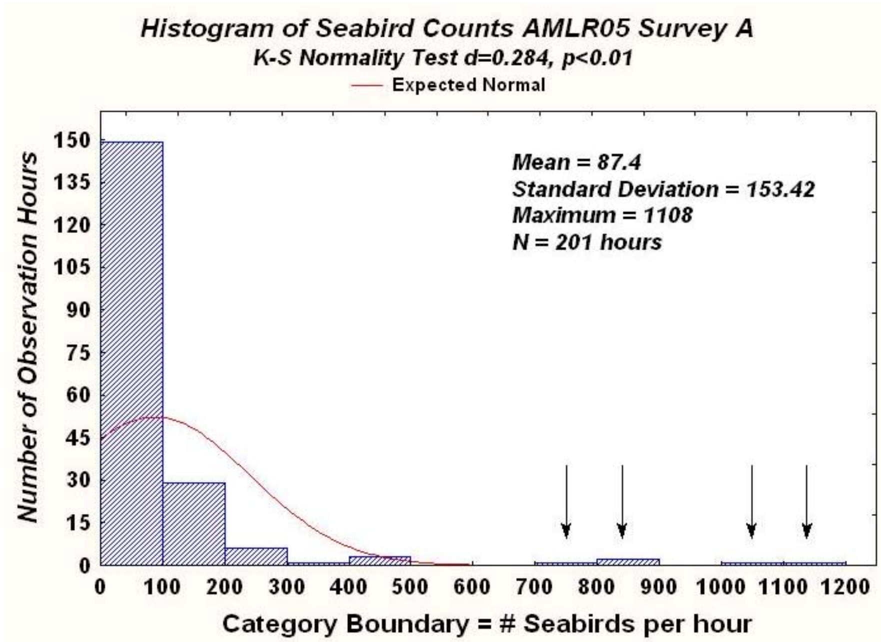
STRATUM 1				
Species	total birds (n=2312)	relative abundance%*	% sp Comp*	birds/km^2*
Black-Browed Albatross *(Thalassarche melanophris)*	320	100	13.8	6.3
Sooty Shearwater *(Puffinus griseus)*	1624	93.8	70.2	31.9
Wilson's Storm-Petrel *(Oceanites oceanicus)*	40	75	1.7	0.8
Antarctic Giant Petrel *(Macronectes giganteus)*	24	62.5	1	0.5
White-chinned Petrel *(Procellaria aequinoctialis)*	15	43.8	0.6	0.3
Imperial Shag *(Phalacrocorax atriceps)*	58	31.3	2.5	1.1
South American Tern *(Sterna hirundinacea)*	190	31.3	8.2	3.7
Cape Petrel *(Daption capense)*	8	25	0.3	0.2
Westland Petrel *(Procellaria westlandica)*	4	25	0.2	0.1
Magellanic Penguin *(Spheniscus magellanicus)*	4	12.5	0.2	0.1
Royal Albatross *(Diomedea epomophora)*	3	12.5	0.1	0.1
Greater Shearwater *(Puffinus gravis)*	6	12.5	0.3	0.1
Rock Shag *(Phalacrocorax magellanicus)*	9	12.5	0.4	0.2
unidentified penguin *(Eudyptes sp.)*	3	6.3	0.1	0.1
Hall's Giant Petrel *(Macronectes halli)*	1	6.3	0	0
unidentified *Procellaria* sp.	1	6.3	0	0
unidentified diving-petrel *(Pelecanoides sp.)*	2	6.3	0.1	0

