Palmer Station, Antarctica (PAL)

Palmer, Antarctica LTER joined the LTER Network of 17 existing sites in 1990, and was the initial Antarctic and the only marine pelagic site in the network until 2004 with the addition of the California Current Ecosystem (CCE). PAL is situated on the south coast of Anvers Island on the western Antarctic Peninsula. The site encompasses a larger region with several circumpolar pelagic habitats including the continental shelf within the marginal ice zone covered seasonally by sea ice and the open ocean beyond the continental shelf break as well as a nearshore zone influenced by glacial meltwater. Within the nearshore zone are small islands that have become deglaciated in the preceding decades. Penguin, Giant Petrel, Brown and South Polar Skua and other seabird colonies are found in the area along with mosses and 3 species of vascular plant. The nearshore waters abound in large marine mammals including Leopard, Fur, Crabeater and Weddell seals, Orca, Humpback and Minke whales. Antarctica, not ruled by any sovereign nation, is a continent dedicated to science. Palmer Station one of three United States bases operated by the National Science Foundation Office of Polar Programs through an outside contractor for logistic and science support, currently Raytheon Polar Services Corp. Palmer Station accommodates a maximum of 45 science and support personnel and hosts several independent science research projects in addition to the LTER. The site is normally accessed via a 4-day transit from Punta Arenas, Chile by ship. Palmer Station is occupied year-round, but most scientific activity is concentrated in the Austral spring and summer.

Research in PAL is organized around the coastal marine pelagic foodweb and includes seven components addressing climate, sea ice, physical oceanography, remote sensing, primary producers (phytoplankton and nutrients), microbial ecology and organic biogeochemistry, zooplankton and micronekton, seabirds, information management and outreach. The primary goals of PAL are to 1) understand the dynamics of the Antarctic marine ecosystem as it is forced by interannual variations in sea ice, 2) document and predict ecosystem responses to rapid climate change and 3) promote understanding of, and familiarity with the Antarctic environment, climate change and polar research generally. Focused on contemporary long-term data issues, infrastructure design, and mutual learning, information management and outreach efforts are integrated within the PAL research program.

Site Description and Characteristics: Palmer Station is located at 64.7ºS, 64.0ºW in the northeast corner of the PAL study region. The Palmer LTER site is defined by five oceanographic transect lines 100 km apart extending 250 km normal to the coast that run cross

shelf in a roughly southeast to northwest direction. These lines compose a 100,000 km^2 pelagic study area that includes gradients of ice cover and duration, depth (300 to 3500 meters), productivity and plankton community composition. The mean annual temperature averaged –1.7ºC during 2001-05 and is increasing at 0.5ºC per decade. The mean winter temperature (June-August) averaged –5.3ºC in the same period and is increasing by over 1ºC per decade, among the most rapid warming rates on the planet. The annual precipitation is about 400 mm.

The site is dominated by the seasonal advance and retreat of sea ice but with the regional warming, the ice duration is decreasing by about 30 days per decade. Currently the duration of ice cover in the region is about 215 days. The vernal retreat of the sea ice and increasing daylength stimulates large diatom blooms, first offshore along the shelfbreak in October, then proceeding coastward with nearshore blooms in December-February. During blooms primary production may exceed 3gC m^{-2} d^{-1}, as high as anywhere in the global ocean. The intense productivity concentrated in a 180-day growing season results in annual rates of 150-250 gC m^{2} a^{-1}, equivalent to moderately productive rates in the subtropical ocean gyres. The blooms support a rich fauna of seabirds and marine mammals, many of which include the Antarctic krill *Euphausia superba* as a main diet item. The local breeding population of the ice-obligate Adélie penguin, *Pygoscelis adeliae*, has declined by 75% since 1980 in response to climate warming. Subpolar Gentoo and Chinstrap penguins are now rapidly colonizing the area as the cold, dry continental polar climate is replaced by southerly migration of warmer, moister subpolar maritime conditions.

Research Focus: There are two PAL fieldwork components: nearshore/seasonal and regional/ annual. The nearshore work is designed to resolve seasonal scale variability with semiweekly sampling in the nearshore zone between November and March, synchronized with the Adélie breeding season. This work performed at Palmer Station includes local oceanographic sampling in the nearshore water column (depths 50-100 m) and bird observations on nearby island breeding sites as well as experimental studies in the laboratory focusing on rate measurements of bacteria, phytoplankton and krill metabolic and growth processes. We have manipulated snow accumulation using snow fences in penguin colonies to test the effects of snowfall on breeding success. Regional-scale sampling on the PAL Grid has been conducted every January (Austral summer) since 1993. The large-scale oceanographic survey occupies ~65 hydrographic stations across the continental shelf aboard ARSV Gould. A time-series sediment trap monitors water column carbon and nitrogen export in the midshelf region. The extensive, whole water-column survey data are aimed at documenting the response of the pelagic ecosystem to regional warming, and uncovering the mechanisms of the responses. To date major changes have been observed in penguin breeding success, and in penguin diets reflecting changes in prey species availability. There have also been changes in the size structure and taxonomic composition of the phytoplankton community.