UNITED STATES

AMLR ANTARCTIC MARINE LIVING RESOURCES PROGRAM

AMLR 1994/95 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; and (2) the distribution of krill is affected by both physical and biological aspects of their habitat. In order to refine these hypotheses, a study area was designated in the vicinity of Elephant Island (Figure 1). A seasonal field camp was established at Seal Island, off the northwest coast of Elephant Island, where reproductive success and feeding ecology of breeding seals and penguins are monitored. A complementary series of shipboard observations were initiated to describe both within and between season variations in the distributions of nekton, zooplankton, phytoplankton, and water types in the study area. The Seal Island and shipboard studies are conducted during each austral summer. In addition, research on the ecology of Adelie penguins is conducted at Palmer Station during each austral spring and summer.

SUMMARY OF 1995 RESULTS

Seven shipboard surveys were conducted in the vicinity of Elephant Island between mid-January and early March, 1995. Two major water types were identified: Drake Passage and Bransfield Strait. A prevailing southwest to northeast water flow was seen across the study area, with intensified flow in several areas. The richest phytoplankton regions were found to the south, southwest, and east of Elephant Island, and also north of the island's shelf-break; the lowest concentrations were found in the northwest portion of the study area. In late January, relatively dispersed layers of large adult krill were found west and northwest of Elephant Island, and dense aggregations of juvenile krill were seen in the Bransfield Strait. One month later, dense discrete krill swarms were common throughout the eastern portion of the study area, while diffuse layers were more often seen in the offshore waters north of Elephant Island. In late January and also in mid-February, high krill densities were found in the shoal waters just north of Elephant Island and in deeper water near sub-surface seamounts. Mean krill abundance in net samples from the Elephant Island area during both legs was about 1/3 that observed during the previous three field seasons. Mature forms of krill (probably at least 4-5 years of age) totally dominated the catches. These results indicate relatively poor krill recruitment since the 1990/91 year class. This period of poor krill recruitment has been linked to below normal winter sea ice coverage/duration in the Antarctic Peninsula area over the past three years. Poor recruitment during low ice years is believed to result from poor feeding conditions for adult krill during the winter period and subsequent delayed reproduction until late summer. In addition, late spawned larvae apparently have low survival rates. The 1994 winter was marked by greater than normal sea ice conditions, and it was thus expected that adult krill would spawn early. These predictions were supported by observations of relatively large proportions of gravid females in January and predominantly gravid and spent females in February. Spawning success was indicated by the appearance of early stage krill larvae in January and widespread occurrence of these larvae in February. Salp mean abundance was over two orders of magnitude less than in 1993 and 1994, and one order less than in 1992, again probably resulting from the presence of above normal sea ice during the 1994 winter. On Seal Island, Antarctic fur seal pup production and growth rates were lower in comparison to previous seasons. However, the mean weight of both male and female pups were similar to previous years, indicating that female seals were able to adequately obtain prey for their offspring. The number of chinstrap penguins attempting to breed this season was the lowest in all past seasons except 1990/91. However, of those eggs that hatched, their success was the second

highest recorded in all past seasons, suggesting an ample food supply offshore. The number of macaroni penguins attempting to breed was the lowest recorded in all past seasons. At Palmer Station, the number of breeding pairs of Adelie penguins at 54 censused colonies decreased by 9.3% relative to last season, while chick production was essentially unchanged.

Epibenthic surveys were conducted in March in the bays, fjords, and anchorages of South Georgia. These surveys revealed 96 distinct morphological/coloration types of fauna, which probably represented a minimum of 110 species. Frequently recorded animal types included various species of sponges, soft corals, bryozoans, sea anemones, polychaetes, isopods, starfish, brittlestars, sea urchins, ascidians, and fish.

