Palmer Long-Term Ecological Research

Palmer LTER: Annual season October 1996 to March 1997

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The Palmer Long-Term Ecological Research (LTER) Program (Smith et al. 1995) completed a sixth season of sampling at Palmer Station. The Palmer LTER sampling strategy combines seasonal time series data from the nearshore Palmer grid and seabird observations from nesting sites near Palmer Station with annual cruises that cover a regional grid along the western Antarctic Peninsula. The LTER January cruise (*PD*97-1) visited the Palmer Basin inshore stations four times to provide continuity in the seasonal record (Ross and Baker, *Antarctic Journal*, in this issue).

A summary of events for the 1996–1997 Palmer field season is given in tables 1 and 2; table 1 gives the weekly standard sampling plan, which varied somewhat, and table 2 gives the season's sampling overview. An additional activity late in the season was excavation of penguin rookery sediments for local paleo studies (S. Emslie). Significant dates include

- arrival of research teams at Palmer (11 November 1996),
- first bird observations (13 October 1996),
- first chlorophyll sample (20 November 1996),
- first zodiac profiling cast (20 November 1996),
- first acoustic transect (22 November 1996),
- start of cruise (11 January 1997),
- end of cruise (13 February 1997),
- arrival of paleo team (3 March 1997),
- last profiling cast (18 March 1997),
- acoustic transect (21 March 1997),
- last LTER bird observation (16 April 1997),
- departure of water-column research teams from Palmer Station (4 April 1997), and
- bird and paleo departure from Palmer Station (17 April 1997).

In table 2, each line summarizes one cycle of standard sampling (from table 1). Initial event number, month begin, day begin, day end, and year are given in the first five columns. The sixth column summarizes the types of standard days included in this particular cycle, and a prime indicates a subset of that standard day. Acoustic transects, hydrographic and optical profiling, phytoplankton sampling, targeted krill tows for physiological condition, and instantaneous growth-rate experiments are given in the next columns followed by general comments.

Some changes in the sampling program were necessary from past seasons (Baker et al. 1996). With six LTER personnel for the 1996–1997 season (1/S016; 1/S032; 1/S028; 1/share; 2/S035) rather than 10 as in 1995–1996 (3/S016; 1.5/S032; 2.5/S028; 3/S035), the daily sampling week had to be reduced by

- sampling five stations instead of nine for weekly profiling hydro-bio-optics;
- sampling for phytoplankton twice weekly at two stations instead of four;
- conducting growth experiments every 2 weeks instead of weekly; and
- dropping krill collection by dives, standard tows, and phosphate measurements.

Further, only the sum of nitrite and nitrate were measured rather than the individual components. Nutrients taken on station at the start of the season were run concurrently with cruise samples when additional personnel were available. The hardware and software for high-performance liquid chromatography and nutrient analysis remained the same as last year. Equipment upgrades included addition of an anemometer for wind speed and a thermometer for air temperature on the zodiac Roze. Also this season, the satellite network link LES9 provided two blocks of approximately 5 hours of online time per day making possible FTP file transfer of data and real-time electronic communication. The data transfer served as both a method of data archive as well as the conduit enabling real-time data analysis at home institutions.

In addition to standard chlorophyll samples run in replicate for the greater than 0.45-micrometer (µm) phytoplankton at selected depths, the <20-µm fraction was sampled at the 50 percent light level [ranging from 2.5 meters (m) to 19 m]. Hydrographic profiles were also run as requested at station Janus (Karentz personal communication) and at the pier (Amos personal communication). Concurrent deployment with the stations' salinity-temperature-depth (STD) instrument will permit intercomparison studies.

During the 1996–1997 U.S. Antarctic Program season, there was no consolidated ice in September 1996. High winds throughout the month of October contributed to ice movement, and the last of the pack ice left on 29 October. Brash ice

Table 1. Palmer LTER 1996–1997 standard sampling: Water column and Adélie penguin

