UNITED STATES

AMLR ANTARCTIC MARINE LIVING RESOURCES PROGRAM

AMLR 1993/94 FIELD SEASON REPORT

Objectives, Accomplishments and Tentative Conclusions

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May 1994

ADMINISTRATIVE REPORT LJ-94-13

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BACKGROUND

The long-term objective of the U.S. Antarctic Marine Living Resources (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 field camp is activated each season in early December and remains occupied through mid-March; shipboard research is conducted from early January through mid-March. In addition, research on the ecology of Adelie penguins is conducted at Palmer Station during each austral spring and summer.

SUMMARY OF 1994 RESULTS

Four shipboard surveys were conducted between mid-January and mid-March, 1994. Two major water types were identified: Drake Passage and Bransfield Strait. A prevailing southwest to northeast water flow across the entire AMLR study area was observed, although intensified flow was evident in several areas. Lowest phytoplankton biomass was observed in Drake Passage waters. Highest biomass was observed in Bransfield Strait waters, particularly during Leg II when it was four times higher than Leg I. Early in the season, the highest densities of krill were found north of King George Island; five weeks later highest densities were found north of Elephant Island. Preliminary estimates indicate that krill biomass in the Elephant Island area was very low this season; the krill density was approximately one-fifth of the 1990-1993 average density. The overall krill length frequency distribution and maturity stage composition during the large-area surveys reflected low recruitment from the last two year classes (1991/92 and 1992/93) and continued importance of the 1990/91 year class. As in 1993, salps were the dominant taxa in zooplankton samples, although their abundance decreased as the season advanced. Throughout the season, salps were more evenly distributed over the survey area than krill. On Seal Island, Antarctic fur seal pup production was slightly lower this year compared to last, but survivorship appeared to be higher. Growth indices indicated that female fur seals were able to adequately obtain prey to feed their offspring. Fur seal pup production throughout the Elephant Island area increased by 10% since the last census conducted in 1991/92. On Seal Island, the survival of chinstrap penguin chicks from egg through creche stage was the highest observed during the last 5 years, although fewer adults attempted to breed and total production decreased from last year. The number of macaroni penguins breeding on Seal Island was 8% higher than last year. At Palmer Station, chick production at 52 sample colonies decreased 10.3% from 1992/93, although breeding success observed at the Humble Island colony improved over 1992/93.

