

Palmer Long-Term Ecological Research

Palmer Long-Term Ecological Research (LTER): Annual January cruise for 1995 (PD95-1)

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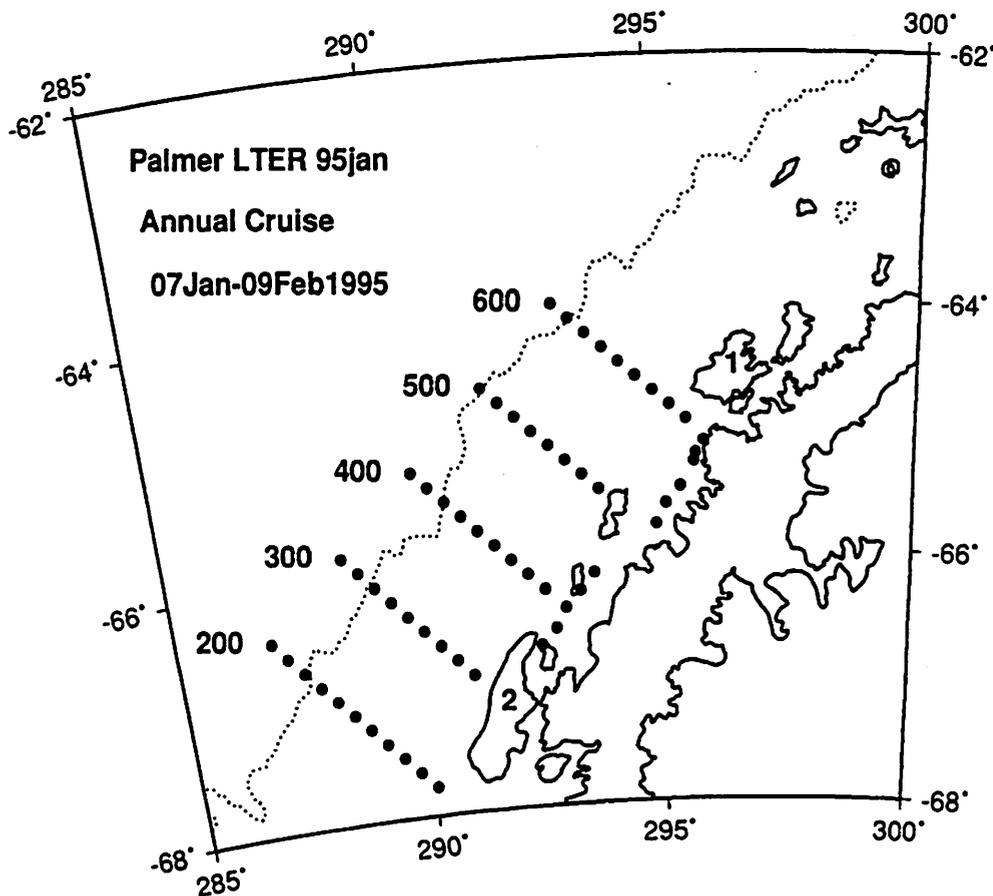
A key objective of the Palmer LTER program is to link ecosystem processes across trophic levels to physical environmental variables and to understand physical forcings and biological responses in the context of interannual variability. Annual austral summer cruises are timed to match the critical period for successful Adélie penguin breeding and to investigate trophic-level linkages during this critical period. These annual cruises also determine key environmental variables within the Palmer LTER regional area by sampling a fixed grid of cardinal stations to separate long-term (decadal) systematic trends from interannual variability in physical conditions and populations.

This third Palmer LTER January 1995 time-series cruise, from 7 January to 8 February 1995 aboard the R/V *Polar Duke* (PD95-1), follows cruises in January 1993 (Quetin, Ross, et al., *Antarctic Journal*, in this issue) and January 1994 (Ross, Quetin, and Baker, *Antarctic Journal*, in this issue).

LTER January cruises typically have two sampling modes: large-scale cardinal grid-line sampling, including stations "inside" the islands (Lemaire/Grandidier areas), and finer scale sampling within the Adélie foraging area. During PD95-1 a modified sampling strategy using combined *Polar Duke* "picket line" and Zodiac tracking (Smith et al., *Antarctic Journal*, in this issue) was used to identify likely Adélie foraging areas for high-density krill/penguin sampling (Quetin, Baker, et al., *Antarctic Journal*, in this issue). The figure shows the large-scale grid covered; tables 1 and

2 provide a cruise overview and summarize daily activities. The cruise sampling log, participant list, and other project information are available online starting from the web page of the LTER network office (<http://lternet.edu>) or from the Palmer LTER specific web page (<http://www.icess.ucsb.edu/lter>).