*NOTE: Standard sampling events include acoustics (bio-ac, Biosonics 120 KHz), discrete sample for chlorophyll analysis (chl), conductivity-temperature-depth (ctd, Seabird), high-performance liquid chromotography of phytoplankton pigments (hplc), instantaneous growth rate (igr), targeted tow for krill (krilltarg, Furuno 50 KHz), microscopic analysis of net plankton (net, >5 µm), inorganic nutrient analysis (nuts), photosynthetically active radiation (par), physiological condition (phycon), microscopic analysis of picoplankton (pico, 0.5–5.0 µm), particulate organic carbon (poc), production photosynthesis versus irradiance (Ppi), primary production simulated-*in-situ *(Psis), profiling radiometer (prr, BSI), discrete sample for salinity analysis (sal), transparent exopolymer particles (tep), and standard zooplankton tows (trwl). Station locations include aquatic inshore A through E within 3.2-kilometer (2-mile) limit of Palmer and islands Humble (Hu), Torgersen (To), Christine (Ch), Cormorant (Co), and Litchfield (Li).*

Date	Frequency	Location	Activity
Oct–Mar	Weekly	Palmer Basin	Zodiac: water column sampling
	Day 1	A to E	ROZE: bio-ac
	Day 1	E and B	ROZE: profile ctd, prr/flt, chlsf, salsf
	Day 1	E and B	LEGEND: profile par, hplc, nuts, poc, Ppi (1), Psis, tep, net, pico chlsf, salsf
	Day 1	BON, GAM	ROZE: chl, sals
	Day 2	—	LAB: conclude 24-hr experiments extract hplc and run prod
	Day 2	Area	RDUKE: krilltarg (50 KHz) for igr, phyconl
	Day 2	—	LAB: igr experiments (every 2 weeks)
	Day 3	—	LAB: chl, pigments, length freq
	Day 4	J to F	ROZE: bio-ac
	Day 4	E, J, and H	ROZE: profile ctd, prr/flt, chlsf, salsf
	Day 4	E and B	LEGEND: profile par, hplc, nuts, poc, Ppi, Psis, tep, net, pico chl, salt for S032
	Day 5	—	RDUKE: weather, krilltarg (if not day 2)
	Day 5	—	LAB: conclude 24-hr experiments (Pp) extract hplc and run prod
	Day 6	—	LAB: chl, analysis
		—	LAB: conclude igr experiments
01 Oct–15 Nov	Once/2 days	Hu	Arrival chronology of breeding adults
01 Oct–15 Mar	Daily	Hu, To	Adult overwinter Age-specific survival/recruitment
01 Oct–15 Mar	Weekly	Li, Ch, Co	Adult overwinter Age-specific survival/recruitment
15–30 Nov	Once/colony	Hu, To, Li, Ch, Co	Breeding population size
15 Nov–30 Jan	Daily	Hu, To	Adult breeding chronology and success (chicks creched per pair)
05 Jan–25 Feb	Once/5 days	To	Chick diet composition and meal size
05 Jan–25 Feb	Daily	Hu	Adult foraging trip duration
15–30 Jan	Once/colony	Hu, To, Li, Ch, Co	Chicks creched per colony
01–25 Feb	Once/2 days	Hu	Chick weights at fledging
15 Feb–25 Mar	Weekly/colony	Hu, To, Li, Ch, Co	Colony-specific breeding chronology

Table 2. Palmer LTER event log overview season 1996–1997

*NOTE: See table 1 for definition of standard sampling week. Events include acoustics (bio-ac, Biosonics 120 KHz), discrete sample for chlorophyll analysis (chl), conductivity-temperature-depth (ctd, Seabird), high performance liquid chromotography of phytoplankton pigments (hplc), instantaneous growth rate (igr), targeted tow for krill (krilltarg, 50 KHz), microscopic analysis of net plankton (net, >5 µm), inorganic nutrient analysis (nuts), photosynthetically active radiation (par), physiological condition larvae (phycon), microscopic analysis of picoplankton (pico, 0.5–5.0 µm), particulate organic carbon (poc), production photosynthesis versus irradiance (Ppi), primary production simulated-*in-situ *(Psis), profiling radiometer (prr, BSI), discrete sample for salinity analysis (sal), transparent exopolymer particles (tep), and standard zooplankton tows (trwl).*