Table 8.5 continued	**STRATUM 2**			
Species	total birds (n=337)	relative abundance %	% sp Comp	birds/km2
Black-bellied Storm-Petrel *(Fregatta tropica)*	117	34.7	53.8	104.7
Wilson's Storm-Petrel	53	15.7	61.5	47.4
Gray-headed Albatross *(Thalassarche chrysostoma)*	41	12.2	61.5	36.7
Black-Browed Albatross	32	9.5	57.7	28.6
Antarctic Giant Petrel	17	5	26.9	15.2
Soft-plumaged Petrel *(Pterodroma mollis)*	16	4.7	30.8	14.3
unidentified prion *(Pachyptila sp.)*	13	3.9	19.2	11.6
unidentified diving-petrel	13	3.9	26.9	11.6
Wandering Albatross *(Diomedea exulans)*	8	2.4	30.8	7.2
Antarctic Prion *(Pachyptila desolata)*	5	1.5	15.4	4.5
Hall's Giant Petrel	4	1.2	11.5	3.6
Rockhopper Penguin *(Eudyptes chrysocome)*	3	0.9	3.8	2.7
Southern Fulmar *(Fulmarus glacialoides)*	3	0.9	7.7	2.7
King Penguin *(Aptenodytes patagonicus)*	2	0.6	3.8	1.8
unidentified penguin	2	0.6	3.8	1.8
Cape Petrel	2	0.6	3.8	1.8
Royal Albatross	1	0.3	3.8	0.9
Light-mantled Albatross *(Phoebetria palpebrata)*	1	0.3	3.8	0.9
unidentified giant petrel *(Macronectes sp.)*	1	0.3	3.8	0.9
Mottled Petrel *(Pterodroma inexpectata)*	1	0.3	3.8	0.9
White-chinned Petrel	1	0.3	3.8	0.9
Common Diving-Petrel *(Pelecanoides urinatrix)*	1	0.3	3.8	0.9

Table 8.5 continued	**STRATUM 3**			
Species	total birds (n=747)	relative abundance %	% sp Comp	birds/km2
Wilson's Storm-Petrel *(Oceanites oceanicus)*	56	87	7.5	0.7
Black-bellied Storm-Petrel *(Fregatta tropica)*	205	78.3	27.4	2.6
Antarctic Prion	54	65.2	7.2	0.7
Southern Fulmar	96	60.9	12.9	1.2
Antarctic Giant Petrel	27	47.8	3.6	0.3
Cape Petrel	32	43.5	4.3	0.4
Black-Browed Albatross	18	39.1	2.4	0.2
Soft-plumaged Petrel	64	39.1	8.6	0.8
Gray-headed Albatross	8	26.1	1.1	0.1
unidentified prion	8	26.1	1.1	0.1
Chinstrap Penguin *(Pygoscelis antarctica)*	18	21.7	2.4	0.2
Kerguelen Petrel *(Aphrodroma brevirostris)*	9	17.4	1.2	0.1
South Polar Skua *(Stercorarius maccormicki)*	4	17.4	0.5	0.1
Wandering Albatross	4	13	0.5	0.1
Hall's Giant Petrel	3	13	0.4	0
unidentified penguin	3	8.7	0.4	0
unidentified skua *(Stercorarius sp.)*	1	4.3	0.1	0

* Notes:

1. Relative abundance: total number of a transects with a detection expressed as a percentage of total transects recorded in the stratum
2. % Sp Comp is the percentage of the total number of birds recorded in the stratum
3. birds/km^2 includes flying birds
4. See Table 8.1 for strata definitions



