Palmer long-term ecological research (LTER) program

Palmer long-term ecological research (LTER): An overview of the 1992–1993 season

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During U.S. Antarctic Program 1992–1993 (USAP 92–93), the Palmer LTER (as described in Ross and Quetin 1992) staged three major research efforts: the nearshore sampling program in the spring and summer, the annual summer cruise on the R/V *Polar Duke* (1 January to 7 February 1993), and an austral autumn process cruise on the R/V *Nathaniel B. Palmer* (25 March to 15 May 1993). The original five components (Ross and Quetin 1992) were joined by a microbial loop component led by David Karl from the University of Hawaii during both research cruises.

The annual cruise is viewed as a time-series cruise with complementary research on processes important to ecosystem functioning. The LTER January 1993 cruise was divided into three phases. During phases I and III the R/V *Polar Duke* occupied stations on five transects, the 600 and 500 transects in phase I and the 400, 300, and 200 transects in phase III (figure 1). Hugo Island was also surveyed to identify a location for an automatic weather station during USAP 93–94. The objective of phases I and III was to document mesoscale variability in the ecosystem and its functions. Stations were occupied at 20-kilometer (km) intervals on the four transects nearest to Palmer Station and at 40-km intervals on the 200 transect. Station work included sampling for hydrographic and optical characteristics of the water column, dissolved inorganic and organic carbon levels, microbial loop activity, phytoplankton biomass, photosynthetic potential and community composition, macronutrients, and distribution, abundance, and physiological condition of selected secondary producers (particularly antarctic krill, *Euphausia superba*, and antarctic silverfish, *Pleuragramma antarcticum*) (see table). Four diel stations to document variability in *in situ* primary production in different regions were also occupied for 24 hours.

Phase II (18–25 January 1993) of the summer cruise was designed to investigate interactions between seabirds nesting near Palmer Station and the marine ecosystem within their foraging range and coincided with a critical period for reproductive success in the Adélie penguins. During this phase, intensive work conducted on penguin diets on shore and observations of seabird abundance and distribution at sea were coupled with a small-scale oceanographic subgrid (figure 2) sampling protocol within the foraging range of the Adélie penguins (Lascara, Quetin, and Ross, *Antarctic Journal*, in this issue).

The major objectives of the austral autumn cruise (figure 3) were the following:

- to conduct a hydrographic survey of all 10 transects within the entire study region with a resolution of 10 km in the onshore/offshore direction and 100 km alongshore (Hofmann et al., *Antarctic Journal*, in this issue);
- to extend the temporal (autumn season) and spatial (further northeast and southwest) scale of LTER data set collections (table);
- to form the basis for defining the prewinter physiological condition, distribution, and abundance of larval krill to compare with postwinter data in the same year; and
- to retrieve and redeploy three sediment traps deployed near the 600 transect in November 1992. The nearshore stations within the Palmer grid (Waters and Smith 1992) were also sampled in both early April and early May to provide a seasonal extension of the austral spring and summer nearshore sampling regime.

Several processes were intensively studied during the autumn cruise. The hydrographic grid, which is the first extensive hydrographic coverage of this region west of the Antarctic Peninsula extending south of Adelaide Island, will form the basis of the LTER's understanding of circulation in the study region. The prewinter data on krill larvae is critical to a test of a working hypothesis about the effect of the extent of winter ice cover on larval survival, and ultimately recruitment into the adult population. Newly formed pancake ice was encountered at the inshore stations on the 100 and 000 transects and behind the Biscoe Islands. Most objectives were accomplished, although a significant number of days were lost to a medical evacuation and to high winds (greater than 36 knots), which prevented deployment of the scientific equipment. To retain full coverage of the entire LTER grid, resolution on the 900, 100, and 000 transect lines was increased to 20 km.

Data sets collected during the annual Palmer LTER cruise (January to February 1993) and the austral autumn process cruise (March to May 1993). Number in each cruise column represents the principal investigator(s) responsible for data collection: (1) Palmer LTER, (2) W. Fraser and W. Trivelpiece, (3) B. Prézelin, (4) E. Hofmann and J. Klinck, (5) R. Ross and L. Quetin, (6) R.C. Smith, (7) D. Karl. (nd denotes no data.)

