Palmer Long-Term Ecological Research (LTER): Annual January cruise for 1994 (*PD*94-1)

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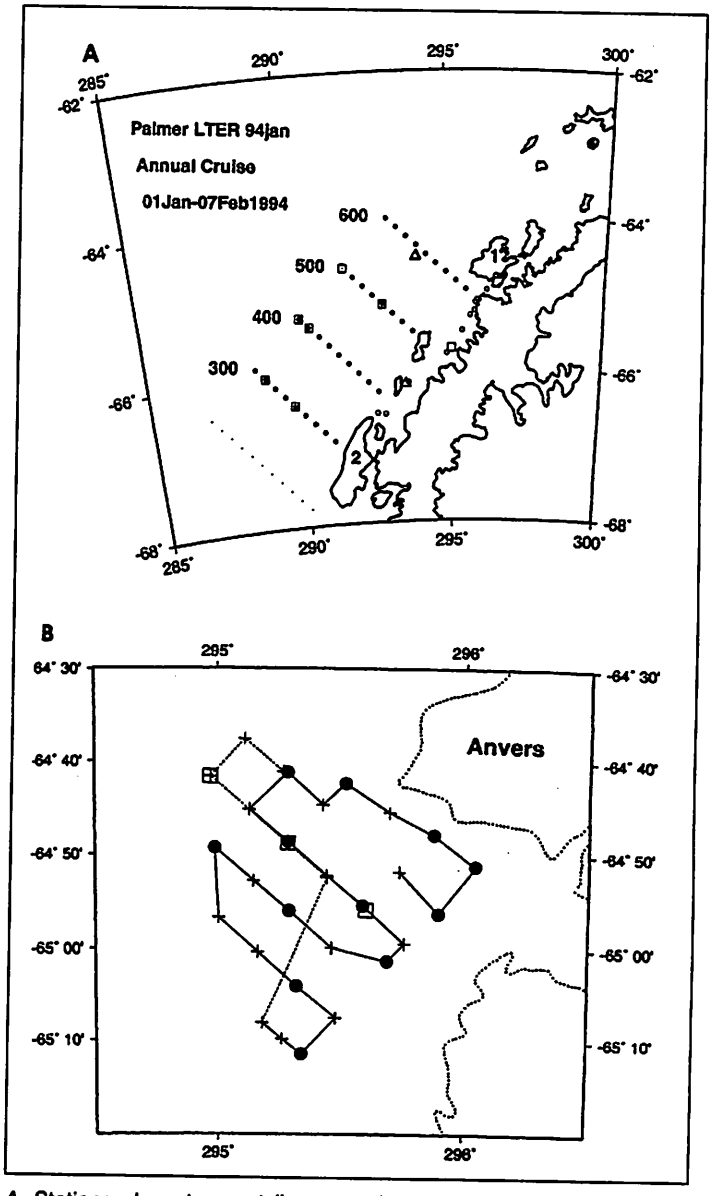
During the 1993–1994 U.S. Antarctic Program, the annual time-series cruise for the Palmer LTER in January and February was the second summer cruise in a series of cruises that spanned all seasons: spring (November) of 1991 (Ross and Quetin 1992), summer (January and February 1993) (Quetin, Ross, and Baker 1993), fall (March, April, and May 1993) (Quetin, Ross, and Baker 1993), and winter (August and September 1993) (Quetin, Ross, and Baker, *Antarctic Journal*, in this issue), and ending with summer (January and February 1994) reported here. The 1994 summer cruise on the R/V *Polar Duke* (*PD*94-1) included research teams from five components: optics and remote sensing, microbial loop, primary production, secondary production, and seabird ecology. The series of four cruises in 15 months with a repeat summer cruise will allow the Palmer LTER to examine the dynamics of population differences both between seasons and between years.

The annual summer cruise for the Palmer LTER has several objectives:

- documenting mesoscale variability in the southern ocean pelagic ecosystem;
- investigating, during a critical period for chick-rearing success, predator-prey interactions within the foraging range of the Adélie penguins that nest on islands near Palmer Station on Anvers Island; and
- sampling the nearshore stations at intervals during the cruise to provide the linkage between the small spatial scale sampling conducted over the entire spring and summer and the mesoscale sampling conducted annually.

