Palmer LTER: Observations in foraging areas of Adélie penguins during the January 1995 cruise

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One objective of the annual January LTER cruise is to characterize both the physical and biological nature of the foraging areas of Adélie penguins nesting near Palmer Station in order to examine the interaction between local prey availability and reproductive success. In January 1995, a "picket line" sampling strategy identified both the direction of travel and the distance of foraging trips of Adélie penguins leaving the Palmer area rookeries (Smith et al., *Antarctic Journal,* in this issue). Once the foraging areas had been located, a high-density sampling grid was run within these areas to characterize the physics, optics, chemistry, and biology within the foraging area.

Based on the results of the picket line and penguin tracking observations, three areas were determined as likely Adélie penguin foraging areas and selected for more intensive sampling (*see* Smith et al., *Antarctic Journal,* in this issue). The high-density (HD) sampling grids (HD grid 1, HD grid 2, HD grid 3) were 10 kilometers by 20 kilometers, with nine transects 2.5 kilometers apart. Each was covered at a ship speed of 4 knots during daylight of 1 day between 0600 and 2100 local time. Along-track, continuous measurements of surface salinity, temperature, chlorophyll-*a*, acoustic biomass (using a BioSonics 120 kHz transducer), and penguin numbers were recorded. The zooplankton biomass detected acoustically in this region is dominated in most years by antarctic krill, *Euphausia superba,* but also includes other euphausiids, salps, and shelled pteropods. At five stations on each grid BOPS (Bio-Optical Profiling System) was deployed to a maximum depth of 500 m to obtain hydrographic and optical data and water for chlorophyll-*a* and primary-production measurements.

The orientation of the grids and cruise track with respect to Palmer Station and the picket lines (Smith et al., *Antarctic*

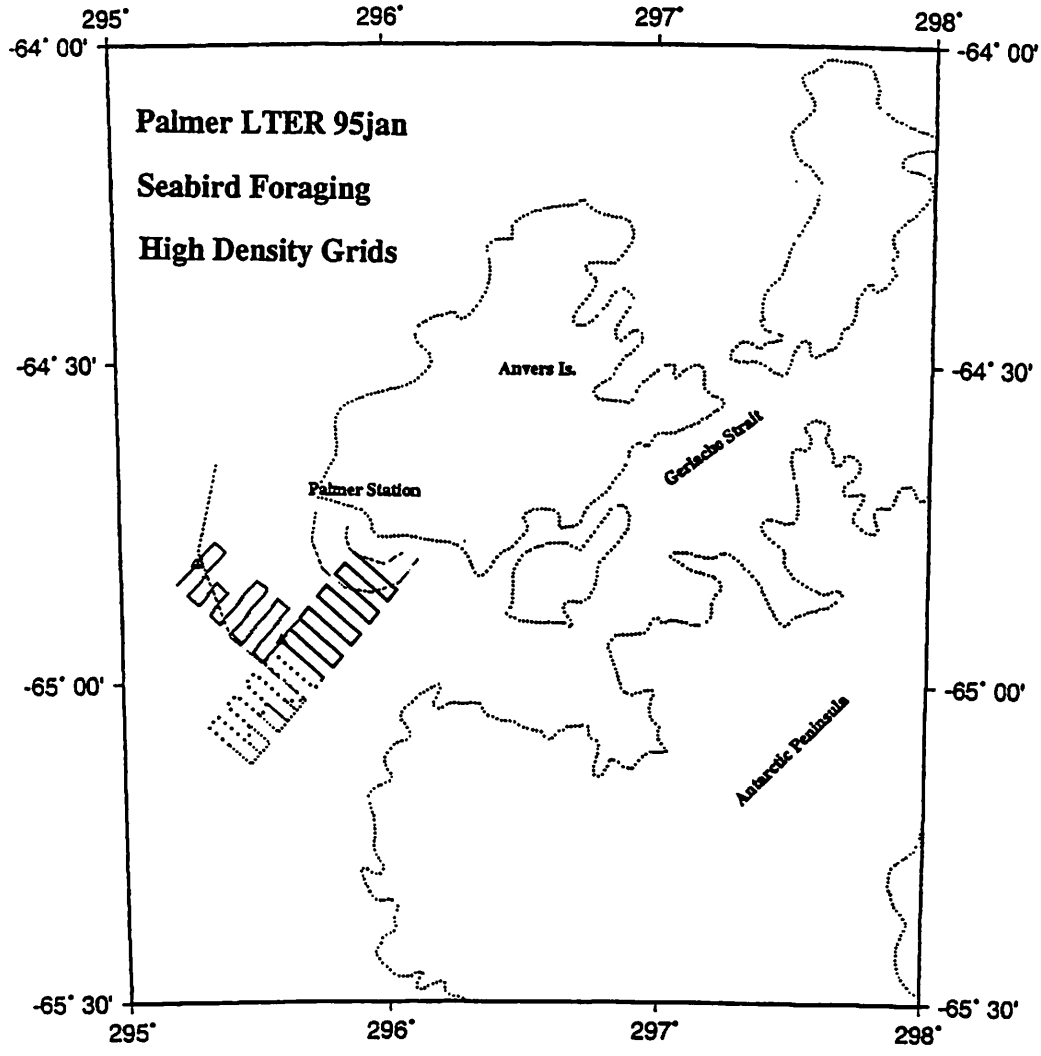

Figure 1. High-density grid (HD grid) locations with references to two stations on the mesoscale LTER grid (triangles located at 600.060 and 600.040; Waters and Smith 1992) and the picket lines (segments of circles made of small dots) surveyed on the cruise (Smith et al., *Antarctic Journal,* in this issue). HD grid 1, solid cruise track; HD grid 2, dotted cruise track; HD grid 3, shaded cruise track.