Code	Data set	Jan	Mar
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	4, 6
ATCTD	Along-track CTD (conductivity and temperature)	4, 6	4, 6
ATK	Along-track position, light	4, 6	4, 6
XBT	XBT (expendable bathythermograph)	4, 6	4
HPLC	HPLC (high-pressure liquid chromotography, six plant pigments)	3	3
PRODPI	Primary production vs. irradiance	3	3
PRODSIS	Primary production simulated *in situ*	3	nd
PRODIS	Primary production *in situ*	3	nd
NUT	Nutrients	3	3, 7
POC/PON	Particulate carbon and nitrogen	3	3
TRWL1M	Zooplankton (1-meter trawl)	5	5
TRWL2M	Micronekton (2-meter trawl)	5	5
TRWLMW	Nekton (midwater trawl)	5	5
BIOFISH	Biofish acoustic transects (120 kilohertz)	4, 5	4, 5
PHYCONL	Physiological condition (growth, condition factor, chemical composition), larval krill	5	5
PHYCONA	Physiological condition (growth, condition factor, chemical composition), adult krill	5	5
SPF	Spawning frequency, adult krill	5	5
SFISH	Silverfish (otolith analysis, chemical composition)	5	5
ATP	Microbial biomass (adenine triphosphate activity)	7	7
DOC	Dissolved organic carbon	7	7
BAC#	Bacterial cell numbers	7	7
LPS	Total and soluble lipopolysaccharide	7	7
LEU	Microheterotrophic production (^{3}H leucine)	7	7
EXO	Exoenzymatic activity of luecine aminopeptidase	7	7
H2O2	Hydrogen peroxide	7	7
O2	Dissolved oxygen	7	7
DIC/ALK	Dissolved inorganic carbon and alkalinity	7	7
GLU	Exoenzymatic activity of B-glucosidase	7	7
CENSUS	Seabird census, along track	2	nd
CTD	CTD with rosette, profiles to seafloor	nd	4
ADCP	ADCP (acoustic doppler current profiler)	nd	4
ACOU	Simrad acoustic transects (38 kilohertz)	nd	4
TRMETZO	Trace metals in zooplankton	nd	4
FINGEST	Field ingestion of krill	nd	5
SALPPIG	Phytoplankton pigment in salps	nd	5
BIRD	Bird observations at BOPS stations	2, 6	6
SEDTRP	Sediment trap pickup and redeployment	nd	7

In addition to the fieldwork this season, data management for the Palmer LTER underwent further development and now takes advantage of Internet connectivity to facilitate communications among our distributed principal investigators. Such an approach is encouraged by the LTER Network Office for intersite communications (Nottrott and Porter 1992). Documentation and data storage for the Palmer LTER is centralized at one site (CRSEO, Center for Remote Sensing and Environmental Optics, at the University of California at Santa Barbara) where a 500-megabyte disk was installed and currently provides sufficient online storage for much of the Palmer LTER documentation and data. Definition of core data sets and development of data forms continues in order to provide both a common vocabulary as well as a similar structure across the diverse data sets. The data structure has been organized to encourage rapid data documentation and report generation as well as to promote data exchange.

In addition to a centralized archive site, an online browse program was developed for data documentation but has been superseded by the implementation of a local Internet gopher server to provide an online menu catalog of the documentation. This effort is aimed specifically at providing realtime accessibility for online browsing of the Palmer LTER documentation to all Palmer LTER investigators as well as to any