In addition, during the January 1994 cruise, three sediment traps were also retrieved after a 9-month deployment and redeployed. Two of the traps were returned to the same area just south of Anvers Island, and one was deployed behind Lavoisier Island in a region covered by seasonal ice every year (figure, block *A*).

The LTER January 1994 cruise was divided into segments which included three phases (table 1). In addition, nearshore Palmer grid stations were occupied at the beginning, middle, and end of the cruise. Phase 1 included two transect lines; phase 2, the foraging subgrid; and phase 3, two additional transect lines. The mesoscale survey area (phases 1 and 3) was defined by four transect lines spaced 100 kilometers apart along shore: 600, 500, 400, and 300 lines (Waters and Smith 1992) (figure, block *A*). Stations were occupied at 20-kilometer intervals running from near the Antarctic Peninsula to past the shelf break on transect lines 600, 500, 400, and 300 plus additional stations inside the Wauwermans and Biscoe Islands, an



A. Stations along transect line occupied during the austral summer cruise on the R/V *Polar Duke* (11 January to 7 February 1994) (● outside islands, ○ inside islands). Locations of deployed sediment traps (△) and deep CTD stations (□) are indicated. Islands are identified as follows: 1-Anvers, 2-Adelaide. *B.* Foraging subgrid occupied during the small-scale sampling for predator/prey interactions, 19–23 January, in relation to Palmer Station on the southern end of Anvers Island. The transect lines extend offshore from the Antarctic Peninsula and have alongshelf spacing of 10 kilometers (LTER grid lines, 570–620). BOPS (●) casts were at 20-kilometer resolution and XBTs (X) and surface chlorophyll samples were taken at 10-kilometer resolution along the grid.

Table 1. Chronological listing of activities during the Palmer LTER annual cruise, 94Jan PD94-1. Grid line refers to stations along standard transects, N and S refer to stations inside the islands, inshore to the Palmer grid within 2 nautical miles (3.3 kilometers) of Palmer Station, HD to the high density foraging grid in Palmer Basin (figure, block B).

Month	Day	Cruise day	Grid line	Grid inshore	Grid HD	Activity
Jan	11	1		B&E		Depart Palmer Station
Jan	12	2	500			500.060 to 500.080; search for midwater trawl
Jan	13	3	500			500.100 to 500.120; deep CTD
Jan	14	4	500			500.140 to 500.200; deep CTD
Jan	15	5	600			600.200 to 600.160
Jan	16	6	600			600.140 to 600.120; deep CTD; sediment trap (3) retrieval
Jan	17	7	600			600.100 to 600.080; deep CTD
Jan	18	8	600			600.040 to 600.060
Jan	19	9			HD	50 km × 50 km bird grid (610.040 to 617.055)
Jan	20	10			HD	50 km × 50 km bird grid (616.060 to 600.060)
Jan	21	11			HD	50 km × 50 km bird grid (600.060 to 590.045); target tow
Jan	22	12			HD	50 km × 50 km bird grid (590.050 to 580.040); target tow
Jan	23	13			HD	50 km × 50 km bird grid (580.035 to 610.070)
Jan	24	14		B2J		Sediment trap (2) deployment; B to J; target tow
Jan	25	15	N			Inside north (620.015 to 595.013); experimental gill net
Jan	26	16	N			Inside north (575.010 to 575.010); experimental gill net
Jan	27	17	N			Inside north (575.010 to 520.000); deep CTD
Jan	28	18	S			Inside south (510.000 to 440.015); sediment trap (1) deployment
Jan	29	19	S;400			400.000; inside south (420.015, Crystal Sound); ice algae sample
Jan	30	20				Weather day
Jan	31	21	400			400.040 to 400.080
Feb	1	22	400			400.100 to 400.140
Feb	2	23	400			400.160 to 400.200; 2 deep CTDs; target tow
Feb	3	24	300			300.140 to 300.160; deep CTD
Feb	4	25	300			300.140 to 300.100; deep CTD
Feb	5	26				Weather day; crossing
Feb	6	27	300			300.080 to 300.040
Feb	7	28		B2E		Arrive Palmer

