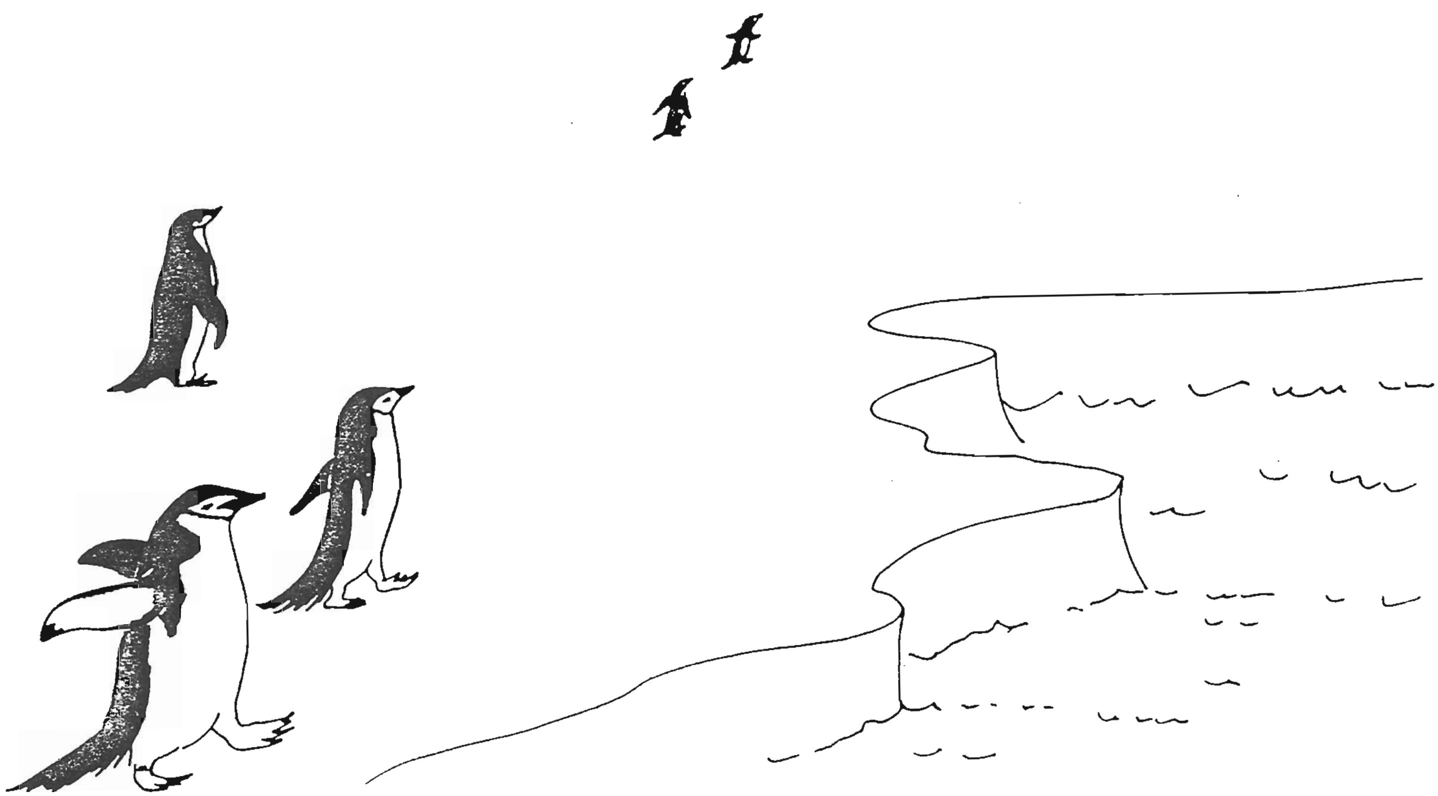
CRUISE REPORT (1987-1988)

ANTARCTIC MARINE LIVING RESOURCES PROGRAM (AMLR)



National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

AMLR Reference Document 3 July 1988

U.S. ANTARCTIC MARINE LIVING RESOURCES (AMLR) PROGRAM ECOSYSTEM MONITORING SURVEY 1987-88

CRUISE RESULTS

R/V *PROFESSOR SIEDLECKI* CRUISE No. 87-88-01 (I-II)

AND

AMLR PROGRAM MARINE MAMMAL FIELD RESEARCH

AND BIRD FIELD RESULTS

National Marine Fisheries Service
Northeast Fisheries Center
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AMLR Reference Document 3

July 1988

U.S. ANTARCTIC MARINE LIVING RESOURCES (AMLR) ECOSYSTEM MONITORING SURVEY

ABSTRACT

CRUISE RESULTS
R/V *PROFESSOR SIEDLECKI* CRUISE No. 87-88-01 (I-II)

The R/V PROFESSOR SIEDLECKI proceeded on 11 December 1987 from Rio de Janeiro, Brazil, to conduct an ecosystem monitoring survey as described in the cruise instructions dated 20 October 1987.

The survey was divided into two parts. Part I terminated on 16 January 1988 at Punta Arenas, Chile. Part II extended from 18 January 1988 to 27 February 1988 and terminated at Rio de Janeiro, Brazil.

The U.S. Chief Scientist was Dr. Kenneth Sherman.

Fish Stock Assessment Survey

The U.S. Field Party Chief was Dr. Richard Crawford.

Krill Assessment Survey

The U.S. Field Party Chief was Dr. Michael Macaulay for the Acoustic Assessment of Krill Operation; the U.S. Field Party Chief was John Green for the Krill Net Avoidance and Escapement Operation.

AMLR PROGRAM MARINE MAMMAL FIELD RESEARCH AND BIRD FIELD RESEARCH

The U.S. Field Party Chief was Dr. John Bengtson for the Marine Mammal Field Research; the U.S. Field Party Chiefs were Dr. David Ainley and Dr. Wayne Trivelpiece for the Bird Field Research. Field work was conducted from 3 December 1987 to 25 February 1988.

Kenneth Sherman
Chief Scientist, NMFS/NOAA
Antarctic Program
Narragansett, Rhode Island

CRUISE RESULTS

U.S. ANTARCTIC MARINE LIVING RESOURCES (AMLR) PROGRAM ECOSYSTEM MONITORING SURVEY, 1987-88 PART 1

R/V *PROFESSOR SIEDLECKI*

INTRODUCTION

CRUISE PERIOD AND AREA

The ship departed Rio de Janeiro, Brazil, after loading scientific equipment and personnel, 11 December, for the South Georgia shelf and Shag Rocks study areas (Figure 1). Scientific operations were conducted between 2140 GMT, 18 December 1987, and 1955 GMT, 10 January 1988. Scientific data, samples requiring immediate attention or easily transported, and personnel were offloaded at Punta Arenas, Chile, on 16 January 1988.

OBJECTIVES

The objectives of Part 1 of the Ecosystem Monitoring Survey were: (1) to conduct a bottom trawl survey to assess the status of South Georgia shelf and Shag Rocks fish stocks; (2) to gather hydrographic data to support interpretation of local oceanographic conditions extant during the bottom trawl survey; (3) to collect ichthyoplankton samples for assessment of possible spawning habitat; (4) to conduct a preliminary fishing gear mesh selectivity study on selected commercially important fish species; (5) to determine an indexing factor for the effectiveness of a P 32/36 bottom trawl for sampling semi-pelagic *Champsocephalus gunnari*; (6) to collect tissue samples of Antarctic fishes for ageing studies; (7) to gather hydroacoustic echograms of bottom topography at each stock assessment survey station for possible correlation with fish species, size, and/or abundance; (8) to gather biological data (e.g., sex, index of sexual maturity, index of stomach fullness) for the study of the life history and behavior of selected fish species; (9) to cryopreserve ovary tissue from selected fish species for recombinant-DNA stock identification analysis; (10) to preserve full stomachs from selected fish species for later contents identification in food habits and community interaction studies; and (11) to provide a representative sample of otoliths from the species captured in the groundfish survey for the preparation of a key to facilitate identification of Antarctic marine mammal and bird stomach contents.

METHODS

GROUNDFISH SURVEY

The survey design was random and stratified between three strata: (1) 50-150 meters, (2) 150-250 meters, and (3) 250-500 meters. The survey began at the northwest corner of the South Georgia Shelf and proceeded in a clockwise fashion through 120 stations along a designed cruise track of 1,034 nautical miles (Figure 1; Appendix 1).

The survey accomplished 113 successful bottom trawls for the purpose of gathering stock assessment statistics (109 on the South Georgia Shelf, 4 in the Shag Rocks area). The trawl was a P 32/36 type with a cod end of about 50 mm stretched mesh between knots. The duration of each tow was standardized to 30 minutes. Catches were sorted by species, total species weight was recorded, fish lengths (total) were recorded using digitized measuring boards interfaced with a microcomputer, and biological data from subsamples (e.g., individual weight, otoliths, stomachs, and tissues) were collected. A total of 36,243 length measurements were taken from 24 species of fish.

SEX RATIO DETERMINATION

Occasionally, a randomly selected subsample of a catch of a particular species was sorted by sex prior to measuring. The purpose was to determe a fish stock sex ratio and possibly to derive sexual differential growth parameters for that species. The four species sampled for statistical analysis are: *C. gunnari* (496 males, 647 females), *Chaenocephalus aceratus* (457 males, 374 females), *Pseudochaenichthys georgianus* (316 males, 279 females), and *Notothenia gibberifrons* (405 males, 442 females).

HYDROGRAPHY

Elementary hydrographic data (salinity, temperature, oxygen concentration) were collected at each station on the cruise track. A total of 87 CTD profiles and 21 XBT casts were made.