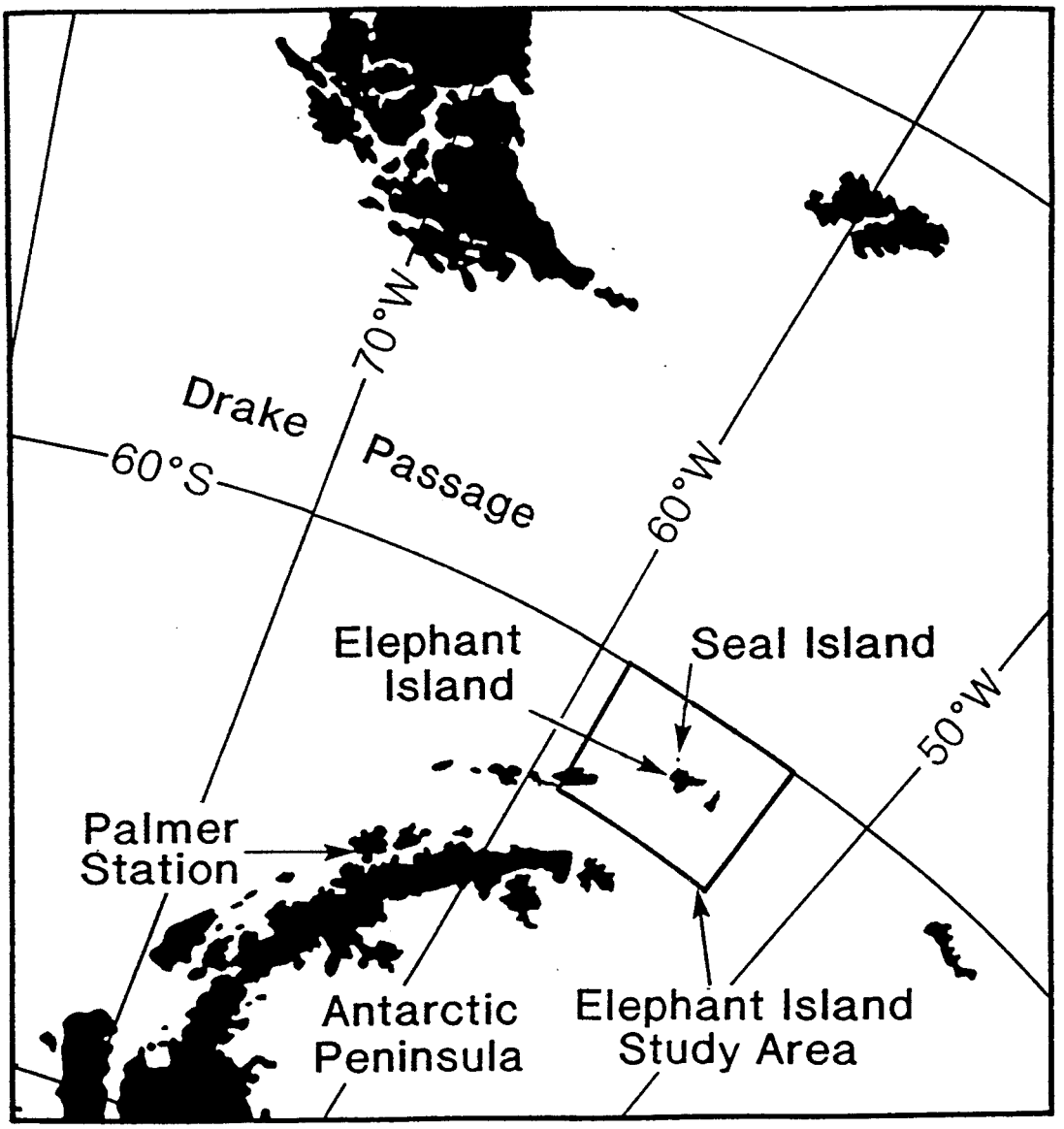

Figure 1. Locations of the U.S. AMLR field research program: Elephant Island Study Area, Seal Island, and Palmer Station.

2. Conduct cooperative research on fur seal foraging patterns and prey availability with scientists from the Japanese R/V *Kaiyo Maru.*

3. Conduct directed research on fur seal pup production, female foraging behavior, diet, abundance, survival, and recruitment.

4. Determine offshore foraging areas of fur seals, using an ADF system.

5. Monitor the abundance of all other pinniped species on the island, and resight tagged female fur seals to assess female survival, reproductive rates, and tag loss.

6. Monitor the breeding success, fledgling size, reproductive chronology, foraging behavior, diet, abundance, survival, and recruitment of chinstrap and macaroni penguins according to CEMP protocols.

7. Conduct directed research on seasonal and diel patterns in the diving behavior of chinstrap penguins to assess changes in foraging patterns and effort as physical and biological components change through the breeding season.

8. Collect data on locations of offshore foraging areas of chinstrap penguins using an automated data collection computer and directional antennas on top of the island.

9. Conduct a cooperative study with scientists on board *Kaiyo Maru* examining interactions between chinstrap penguins and their prey by tracking birds on foraging trips while simultaneously conducting oceanographic sampling.

10. Describe and report marine debris sighted on beaches or on animals.

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 duration of Adelie penguin foraging trips.

6. Band a representative sample (1000 chicks) of the Adelie penguin chick population for demographic studies.

7. Determine adult Adelie penguin breeding chronology.

10. Seabird research undertaken as part of the NMFS/AMLR ecosystem monitoring program at Palmer Station, 1994/95; submitted by William R. Fraser, Donna L. Patterson, Eric J. Holm, and Karen M. Carney.