Event number	Month	Day Begin	End	Year	Standard day	bio-ac	ctd/prr/ chl/sal	hplc/ nuts/poc	net Ppi	Psis	tep	krilltarg	phycon	igr	Comments
	11	11	20	96	Arrive										Arrive Palmer
1	11	20	21	96	1'2'			EB	E	EB	B				ctdfail; prr_flotation
25	11	22	23	96	123	AC	EB	EB	EB	EB	B	C	C	C	Brash AC
58	11	25	28	96	1345	AE;JF	EB;HJ;Js	EB	EB	EB	B				Krill CD&J-spume
101	12	2	8	96	12345	AC;JF	BE;dk;E;HJ	BE	BE	BE	B	J	J	J	Winds cancel
174	12	10	16	96	123456	AE;JK	EB;HJ;E	EB	EB	EB	B	D;SP;G;C; Csalp	C	C	Krill; heavy fog
251	12	17	19	96	14'2'3	AE;JF	EB;HJ	EB	EB	EB	B				
298	12	24	31	96	1243'5'6	AE;JF	EB;pier;E;HJ	EB	EB	EB	B	D;Dsalp;A	A	A	
376	1	2	7	97	123456	AE	EB;E;HJ	EB	EB	EB	B	No krill			
	1	11		97	Cruise										LTERJAN97 begin
445	1	16	7	97											Krill_feed_exps
	2	12	13	97	Cruise end							Dock			LTERJAN97 end
461	2	18	21	97	1'326			EB	EB	EB	B	Dock			High winds for JI bio-ac
485	2	24	28	97	1342'5	A;BE	EB;E;pier;E; HJ	EB	EB	EB	B				
554	3	3	7	97	123	AE;JF	EB	EB	EB	EB	B	E-A			
593	3	8	11	97	1'2'3'	A;C/ D;JF		EB	EB	EB	B	No krill			
622	3	12	16	97	12'4'6	JF	HJ;EB	EB	EB	EB	B	ArthH			
665	3	18	22	97	1234'6	AE;JF	EB	EB	EB	EB	B	3*C	C	C	Krill A-D
722	4	4	4	97	2'							SWI			Depart Palmer water colm
	4	14	14	97											Winter chl sampling begin
	4	17	17	97											Depart Palmer bird/paleo

continued to appear sporadically through April, accompanied by high winds. This pattern differed from that of 1995–1996 (Baker et al. 1996) when the spring and summer were preceded by a heavy-ice winter, and pack ice did not begin to clear from the nearshore Palmer region until November 1995. Preliminary data show seasonal progression in selected parameters through the spring and summer (figure), providing an overview of the season. The 1996–1997 season showed average to low chlorophyll biomass with initial surface phytoplankton blooms of 5–10 milligrams per cubic meter (mg m^{-3}) in November at station B and in December at station E. Chlorophyll concentrations remained below 1–3 mg m^{-3} through January, followed by another short bloom reaching 5 mg m^{-3} occurring in February 1997 at station E. The nitrate-nitrite showed less pronounced bloom activity this season compared with last season.

Between 22 November and 21 March, 14 acoustic transects were run from stations A to E (figure, block *C*), and 14 from F to J. Acoustic biomass in the spring and early summer was generally less than 100 grams per square meter (g m^{-2}), whereas from mid-January to mid-February acoustic biomass was between 100 and 500 g m^{-2}, decreasing to extremely low values in late February and early March. Length frequency distributions of antarctic krill collected with target tows indicated that age class 1 and 2 krill between 9 and 30 millimeters (mm) dominated the catch in the spring and early summer. Salps were abundant on the surface in late spring (mid- to late December) but did not exclude the krill. Some of the reproductive events associated with breeding chronology of Adélie penguins on Humble Island this season (Fraser et al. 1997) are noted by diamonds in the figure (block *C*). The breeding success of these penguins was 1.47 chicks creched per pair, repre-

senting a small decrease relative to last year.

The LTER seasonal observations of the marine environment, the lower-trophic level abundance and distributions for the area, and the seabird observations at nesting sites near Palmer were recorded from October 1996 to March 1997. The sampling event log, participant list, and other project information for the season are available online (*http://www.icess.ucsb.edu/lter*).

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References

Amos, T. 1997. Personal communication.