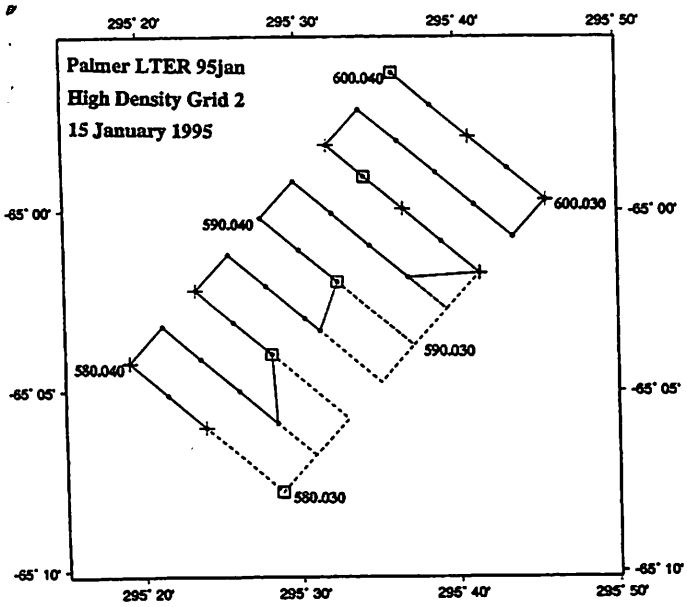

Figure 2. High-density grid 2 cruise track divided into 2.5 km segments with BOPS (squares) and XBT (Xs) locations. The solid and dashed lines are, respectively the R/V *Polar Duke* and Zodiac cruise tracks. Numbered stations are LTER grid references (Waters and Smith 1992).

Journal, in this issue) is shown in figure 1. HD grid 1 begins 3.7 km from Palmer Station and is contiguous with HD grid 2 to the southwest. HD grid 3 is at a right angle to HD grid 1 and HD grid 2, and it extends to the northwest. On HD grid 2, the cruise track of the R/V *Polar Duke* was modified to avoid the Myriad Islands. Calm weather during the sampling period, however, allowed a Zodiac excursion, following a global positioning system course, to complete the grid where it intersected the island group and record seabird observations not often obtained on oceanographic cruises in the Antarctic (figure 2). The cruise track of HD grid 3 also had to be modified to avoid Buff Island, but weather conditions prevented completion of the grid bird observations with a Zodiac (figure 1).

Each grid was surveyed once during the cruise and HD grid 1 was surveyed three times during the cruise (table). Both HD grid 2 and 3 were covered the day after HD grid 1. In a summary of the observations, some trends are apparent (table). For both HD grids 2 and 3, the normalized acoustic biomass was greater than in HD grid 1 the previous day. During the three surveys of HD grid 1, acoustic biomass increased by two orders of magnitude. Based on observations of swarm density and shape, this increase is likely caused by krill swarms moving into the area.

Normalized penguin counts followed a different pattern. Adélie penguin counts during HD grid 1b were double or greater than Adélie penguin counts from either HD grids 1a and 1c. These numbers suggest a change in the foraging pattern of penguins from the rookeries near Palmer Station, a change that may be related to the density of krill in the foraging area. The doubling in penguin numbers during HD grid 1b suggests either

- that both penguins for each nesting pair were simultaneously foraging rather than one, as is usually the case or
- that penguins foraging elsewhere temporarily moved into the area.

This period coincides with the time when most of the adult Adélie penguins abandoned the colonies near Palmer Station and went to sea to feed, leaving only a small portion of the adults to guard the chicks.

Temporally, total acoustic biomass does not follow the same pattern as chlorophyll-*a* and primary production. Total acoustic biomass continually increased in HD1 over the 3 weeks, whereas the highest values for chlorophyll-*a* and pri-

Adélie penguin counts, acoustic biomass, chlorophyll-a, and primary production in the foraging areas of Adélie penguins. (nd=no data.)

HD grid	Date (m/d/yr)	Distance of track (m)	Acoustic biomass[a]	Chlorophyll-a[b]	Integrated primary production[c]	Adélie count[d]	Normalized acoustic biomass[e]	Normalized Adélie counts[f]
HD1a	1/14/95	103,012	551	2.34	922	195	5.3	1.89
HD1b	1/22/95	106,651	9,822	2.97	2,730	529	92.1	4.96
HD1c	2/6/95	99,595	78,514	1.85	nd	268	788.3	2.69
HD2 Duke	1/15/95	89,730	6,202	1.43	704	223	69.1	2.49
HD2 Zodiac	1/15/95	31,000	nd	nd	nd	30	nd	0.97
HD3	1/23/95	93,406	24,528	1.95	329	216	262.6	2.31

[a]In kilograms per meter.
[b]In micrograms per liter.
[c]In milligrams of carbon per square meter per day.
[d]Number of individuals.
[e]In kilograms per meter per kilometer.
[f]Number of individuals per kilometer.

mary production were for HD1b. Primary production values are not available for HD1c.

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References

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