10.1 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). Objectives during 1994-1995, the eighth 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 duration of Adelie foraging trips,

6. To band a representative sample (1000 chicks) of the Adelie penguin chick population for future demographic studies, and

7. To determine adult Adelie penguin breeding chronology.

10.2 Accomplishments: Field work at Palmer Station was initiated on 18 October 1994 and terminated on 24 March 1995. The early start date was aided by joint funding from the National Science Foundation's (NSF) Office of Polar Programs. In 1990, NSF selected Palmer Station as a Long Term Ecological Research (LTER) site, and it 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 population size was determined by censusing the number of breeding pairs at 54 sample colonies during the peak egg-laying period (29 November - 2 December, 1994). In 1994, these colonies contained 5591 pairs, a 9.3% decrease in population relative to the 6165 breeding pairs censused in 1993.

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 in 1994/95, creching 1.49 chicks per pair, or 0.11 chicks less than were creched per pair in 1993/94. As in past seasons, two other indices of breeding success were also determined.

The proportion of 1 and 2 chick broods was assessed at 49 sample colonies between 9 January and 12 January (1995). Of the 3078 broods censused, 66.5% (N=2047) contained two chicks, a slight increase over the 62.1% reported in 1994. Chick production was determined by censusing chicks on 22 and 23 January (1995) at 54 sample colonies when approximately 2/3 of them were in the creche stage. Production at these colonies totaled 6685 chicks, an increase of 1.9% over 1994 when 6561 chicks were censused.

Chick fledging weights were obtained between 4-23 February (1995) at beaches near the Humble Island rookery. Peak fledging occurred on 11 February, 5 days earlier than in 1994. Compared to 1993/94, the average fledgling weight of the 370 Adelie penguin chicks sampled decreased by less than 100 g (3.0 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 3 February 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.

Diet studies were initiated on 11 January and terminated on 18 February. During each of the 8 sampling periods, 5 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=40) were subsequently released unharmed. The resulting diet samples were processed at Palmer Station. The early samples taken contained a mix of prey items dominated by the presence of the euphausiids *Thysanoessa macrura* and *Euphausia superba*. Of these, only the krill (*E. superba*) was prevalent in the diets later in the season, with fish becoming a secondary component. An abundance of large krill (*Euphausia superba*) in the size classes 41-45mm and 46-50mm characterized the 1994/95 samples. These were similar to the size classes that predominated in the samples during the 1993/94 season.

Radio receivers and automatic data loggers were deployed at the Humble Island rookery between 7 January and 24 February to monitor presence-absence data on 39 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.

10.3 Tentative Conclusions: The 1994/95 season was characterized by the persistence of heavy winter/spring pack ice until December and a 2-week delay in the timing of the January blooms, conditions that were last present during the 1990/91 season. Although the number of breeding pairs at the 54 censused colonies decreased by 9.3% relative to last season, chick production in these colonies, exhibiting a 1.9% increase, was essentially unchanged. This would argue that the slight decrease in per-pair breeding success shown by Adelie penguins in 1994/95 relative to last season (1.49 vs. 1.60 chicks creched/pair) may be an artifact produced by the 100-nest sample on Humble Island used to determine per-pair productivity. This sample may not be indicative of overall breeding conditions in the 54 colonies used to

measure chick production, suggesting that the number of chicks fledged per colony may in fact be the more significant data for determining year-to-year trends in Adelie penguin breeding success. Increasingly, the long-term data being accumulated at Palmer Station are suggesting that breeding success is colony specific, with year-to-year variability within and between colonies being largely determined by environmental features specifically associated with the terrestrial nesting habitat.

Unlike last season, the predominant components in the diets of Adelie penguins varied from a mixed species assemblage of *T. macrura* and *E. superba* early in the season, to one dominated by *E. superba* later in the season. This change was concurrent with longer and shorter foraging trip durations (on average, 30 hours vs. 8 hours, respectively, based on a partial analysis of the data) and the early absence vs. the late presence of blooms within the penguins' foraging area. Although the causal factors associated with a delayed bloom are not yet clear, the data suggest that the availability of *E. superba* to foraging penguins is at least in part determined by spatial and temporal changes in the availability of phytoplankton within the foraging area. These environmental signals are not reflected as changes in either reproductive success or fledging weights between this season and the 1993/94 data; however, at this point, this should not be interpreted as a "lack of effect." The interactions between these environmental variables, the distribution and availability of prey, and key Adelie penguin reproductive and condition indices are potentially complex, suggesting that longer-term data are needed to begin resolving causal relationships.

10.4 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 AERG.

10.5 Problems, Suggestions and Recommendations: It is becoming more apparent that environmental variables such as sea ice extent and 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 environmental data. It is our opinion that the development of such standards would greatly aid our interpretive potential within and between CEMP monitoring sites.