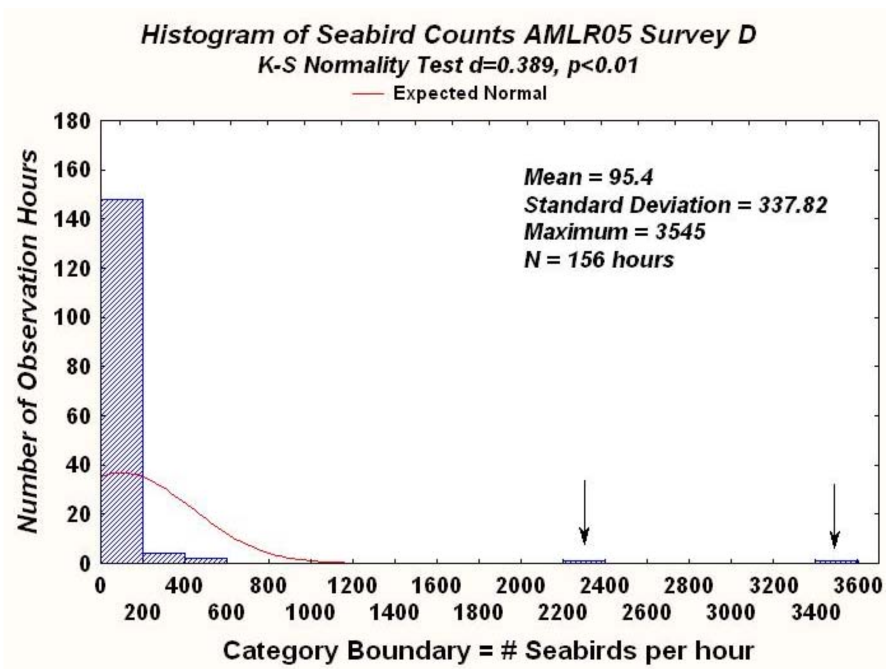


Figure 8.1. Histogram of total seabird abundance and number of observation hours recorded during (a) Leg I and (b) Leg II AMLR 2004/05. Observational data display significant differences from a normal distribution; caused by the few but dense seabird numbers observed in a small number of observation hours (indicated by arrows). During Leg I, the largest aggregations of predators were observed feeding along the shelf break north of Elephant Island. Whereas, during Leg II, the two largest aggregations encountered were rafts of Southern Fulmars sitting on the waters.

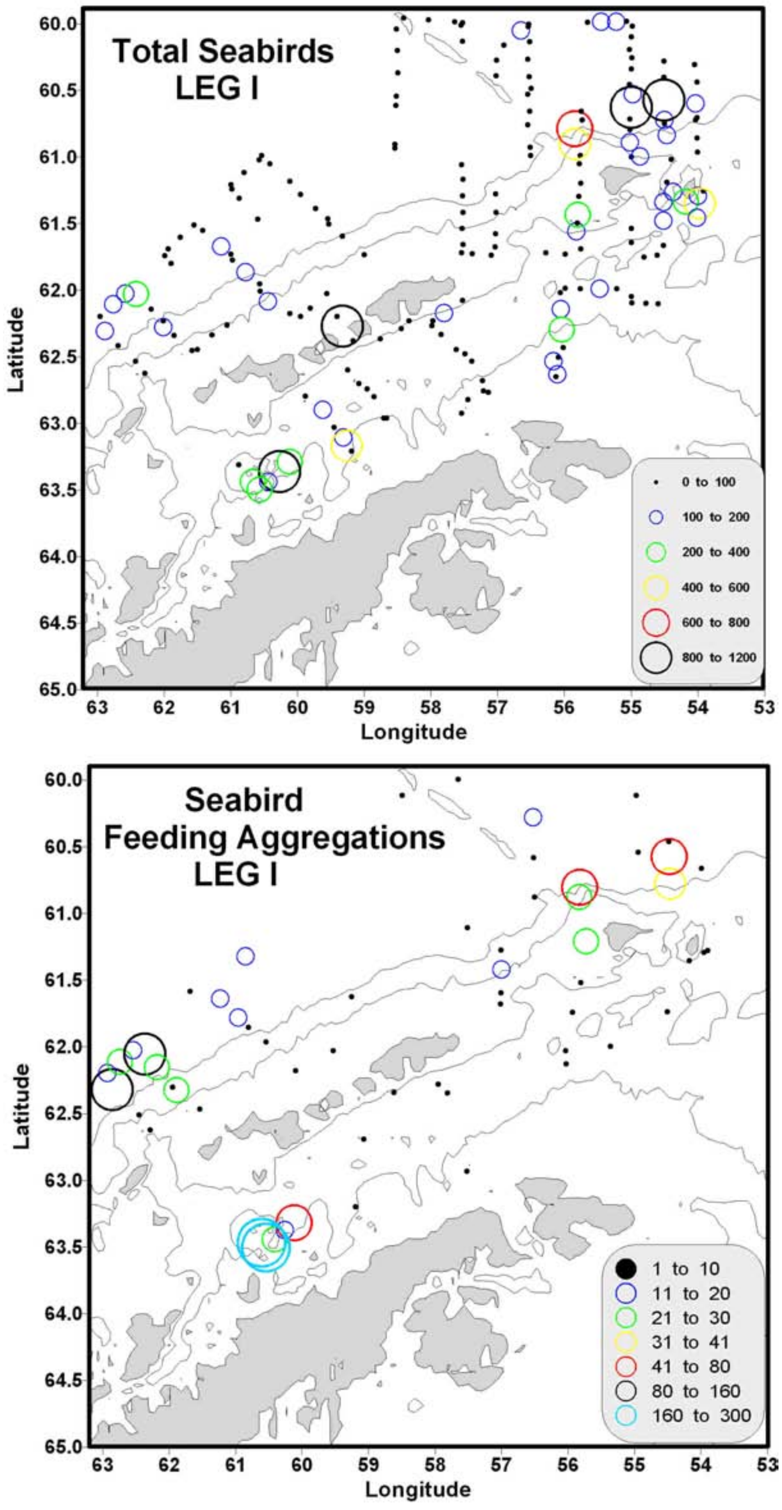


Figure 8.2. Antarctic seabird dispersion and abundance map during Leg I of AMLR 2004/05; (a) Total seabird species, and (b) feeding aggregations. 'Total seabirds' is the abundance of all species encountered during a one hour sampling interval (˜ 10 nm). Feeding aggregations were mapped by plotting the total number of feeding birds encountered per one hour of sampled transect.