All cardinal stations along the LTER 600, 500, 400, 300, and 200 grid lines as well as "inside" stations both north and south were occupied (figure, and column labeled "grid line" in table 1). Grid lines are 100 kilometers (km) apart with cardinal stations every 20 km along these lines (Waters and Smith 1992). A cardinal station includes a Bio-Optical Profiling System (BOPS) cast, 1- and 2-meter (m) nets plus acoustics



The cardinal stations of the Palmer LTER large-scale grid (dots) off the Antarctic Peninsula indicate stations occupied during the PD95-1 cruise. The 1,000-m bathymetry line (dashed), Anvers Island (1), and Adelaide Island (2) are also shown.

Table 1. Overview of LTER cruise PD95-1

Date	Cruise day	Grid line	Station 600.040	Grid inshore	Grid HD	Picket line (km)			Multi	Bird Zodiac	Other information
						3.7	10	30			
January											
7	1	—	—	B2E	—	1	—	—	—	—	Targeted tows
8	2	500	—	—	—	—	—	—	—	—	500.060 to 500.100
9	3	500	—	—	—	—	—	—	—	—	500.120 to 500.200
10	4	600	—	—	—	—	—	—	—	—	600.200 to 600.140
11	5	600	*	—	—	—	—	—	—	*	600.120 to 600.040
12	6	—	—	B&E	—	1	1	—	—	*	
13	7	—	—	—	—	—	2	—	—	*	
14	8	—	—	—	HD1	—	—	—	—	—	10 km × 20 km (620.040×620.030×600.040×600.030)
15	9	—	*	—	HD2	—	—	—	—	—	10 km × 20 km (600.040×600.030×580.030×580.040)
16	10	600	*	—	—	—	—	—	—	—	600.080 to 600.040, 620.015
17	11	N	—	—	—	—	—	—	—	—	Inside north (Lamaire, 595.014, 585.010)
18	12	N	—	—	—	—	—	—	—	—	Inside north (575.010, 550.005, 530.005, 510.000)
19	13	—	—	B2J	—	3	—	—	—	—	
20	14	—	—	B&E	—	—	2	—	—	*	
21	15	—	—	—	—	—	—	4	—	—	600.06
22	16	—	*	—	HD1	—	—	—	—	—	10 km × 20 km (620.040×620.030×600.040×600.030)
23	17	—	—	—	HD3	—	—	—	—	—	20 km × 10 km (605.040×595.040×595.060×605.060)
24	18	—	—	B2J	—	—	—	—	—	—	Targeted tows
25	19	—	—	—	—	—	—	—	1	—	10 km to 100 km (615.045 to 525.063)
26	20	400	—	—	—	—	—	—	—	—	400.200 to 400.120
27	21	400	—	—	—	—	—	—	—	—	400.100 to 400.040
28	22	300	—	—	—	—	—	—	—	—	300.040 to 300.120
29	23	300	—	—	—	—	—	—	—	—	300.140 to 300.200
30	24	200	—	—	—	—	—	—	—	—	200.200 to 200.120
31	25	200	—	—	—	—	—	—	—	—	200.100 to 200.040
February											
1	26	200	—	—	—	—	—	—	—	—	200.020 to 200.000 + visit to Rothera
2	27	S	—	—	—	—	—	—	—	—	360.010, 380.010
3	28	S	—	—	—	—	—	—	—	—	Inside south (400.015, 420.015, 440.015)
4	29	S	—	—	—	—	—	—	—	—	Inside south
5	30	—	*	B&E	—	—	—	—	1	—	60 km to 10 km (564.055 to 663.120)
6	31	—	—	—	HD1	—	—	—	—	—	10 km × 20 km (620.040×620.030×600.040×600.030)
7	32	—	—	—	—	—	—	—	—	—	Arrive Palmer
8	33	—	—	—	—	—	—	—	—	—	At Palmer
9	34	—	—	—	—	—	—	—	—	—	Depart Palmer 1200
10	35	—	—	—	—	—	—	—	—	—	Arrive Copa 0800
11	36	—	—	—	—	—	—	—	—	—	
12	37	—	—	—	—	—	—	—	—	—	
13	38	—	—	—	—	—	—	—	—	—	Arrive Punta Arenas

and on-station seabird observations. A BOPS cast includes the following:

