UNITED STATES
AMLR ANTARCTIC MARINE LIVING RESOURCES PROGRAM

AMLR 1996/97 FIELD SEASON REPORT

Objectives, Accomplishments and Tentative Conclusions

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BACKGROUND

The long-term objective of the U.S. AMLR field research program is to describe the functional relationships between krill, 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. For eight consecutive austral summers, 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 seals and penguins were also accomplished at Seal Island.

Because Seal Island was found to be unsafe due to landslide hazards, research at the field camp was significantly curtailed. Beginning this season, the AMLR study area was expanded to include a larger area around the South Shetland Islands, and a new field camp was established at Cape Shirreff, Livingston Island (Figure 1). Descriptive surveys of the pelagic ecosystem were conducted in the expanded AMLR study area, and studies on the reproductive success and feeding ecology of pinnipeds and seabirds were initiated at Cape Shirreff.

As in the past, research on the ecology of Adelie penguins was conducted at Palmer Station during the austral spring and summer.

SUMMARY OF 1997 RESULTS

Shipboard surveys were conducted on two legs in the AMLR study area between mid-January and late March 1997. Two major water zones were identified: Drake Passage and Bransfield Strait. A prevailing southwest to northeast flow was seen across the AMLR study area, with an eddy-like feature northwest of Elephant Island. The flow was most intense at the shelf-break near the 56°W meridian. Surface waters temperatures exceeded 4°C for the first time in eight years of AMLR surveys. The richest phytoplankton regions were found close to the continental shelf running in a northeasterly direction to the north of the South Shetland Islands and also in Bransfield Strait waters. The lowest phytoplankton concentrations were found in the northwest portion of the study area, including the northernmost new stations near Livingston Island, and in Weddell Sea waters in the southeastern portion of the study area.

The 1997 bioacoustic surveys revealed a discontinuous band of high krill density on the north side of the South Shetland Islands. The band tended to be north of the frontal zone running parallel to the archipelago, spreading onto the shelf near Elephant Island. Other areas of high density were mapped on the shelf near Livingston Island and in deeper water in the Bransfield Strait. A preliminary estimate of krill density was higher than the last five field seasons. Krill sampled with the Isaacs-Kidd Midwater Trawl (IKMT) demonstrated three size modes centered

on 26-30 millimeters (mm) (1+ age group), 34-41mm (2+), and 49-52mm (3+). The female maturity stage composition suggested a prolonged 1996/97 spawning period, extending from mid-December through March. Moderate catches of krill larvae in mid-March suggested only moderate spawning success, despite the long duration of the spawning season. Excellent recruitment success of the 1994/95 year class (2+) was associated with above average sea-ice conditions during winters 1994 and 1995, and reflects early seasonal spawning activity and overwintering survival associated with such sea-ice conditions. Winter 1996 was characterized by average sea-ice conditions. Lower recruitment success of the 1995/96 year class (1+) supports the hypothesis that winter sea-ice extent affects larval survival and recruitment even when krill spawning is relatively early. Salp biomass concentrations in the Elephant Island area during 1997 were the largest observed since 1993 and 1994. Competition by salps for food resources may have reduced krill spawning efforts, while predation by salps on krill eggs and larvae may have greatly reduced their numbers.

On Seal Island, chinstrap penguins started fledging at a similar time compared to past seasons; the average fledging weight was slightly higher than those recorded in the last seven seasons. The estimated number of Antarctic fur seal pups was the second highest since the 1993/94 season. At the new Cape Shirreff camp, seabird studies were initiated by observing numbers and distributions of the seabird populations. Surveys of the area found 19 chinstrap penguin colonies, 6 gentoo penguin colonies, and 5 mixed chinstrap/gentoo penguin colonies. An initial 1000 chinstrap penguin chicks were banded for future demographic studies, and fledging weights were also recorded.

At Palmer Station, there was an 18.3% decrease in Adelie penguin population size relative to last season, which agrees with the predicted effects of a low ice year on overwinter survival. Breeding success of Adelie penguins was also down slightly, creching 1.47 chicks per pair or 0.14 chicks less than were creched last season. Conversely, there was a slight increase in the proportion of two-chick broods compared to last year. Also, the average fledging weight of sampled Adelie penguin chicks increased by 80 grams as compared to last season.