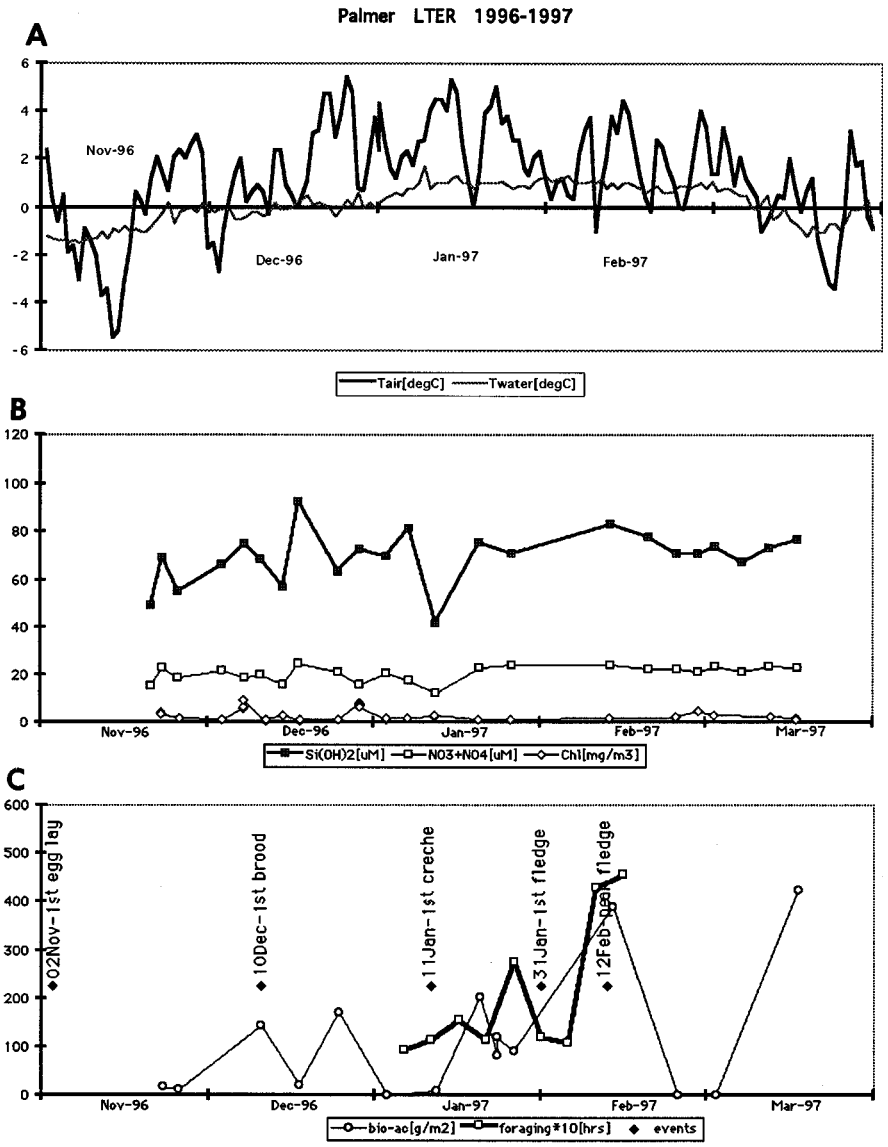
Baker, K.S., M. Vernet, W.A. Kozlowski, R.C. Smith, J.L. Jones, R.M. Ross, L.B. Quetin, and W.R. Fraser. 1996. Palmer LTER: Annual season October 1995 to March 1996. *Antarctic Journal of the U.S.*, 31(2), 160–162.

Fraser, W., D. Patterson, E. Holm, K. Carney, and J. Carlson. In press. Seabird research undertaken as part of the NMFS/AMLR ecosystem monitoring program at Palmer Station, 1996/97. In J. Martin (Ed.), *AMLR 1996/97 field season report: Objectives, accomplishments and tentative conclusions.* La Jolla, California: Southwest Fisheries Science Center.

Karentz, D. 1997. Personal communication.

Ross, R.M., and K.S. Baker. 1997. Palmer LTER: Annual January cruise for 1997 (*PD*97-1). *Antarctic Journal of the U.S.*, 32(5).

Smith, R.C., K.S. Baker, W.R. Fraser, E.E. Hofmann, D.M. Karl, J.M. Klinck, L.B. Quetin, B.B. Prézelin, R.M. Ross, W.Z. Trivelpiece, and M. Vernet. 1995. The Palmer LTER: A long-term ecological research program at Palmer Station, Antarctica. *Oceanography*, 8(3), 77–96.



A. Air temperature (in °C; solid line) and water temperature (in °C; boxes) at Palmer Station for the 1996–1997 season. *B.* Surface chlorophyll (in mg m^{-3}; filled diamonds), nitrate+nitrite (micromolar; open squares), and silicate (micromolar; filled squares) at station E for the 1996–1997 season. *C.* Krill abundance (in g m^{-2}; open circles) from transect A to E and Adélie penguin foraging (in hours; open squares). Diamonds indicate day of first egg laying, first brood, first creche, first fledging, and peak fledging at Humble Island for the 1996–1997 season.