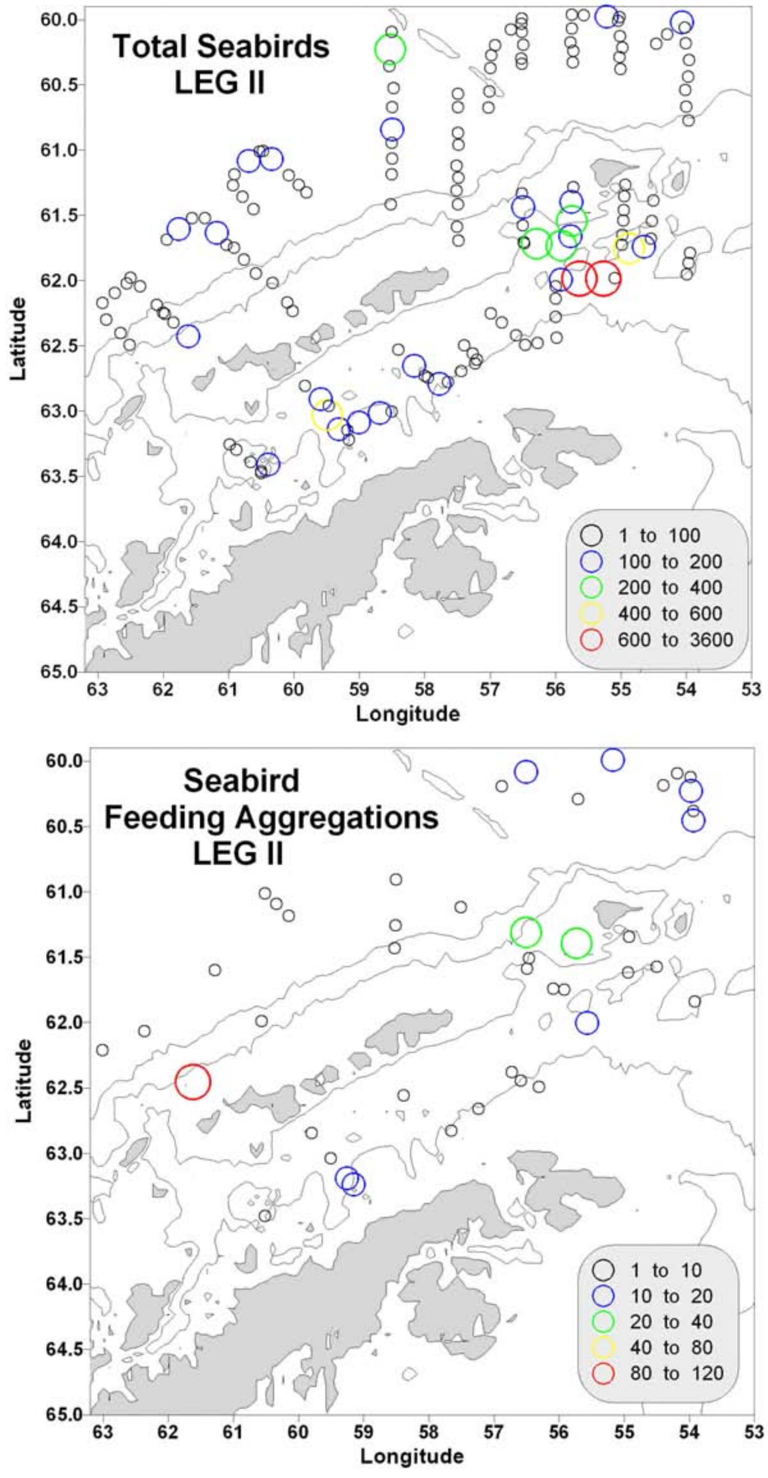


Figure 8.3. Antarctic seabird dispersion and abundance map during Leg II of AMLR 2004/05; (a) Total seabird species, and (b) feeding aggregations. ‘Total seabirds’ is the abundance of all species encountered during a one hour sampling interval (˜ 10 nm). Feeding aggregations were mapped by plotting the total number of feeding birds encountered per one hour of sampled transect.