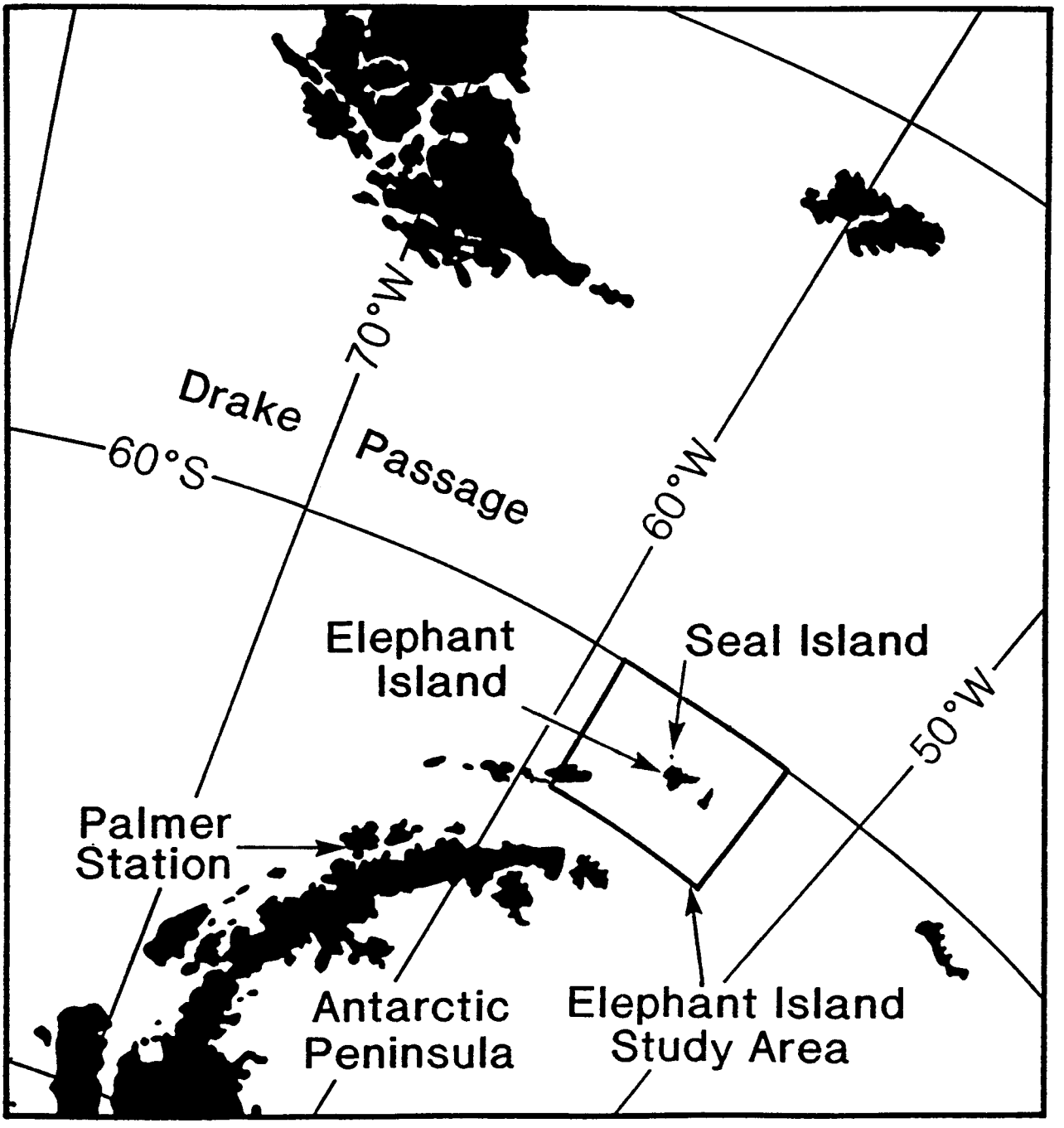

Figure 1. Locations of the U.S. AMLR field research program: Elephant Island Study Area, Seal Island, and Palmer Station.

OBJECTIVES

Shipboard Research:

1. Map meso-scale (10's to 100's of kilometers) features of water mass structure, phytoplankton biomass and productivity, and zooplankton constituents (including krill) in the area around Elephant Island.

2. Estimate the abundance of krill in the area around Elephant Island.

3. Delineate hydrographic and biological features along three transects: across the Bransfield Strait extending northwest of Nelson Island; across the shelf-break north of Elephant Island; and east of Elephant Island.

4. Map micro-scale (1 to 10's of kilometers) features of the distribution, density, and abundance of krill immediately north of Elephant Island, within the foraging range of krill predators breeding on Seal Island.

5. Describe the vertical and horizontal movement of krill swarms relative to the upper mixed layer of the ocean.

6. Conduct a fur seal survey at selected sites in the South Shetland Islands.

7. Calibrate an automatic direction finding (ADF) system located on Seal Island.

8. Provide logistical support to the Seal Island field camp.

9. Conduct seabird and marine mammal observations in the AMLR study area during Legs I and II, and correlate seabird and marine mammal abundance and distribution with aspects of their prey field. Also, conduct seabird and marine mammal observations during the northbound transit.

10. Calibrate acoustic transducers.

Land-based Research:

<u>Seal Island</u>

1. Monitor pup growth rates and adult female foraging of Antarctic fur seals according to CCAMLR Ecosystem Monitoring Program (CEMP) protocols.

2. Conduct directed research on pup production, female foraging behavior, diet, abundance, survival, and recruitment of fur seals.