Using newly procured trawl equipment, seven bottom trawls were made at stations northwest of Robert and Nelson Islands, and west of Elephant Island. These trawls were conducted as part of a feasibility study for future surveys of finfish stock abundances. Four species dominated the trawl catches: *Notothenia coriiceps*, *Gobionotothen gibberifrons*, *Chaenocephalus aceratus*, and *Champsocephalus gunnari*. Overall, the new trawl equipment and the set-up aboard the R/V *Yuzhmorgeologiya* worked well.

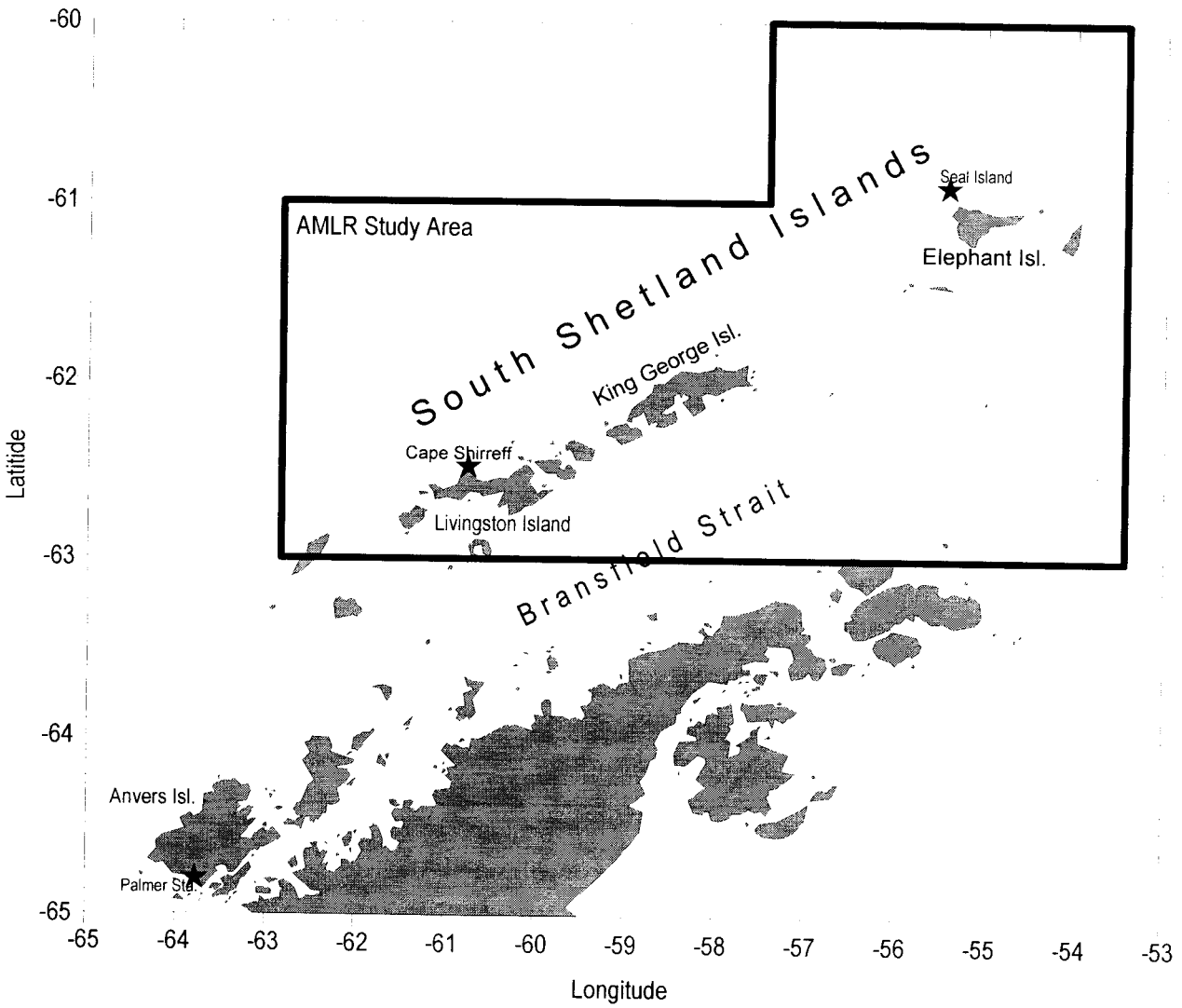

Figure 1. Locations of the U.S. AMLR field research program: AMLR study area, Cape Shirreff, Seal Island, and Palmer Station.

