LTER NETWORK NEWS

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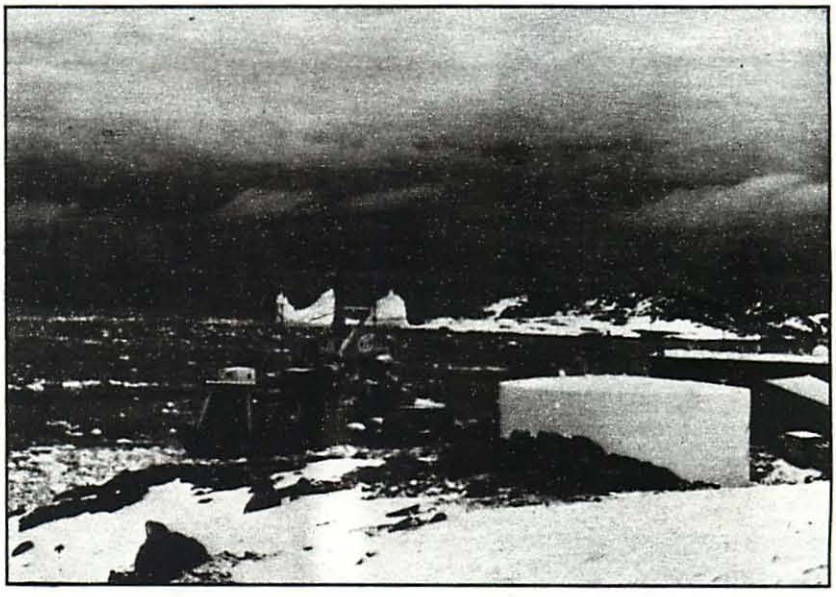
PALMER STATION

The Antarctic Marine LTER: An Ecosystem Dominated by Ice

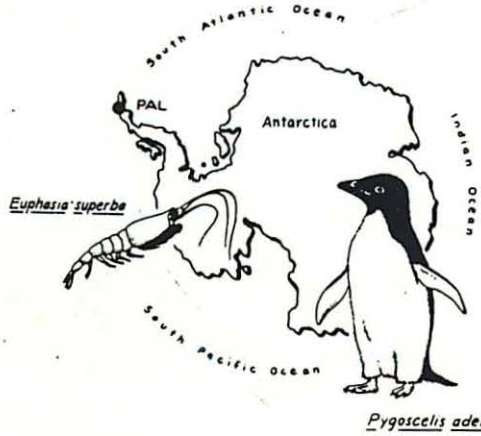
by Robin M. Ross & Langdon B. Quetin



ROBIN M. ROSS & LANGDON B. QUETIN

Palmer Station and the surrounding waters have been chosen as the site of the first Antarctic LTER. The smallest of the three U.S. antarctic research stations managed by NSF, the station is located in a protected harbor on an island midway down the Antarctic Peninsula, and more than 600 miles from the tip of South America. LTER research will focus on the pelagic marine ecosystem and the ecological processes which link the extent of annual pack ice to the biological dynamics of different trophic levels. In these polar waters the annual cycle of ice formation and melting affects about 50% of the open sea.

Because pack ice is postulated to be the major physical determinant of temporal/spatial changes in the structure and function of polar biota, interannual cycles and/or trends in the annual extent of pack ice are likely to have significant effects on all levels of the food web, from total annual primary production to breeding success in seabirds. For example, recent studies suggest a connection between the extent of winter sea ice and the winter-over survival or reproductive success of the seabirds and their prey. Both Adélie penguins and antarctic krill, the 35 to 50 mm-long crustacean which is their favored prey, are positively affected when ice cover is most extensive. Conversely, reproductive success in south polar skuas, gull-like migratory seabirds, appears to be connected to the abundance of one age group of the antarctic silverfish, which appears to improve with less extensive ice.



Site Characteristics

The climate is typically maritime Antarctic, with snow and rain common any time of the year. The temperature at Palmer Station is relatively mild, averaging about -10°C in July and 2°C in January. The extent of sea ice is highly variable in the region, with particularly severe ice conditions occurring roughly every seven to 10 years and lasting two to three years within the last two decades. The areal extent of ice can vary by 25% between years.