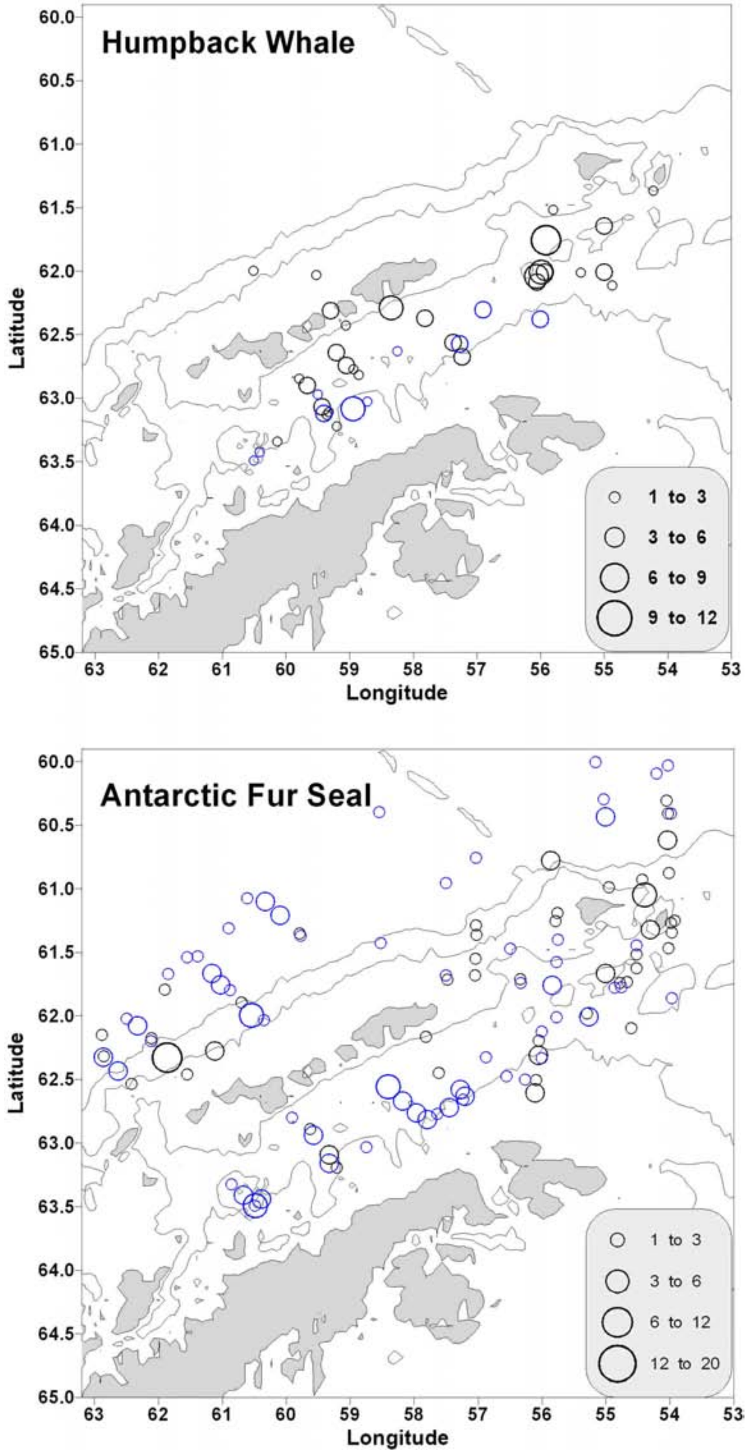


Figure 8.4. A) Humpback whale (*Megaptera novaeangliae*) abundance and dispersion (#/hour), and (B) Antarctic fur seal (*Arctocephalus gazella*) abundance and dispersion (#/hour) during Legs I and II of the AMLR 2003/04 survey. Data were collected during transit between stations during daylight hours. Black circles represent survey effort conducted during Leg I; Blue circles represent survey effort conducted during Leg II. Humpback whales were relatively restricted to the Bransfield Strait region, whereas Fur Seals were more broadly dispersed (especially during Leg II) over the entire AMLR survey.

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