OBJECTIVES

Shipboard Research:

1. Map meso-scale (10's of kilometers) features of water mass structure, phytoplankton biomass and productivity, and zooplankton constituents (including krill) in the AMLR study area.
2. Estimate the abundance and dispersion of krill in the AMLR study area.
3. Conduct acoustic and net sampling surveys in Admiralty Bay, King George Island to describe krill demographic characteristics.
4. Collect continuous measurements of ship's position and heading, water depth, sea temperature, salinity, water clarity, chlorophyll, air temperature, barometric pressure, relative humidity, wind speed and direction, and solar radiation.
5. Provide logistical support to three land-based field sites: Copacabana field camp (Admiralty Bay, King George Island); Cape Shirreff (Livingston Island); and Seal Island.
6. Conduct bottom trawls at selected sites in the area around the South Shetland Islands as a feasibility study for future surveys.

Land-based Research:

Cape Shirreff

1. Weigh chinstrap penguin chicks at fledging.
2. Band 1000 chinstrap penguin chicks for future demographic studies.
3. Reconnoiter, census, and map seabird distributions as a requisite for designing future seabird studies.
4. Observe and assist with ongoing Chilean studies of Antarctic fur seals to plan future collaborative research.

Seal Island

1. Weigh chinstrap penguin chicks at fledging.
2. Record the presence of known-aged and previously-instrumented or handled seabirds and pinnipeds.
3. Record the abundance of Antarctic fur seals.

Palmer Station

1. Determine Adelie penguin breeding population size.
2. Determine Adelie penguin breeding success.
3. Obtain information on Adelie penguin diet composition and meal size.
4. Determine Adelie penguin chick weights at fledging.
5. Determine adult Adelie penguin foraging trip durations.
6. Band 1000 Adelie penguin chicks for future demographic studies.
7. Determine Adelie penguin breeding chronology.

11. Seabird research undertaken as part of the NMFS/AMLR ecosystem monitoring program at Palmer Station, 1996/97; submitted by William R. Fraser, Donna L. Patterson, John Carlson, Peter Duley, and Eric J. Holm.

11.1 Objectives: Palmer Station is one of two sites on the Antarctic Peninsula where long-term monitoring of seabird populations is being undertaken in support of U.S. participation in the CCAMLR Ecosystem Monitoring Program (CEMP). Our objectives during 1996/97, the tenth season of field work at Palmer Station on Adelie penguins (*Pygoscelis adeliae*), were:

1. To determine Adelie penguin breeding population size,

2. To determine Adelie penguin breeding success,

3. To obtain information on Adelie penguin diet composition and meal size,

4. To determine Adelie penguin chick weights at fledging,

5. To determine adult Adelie penguin foraging trip durations,

6. To band 1000 Adelie penguin chicks for future demographic studies, and

7. To determine Adelie penguin breeding chronology.

11.2 Accomplishments: Field work at Palmer Station was initiated on 28 September 1996 and terminated on 15 April 1997. The early start date was aided by joint funding from the NSF's Office of Polar Programs. In 1990, NSF selected Palmer Station as a Long Term Ecological Research (LTER) site, and has committed long-term funding and logistics support to an ecosystem study in which Adelie penguins represent one of two key upper trophic level predators selected for research. As a result of this cooperative effort between the National Marine Fisheries Service (NMFS) and NSF, field season duration at Palmer Station now covers the entire 5-month Adelie penguin breeding season.

Breeding Biology and Demography.

Adelie penguin breeding population size was determined by censusing the number of breeding pairs at 54 sample colonies during the peak egg-laying period (14 November- 15 November 1996). These colonies contained 4445 pairs, a 18.3% decrease in population relative to the 5457 breeding pairs censused 21-23 November 1995.

Breeding success was determined by following a 100-nest sample on Humble Island from clutch initiation to creche. Adelie penguins exhibited a slightly decreased breeding success this season, creching 1.47 chicks per pair, or 0.14 chicks less than were creched per pair last season. As in past seasons, two other indices of breeding success were also determined. The proportion of one

and two chick broods was assessed at 54 sample colonies on 7 and 8 January 1997. Of the 2751 broods censused, 68.1% (N=1875) contained two chicks, a slight increase from the 63.5% reported in January 1996.