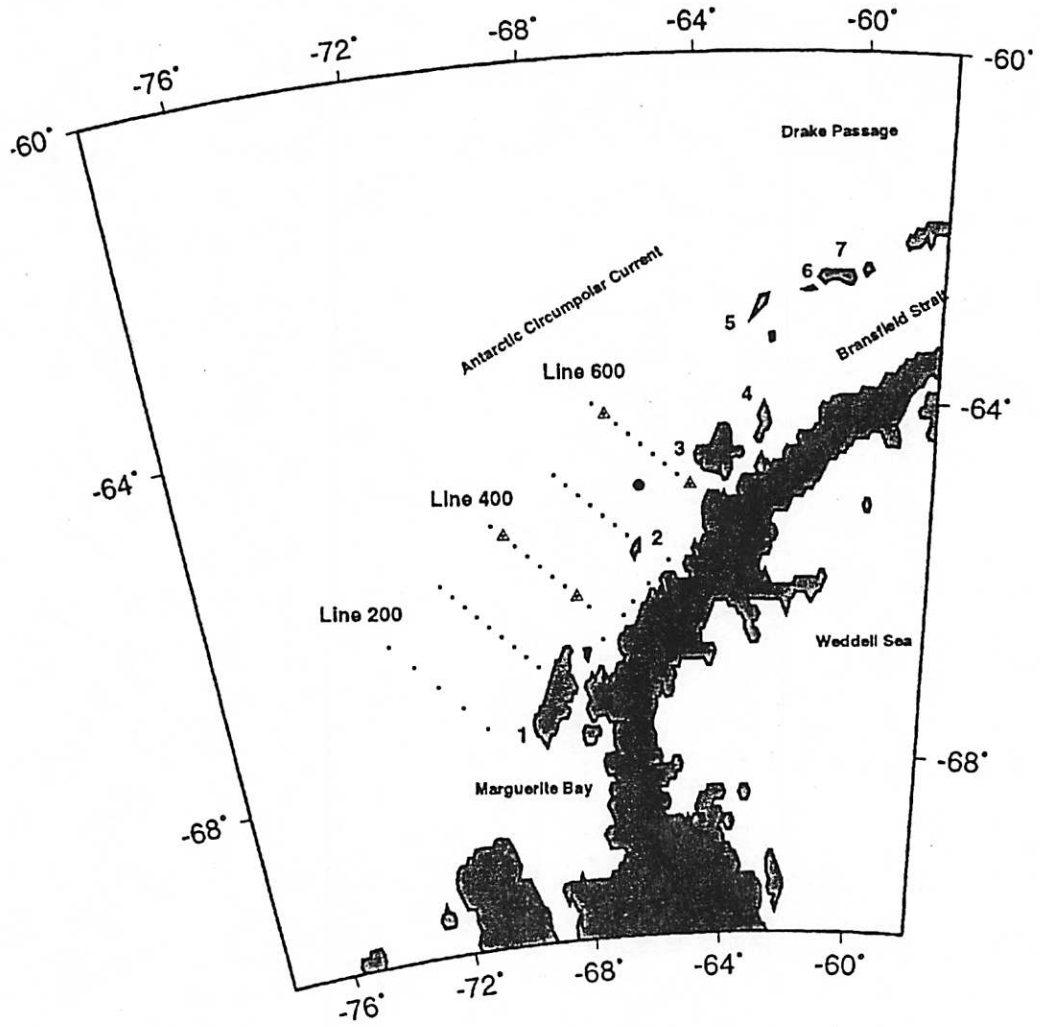

Figure 1. Stations (□) occupied during phase I and III of the austral summer cruise on the R/V *Polar Duke* (1 January to 7 February 1993). The proposed site (on Hugo Island) for deployment of an automatic weather station during USAP 93–94 is shown (●). Some stations were sampled over a diel cycle (▲). Islands are identified as: 1-Adelaide, 2-Renaud, 3-Anvers, 4-Brabant, 5-Smith, 6-Snow, 7-Livingston.

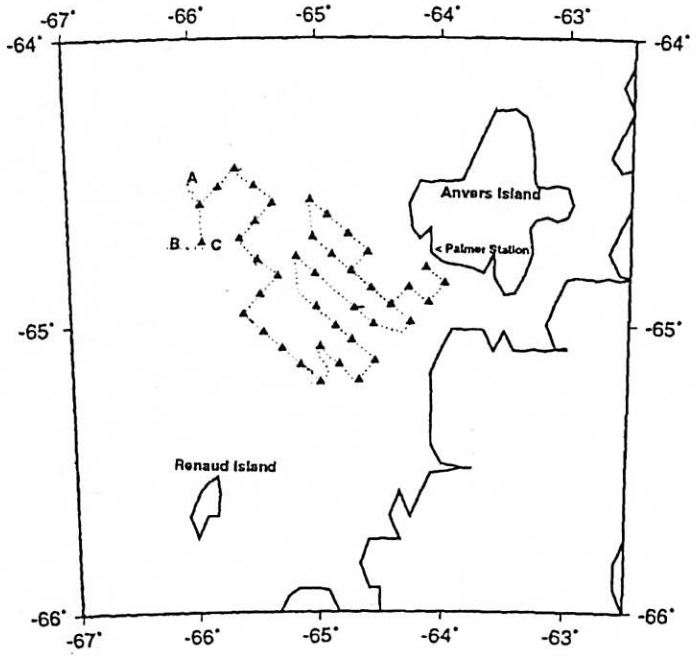

Figure 2. The sampling subgrid occupied during phase II of the austral summer cruise (18–25 January 1993) in relation to Palmer Station (on Anvers Island). The transect lines extend offshore from the Antarctic Peninsula and have alongshelf spacing of 10 km (LTER grid lines, 560–620). The dotted line represents the along-track path of the ship during the first survey of the transect grid. XBTs and surface nutrient and chlorophyll samples were taken at 10-km resolution along the grid (▲). The locations of three sediment traps (A, B, and C) are identified.

