Palmer LTER: Annual season sampling at Palmer Station, October 1998-April 1999

Karen S. Baker, Wendy A. Kozlowski, and Maria Vernet, *Marine Research Division, Scripps Institution of Oceanography, University of California at San Diego*

Karen W. Patterson, Langdon B. Quetin, Robin M. Ross, and Raymond C. Smith, *Institute for Computational Earth System Science and Marine Science Institute, University of California at Santa Barbara*

William R. Fraser, *Polar Oceans Research Group, Biology Department, Montana State University*

The Palmer Long-Term Ecological Research (LTER) Program (Smith et al., 1995) completed an eighth 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, LMG99-01 aboard the research ship *Laurence M. Gould*, visited the Palmer Basin inshore stations three times (8 January, 23 January, and 11 February) to provide continuity in the inshore seasonal record (Ross and Baker this issue).

The original station sampling plan (Smith et al 1996) was modified for the 1998-1999 Palmer field season to include a 3-4 day cycle of water column sampling largely at stations B & E and weekly or biweekly sampling for bioacoustics (table 1). Table 2 summarizes this season's sampling specifics.

Significant dates include arrival of first research teams at Palmer (01 October), first chlorophyll sample (16 October 1998), first zodiac profiling cast (21 October 1998), arrival of subsequent research teams at Palmer (10 November), first bird observations (10 December 1998), start of cruise (08 January 1999), end of cruise (12 February 1999), first station Bionomics acoustic transect (16 February 1999), last profiling cast (02 March 1999), last acoustic transect (06 March 1999), and last LTER bird observation in early April at Palmer Station.

Table 1. LTER Palmer 9899 planned sampling cycle: Water-column and Adélie penguin

Planned sampling events include acoustics (bio-ac, Furuno 50KHz and Biosonics 120 KHz), discrete sample for chlorophyll analysis (chl), total particulate absorption (Ap), detrital particulate absorption (Ad), dissolved organic matter absorption (Acdom), conductivity-temperature-depth (ctd, Seabird), high-performance liquid chromotography of phytoplankton pigments (hpic), instantaneous growth rate (igr), targeted tow for krill (krilltarg, Furuno 50 KHz), microscopic analysis of net plankton (net, >5um), inorganic nutirent analysis (nuts), photosynthetically active radiation (par), physiological condition (phycon), microscopic analysis of picoplankton (pico, 0-5-5. Ourn), particulate organic carbon and nitrogen (chn: poc, pon), production photosynthesis versus irradiance (Ppi), primary production simulated-in-situ (Psis), profiling visible radiometer/profiling ultraviolet radiometer (prr/puv, BSI) package, and transparent exopolymer particles (tep). 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
01 Oct-08 Jan			
14 Feb-13 Mar			
	Twice/week	Palmer Basin	Zodiac: water-column sampling
	Day1	E & B	ROZEJr: profile CTD, prr/puv
	Day 1	E & B	LEGEND: profile par, hplc, nuts, chn, Ppi (3, temp), Psis, tep, net, pico, rignet, Ap, Acdom
	Day 1	BON,GAM	LEGEND: chlsurf
	Day 1	–	LAB: filter samples, scan Acdom start 24h SIS experiments
	Day 2	–	LAB: scan Ap, start Ad extract, read chl conclude 24-hr prod experiments, conclude PI experiments, extract hplc
	Day 3	–	LAB: scan Ad, process CTD/PRR
	Twice/week	Area	SCUBA dive (when ice cover)
	Weekly	A to E & F to J	ROZE: bioacoustic transects (open water)
	Weekly	Area	ROZE: target tows krill (open water) (Total Length, phycon, igr)
	Biweekly	–	RDUKEI: krill growth 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 Nov-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-02 Feb	Once/5 days	To	Chick diet composition & meal size
05 Jan-25 Feb	Daily	Hu	Adult foraging trip duration
15 Jan-30 Jan	Once/colony	Hu, To, Li, Ch, Co	Chicks creched per colony
01 Feb-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. LTER Palmer Even Log Overview Season 1998-1999

See table 1 for definition of standard sampling days. Events include particulate absorption (Ap), dissolve organic material analysis (Acdom), acoustics (bio-ac, Furuno 50kHz and Biosonics 120kHz), discrete chlorophyll analysis (chl), conductivity-temperature-depth (ctd, Seabird), high-performance liquid chromotography of phytoplankton pigments (hplc), instantaneous growth rate (igr), target tow for kirl (krilltarg, 50kHz), microscopic analysis of net plankton (net, >5µm), inorganic nutrient analysis (nuts), photosynthetically active radiation (par), physiological condition larvae (phycon), microscopic analysis of picoplankton (pico, 0.5-5.0µm), particulate organic carbon and nitrogen (chn), production phyotosysnthesis versus irradiance (Ppi), primary production simulated-in-situ (Psis), profiling radiometer (prr&puv, BSI), transport exopolymer particles (tep), and SCUBA diving (dive). Operations take place at LTER stations A, B, E, F, J, Sea-water-intake (SWI), Palmer dock, and Hero Inlet.