ICHTHYOPLANKTON SAMPLING

A total of 28 bongo net samples were collected (13 in stratum 1, 13 in stratum 2, 2 in stratum 3). The nets were 60 centemeters in diameter and were of 0.333-millimeters and 0.505-millimeters mesh. Analog flowmeters were placed within in each net to measure volume of water sampled. A time and depth recorder was fitted at the point of bongo frame attachment to the tow wire in order to record the deployment pattern and maximum depth of the sample. Samples were preserved in 4% seawater Formalin buffered with sodium borate. They were archived on board for later splitting, whereby one-half of the samples were sent to Poland for study and the other half to the United States.

MESH SELECTIVITY

An experiment was conducted for the purpose of generating a preliminary mesh selectivity curve for *C. gunnari*.

Baseline information for this exercise will be derived from data obtained with the groundfish survey bottom trawl.

For the experiment, the cod end mesh size was changed three times:

1. the "standard" cod end described above was replaced with one made of nominal 110-millemeter mesh (double 3-millimeter twine) fitted with an 80-millimeter mesh liner (single 3-millimeter twine),

2. the liner identified in 1. above was removed, resulting in 110-millimeter mesh, and

3. the 110-millimeter mesh bag was replaced with one of 140-millimeter mesh (double 3-millimeter twine).

The result was four samples using mesh sizes of approximately 50, 80, 110, and 140 millimeters. Each configuration was towed over the same grounds for separate 30-minute tows. Catches will be analyzed to generate preliminary mesh selectivity curves.

AGE DETERMINATION

Otoliths (Sagittae) and scales were collected from specimens representing the observed size range of the principal species in our catch. We targetted for 10 specimens from each 3-centimeter size division in the range of total length for each species (e.g., 10-12 centimeters, 13-15 centimeters, etc.). Samples were shared between the United States and Poland, with the left side going to the United States and the right to the Sea Fisheries Institute, Gdynia, Poland (MIR). Some species, such as *C. gunnari* were sampled more intensively and the surplus samples went to Poland.

In addition to otoliths and scales, brain, heart, and eye tissues were also collected and preserved for lipofuscin age determination. The species sampled, and the number of samples, are: *C. gunnari* (24), *C. aceratus* (20), and *Notothenia rossii* (22).

OTHER SUPPORTIVE STUDIES

A separate collection of otoliths from 14 species of fish was taken for the preparation of a species key to otoliths found in marine mammal stomach contents. It should be noted that during the removal of otoliths in all these collections, the gonads as well as the relative fullness of the stomach were examined. Intact stomachs were collected from several specimens to examine the food habits of the principal species in our catch. This work will form the basis for a comparison with similar work done previously in the South Georgia area, as well as with future collections. Because some of this early work (c. 1975) was done at the peak of commercial landings in this area, these studies may detect shifts in predator/prey interactions as a function of fishery-induced population changes.

Finally, liquid nitrogen was used to cryopreserve ovaries for recombinant mitochondrial-DNA examination.

DISCUSSION

GENERAL SEASONAL/OCEANOGRAPHIC CONDITIONS

The fleet of high endurance fishing trawlers and factory ships, which routinely work within the study area, was conspicuously absent during the survey. Most of the fleet was pursuing myctophids at the Scotia Rise, or krill near the South Shetland Islands. Radio transmitted reports, from the few commercial trawlers in the South Georgia area, indicated that catches were below average. In general, 1987-88 catches of commercially important

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Radoslaw Zaporowski	Biological technician
Zdzislaw Cielniaszek	Biological technician
Krzysztof Kreft	Biological technician
Irena Rutkowska	Biological technician
Dariusz Gornowicz	Biological technician
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Stanislaw Fulawka	Cartographer
Karol Szynaka	Technician
Emil Ociepka	Electronics technician
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Piotr Teclaw	Hydro-acoustician
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Slawomir Kurzyk	Gear technologist
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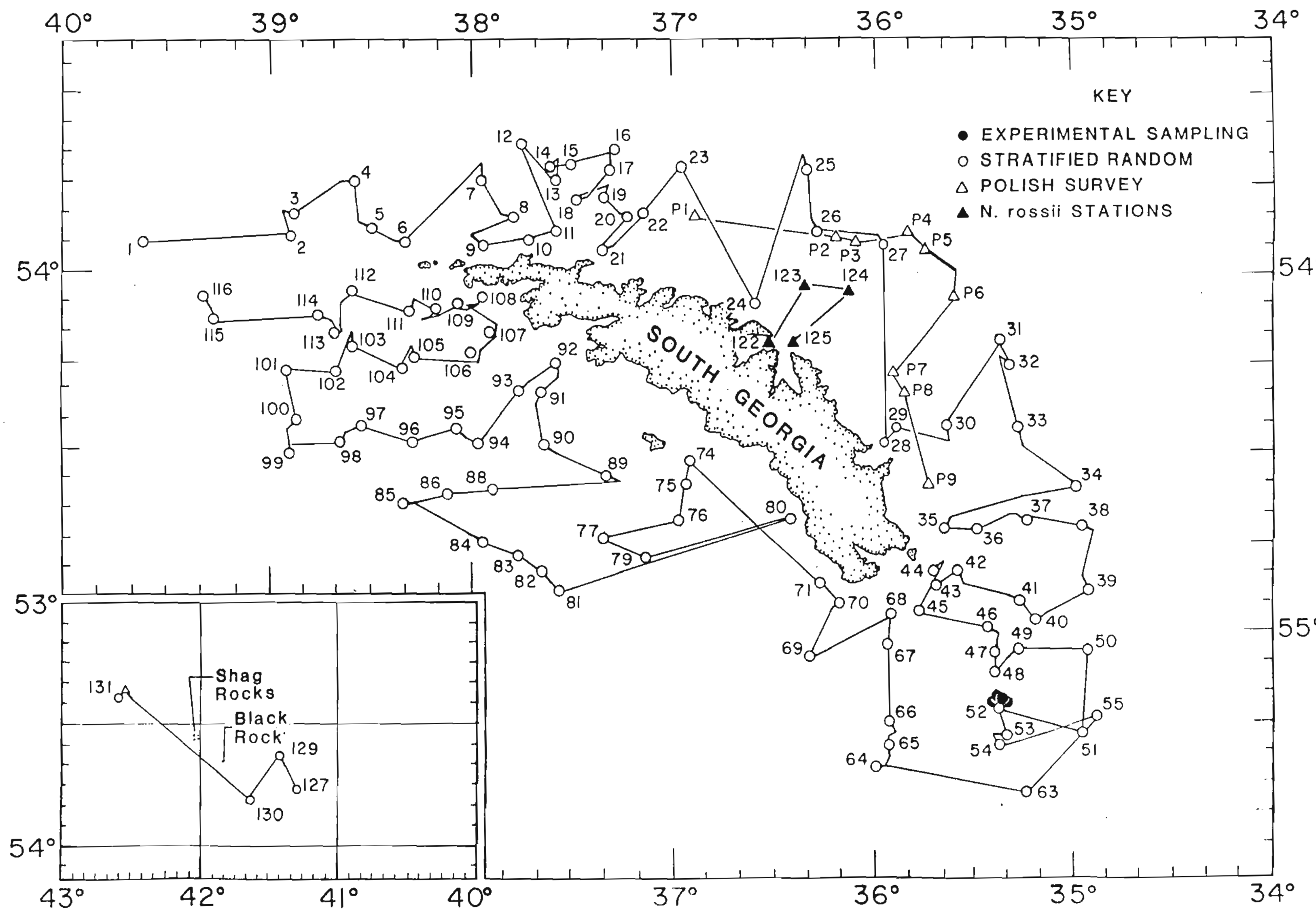

Figure 1. Cruise track and sample locations for Fish Assessment Survey-Leg 1, R/V *Professor Siedlecki* 1987-88.

APPENDIX 1

STARTING AND ENDING LONGITUDE AND LATITUDE
1987-1988 AMLR CRUISE
(SOUTH GEORGIA)
[DEG. MIN. SEC.]

STATION	ST.LONG.	END LONG.	ST.LAT.	END LAT.
1	39 34 54	-- -- --	53 56 12	-- -- --
2	38 57 12	38 54 12	53 53 36	53 53 30
3	38 55 12	38 52 18	53 50 6	53 50 6
4	38 37 12	38 33 54	53 44 12	53 44 24
5	38 31 12	38 29 24	53 52 0	53 53 0
6	38 20 48	38 17 48	53 54 18	53 53 48
7	37 57 12	37 56 18	53 41 54	53 44 0
8	37 49 24	37 47 0	53 49 48	53 51 12
9	37 57 48	37 56 0	53 53 24	53 54 48
10	37 43 6	-- -- --	53 54 42	-- -- --
11	37 36 0	37 33 24	53 52 42	53 51 48
12	37 39 30	37 42 36	53 37 18	53 38 12
13	37 35 6	37 33 18	53 41 54	53 43 24
14	37 32 54	37 34 48	53 40 36	53 42 12
15	37 27 48	37 30 0	53 40 0	53 41 36
16	37 13 36	37 16 24	53 38 54	53 38 18
17	37 17 30	37 18 12	53 41 18	53 42 42
18	37 25 18	37 27 48	53 46 48	53 47 12
19	37 18 18	37 20 0	53 45 18	53 46 48
20	37 15 30	37 12 36	53 49 0	53 48 48
21	37 17 30	37 19 18	53 55 12	53 55 0

STARTING AND ENDING LONGITUDE AND LATITUDE
1987-1988 AMLR CRUISE
(SOUTH GEORGIA)
[DEG. MIN. SEC.]