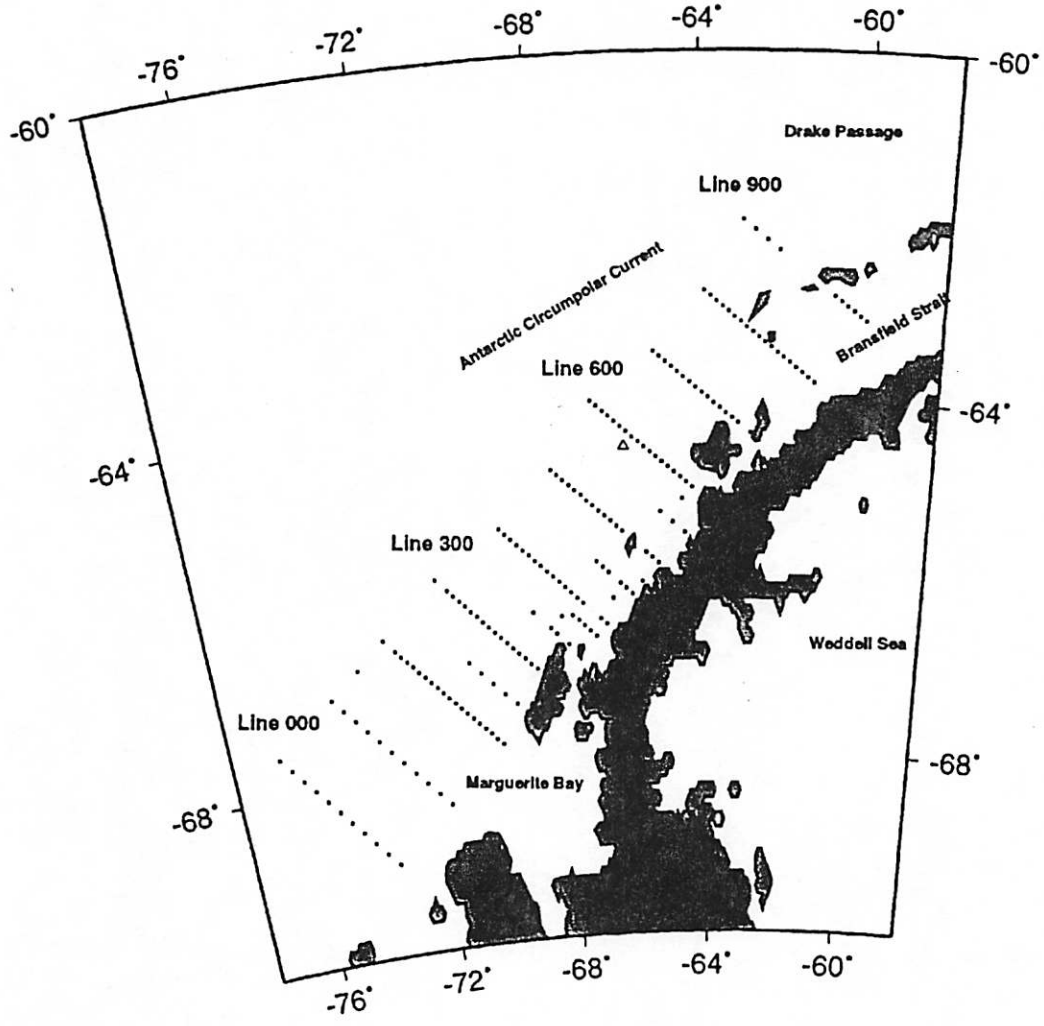

Figure 3. Stations (□) occupied during the austral autumn process cruise on the R/V *Nathaniel B. Palmer* (25 March to 15 May 1993). Three sediment traps are located within the △; see figure 2 for more detail of this area.

outside investigator over the Internet. Our goal is to make our large data sets easily available since this is a requirement for effective interdisciplinary, long-term research.

Connectivity, the ability to communicate and exchange information between computers, is an important objective of our system since it facilitates the sharing of computer resources in addition to the sharing of information using existing computer systems. The rapid developments in computer technology and the decrease in computer equipment costs have permitted connectivity to remote sites. For example, a remote University of California at Santa Barbara campus site Appletalk network was linked using gatorboxes to the central Palmer LTER Appletalk network at the university. The gatorboxes perform tunneling across the campus network; the tunneling links the remote site with the central Palmer LTER UNIX network. Rather than encouraging a standardization of equipment, we are working to accommodate diverse platforms by providing as powerful a connectivity as possible to provide transparent data access from IBM/PCs to Macintosh's to UNIX workstations.

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