Event no.	Month	Day		Year	Sampling day	bio-ac	ctd/prr/ puv/chl	Ap/ Acdom	hplc/ nuts/chn	net Ppi	Psis	tep	krilltarg	phycon	igr	Comments
		Beg	End													
1	10	1	–	98	–	–	–	–	–	–	–	–	–	–	–	Arrive Palmer
10	10	14	15	98	1	–	–	–	A	A	–	A	–	–	–	–
19	10	16	19	98	1234	–	–	B	B	B	B	B	–	–	–	–
39	10	20	23	98	1234	Ajanus	E,B	E,B	B,E,B	B,E	E,B	B,B	–	–	–	Furuno
82	10	24	25	98	12	–	–	–	SWI	SWI	–	–	–	–	–	–
90	10	26	28	98	123	DF,FJ	–	–	SWI	SWI	–	–	–	–	–	Furuno
100	10	29	1	98	1234	–	–	–	SWI	SWI	–	–	–	–	–	–
111	11	2	5	98	1234	–	E,B	E,B	SWI,E,B	SWI,E	E,B	B	–	–	–	–
151	11	6	8	98	123	–	–	–	SWI	–	–	–	–	–	–	–
160	11	9	11	98	124	–	–	–	SWI	–	–	–	–	–	–	–
168	11	12	15	98	1234	–	B	B	B	B	B	B	–	–	–	Dive1-5; ship *LM Gould*
190	11	16	18	98	123	–	–	SWI	–	–	–	–	–	–	–	–
204	11	19	21	98	123	–	–	SWI	–	–	–	–	–	–	–	Dive6:dock; Dive7:Hero

Event no.	Month	Day		Year	Sampling day	bio-ac	ctd/prr/ puv/chl	Ap/ Acdom	hplc/ nuts/chn	net Ppi	Psis	tep	krilltarg	phycon	igr	Comments
		Beg	End													
217	11	22	25	98	1234	–	B	B	B	B	B	B	–	–	–	–
239	11	26	27	98	12	–	–	–	SWI	SWI	–	–	–	–	–	Dive8:Hero
249	11	28	31	98	1234	–	B*	B*	C,B	B	B	B	–	–	–	–
274	12	1	3	98	123	–	–	–	SWI	SWI	–	–	–	–	–	–
283	12	4	6	98	123	–	–	–	SWI	SWI	–	–	–	–	–	Dive9:Hero
294	12	7	9	98	123	–	–	–	SWI	SWI	–	–	–	–	–	–
304	12	10	13	98	1234	–	–	–	B	–	–	B	–	–	–	Dive10:Hero
319	12	14	16	98	123	–	–	–	SWI	–	–	SWI	–	–	–	Dive11:Hero
332	12	17	18	98	12	EJ,EA	B,E	B,E	B,E	–	B	B	–	–	–	Dive12:Hero; Furuno
361	12	19	21	98	123	–	–	–	E	–	E	–	–	–	–	–
376	12	22	24	98	123	–	B	B	B,E	–	B,E	B	–	–	–	–
409	12	27	29	98	123	–	E,B*	E,B	E,B	–	E,B	B	–	–	–	–
442	12	30	1	99	123	–	E,B	E,B	E,B	E,B	E,B	B	–	–	–	–
477	1	2	2	99	1	–	E,B	E,B	E,B	E,B	E,B	B	–	–	–	–
	1	8	8	99	–	EA,FJ	–	–	–	–	–	–	–	–	–	LTERJAN99 begin; BioSonics
	1	23	23	99	–	EB,FJ, FJ	B,E	B,E	B,E	B,E	B,E	–	–	–	–	cruise; BioSonics
	2	11	11	99	–	JF	E,B	E,B	E,B	E,B	E,B	–	–	–	–	cruise; BioSonics
	2	12	12	99	–	EA	E,B	E,B	E,B	E,B	E,B	–	–	–	–	BioSonics; LTERJAN99 end
517	2	16	18	99	123	EA,FJ	E,B	–	E,B	E,B	E,B	B	–	–	–	BioSonics
549	2	19	21	99	123	FJ	E,B	–	E,B	E,B	E,B	B	–	–	Dip	BioSonics