There are several groups of islands with seabird rookeries between Palmer Station and Palmer Basin, the only deep basin in the area. Species studies under LTER will include the Adélie penguin, which dominates the seabird assemblage, and south polar skuas. During the breeding season, they forage in the upper water column within a 100 km radius of the rookeries, moving southwest into the Basin and west into the open ocean. The summer foraging region and wintering grounds of the seabirds help define the scale of the region to be investigated.

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Palmer Station, Antarctic LTER

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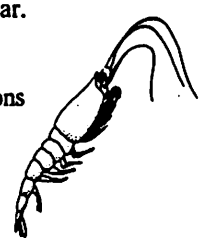
Overall Objectives

The overall objectives of the Antarctic Marine LTER are: (1) to document interannual variability in the development and extent of annual pack ice, and in life-history parameters of primary producers and populations of key species from different trophic levels; (2) to quantify the processes that underlie natural variation in these representative populations; (3) to construct models that link ecosystem processes to physical environmental variables, and that simulate the spatial/temporal relationships between representative populations; and (4) to employ such models to predict and validate the impacts of altered periodicities in the annual extent of pack ice on ecosystem dynamics.

Approach & Methodology

The general approach capitalizes on populations that are easily accessible near Palmer Station during a prolonged breeding season, and that sample the surrounding marine environment. Beginning in October 1991 (austral spring) a suite of critical biological and environmental variables will be monitored continuously on a small spatial scale (adjacent to Palmer Station) representing the seabird summer foraging area, but a long and recurrent temporal scale (every year, the entire breeding season).

Satellite imagery will be used to continuously monitor certain environmental parameters such as sea ice extent and thickness, sea surface temperature, and potentially color (fluorescence) on larger spatial scales and throughout the year. In addition, automatic weather stations at several selected positions in the regions will continuously monitor atmospheric pressure, wind speed and direction, and air temperature. Research at Palmer Station and in the surrounding nearshore waters will focus on the seabirds, the prey of the seabirds, primary production and hydrographic characteristics of the water column.



Processes (reproduction, recruitment) and parameters (food availability) that are sensitive to environmental change and are important in the structure and function of the communities will also be monitored. The inherent interan- nual variability in the extent of pack ice allows researchers to "conduct" natural experiments on the effects of pack ice on the various trophic levels as parameters and processes are monitored during and after seasons of different pack ice cover.

The spatial scale of sampling prey distribution, abundance, and physiological condition, water column properties, primary production estimates, and hydrographic measurements will be extended during two types of research cruise: (1) time-series cruises in the late spring; and (2) process-oriented cruises at critical times in biological cycles. These process-oriented cruises are essential for verification of the models of regional processes, such as primary production, oceanic circulation, and the biological/physical models of prey abundance.

Robin Ross or Langdon Quetin, Marine Science Institute, University of California, Santa Barbara, 98106, 805-893-2096, "rRoss@lternet.washington.edu" or "lQuetin@lternet.washington.edu".

Arctic LTER

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• **Terrestrial.** Plots of tussock tundra were fertilized with N and P beginning in 1980. Air temperature and light intensity were also manipulated on experimental plots by placing small greenhouses over the tundra. The greatest responses were seen on the fertilized plots. In the first three years the grasses and sedges responded most rapidly to the fertilization, while deciduous shrubs were able to take advantage of the increased nutrients only when air temperature was also increased. By year nine, the main component of the increased productivity in the fertilized plots was the dramatic increase in the slower-growing deciduous shrubs. Nutrient supply appears to be the primary control over net productivity and eventual composition of the community. Temperature, however, plays a major role in controlling the rate of change in community composition.

In 1989 the study was expanded to include dry heath and wet sedge areas. Results from these studies show that it may take years for ecosystem responses to appear.

Field Database

Communications at the Toolik Lake Station took a great step forward last summer with the addition of a satellite phone system that provides for voice communication as well as a computer link through the University of Alaska. This summer the Arctic LTER database will be available at the Toolik Research Camp, allowing resident scientists to quickly access data.

Contact Bernie Moller, Marine Biological Laboratory Ecosystem Center, Woods Hole, MA 02543, 508-548-3705, or "bMoller@lternet.washington.edu".