STATION	ST.LONG.	END LONG.	ST.LAT.	END LAT.
22	37 10 0	37 8 12	53 48 42	53 48 24
23	36 58 18	36 57 36	53 43 0	53 42 12
24	36 37 18	36 36 0	54 3 36	54 5 12
25	36 21 36	36 19 48	53 40 54	53 42 36
26	36 18 12	36 17 24	53 52 0	53 53 30
27	36 0 0	35 57 36	53 53 54	53 54 48
28	35 56 48	35 56 42	54 27 18	54 28 42
29	35 55 0	35 54 6	54 27 24	54 25 48
30	35 38 6	35 37 54	54 27 36	54 26 6
31	35 22 12	35 23 42	54 11 36	54 10 30
32	35 19 36	35 20 6	54 15 6	54 14 6
33	35 16 30	35 16 12	54 26 30	54 28 18
34	35 14 48	35 16 6	54 36 48	54 35 24
35	35 37 6	35 38 24	54 41 12	54 42 30
36	35 31 30	35 28 48	54 43 24	54 43 6
37	35 18 42	35 15 42	54 40 54	54 40 42
38	34 55 18	34 58 24	54 42 54	54 42 42
39	34 57 42	34 55 36	54 51 42	54 52 54
40	35 7 42	35 10 12	54 57 30	54 58 24
41	35 14 54	35 17 30	54 55 18	54 54 54
42	35 33 12	35 34 24	54 52 18	54 50 30
43	35 38 12	35 41 12	54 52 6	54 52 42
44	35 41 36	35 39 30	54 50 30	54 49 12
45	35 45 0	35 46 30	54 56 0	54 57 30
46	35 26 6	35 23 0	54 59 36	55 0 30
47	35 22 42	35 23 0	55 2 12	55 4 6
48	35 22 42	35 22 48	55 5 36	55 7 18
49	35 18 0	35 15 48	55 4 36	55 3 30
50	34 57 36	34 55 42	55 4 48	55 3 36
51	34 57 12	34 57 24	55 19 6	55 17 12
52	35 23 0	35 19 42	55 12 12	55 12 6
53	35 20 18	35 22 36	55 18 48	55 18 42
54	35 22 0	35 19 0	55 17 54	55 17 12
55	34 54 12	34 53 18	55 14 42	55 14 18
63	35 16 48	35 13 48	55 27 0	55 26 36
64	35 56 36	35 59 0	55 23 6	55 23 18
65	35 56 0	35 55 48	55 20 36	55 19 30
66	35 56 6	35 56 24	55 16 48	55 15 30
67	35 56 36	35 56 30	55 4 54	55 3 12
68	35 56 12	35 55 36	55 0 12	54 58 18
69	36 17 0	36 19 30	55 4 18	55 4 48
70	36 12 24	36 10 24	54 56 24	54 56 12
71	36 14 48	36 16 6	54 53 30	54 52 24
74	36 55 0	36 54 18	54 31 36	54 29 54
75	36 56 54	36 56 36	54 35 42	54 34 12
76	36 57 48	36 55 42	54 41 30	54 39 48
77	37 24 12	37 22 42	54 47 12	54 45 42
79	37 10 54	37 6 30	54 51 6	54 50 6

STARTING AND ENDING LONGITUDE AND LATITUDE
1987-1988 AMLR CRUISE
(SOUTH GEORGIA)
[DEG. MIN. SEC.]

STATION	ST.LONG.	END LONG.	ST.LAT.	END LAT.
80	36 17 0	36 17 0	54 45 30	54 43 54
81	37 33 18	37 32 6	54 54 24	54 55 30
82	37 35 30	37 38 0	54 52 42	54 50 48
83	37 43 30	37 45 36	54 49 0	54 48 12
84	37 57 54	37 56 30	54 44 54	54 45 18
85	38 19 0	38 16 36	54 39 42	54 39 6
86	38 5 42	38 2 36	54 37 36	54 37 18
88	37 54 48	37 53 12	54 37 30	54 36 6
89	37 17 12	37 19 0	54 35 0	54 34 30
90	37 34 30	37 35 12	54 30 18	54 28 18
91	37 39 18	37 38 12	54 22 6	54 21 18
92	37 33 18	37 32 36	54 14 54	54 16 42
93	37 42 30	37 44 30	54 19 0	54 20 48
94	37 55 12	37 57 6	54 27 48	54 29 0
95	38 1 12	38 3 30	54 27 42	54 26 30
96	38 14 12	38 16 42	54 28 36	54 28 48
97	38 31 48	38 34 42	54 26 18	54 26 0
98	38 36 42	38 37 54	54 27 54	54 29 30
99	38 53 54	38 56 6	54 31 6	54 30 0
100	38 54 0	38 52 6	54 26 42	54 25 24
101	38 54 30	38 52 42	54 17 48	54 17 18
102	38 38 6	38 35 30	54 17 24	54 17 30
103	38 34 6	38 33 24	54 11 30	54 13 12
104	38 19 6	38 16 42	54 16 24	54 17 12
105	38 16 24	38 17 0	54 14 48	54 13 30
106	37 55 48	37 56 0	54 13 0	54 14 48
107	37 51 18	37 50 18	54 10 30	54 8 48
108	37 55 24	37 58 36	54 5 30	54 5 36
109	38 2 18	38 4 54	54 6 24	54 6 18
110	38 10 0	38 12 0	54 7 6	54 7 36
111	38 16 0	38 17 42	54 4 42	54 6 30
112	38 34 42	38 37 18	54 4 48	54 5 0
113	38 37 54	38 37 0	54 9 18	54 10 48
114	38 41 30	38 44 18	54 8 30	54 7 48
115	39 12 36	39 15 12	54 8 24	54 8 0
116	39 16 48	39 18 36	54 6 6	54 4 36
122	36 26 6	36 24 54	54 13 0	54 10 54
123	36 17 54	36 21 18	54 1 48	54 2 0
124	36 8 54	36 8 36	54 4 30	54 2 24
125	36 19 12	36 16 36	54 11 54	54 11 42
127	41 19 36	41 17 6	53 46 18	53 45 30
129	41 24 36	41 27 30	53 37 12	53 36 36
130	41 39 42	41 37 48	53 49 48	53 48 30
131	42 29 36	42 32 12	53 23 36	53 21 42

CRUISE RESULTS

U.S. ANTARCTIC MARINE LIVING RESOURCES (AMLR) PROGRAM ECOSYSTEM MONITORING SURVEY, 1987-88 PART II

R/V *PROFESSOR SIEDLECKI*

INTRODUCTION

CRUISE PERIOD AND AREA

The cruise departed Punta Arenas, Chile, on 18 January 1988, and returned to Rio de Janeiro, Brazil, 27 February 1988. The survey of Elephant Island began 22 January and ended 31 January. The survey of King George Island and Bransfield Strait began 31 January and was completed 5 February. Additional special studies were done north of Elephant Island from 21 January until 22 January and 5 February until 14 February when the return to Rio was begun (Figure 1).

OBJECTIVES

The objectives of Part II were consistent with the CCAMLR Ecosystem Monitoring Program. This survey was designed to: (1) assess the abundance and distribution of krill (*Euphausia superba*) using hydroacoustic and net sampling survey methods and conduct hydroacoustic assessment intercomparison studies with Polish and Japanese survey teams; (2) collect information on krill population structure and associated fish, ichthyoplankton, and zooplankton in relation to phytoplankton distributions, primary productivity, and physical oceanographic conditions; (3) conduct experiments to compare the effectiveness and comparability of bongo nets, multiple opening/closing, and net environmental sensing system (MOCNESS) rectangular midwater trawl (RMT), Methot Isaacs Kidd Trawls (MIK), and krill trawls under various conditions of krill abundance and population structure; (4) collect krill and fish samples for evaluation of the mitochondrial DNA method of determining stock identification; (5) conduct experiments to determine the effects of varying levels of ultraviolet (UV) radiation on phytoplankton productivity; (6) determine abundance and variety of nekton and micronekton taken during commercial krill harvesting with midwater trawls; and (7) conduct experiments to evaluate krill assessment methods using molting frequency.

METHODS

An initial hydroacoustic intercalibration study was conducted with R/V *Kaiyo Maru* of Japan. During this study, multiple passes were made along a series four track line with one thing following the other on the same heading attempting to sample the same water column. At the end of the hydroacoustic survey, a series of net tows with both vessels in close proximity, were conducted. The R/V *Kaiyo Maru* towing a version of the RMT and the R/V *Professor Siedlecki* towing bongo nets. Four successful tows were completed before the two vessels ceased joint operations.

The hydroacoustic survey was conducted jointly using simultaneously operated acoustic systems utilizing a towed system (American) and a hull mounted system (Polish) in the R/V *Professor Siedlecki*. There were no indications of interference between systems due to the operating frequencies having no common multiple (50 kHz and 200 kHz, American; 120 kHz Polish). The coverage by frequency/depth/method of integration is as follows: 120 kHZ/6-180 meters/analog; 50 kHz/6-250 meters/digital; 200 kHz/6-250 meters digital. Echo data were processed by analog integrator (120 kHz) or processed using the software and hardware developed at NWAFC (50 kHz and 200 kHz). The methods, constants, and target strengths used for processing the 120 kHz and 200 kHz data presented in this report are included in Appendix 1.