Chick production was determined by censusing chicks on 25 January 1997 at 54 sample colonies when approximately 2/3 of them entered the creche stage. Production at these colonies totaled 6142 chicks, a decrease of 6.0% from January 1996 when 6532 chicks were censused.

Chick fledging weights were obtained between 2-18 February 1997 at beaches near the Humble Island rookery. Peak fledging occurred on 12 February, two days later than in February 1996. Compared to February 1996, the average fledging weight of the 364 Adelie penguin chicks sampled increased by approximately 80g (3.04 vs 2.96 kg). Data specific to the chronology of other breeding events are still under analysis and will be reported later.

As part of continued demographic studies, 1000 Adelie penguin chicks were banded on 2 February 1997 at selected AMLR colonies on Humble Island. The presence of birds banded in previous seasons was also monitored during the entire field season on Humble Island as part of these studies.

Foraging Ecology.

Diet studies were initiated on 06 January and terminated on 15 February 1997. During each of the nine sampling periods, five adult Adelie penguins were captured and lavaged (stomach pumping using a water off-loading method) as they approached their colonies to feed chicks on Torgersen Island. All birds (N=45) were subsequently released unharmed. The resulting diet samples were processed at Palmer Station. The samples taken contained a mix of prey items dominated by the presence of the euphausiid *Euphausia superba*. The number of samples containing fish and amphipods was significantly lower compared to last season. Unlike the extreme bimodal distribution of krill seen during last season, this season's samples were mainly comprised of krill (*E. superba*) in the size classes 31-35mm and 36-40mm. The predominance of krill in the 31-40mm size range is completely different than the larger individuals (46-55mm) that characterized last season's samples.

Radio receivers and automatic data loggers were deployed at the Humble Island rookery between 7 January and 20 February 1997 to monitor presence-absence data on 36 breeding Adelie penguins carrying small radio transmitters. These transmitters were glued to adult penguins feeding 10-14 day old chicks. Analysis of the data has not yet been accomplished due to the size of the databases obtained.

11.3 Tentative Conclusions: The 1996/97 season was characterized by minimal sea ice cover, but frequent and occasionally heavy snows during much of the Adelie penguin breeding season. The 18.3% decrease in breeding pairs agrees with the effects that a low ice year is expected to have on overwinter survival. An unprecedented, heavy infestation of ticks was also noted during

the egg-laying period, with some preliminary evidence that it forced some birds to abandon nest sites. The decrease in breeding success of 0.14 chicks per pair may in part reflect the effects of this infestation, as some of the birds in our breeding success samples became heavily infested.

Unlike last season, when the predominant components in the diets of Adelie penguins included a mixed species assemblage of *T. macrura* and *E. superba*, this season's diets were dominated by krill. Krill size classes represented primarily intermediate lengths (31-40mm), which agrees with expectations based on a strong recruitment year in 1994. This season, in contrast to last, foraging trip durations increased by an average of 1.78 hours (10.0 hours in 1996 vs. 11.78 hours in 1997) for the same CEMP period, although we observed no delays in the onset of bloom conditions. Last season's data suggested that the timing of blooms could strongly affect within season variability in foraging trip durations. Both the foraging and phytoplankton data are still being analyzed at this writing.

11.4 Disposition of the Data: No diet samples were returned to the U.S. for analysis as all work was successfully completed at Palmer Station. All other data relevant to this season's research are currently on diskettes in our possession and will be made available to the Antarctic Ecosystem Research Group.

11.5 Problems, Suggestions and Recommendations: It is becoming more apparent that environmental variables such as snow deposition, among others, may be key determinants of at least some aspects of the annual variability inherent in some of the monitored parameters. However, at the moment, there is no formal requirement in effect by which to standardize the collection and reporting of these data. Where these effects are becoming especially clear, is in the information conveyed by measures of reproductive success based on per-pair productivity. For example, the former can vary by up to 100% within the same colony based strictly on nest location, meaning this parameter is probably not "measuring" variability in the marine foraging environment as we assume. It is our opinion that the development of standards to measure snow deposition would greatly aid our interpretive potential within and between CEMP monitoring sites.