Summary	Number of events	Number of days	Percentage of time
Grid lines		13.5	48
Grid N/S		4	14
Grid inshore	3	2.5	9
High-density bird grid	1	5	18
Sediment trap, CTD		2	4
Weather days		1	

area with high phytoplankton biomass in 1993. This area is also important for larval fish surveys, which are important because adult fish are the dominant prey of flying seabirds. Several of these planned stations were not occupied in January 1994 because they were covered with sea ice, but the presence of sea ice provided the opportunity to investigate the relative activities of several bacterial exoenzymes under varying ice conditions (Christian and Karl 1994). At these stations, sampling included

- hydrographic and optical characteristics of the water column,
- dissolved inorganic and organic carbon levels,
- microbial loop activity,
- phytoplankton biomass,
- photosynthetic potential and chemotaxonomic pigments,
- macronutrients,
- distribution and abundance of macrozooplankton,
- physiological condition and reproductive status of antarctic krill, and
- seabird censuses (table 2).

Seabird censuses were also conducted during part of the transit between stations.

Table 2. Data sets collected during the annual Palmer LTER cruise (January 1994, PD94-1), for the mesoscale and small scale foraging grids.

Code	Data set	Meso[a]	Small[a]
BOPS	Bio-optical profiling system with rosette(conductivity, temperature, fluorescence, transmittance, irradiance, radiance, PAR)	6	6
CHL	Chlorophyll, phaeopigments (discrete fluorometer)	6	6
SALT	Salinity (discrete)	6	6
ATCTD	Along-track CTD (conductivity and temperature)	6	6
ATK	Along-track position, light	6	6
XBT	XBT (expendable bathythermograph)	6	6
CTD	CTD with rosette, profiles to seafloor	7	
HPLC	HPLC (high-pressure liquid chromotography, 16 plant pigments)	3	3
PRODPI	Primary production vs. irradiance	3	3
NUT	Nutrients	3	3
POC/PON	Particulate carbon and nitrogen	3	3
TRWL1M	Zooplankton (1-meter trawl)	5	5
TRWL2M	Micronekton (2-meter trawl)	5	5
TRW1KMT	Nekton (Isaacs-Kidd Midwater trawl, 1-meter)	5	nd
BIOFISH	Biofish acoustic transects (120 kilohertz)	5	5
PHYCONA	Physiological condition (growth, condition factor, chemical composition), adult krill	5	nd
SPF	Spawning frequency, adult krill	5	nd
ATP	Microbial biomass (adenine tri-phosphate activity)	7	nd
DOC	Dissolved organic carbon	7	nd
BAC#	Bacterial cell numbers	7	nd
LPS	Total and soluble lipopolysaccharide	7	nd
LEU	Microheterotrophic production (^{3}H leucine)	7	nd
EXO	Exoenzymatic activity of luecine aminopeptidase	7	nd
H2O2	Hydrogen peroxide	7	nd
O2	Dissolved oxygen	7	nd
DIC/ALK	Dissolved inorganic carbon and alkalinity	7	nd
GLU	Exoenzymatic activity of B-glucosidase	7	nd
VIR	Viral abundance and size class	7	nd
CENSUS	Seabird census, along track	2	2
BIRD	Bird observations at BOPS stations	2,6	6
SEDTRP	Sediment trap pickup and redeployment	7	nd

[a]Number in each cruise column represents the principal investigator(s) responsible for data collection: 1, Palmer LTER; 2, W. Fraser and W. Trivelpiece (Montana State University); 3, B. Prézelin (University of California at Santa Barbara); 5, R. Ross and L. Quetin (University of California at Santa Barbara; 6, R.C. Smith (University of California at Santa Barbara); 7, D. Karl (University of Hawaii).

The small-scale survey of the Adélie penguin foraging area, phase 2, was conducted between 19 and 23 January. The foraging subgrid was within 50 kilometers of the rookeries because this was believed to be the foraging range of the Adélie penguin colonies near Palmer Station. During this phase, intensive work on penguin diets on shore, simultaneous observations of seabird abundance and distribution at sea, and acoustic transects to quantify antarctic krill distributions were coupled with a small-scale oceanographic subgrid (figure, block *B*). A subset of transect station parameters was measured on this grid (table 2). Concentrations of both krill and Adélie penguins were lower, whereas the concentration of salps was higher in January 1994 than in January 1993.

Further details on data sets collected during this cruise, a roster of cruise participants, and a sampling log can be found in the online Palmer LTER information system (*http://www.icess.ucsb.edu/lter*).

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