Event no.	Month	Day		Year	Sampling day	bio-ac	ctd/prr/ puv/chl	Ap/ Acdom	hplc/ nuts/chn	net Ppi	Psis	tep	krilltarg	phycon	igr	Comments
		Beg	End												Net	
581	2	22	25	99	1234	–	E,B	–	E,B	E,B	E,B	B	–	–	–	–
612	2	26	1	99	1234	EA,FJ	E,B	E,B	E,B	E,B	E,B	B	–	–	–	BioSonics
649	3	2	4	99	123	EA	E,B	E,B	E,B	E,B	E,B	B	E	–	–	BioSonics; targ.tow salps
687	3	6	6	99	1	FJ	–	–	–	–	–	–	–	–	–	BioSonics

Each line in table 2 represents one cycle of planned sampling. Acoustic transects, hydrographic and optical profiling, absorption profiling phytoplankton sampling, targeted krill tows for physiological condition and instantaneous growth rate experiments are given in separate columns.

There were various changes from past seasons in the sampling program both due to limitations in time, personnel and scheduling as well as due to focus on specific new queries. With six to eight LTER personnel on station for the 1998-99 season (2 to 3/Vernet; 1 to 2/Smith; 0 to 2/Ross/Quetin; 1 to 2/Fraser), zodiac sampling included 2 stations per cycle instead of 4 for hydro-bio-optics and for phytoplankton. Water column sampling was usually performed between 1200 and 1400 GMT with 5 l go-flo bottles capturing samples at light depths of 100%, 60%, 30%, 10%, 5% and 1%.

Chlorophyll analysis on phytoplankton samples was run in replicate using 0.45 micron filters, and the >20 micron phytoplankton fraction was sampled at the 60% light level (ranging from 2.0 m to 7.5 m). Palmer station work with Turner Designs chlorophyll solid standards was part of an investigation into verification of methods for fluorometer calibration. There was a special focus this season on investigation of the water column absorption of particulate (Ap) and dissolved (Acdom) material with additional filtering performed for spectrophotometric analysis. Two optical instruments measuring visible and ultraviolet radiation (PRR and PUV) were packaged together with foam fins in order to permit simultaneous deployment from a zodiac in free-fall mode. The CTD calibration was carefully documented since no salts were run.

The hardware and software for HPLC analysis remained the same as last year, and samples up to and including the January cruise were analyzed during the month of January. Nutrient samples were shipped to the University of California Santa Barbara Analytic Facility for analysis. Core data collection for production (SIS) continued through the season, and water collection was increased in order to facilitate a study on temperature effects on production.

Due to ship scheduling and equipment issues, personnel for the LTER Palmer Krill Component were on station during two separate periods: November 10 – December 22 and February 14 - March 13. Spring pre-cruise ice conditions prohibited standard acoustic transects or target tows for krill.

During the 1998-1999 USAP season, ice remained in Arthur Harbor through November so samples were taken for analysis from the station seawater intake during this period. A one day window of opportunity on the research ship *Laurence M. Gould* on 12 November made it possible to sample at Station B during the period that Arthur Harbor was iced in. Very limited boating was possible until mid-December when sampling from zodiacs began on a regular basis. This local situation with ice contrasts with the Peninsula at large, which experienced below average ice. The peninsula's below average ice started the preceding winter and continued into the spring/summer. This ice development differs significantly with that of both the spring/summer of 1995-1996 and of 1997-1998, which were preceded by an above average winter of ice with pack ice, yet ice began to clear from the nearshore Palmer region in mid-November.

An overview of the season is provided by preliminary data showing seasonal

progression in selected parameters through the spring and summer (figure). The early part of the season surface water samples were taken both from the seawater intake as well as from shore at Bonaparte and Gammage Point. This alternate sampling continued through the season. The 1998-1999 season showed generally low chlorophyll biomass nearshore with small surface phytoplankton blooms of 5-10 mg/m3 beginning in November although values remained < 2 mg/m3 in December. The subsurface chlorophyll max was found between 5-10 m with an average value in December of 1.0 mg/m3. Absorption due to dissolved organic material of < 0.2 micron size was found near Palmer to be very low with an average absorption at 305 nm of 0.28 per m with values ranging from 0.23 per m to 0.46 per m at Stations B and E. Absorption increased when samples were taken in the presence of sea ice. In these circumstances, indications of the presence of ultraviolet protective pigments were also found.