The hydroacoustic survey was conducted 24 hours a day, incorporating minimal interruption of survey mode. These breaks were limited to bongo-net hauls (reduced speed from 6-8 knots to 3 knots for 45 minutes) spaced approximately every 30 nautical miles; RMT--eight hauls taken at several locations for length-frequency of ensonified populations; and productivity stations incorporating a hydrocast and STD cast taken daily at noon (see Appendix 2.)

The hydroacoustic survey was conducted 22 January-5 February 1988 using hydrophones operating at 50 and 200 kHz deployed from a towed V fin simultaneously with the ship's hull-mounted transducers operating at 120 kHz. Length frequency and abundance data derived from net sampling were collected for target strength estimates. Bongo sampling gear consisted of a 0.61-meter bongo frame fitted with 0.505 and 0.333-millimeter mesh nets. A water column approximately 180 meters deep was sampled during an average 45-minute tow at 3.0-3.5 knots. A V fin was used to depress the sampler and a time depth recorder mounted above the bongo frame recorded tow depth and duration. RMT and MIK hauls were at 3.0 knots and followed the same general procedures as bongo hauls except that no depressor was used. Mesh size of the RMT and MIK were 1/4 inch and the mouth opening was 8 square meters. Digital flowmeters suspended across the mouth of both nets measured volume filtered. Gear was lowered at approximately 40 meters per minute and retrieved at 20 meters per minute. Material from krill samples taken during survey operations was collected for stock identification studies based on mitochondrial DNA analysis. After the hydroacoustic survey of the Bransfield Straight and Elephant Island areas, a region of relatively high krill biomass was selected based on preliminary survey results for detailed studies of differential avoidance/extrusion of krill and the structure and vertical distribution of the pelagic community using bongo nets, RMT and MOCNESS. The bongo and RMT were rigged as described above. The mouth area of the MOCNESS was 1 square meter and the mesh on each of the 9 nets was 0.333 millimeter. The MOCNESS was deployed at 2.0 knots, sampling obliquely down to a maximum depth of 175 meters. During descent 4 nets were used to provide samples of discrete depth strata over 20- to 75-meter intervals. A fifth net was used to sample the maximum depth stratum and each of the remaining 4 nets repeated the same interval during retrieval to provide replicated sampling of each depth stratum. Electronic instrumentation mounted on the MOCNESS frame provided "real time" data on volume filtered, tow speed, tow duration, mouth area (net angle), temperature, sampling depth, and salinity. This information was displayed on deck on an instrument panel and recorded both on audio tape and floppy disk. An on-line minicomputer provided data reduction and printed out results as well as plotted temperature and salinity during the tow. Nets were opened and closed by the operator at the appropriate times for sampling of each depth interval. A final MOCNESS series was conducted with successive nets released at a single depth to evaluate horizontal variability. During this series a depressor vane was added to the MOCNESS to test the feasibility of attaining higher tow speeds than 2.0 knots.

The krill assessment survey was conducted in the areas of Bransfield Strait, Elephant Island, and King George Island. During the survey, 98 bongo hauls, 5 midwater trawls, 31

RMT hauls, 6 MOCNESS hauls, 5 MIK hauls, 10 Van Veen Grab samples, and 18 bottom trawls were conducted. Of the bongo hauls, 61 were survey hauls, 23 were for gear comparisons, and 9 were in conjunction with bottom trawls off King George Island.

Of the RMT hauls, 9 were conducted during the survey for hydroacoustic target strength estimates and 22 were conducted during gear comparisons. Finally, of the bottom trawls, 3 were conducted from each of the three depth strata off king George Island and west and northwest off Elephant Island. Three midwater trawls were taken at the convergence zone and two were taken during the hydroacoustic survey ranging from northeast Elephant Island to the southwest and northwest of King George Island.

Mitochondrial DNA studies were conducted on 110 ovarian samples from fish taken at King Georges Island, and 24 ovarian samples from fish taken at Elephant Island during bottom trawls. During this hydroacoustic survey, 220 specimens of krill from 10 localities from northeast of Elephant Island to the southwestern and northwestern ends of King Georges Island.

Bottom trawls were taken at a series of stations to the northwest of King George Island and to the west and northwest of Elephant Island. Nine tows were taken in each area; three stations in each of three depth strata from near shore to off shore. During bottom trawling and in shallow areas near Elephant Island, Van Veen grab samples were taken at regular intervals.

Krill were maintained in aquaria under various temperatures and light regimes to study molting frequency under a number of conditions. Also samples from net tows were examined for occurrence of molts to determine a molting frequency which will be investigated as a means of assessing population density. Subsamples from RMT hauls were preserved for continuation of krill ageing studies using length-frequency and lipofuscin methods begun in 1987.

DISCUSSION

RESULTS

The results of the analog integration (120 kHz data) gave an estimate of 39,000 tons (in 2,894 square nautical miles) in the Bransfield Strait and 260,000 tons (in 7,453 square nautical miles) in the Elephant Island area for a total of 299,000 tons in the areas surveyed last year. The full survey found (120 kHz data) 385,000 tons (in 7,787 square nautical miles) in the Bransfield Strait and the area north of King George Island, and 309,000 tons (in 8,836 square nautical miles) in the expanded area around Elephant Island. This is probably a minimum figure because the 120 kHz system had a higher threshold of detection than the 200 kHz system. It is, however, much lower than last year and closer to the estimates observed in 1984 in this area, i.e., a low density. The survey in areas covered last year were very comparable (2,894 square nautical miles in 1988 vs. 3,000 square nautical miles in 1987 for the Bransfield Strait; 7,453 square nautical miles in 1988 vs. 7,346 square nautical miles for Elephant Island). The additional areas covered were to the west of Elephant Island (1,383 square nautical miles) and east of Elephant Island (336 square nautical miles), and the area north of King George Island (3,239 square nautical miles) so that the total survey covered 16,623 square nautical miles in 1988 vs. 10,346 square nautical miles in 1987.

DISPOSITION OF SAMPLES

The data collected to examine the effect that ultraviolet (UV) radiation may have on phytoplankton productivity are currently under analysis at Texas A&M University. Analysis of intercomparison and krill, zooplankton, and ichthyoplankton distribution samples are currently underway at Moss Landing Marine Laboratory, Monterey, California; Texas A&M University, College Station, Texas; and the Narragansett Laboratory of the National Marine Fisheries Service, Narragansett, Rhode Island. Analysis of hydroacoustic data is underway at the University of Washington, Seaattle, Washington. DNA analysis is being conducted at the Chesapeake Biological Laboratory of Johns Hopkins University, Shady Side, Maryland. Analysis of benthic samples and bottom trawl samples will be completed at Morski Instytut Rybacki, Gdynia, Poland.

U.S. SCIENTIFIC PERSONNEL

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John Moisan	Primary Productivity, Biologist
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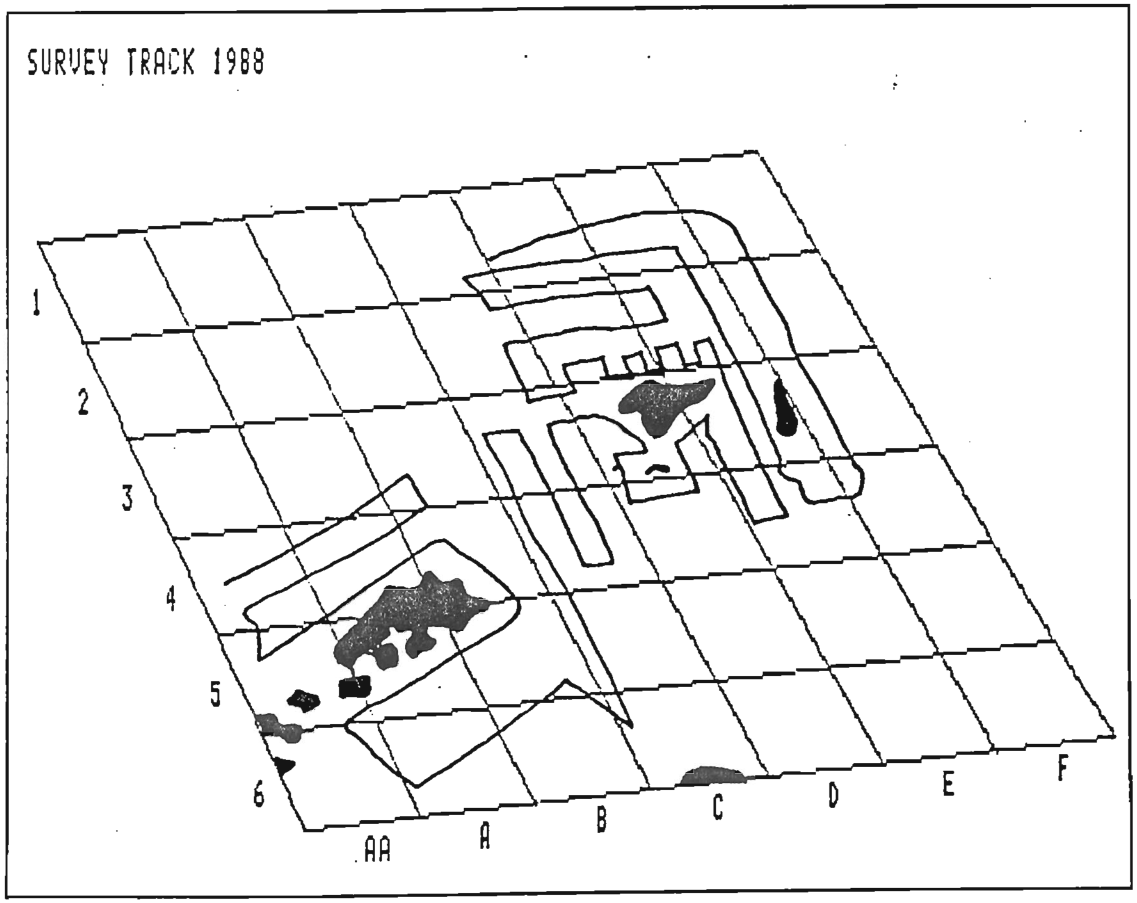

Figure 1. Survey track and block locations in the area of Bransfield Strait and Elephant Island.