3. Monitor the abundance of all other pinniped species ashore.

4. Deploy and calibrate an ADF system for determining the offshore foraging areas of fur seals and chinstrap penguins.

5. Conduct directed research on the predator-prey relationship between leopard seals and fur seals.

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

7. Examine penguin chick growth and condition for intra- and inter-seasonal comparisons.

8. Conduct directed research on seasonal and diel patterns in the diving behavior of chinstrap penguins.

9. Assess the reproductive success, breeding chronology, survival, and recruitment of cape petrels.

10. Count Antarctic fur seals at known breeding colonies, and search for and identify newly-established or previously unknown fur seal colonies.

11. Resight tagged animals to better understand fur seal movements.

12. 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 the amount of time breeding adult Adelie penguins need to procure food for their chicks.

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

7. Determine adult Adelie penguin breeding chronology.

11. Seabird research undertaken as part of the NMFS/AMLR ecosystem monitoring program at Palmer Station, 1993/94; submitted by William R. Fraser and Donna L. Patterson.

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 1993/94, the seventh 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 the amount of time breeding adult Adelie penguins need to procure food for their chicks,

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.

11.2 Accomplishments: Field work at Palmer Station was initiated on 8 October 1993 and terminated on 1 April 1994. The early start date was aided by joint funding from the National Science Foundation's (NSF) Office of Polar Programs. NSF recently chose 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). In 1993, these colonies contained 6165 pairs, a negligible decrease relative to the 6216 breeding pairs censused in 1992.

Breeding success was determined by following a 100-nest sample on Humble Island from clutch initiation to creche. Adelie penguins again exhibited high reproductive success in 1993, creching 1.60 chicks per pair, or 0.14 chicks more than they creched per pair in 1992. 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 on 9 January. Of the

4155 broods censused, 62.1% (N=2578) contained two chicks, a slight increase over the 60.2% reported in 1992. Chick production was determined by censusing chicks on 23 January at 52 sample colonies when approximately 2/3 of them were in the creche stage. Production at these colonies totaled 6561 chicks, a 10.3% decrease over 1992 when 7319 chicks were censused.

Chick fledging weights were obtained between 6-23 February at beaches near the Humble Island rookery. Peak fledging occurred on 16 February, 3 days later than in 1992. Compared to 1992, the average fledgling weight of the 362 Adelie chicks sampled decreased by 200g (3.2 vs 3.0 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 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. A nearly complete absence of all prey other than krill (*Euphausia superba*) characterized the 1993/94 samples. These krill were larger than in previous seasons, averaging 40-50mm in length.

Radio receivers and automatic data loggers were deployed at the Humble Island rookery between 10 January and 15 February to monitor presence-absence data on 33 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: Adelie penguin breeding success was significantly higher during 1993/94 than it was during 1992/93 (1.60 vs. 1.46 chicks creched/pair), yet overall chick production at 52 sample colonies decreased by 10.3%, despite the fact that there was an insignificant decrease in the number of breeding pairs between these two seasons. Increasingly, the long-term data being accumulated at Palmer Station are suggesting that colony location relative to topographic features that influence winter snow deposition may be a key determinant of breeding success at the colony level. The somewhat anomalous condition suggested by the above data may result from the fact that the 100-nest sample used to determine per-pair productivity is not indicative of overall breeding conditions in the 52 colonies used to measure chick production. This would suggest 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 populations.

As last season, the predominant component in the diets of Adelie penguins was krill (*Euphausia superba*). However, unlike last season, more krill in the larger size classes dominated the diet samples (40-50mm vs. 30-40mm). This is consistent with LTER data on the pelagic distribution and size of krill between seasons (R. Ross, personal communication), and may be reflected in the slightly lower average fledging weights of chicks during 1993/94. More specific conclusions related to the interactions between diet, pelagic distribution of krill, fledging weights, and the duration of foraging trips are currently beyond the scope of this report due to the large size of the pertinent databases awaiting analysis.

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 Ecosystems Research Group.

11.5 Problems, Suggestions and Recommendations: This season was generally free of problems at Palmer Station. Minor problems with the telemetry equipment were repaired on site, allowing this aspect of the research to achieve a potential comparable to last season. Early season problems with access to the rookeries due to wind and pack ice again made it impossible to implement Standard Method A6.2, Procedure C (chicks raised per colony) as specified in the CEMP manual.