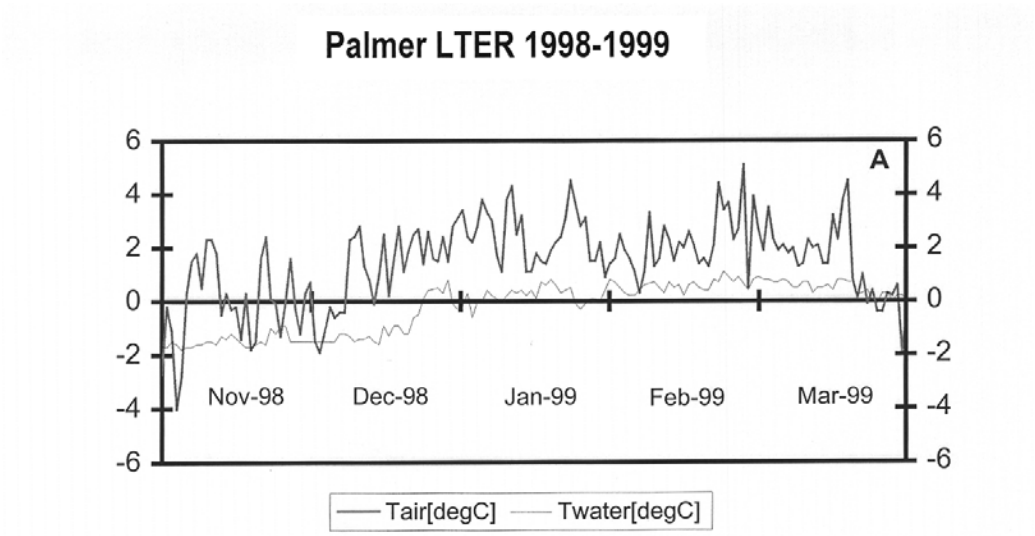

Figure 1a: Air temperature [degrees C] (heavy line) and water temperature [degrees C] (dashed line) at Palmer Station for the 1998-1999 season.

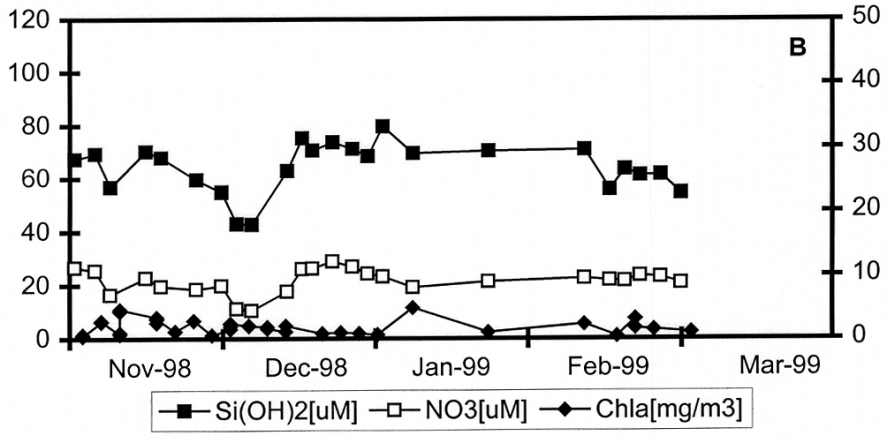

Figure 1b: Surface chlorophyll [mg/m3] (filled diamonds) with the scale to the right as well as nitrate [microMolar] (open squares) and silicate [microMolar] (filled squares) with the scale to the left for the 98 99 season at Station E in addition to Seawater intake samples when boating was closed due to ice in November-December time period.