APPENDIX 1

CALCULATION OF TARGET STRENGTH AND SYSTEM CONSTANTS

The R/V Siedlecki hull mounted system consisted of a Simrad[1] EK-120 sounder coupled to a Simrad QM MK II analog echo integrator. A Simrad EK-38 sounder was used for auxiliary observaton of targets outside the range of the EK-120 (ie. below 130m). Before the cruise, the equipment was calibrated in acoustic and electrical units. These values are presented in Table II. Echo integration was done for the depths of 6 to 180 m. Because the range of the EK-120 TVG is limited to 110 m, during calculations the results from 110 to 180 m were corrected. The basis for the estimation of krill biomass was the calculation of the mean value of volume back-scattering-strength S_v for each 1 nm of vessel track following the method described in BIOMASS Report Series No. 40. Mean volume back-scattering is here defined as:

$$\bar{S}_v = -75.81 + 10 \log \bar{I} \qquad 1.0$$

where $\bar{S}_v$ is mean volume back-scattering-strength; $\bar{I}$ is echo integrator deflection for 1 nm segment (in mm). The mean abundance of krill per unit of surface area was calculated using:

$$\bar{\sigma} = 10^{0.1(S_v + 10 \log R - TS)} \qquad 1.1$$

where $\bar{\sigma}$ is mean abundance of krill (number/m^2); R is width of integration layer (110 m value was assumed; and TS is mean target strength of ensonified krill. The Target strength to length relation used was:

$$\overline{TS} = 19.9 \log \bar{L} - 95.7 \quad (db) \qquad 1.2$$

1. Reference to trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service (NMFS), NOAA.

where $\bar{L}$ is the length of krill in mm. Mean surface density or abundance (tons/nm^2) was calculated from the following formula:

$$\bar{B} = 3.43 * \bar{\rho} * \bar{w} \qquad 1.3$$

where $\bar{B}$ is mean surface abundance of biomass; $\bar{w}$ is the mean weight of krill (in g) and is meaan density of krill from 1.1 above Mean weight of krill was calculated from the relation:

$$\bar{w} = 0.000925 * \bar{L}^{3.55} \qquad 1.4$$

where $\bar{w}$ is weight of krill (mg) and $\bar{L}$ is length of krill (mm)

The towed acoustic systems used from R/V Siedlecki consisted of a BIOSONICS Inc.[2] Model 101 sounder operating at 200 kHz and coupled to an Hewlett Packard[2] A900 computer for real-time digital integration of the data. A BIOSONICS Inc Model 101 sounder operating at 50 kHz was also used. The 50 kHz envelope detected signal was recorded in FM mode on an instrument recorder for post cruise analysis. Before the cruise, the equipment was calibrated in acoustic and electrical units. These values are presented in Table II. Analysis of the 200 kHz acoustic data follows the methods of Johanneson and Mitson, 1983 and Macaulay et al., 1984. Measurements of envelope detected voltage for each ping were made every 0.1 m (a digitizing rate of 7.5 kHz), then squared and summed into 1 m depth intervals and averaged for 60 pings (1 min). The estimate of average density in each depth interval and for the total column selected (6-250 m) was then calculated. One-min estimates then were recorded on magnetic disk files for further analyses. Estimates of average density were determined for intervals down to 250 m or bottom whichever occurred first. Provision for elimination of the bottom signal is made in the system by means of a combination software and hardware bottom detection methods. For comparison with 120 kHz data, the

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2. See note 1 above

data were stratified for the depth bin 6-180 m. The target strength (1.2 above) and length-weight (1.4 above) relations were used for calculations of density and biomass. This was done on the basis of (Kristensen and Dalen, 1986) which indicates no correction for frequency is necessary between 120 kHz and 200 kHz, unlike that proposed in BIOMASS Report No. 40.

APPENDIX 2

STA NO.	ARR DATE (GMT)	ARR TIME (GMT)	LAT (S)	LON (W)	BOT Z (M)	WIND SPD (KTS)	WIND DIR (T)	ATM PRESS (MB)	WAVE HT(m)	AIR TEMP (C)	SURF TEMP (C)	GEAR	TOW TIME	SHIP SPD (KTS)
1	01/24/88	1355	60-33.7	55-37.9	3270	10	40	992	1.5	2.0		BONGO	1357	3.5
2	01/24/88	1520	60-36.9	55-40.5	3500	11	40	991	1.5	2.0		BONGO	1521	3.5
3	01/24/88	1600	60-38.2	55-44.3	3420	11	40	991	1.5	2.0		BONGO	1602	3.5
4	01/24/88	1635	60-38.9	55-47.1	3500	14	40	991	1.5	2.0		BONGO	1638	3.5
5	01/24/88	1740	60.38.8	55-49.7	3400	14	45	990	1.5	2.0		BONGO		3.5
6	01/25/88	1250	60-28.1	53-48.2	2820	5	200	991	0.5	3.0		BONGO	1320	3.5
7	01/25/88	1730	60-51.9	53-48.6	820	5	200	989	0.3	7.0		BONGO	1800	3.5
8	01/25/88	2135	61-19.8	53-47.8	892	5	50	988	0.5	2.0	-0.2	BONGO	2210	3.5
9	01/26/88	105	61-42.0	53-48.7	342	25	90	988	2.5	1.0	0.8	BONGO	135	3.5
10	01/26/88	305	61-42.0	54-15.9	702	26	90	986	2.5	0.0	0.9	BONGO	335	3.5
11	01/26/88	625	61-20.5	54-16.0	278	30	90	988	2.8	0.0	0.2	BONGO	645	3.5
12	01/26/88	1045	60-52.4	54-16.4	739	35	100	988	2.5	1.0	1.2	BONGO	1120	3.5
13	01/26/88	1505	60-27.3	54-17.0	3150	30	100	993	2.4	1.5	1.5	BONGO	1540	3.5
14	01/26/88	1945	60-27.3	55-09.6	3500	10	100	997	1.5	5.0		MWT	2100	2.0
15	01/26/88	2155	60-26.7	55-10.4	3500	5	80	998	1.5	3.0	1.8	BONGO	2230	3.5
16	01/27/88	330	60-27.0	56-00.6	3800	5	270	998	1.5	2.0	2.4	BONGO	405	3.5
17	01/27/88	710	60-33.5	55-36.4	3500	NO WIND		998	1.5	2.0	1.0	BONGO	750	3.5
18	01/27/88	1200	60-33.7	55-30.2	3000	5	90	998	0.8	2.0	1.4	BONGO	1240	3.5
19	01/27/88	1705	60-44.1	55-10.3	3000	20	90	998	1.0	4.0		CTD	1805	0.0
19	01/27/88	1820	60-44.1	55-10.6	3000	20	90	998	1.2	4.0		BONGO	1855	3.5
20	01/27/88	2130	60-43.2	55-58.3	3500	20	90	998	1.5	3.0		RMT	2200	2.0
21	01/27/88	2310	60-44.0	56-09.0	4050	18	90	999	2.0	2.0	2.2	BONGO	2350	3.5
22	01/28/88	400	61-00.8	56-11.7	1450	20	120	1002	2.2	0.0	2.0	BONGO	435	3.5
23	01/28/88	740	60-52	55-37	215	20	120	1003	1.5	0.0	0.8	BONGO	810	3.5
24	01/28/88	1030	61-01.1	55-21.4	19	20	140	1003	0.5	0.0		BONGO	1035	3.5
25	01/28/88	1810	60-52.1	55-15.9	1450	23	180	1008	1.2	1.0		RMT	1840	2.0
26	01/28/88	1910	60-52	55-10	1650	30	170	1009	1.0	1.0	1.4	BONGO	1950	3.5
27	01/28/88	2130	61-01	55-02	159	10	170	1010	0.7	0.0	0.6	BONGO	2205	3.5
28	01/29/88	0	60-52.0	54-50.0	1020	12	180	1010	1.0	0.0	1.2	BONGO	40	3.5
29	01/29/88	225	61-01	54-44.0	554	12	180	1010	1.0	0.0		BONGO	305	3.5
30	01/29/88	445	60-52.0	54-34.0	773	14	180	1008	1.2	-0.5	1.2	BONGO	525	3.5
31	01/29/88	1115	61-41.6	54-31.0	940	22	180	1006	1.5	-2.0	0.4	BONGO	1155	3.5
32	01/29/88	1440	61-32.1	54-50.5	1410	17	180	1004	0.8	0.0		CTD	1550	0.0
32	01/29/88	1600	61-32.1	54-50.8	1350	15	180	1003	1.0	2.0	1.0	BONGO	1640	3.5
33	01/29/88	1830	61-18.2	54-50.8	421	12	180	1003	0.8	2.0		RMT	1900	2.0
34	01/29/88	1950	61-15.4	54-51.3	191	5	180	1003	0.5	0.0	0.7	BONGO	2010	3.5
35	01/29/88	2010	61-14.4	54-50.2	145	3	180	1003	0.3	0.0		BENTHOS	2045	0.0
36	01/29/88	2245	61-24	55-10	602	5	170	1003	0.3	0.0	1.2	BONGO	2325	3.5
37	01/30/88	245	61-32	55-49.9	230	6	170	1004	0.3	-2.0	0.4	BONGO	325	3.5
38	01/30/88	330	61-29.7	55-49.9	115	11	150	1003	0.5	-1.0		BENTHOS	345	0.0
39	01/30/88	540	61-20.2	55-41.2	227	12	150	1003	0.7	-1.0		BENTHOS	625	0.0
40	01/30/88	755	61-20.1	55-26.2	340	15	150	1003	0.7	0.0	0.4	BONGO	825	3.5
41	01/30/88	935	61-12.5	55-37	75	20	160	1003	1.0	1.0		BENTHOS	1000	0.0
42	01/30/88	1110	61-10	55-51	112	22	160	1006	1.2	1.0	0.6	BONGO	1125	3.5
43	01/30/88	1125	61-11	55-52.1	116	22	160	1006	1.3	1.0		BENTHOS	1150	0.0
44	01/30/88	1505	61-25.0	56-10.3	220	12	160	1008	1.0	1.0		CTD	1550	0.0
44	01/30/88	1555	61-25.2	56-11.0	227	12	160	1009	1.0	1.0	1.1	BONGO	1620	3.5
45	01/30/88	1315	61-41.3	56-08.3	590	10	260	1006	0.9	2.0	1.4	BONGO	1855	3.5
46	01/30/88	2130	61-34.5	56-31.6	525	15	260	1005	1.0	2.0		RMT	2200	2.0
47	01/30/88	2245	61-30.8	56-30.5	508	15	260	1005	1.0	2.0	1.5	BONGO	2325	3.5
48	01/31/88	130	61-16.3	56-30.2	435	20	280	1003	1.2	1.0	1.0	BONGO	210	3.5