- optics [up- and downwelling spectral irradiance, upwelling spectral radiance, downwelling scalar irradiance, and photosynthetically available radiation (PAR)];
- hydrography [temperature, conductivity, depth (CTD)];
- beam-transmittance;
- stimulated chlorophyll fluorescence;

- oxygen; and
 - twelve 5-liter GoFlo rosette bottles for nutrients (nitrate, nitrite, orthophosphate, and silicate), microbial biomass, exoenzymes, dissolved organic carbon, hydrogen peroxide, dissolved inorganic carbon, dissolved-oxygen archeoplankton, phytoplankton pigments, and primary productivity.
- Between cardinal stations along track, beam transmittance was done, CTD and chlorophyll fluorescence measurements

Table 2. Summary of cruise PD95-1

Parameter	Number of events	Number of days per event	Number of days	Percentage of cruise time
Grid lines			11.5	37
Grid north/south			5	16
Grid inshore B2J	3	0.66	2	6
Grid inshore B&E	3	0.33	1	3
High-density grid	5	1	5	16
Picket line/3.7, 10, 30	7	0.33	2.2	7
Picket line/multi	2	1	2	6
Bird Zodiac observations	4	0.66	2.5	8
Weather days	0	0	0	0
Total	—	—	31.2	—

were made, and meteorological and seabird observations were carried out. In addition, expendable bathythermograph (XBT) and discrete chlorophyll samples were taken each 10 km.

The intensive penguin survey began with a combined *Polar Duke* and Zodiac Adélie penguin tracking routine (columns labeled "picket line" and "bird Zodiac" in table 1). Aboard the *Polar Duke*, semicircular tracks (referred to as "picket lines") centered on the Torgersen Island Adélie rookery, were run at increasing distances from Torgersen while continuous seabird observations were made to "vector," both direction and distance, foraging penguins (Smith et al., *Antarctic Journal*, in this issue). At the same time, two Zodiacs, equipped with bird observers and global positioning system (GPS) units, tracked groups of penguins departing nesting sites. Observers in the Zodiacs noted behavior and accurate locations of various Adélie activities using the portable GPS units.

Once likely foraging areas were identified by picket-line and Zodiac tracking, high-density ("grid HD" column in tables 1 and 2) sampling was carried out covering a 10-km × 20-km area (Quetin, Baker, et al., *Antarctic Journal*, in this issue). These sampling areas were composed of nine transects, each 10 km long separated by 2.5 km, and each transect was divided into 15-minute (2.5 km) segments. Seabird observations and simultaneous acoustic sounding for krill were recorded along each of these 36 segments; XBT measurements were made at 5-km intervals, and BOPS casts were made each 5.6 km along the diagonal of the sampled area.

Embedded within this cruise plan were two sets of repeatedly visited, nearshore stations (columns "station 600.040" and "grid inshore" in table 1). Station 600.040, over Palmer basin and common to the high-density foraging areas sampled, provided a record of change at this location over the cruise period. Stations within the Palmer nearshore grid, which are within a 3.2-km boating limit of Palmer station, were sampled weekly from October 1994 to March 1995 via Zodiac from Palmer and were sampled during PD95-1 to provide continuity to the seasonal nearshore time series.

Both satellite imagery and ship observations show that most of the LTER grid, outside the islands, was free of pack ice. Small (20–100-m) and medium (100–500-m) ice floes seemed especially abundant in some areas within the grid this year, and radar counts of these floes were noted in the log. Pigment biomass along the 600 grid line, characterized as the average chlorophyll to 30 m, was about 2 milligrams per cubic meter, which was roughly 30 percent higher pigment biomass than observed in either the January 1993 or the January 1994 cruises. This cruise was successful in that we had no bad weather days and so could sample all planned grid stations. The inshore Palmer stations were revisited frequently enough to provide continuity to the Palmer season time series, and the ship and station bird observations were closely coordinated on a daily basis.

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