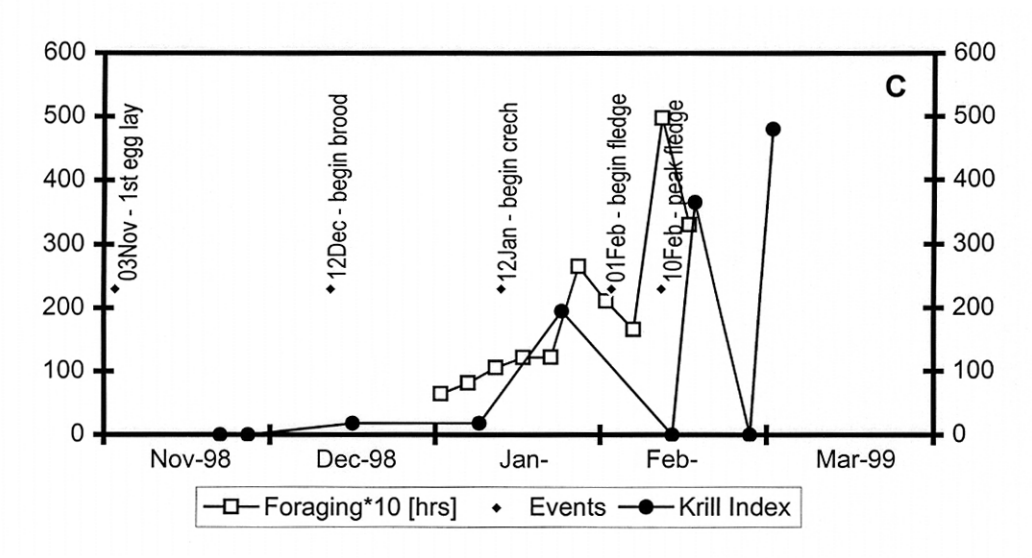

Figure 1c: Adélie penguin foraging [hours] (filled squares). Arrows indicate day of first egg laying, first brood, first creche, first fledging, and peak fledging at Humble Island for the 1998-1999 season. Also plotted is an "index" of krill biomass consisting of the areal extent of schools per km.

A total of 19 acoustic transects were conducted in the area near Palmer Station between 10 November 1998 and 12 March 1999, 9 between stations A and E, and 10 between stations F and J. As the data were collected, the depth and vertical dimensions (meters), the horizontal dimension in mm on the computer screen, and color of each aggregation were noted. The color is based on the density of acoustic biomass in the aggregation. An index of acoustic biomass was estimated from the dimensions and color data. Acoustic biomass was at undetectable levels in November and December 1998 during acoustic transects conducted with the Furuno echosounder (50 kHz). Transects were only possible on 3 days due to ice conditions. During 12 SCUBA dives under the ice, a few scattered individuals were seen, but aggregations of adult and larval krill were not observed. Acoustic biomass was still very low in early January, increasing in late January. Of the four transects conducted from mid-February to early March, no krill were found on two days, but large amounts on the two other days. In late February when krill were not found, many salp chains were seen floating at the surface.

Reproductive events associated with breeding chronology of Adélie penguins on Humble Island this season (Fraser et al. 1999) are noted by arrows in figure c. The Adélie penguin breeding population size, a measure of winter survival, decreased by 14.7% relative to the past season while the per-pair breeding success of these penguins dropped to 1.49 chicks creched per pair, or a decrease of 6.0% relative to the 1997-98 season. The decrease in breeding success of 0.09 chicks per pair is not statistically significant. Breeding chronology was slightly advanced relative to last year while mean fledging weights were unchanged.

The sampling event log, participant list and other project information for the season are available online (http://www.icess.ucsb.edu/lter). Acknowledgement and thanks are given to members of the Palmer LTER research team and of Antarctic Support

Associates. This material is based upon work supported by the National Science Foundation under Award No. OPP-9632763 with additional funding provided by the Regents at the University of California.

References

Fraser, W., D. Patterson, P. Duley, and M. Irinaga. 1999. Seabird research undertaken as part of the NMFS/AMLR ecosystem monitoring program at Palmer Station, 1998/99. In J. Martin (ed), *AMLR 1998-99 Field Season Report: Objectives, Accomplishments and Tentative Conclusions*. Southwest Fisheries Science Center.

Ross, R. and K.S. Baker. This issue. Palmer LTER: Annual January Cruise for 1999 (LMG99-01). *Antarctic Journal of the U.S.*

Smith, R.C., K.S. Baker, W.R. Fraser, E.E. Hofmann, D.M. Karl, J.M. Klinck, L.B. Quetin, B.B. Prezelin, 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.

Smith, R.C., J.L. Jones, L.B. Quetin, R.M. Ross, K.S. Baker, W.A. Kozlowski, M. Vernet, and W.R. Fraser. 1996. Palmer LTER: Annual Season Sampling on Station. *Antarctic Journal of the U.S.*, 31(2):164-166.