49	01/31/88	440	61-01.0	56-30.6	2150	20	260	1001	1.3	2.0	2.1	BONGO	520	3.5
50	01/31/88	955	61-00.6	56-50	2800	25	260	998	1.5	3.0	2.2	BONGO	1030	3.5
51	01/31/88	1140	61-05	56-51.1	2740	25	260	997	2.0	3.0		RMT	1210	2.0
52	01/31/88	1525	61-24.5	56-50.0	460	25	260	992	2.8	3.0	1.4	BONGO	1605	3.5
53	01/31/88	1925	61-49	56-46	445	25	260	989	2.0	4.0	1.2	BONGO	1900	3.5
54	01/31/88	2345	62-19.5	56-48.7	1320	25	260	988	1.8	4.0	1.4	BONGO	25	3.5
55	02/01/88	315	62-42.2	56-52.1	200	10	240	988	1.5	2.0	-0.5	BONGO	345	3.5
56	02/01/88	735	62-28.1	57-19.4	1175	12	240	988	1.5	2.0	1.4	BONGO	815	3.5
57	02/01/88	1000	62-32.6	57-46.1	1600	15	230	988	1.5	2.0	1.6	BONGO	1040	3.5
58	02/01/88	1235	62-40.3	58-14.2	1350	15	240	988	1.4	2.0	1.4	BONGO	1315	3.5
59	02/01/88	1505	62-48.4	58-45.5	1140	16	250	992	1.0	5.0		CTD	1600	0.0
60	02/01/88	1635	62-49.3	58-55.2	1100	16	250	993	1.0	6.0	0.7	BONGO	1710	3.5
61	02/01/88	1915	62-36	59-09	1500	15	250	994	1.0	5.0		RMT	1945	2.0
62	02/01/88	2020	62-31.2	59-13	800	8	250	995	0.8	5.0	1.3	BONGO	2100	3.5
63	02/01/88	2245	62-22.3	58-42.6	700	8	130	997	0.5	1.0	1.4	BONGO	2325	3.5
64	02/02/88	225	62-10.0	57-44.1	550	17	100	998	0.9	0.0	1.3	BONGO	300	3.5
65	02/02/88	439	62-02.1	57-16.2	240	25	100	1000	1.2	0.0	1.0	BONGO	500	3.5
66	02/02/88	2000	62-11.2	58-24.8	228	0		1006	0.0	6.0		MILLER	2015	6.0
67	02/02/88	2030	62-12.9	58-24	165	0		1006	0.0	6.0		BONGO	2045	3.5
68	02/02/88	2055	62-12.3	58-24	144	0		1006	0.0	6.0		BONGO	2105	3.5
69	02/02/88	2110	62-12.3	58-24	142	3	340	1006	0.0	5.0		BONGO	2120	3.5
70	02/02/88	2125	62-11.8	58-24.4	299	3	340	1006	0.0	5.0		BONGO	2135	3.5
71	02/03/88	105	62-02.0	57-16.2	235	3	340	1005	0.0	2.0	0.8	BONGO	140	3.5
72	02/03/88	340	61-50.0	57-37.0	230	15	300	1005	0.5	2.0		BONGO	420	3.5
73	02/03/88	625	61-47.8	58-13.5	440	10	290	1003	0.5	1.0	0.2	BONGO	700	3.5
74	02/03/88	900	61-56.5	58-52.6	260	10	290	1003	0.5	1.0	0.4	BONGO	935	3.5
75	02/03/88	1205	62-07.1	59-44.1	112	11	290	1002	0.5	2.0	0.7	BONGO	1220	3.5
76	02/03/88	1400	61-55	59-39	312	11	290	1001	0.5	2.0		CTD	1450	0.0
77	02/03/88	1525	61-56.0	59-41.2	300	11	290	1000	0.5	5.0		RMT	1555	2.0
78	02/03/88	1620	61-54.9	59-39.4	300	10	290	1000	0.5	5.0	1.8	BONGO	1700	3.5
79	02/03/88	1925	61-48.0	59-04	260	10	290	999	0.5	5.0	2.3	BONGO	2005	3.5
80	02/03/88	2130	61-45.8	58-54.2	270	5	290	999	0.5	6.0		MWT	0	2.0
81	02/04/88	120	61-39.0	58-23.0	237	4	160	999	0.2	3.0	1.7	BONGO	200	3.5
82	02/04/88	415	61-30.9	57-46.5	420	0		999	0.2	3.0		BONGO	455	3.5
83	02/04/88	630	61-20.0	57-49.0	1950	10	250	999	0.2	3.0	2.4	BONGO	705	3.5
84	02/04/88	920	61-28.6	58-30.7	1300	15	240	1000	0.5	2.0	2.0	BONGO	1000	3.5
85	02/04/88	1240	61-35.6	59-03.4	1500	11	240	1000	0.5	4.0		RMT	1310	2.0
86	02/04/88	1345	61-37.0	59-13.5	1340	11	240	1000	0.5	4.0	2.5	BONGO	1420	3.5
87	02/04/88	1420	61-37.9	59-18.3	1500	11	240	1000	0.5	4.0		CTD	1525	0.0
88	02/04/88	1850	61-43.9	59-45.4	1650	11	310	997	0.6		2.7	BONGO	1925	3.5
89	02/04/88	2115	61-36.3	59-21	2100	5	360	996	0.5	5.0	2.6	BONGO	2155	3.5
90	02/04/88	2155	61-35.9	59-17.1	2000	3	360	996	0.3	4.0	2.6	VERT	2335	0.0
91	02/05/88	30	61-41.0	59-11.0	700	5	360	996	0.3	4.0	2.6	BONGO	105	3.5
92	02/05/88	105	61-40.5	59-10.0	720	5	360	996	0.3	3.0		VERT	250	0.0
93	02/05/88	505	61-51.6	59-05.0	217	11	70	990	0.6	3.0	1.9	BONGO	520	1.5
94	02/05/88	550	61-53.2	59-03.2	194	20	70	989	0.7	2.0		VERT	830	0.0
95	02/05/88	945	62-00.5	58-59.4	127	28	70	989	1.0	2.0	0.6	BONGO	1000	2.0
96	02/05/88	1030	62-00.5	58-53.8	116	25	55	989	1.0	3.0		VERT	1210	0.0
97	02/05/88	1330	62-01.2	58-52.9	105	26	60	990	0.8	5.0	0.8	BONGO	1345	2.0
98	02/05/88											MWT		
99	02/05/88	1530	62-03.6	59-07.0	112	12	45	991	1.[illegible]	5.0		CTD	1600	0.0
100	02/05/88											MWT		
101	02/05/88	1905	62-02.1	59-04.7	130	12	180	991	1.0	7.0	[illegible]	BONGO	1945	3.0
102	02/05/88											MWT		
103	02/05/88	2250	62-[illegible]2.8	59-15.3	[illegible]	[illegible]	130	996	.5	[illegible]		BONGO	2305	[illegible]
104	02/05/88											MWT		

105	02/06/88	130	61-58.8	59-40.3	221	10	180	999	0.5	2.0		BONGO	155	2.0
106	02/06/88											MWT		
107	02/06/88	600	61-51.9	59-33.7	354	12	240	1000	0.7	1.0	2.2	BONGO	625	2.0
108	02/06/88											MWT		
109	02/06/88	1000	61-56	59-11.2	174	15	240	1001	0.7	1.0		CTD	1050	0.0
110	02/06/88											MWT		
111	02/06/88	1230	61-53.7	59-03.1	210	20	220	1002	0.8	2.0	1.2	BONGO	1255	2.0
112	02/06/88											MWT		
113	02/06/88	1455	61-49.1	58-39.8	218	21	210	1001	0.8	3.0	1.8	BONGO	1525	2.0
114	02/06/88	1535	61-48.5	58-39.3	240	20	240	1002	1.2	3.0		CTD	1610	0.0
115	02/06/88											MWT		
116	02/06/88	1910	61-43.1	58-42.8	298	15	240	1002	1.0	4.0	1.7	BONGO	1650	2.0
117	02/07/88	915	61-29.5	58-41.1	1600	20	240	992	1.5	2.0		CTD	1040	0.0
118	02/07/88	1315	61-28.8	58-31.0	1140	12	330	989	1.0	1.0	1.9	BONGO	1355	3.5
119	02/07/88	1420	61-28.7	58-30.9	1140	12	340	988	1.0	2.0		RMT	1445	3.5
120	02/07/88	1500	61-29.3	58-36.0	1500	11	130	987	1.2	2.0		CTD	1550	0.0
121	02/07/88	1615	61-29.0	58-30.9	1450	11	130	987	1.2	3.0		MIK	1700	3.5
122	02/07/88	1950	61-29.2	58-31.4	1500	15	250	988	1.5	3.0	2.0	BONGO	2005	3.5
123	02/07/88	2020	61-29.3	58-31.6	1500	15	250	988	1.5	3.0	1.8	RMT	2050	3.5
124	02/08/88	1000	61-30.5	58-41	1350	35	225	995	1.5	3.0		CTD	1105	0.0
125	02/08/88	1120	61-31.2	58-42.6	1350	35	230	995	1.5	3.0		RMT	1135	2.0
126	02/08/88	1200	61-31.2	58-42.9	1350	36	230	996	1.5	3.0	2.1	BONGO	1230	3.5
127	02/08/88	1300	61-31.2	58-43.1	1350	35	230	996	1.5	4.0		MIK	1325	3.5
128	02/08/88	1410	61-30.7	58-42.7	1350	27	230	997	1.0	4.0		CTD	1505	0.0
129	02/08/88	1520	61-31.1	58-43.1	1400	27	230	997	1.2	3.0		RMT	1550	2.0
130	02/08/88	1615	61-31.5	58-39.5	1200	29	230	998	2.0	5.0	1.6	BONGO	1640	3.5
131	02/08/88	1910	61-31.3	58-39.2	1170	30	235	999	2.0	5.0	2.2	RMT	1950	2.0
132	02/08/88	2015	61-31.3	58-39.1	1170	25	235	999	2.0	5.0	1.7	BONGO	2030	3.5
133	02/08/88	2055	61-30.8	58-38.7	1200	25	235	999	1.8	5.0		RMT	2155	2.0
134	02/08/88	2225	61.31.3	58-39	1150	20	235	1000	1.5	4.0	2.2	RMT	2250	2.0
135	02/08/88	2305	61-31.4	58-39.2	1140	20	230	1000	1.8	4.0		BONGO	2325	3.5
136	02/09/88	5	61-31.4	58-40.2	1150	20	230	1001	1.5	3.0		MIK	35	3.5
137	02/09/88	110	61-30.9	58-39.6	1140	20	230	1001	1.2	3.0		MOCNESS	200	3.5
138	02/09/88	255	61-29.1	58-39.6	1250	20	230	1000	1.5	2.0		RMT	330	2.0
139	02/09/88	350	61-29.7	58-40.0	1250	17	230	1000	1.6	2.0		BONGO	410	3.5
140	02/09/88	430	61-30.4	58-37.8	1200	20	260	1000	1.6	3.0		MIK	540	3.5
141	02/09/88	930	61-33.2	58-28.5	550	18	280	997	1.5	3.0		CTD	1030	0.0
142	02/09/88	1315	61-31	58-36	1110	21	320	994	1.6	4.0		RMT	1340	2.0
143	02/09/88	1415	61-32.5	58-41.5	1000	25	310	994	1.8	4.0		CTD	1515	0.0
144	02/09/88	1535	61-32.0	58-39.7	1100	25	310	991	1.8	4.0		RMT	1555	2.0
145	02/09/88	1610	61-32.6	58-41.8	1100	25	310	990	2.0	4.0	1.9	BONGO	1630	3.5
146	02/09/88	1715	61-32.5	58-42.2	1150	25	310	989	2.0	4.0		MIK	1750	3.5
147	02/09/88	1820	61-32.5	58-42.4	1000	25	280	989	2.3	4.0		MOCNESS	1915	3.5
148	02/09/88	1950	61-30.1	58-33.6	1000	30	270	990	2.0	4.0	1.8	RMT	2015	2.0
149	02/09/88	2140	61-30.1	58-33.1	1050	30	270	990	2.0	4.0	1.6	BONGO	2205	3.5
150	02/09/88	2240										MIK		
151	02/09/88	2330	61-30.3	58-35.9	1200	31	270	990	2.0	4.0		RMT	2355	2.0
152	02/10/88	20	61-30.3	58-35.8	1250	32	270	990	2.8	4.0	1.7	BONGO	55	3.5
153	02/10/88	110	61-30.9	58-39.1	1200	32	270	990	3.0	3.0		RMT	145	2.0
154	02/10/88	950	61-31.5	58-38.7	1150	35	270	992	3.5	4.0		CTD	1050	0.0
155	02/10/88											BTRAWL		
156	02/10/88											BTRAWL		
157	02/11/88	950	61-17.5	55-52	226	12	260	1003	1.0	3.0		CTD	1030	0.0
158	02/11/88											BTRAWL		
159	02/11/88											BTRAWL		
160	02/11/88	1420	61-14.7	55-39.7	193	15	315	1003	1.0	3.0		CTD	1450	0.0

161	02/12/88											BTRAWL		
162	02/12/88											BTRAWL		
163	02/12/88											BTRAWL		
164	02/12/88											BTRAWL		
165	02/12/88											BTRAWL		
166	02/12/88	1430	60-49.1	54-29.3	1750	20	260	1003	1.2	5.0		CTD	1540	
167	02/12/88	2055	60-53.6	55-07.5	1000	30	290	1003	1.5	4.0	1.1	BONGO	2120	3.5
168	02/12/88	2145	60-53.6	55-07.5	1000	30	290	1003	1.5	4.0		RMT	2210	2.0
169	02/12/88	2230	60-53.5	55-07.5	1050	30	290	1003	1.5	4.0		MOCNESS	100	3.5
170	02/13/88	215	60-53.7	55-07.7	1060	30	290	1003	1.8	4.0	1.2	BONGO	240	3.5
171	02/13/88	305	60-53.5	55-07.7	1055	30	290	1003	1.8	4.0		RMT	335	2.0
172	02/13/88	400	60-53.6	55-08.0	1050	30	290	1003	1.6	4.0		MOCNESS	550	3.5
173	02/13/88	715	60-53.5	55-07.6	1050	20	310	1002	1.5	3.0	1.2	BONGO	745	3.5
174	02/13/88	805	60-53.5	55-07.5	1050	20	310	1002	1.5	3.0		RMT	835	2.0
175	02/13/88	930	60-53.5	55-07.5	1050	20	310	1002	1.5	3.0		MOCNESS	1025	3.5
176	02/13/88	1100	60-53.5	55-07.5	1050	25	330	1000	1.5	3.0	1.2	BONGO	1125	3.5
177	02/13/88	1235	60-53.5	55-07.5	1040	30	330	999	1.5	3.0		RMT	1310	2.0
178	02/13/88	1335	60-53.6	55-07.5	1020	32	330	998	1.8	3.0		MOCNESS	1435	3.5
179	02/13/88	1505	60-53.6	55-08.0	900	34	320	997	2.0	3.0		CTD	1550	0.0
180	02/13/88	1605	60-53.6	55-07.8	980	35	330	996	2.0	3.0	1.2	BONGO	1630	3.5
181	02/13/89	1650	60-53.6	55-07.6	980	35	330	996	1.8	5.0		RMT	1720	2.0
182	02/13/89	1740	60-53.5	55-07.5	1050	35	330	996	1.5	4.0		MOCNESS	1820	3.5
183	02/13/88	1915	60-53.4	55-07.4	1050	35	330	996	1.5	4.0	1.2	BONGO	1940	3.5
184	02/13/88	2000	60-53.5	55-07.5	1050	35	330	996	1.5	4.0	1.0	RMT	2025	2.0
185	02/13/88	2045	60-53.5	55-07.7	1050	35	330	996	1.5	4.0		BONGO	2110	3.5
186	02/13/88	2135	60-53.5	55-07.8	1050	30	330	996	1.5	4.0	1.1	RMT	2200	2.0
187	02/13/88	2225	60-53.5	55-07.7	1050	30	330	996	1.5	3.0		BONGO	2250	3.5
188	02/13/88	2300	60-54.3	55-10	900	30	310	996	1.5	3.0		CTD	2340	0.0
189	02/14/88	10	60-53.2	55-07.5	1050	24	310	996	1.2	3.0		RMT	35	2.0
190	02/14/88	55	60-53.3	55-07.8	1060	24	310	996	1.3	3.0	1.0	BONGO	120	3.5
191	02/14/88	225	60-53.2	55-07.6	1080	23	315	996	1.3	3.0		RMT	250	2.0
192	02/14/88	315	60-53.3	55-07.8	1000	25	315	996	1.5	3.0		BONGO	345	3.5
193	02/14/88	1100	60-53.4	55-06.7	1150	30	310	995	1.5	4.0		CTD	1155	0.0
194	02/14/88	1205	60-53.1	55-08.1	1050	30	320	994	1.5	3.0	1.3	BONGO	1230	3.5
195	02/14/88	1300	60-53.3	55-07.5	1050	30	320	993	1.5	4.0		RMT	1325	2.0
196	02/14/88	1350	60-53.3	55-07.6	1050	30	320	992	1.5	4.0		CTD	1440	0.0
197	02/14/88	1440	60-53.6	55-07.6	1030	30	320	992	1.5	4.0	1.3	BONGO	1505	3.5
198	02/14/88	1530	60-53.4	55-07.5	1010	30	320	991	1.7	4.0		RMT	1600	2.0
199	02/14/89	1730	60-53.3	55-07.6	1100	30	320	989	2	3.0	1.8	BONGO	1755	3.5
200	02/14/88	1820	60-53.2	55-07.7	1010	32	320	988	2	3.0	1.1	RMT	1850	2.0
201	02/14/88	1910	60-53.7	55-08.7	800	30	315	988	2	3.0		CTD	2000	0.0

REPORT OF THE 1987-88 U.S. ANTARCTIC MARINE LIVING RESOURCES PROGRAM MARINE MAMMAL AND BIRD FIELD RESEARCH

INTRODUCTION

SCHEDULE AND AREA

Marine mammal and bird field work was conducted from 3 December 1987 to 25 February 1988. Predator studies were located at three land-based sites: (1) Seal Island, Elephant Island; (2) Admiralty Bay, King George Island; and (3) Palmer Station, Anvers Island. A joint U.S./Chilean cruise was undertaken to test the feasibility of tracking fur seals and penguins at sea.

OBJECTIVES

Marine mammal and bird studies were conceived to provide information needed in support of the CCAMLR Ecosystem Monitoring Program. These predator investigations were designed to link closely with the pelagic prey and environmental sampling efforts carried out on the R/V *Professor Siedlecki*. Field work at the three land-based sites investigated various aspects within the four general topics listed below for Antarctic fur seals, chinstrap, macaroni, and Adelie penguins, and Cape petrels:

(1) Reproductive behavior and success,

(2) Growth rates and body condition,

(3) Feeding ecology and behavior, and

(4) Abundance and demographics.

METHODS AND RESULTS

ACTIVITIES AT SEAL ISLAND

Work at Seal Island concentrated on initiating long-term studies of Antarctic fur seals, chinstrap penguins, macaroni penguins, and Cape petrels according to the guidelines of the CCAMLR Ecosystem Monitoring Program.

Time-depth recorders were deployed on 22 female fur seals to monitor their foraging behavior at sea. Preliminary analyses of the records recovered revealed the ocean strata favored by the seals for finding their principal prey, Antarctic krill. Female fur seals were frequently diving to depths of 50-70 meters in search of prey. The intraseasonal variation in foraging effort for individual females and between different females is being analyzed to evaluate the sensitivity of measures of effort in relation to changing prey availability.

The joint U.S./Chilean pilot project to track fur seals and penguins at sea was very successful. The R/V *Alcazar* was demonstrated to be an effective platform for this work. Newly designed automatic radio direction finding equipment worked well throughout the 3-day operation. Two female fur seals were independently tracked from their rookery on

Seal Island to foraging sites approximately 25 nautical miles north of the island. One male chinstrap penguin was tracked from its nest to its feeding site 13 nautical miles north of Seal Island. These results provide important information for making the essential links between the AMLR Program's land-based and pelagic sampling components.

A total of 120 samples of scats (feces) was collected from female (10/week) and male (10/week) fur seals over a 6-week period to analyze food habits. Preliminary analyses have shown krill and fish to be the principal prey items, with an apparent shift in prey preference as the season progresses.

The growth and survival rates of fur seal pups were monitored over a two-month period. The mothers of some of the pups monitored were equipped with time-depth recorders, so it will be possible to compare the growth rates of pups in relation to their mothers' foraging efforts. The mortality rate of pups was over 50%, with leopard seal predation thought to be a significant factor.

The number of female fur seals pupping at Seal Island was higher this season (approximately 280) than during the 1986-87 season (about 250). The status of females tagged last year was noted and recorded as part of the long-term monitoring of their reproductive performance. An additional 32 adult females, 7 subadult males, and 112 pups were tagged as part of that study.

A census of the island revealed 67 chinstrap penguin colonies and 3 macaroni penguin colonies. Representative colonies were selected for long-term monitoring according to CCAMLR protocols. Breeding success was measured for chinstrap penguins in three ways: (1) the proportion of chicks to adults ranged from 0.40 to 0.74, (2) the number of chicks successfully raised to creche stage per breeding pair ranged from 1.39 to 1.23, and (3) the number of chicks at selected colonies was counted at predetermined intervals. For macaroni penguins, 0.91 chicks were raised to creche stage per breeding pair.

In preparation for future studies of age-specific and year-specific mortality, 2,000 chinstrap penguin chicks and 13 macaroni penguin chicks were marked with metal wing bands. Resighting efforts in subsequent seasons will be focused on the colonies where banding was performed.

Radio transmitters were deployed on 40 chinstrap penguins (each mate of 20 breeding pairs) to monitor chick attendance during the chick raising period. Scanning radio receivers monitored the length of adults' foraging trips to sea and the amount of time that they spent ashore with their chicks. In addition, 10 time-depth recorders were deployed on chinstrap penguins to study diving patterns. Preliminary analyses indicate that chinstrap penguins were diving up to 100 m in search of prey. Recorders were also placed on 4 macaroni penguins, which were shown to be diving to depths of up to 100 m, as well.

The stomachs of 60 (10 every 5 days) chinstrap penguins were pumped for diet analysis. Antarctic krill (35-55 mm in length) was the predominant prey item. Fish and squid were also evident. Regurgitated pellets recovered at Cape petrel nests indicated that the adults were returning to their nests and feeding krill (35-50 mm in length) to their chicks.

Every 5 days, between 26 January and 15 February, the growth rate of a sample of chinstrap penguin chicks was measured. Culmen length, wing length, and body weight was taken for 30 chicks selected at random. Chicks were marked after handling to avoid being included in the next sample period. Mean chick weight increased about 0.5 kg every 5-day period. Fledging weights of 60 chinstrap penguin chicks were taken just prior to closing the field camp on 19 February. The mean weight of all chicks was 3.33 kg.

A survey of accessible areas on Seal Island between 1 and 11 January revealed 106 Cape petrel nests concentrated in five areas. Of these nests, 11 were empty and 95 had chicks, or eggs. Hatching was synchronous (11-15 January) and hatching success was 0.94. Cape petrel chick growth rates were monitored at 24 nests. Measurements of wing length, culmen length, and body weight were made every other day between 3 and 17 February. No Cape petrel chicks had fledged prior to closing the field camp on 19 February. Stainless steel leg bands were placed on 25 chicks for future studies of survival and reproductive performance.

ACTIVITIES AT ADMIRALTY BAY

Data were collected in January and February 1988 on chinstrap penguin diet, Adelie and chinstrap penguin chick abundance and fledging weights. Chinstrap penguin stomach samples were obtained by stomach pumping on six occasions (10 samples each time) between 20 January and 16 February. A subsample of 50 krill was measured and weighted. Other prey items (e.g., otoliths, squid beaks, amphipods) were sorted and saved for analysis.

A total of 274 Adelie penguin chicks was captured and weighed as these birds were about to fledge in late January. All birds in the sample had been previously banded with flipper-tags when they were approximately 4 weeks old. While still at their colony nest sites, 100 chinstrap penguin chicks were captured and weighed. The chinstrap weights were taken at this time rather than waiting for actual fledging because of the pickup ship's schedule, which had been moved forward.

Adelie and chinstrap penguin chicks were censused at the beginning of creche for both species. Colonies for monitoring of this parameter were selected, mapped, and will be repeated each season as suggested in the CCAMLR protocols. The chicks in 23 Adelie penguin colonies in 2 rookeries and 17 chinstrap penguins in 3 rookeries were counted.

ACTIVITIES AT PALMER STATION

Data were collected in January and February 1988 on Adelie penguin diet, chick fledging weights, and chick counts. The sampling effort was curtailed by an early departure from Palmer Station on 22 January. Adelie penguin stomach samples were collected from Torgersen Island between 5 and 20 January; 10 samples per each of four 5-day intervals (40 samples total). Available data are similar to those described above for Admiralty Bay.

Body weights and wing lengths of about 200 creche-age Adelie penguin chicks were taken during banding activities on 18 January. Samples of about 30 fledgings were captured on three separate days at Humble Island, for a total of 92 weights (13-17 February).

Adelie penguin chicks were counted at 39 colonies in five rookeries in the Palmer Station vicinity. Methods were similar to those described above for Admiralty Bay.

INTERNATIONAL COOPERATION

The radio tracking of fur seals and penguins at Seal Island was conducted jointly with Chilean colleagues aboard a research vessel chartered by the Instituto Antarctico Chileno

(INACH). This group also arranged for picking up U.S. scientists from their field camps at Seal Island and Admiralty Bay at the end of the summer season.

DISPOSITION OF SAMPLES AND DATA

Analysis of information collected on Antarctic fur seals (e.g., reproductive behavior, growth and condition, foraging behavior, diet, maternal attendance) will be completed at the National Marine Mammal Laboratory, Northwest and Alaska Fisheries Center, Seattle, Washington.

Data on penguin breeding success, diet, population size, growth rates, and fledging weights will be analyzed at the Point Reyes Bird Observatory, Stinson Beach, California. Information on the attendance patterns and diving behavior of penguins will be analyzed at the National Marine Mammal Laboratory.

U.S. SCIENTIFIC PERSONNEL

National Marine Mammal Laboratory, Seattle, WA

John L. Bengtson	Field Party Chief (Seal Island)
Michael E. Goebel	Wildlife Biologist
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