Long-term ecological research program

Palmer long-term ecological research (LTER): An overview of the 1991-1992 season

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Long-term ecological research (LTER) recognizes that some ecological phenomena occur on time scales of decades or centuries, and that investigations on these time scales are not routinely supported by funding agencies. Without an understanding of interannual variability over the long term, interpretation of ecological experiments and distinguishing long-term trends from cyclic changes in natural ecosystems are difficult. The LTER Network, sponsored by the National Science Foundation, has grown during the last decade to a total of 18 sites in ecosystems ranging from tall grass prairies to tundra. To facilitate comparison and the ability to construct ecological generalities, all sites are required to set up research efforts in five core areas:

(1) pattern and control of primary production;

(2) spatial and temporal distribution of populations representing trophic structures;

(3) pattern and control of organic matter accumulation;

(4) pattern of inorganic inputs and movements of nutrients; and

(5) pattern and frequency of disturbance to the research site.

The Palmer LTER, established in October of 1990, focuses on the pelagic marine ecosystem in the Antarctic, and the ecological processes which link the extent of annual pack ice to the biological dynamics of different trophic levels. Pack ice may be a major physical factor affecting the structure and function of polar biota. Interannual cycles and/or trends in the annual extent of pack ice are hypothesized to impact all levels of the food web, from total annual primary production to breeding success in seabirds. In the region around Palmer Station (64°40' S 64° W) west of the Antarctic Peninsula, the maximum extent of pack ice varies from near zero to halfway across Drake Passage (Quetin and Ross 1991), and appears to vary on a 6- to 8-year cycle. Satellite data on the maximum extent of pack ice in the Weddell Sea sector shows cold winters with heavy ice pack in 1973, and 1980 and 1981 (Zwally et al. 1983; Smith et al. 1988), and personal observations (Palmer Station personnel, Quetin and Ross) confirm that winters of 1980 and 1981, and 1986 and 1987, had heavy ice cover in the region around Palmer Station.

The overall objectives of the Palmer LTER are

(1) to document interannual variability in the development and extent of annual pack ice;

(2) to document interannual variability in life-history parameters of primary producers and populations of key species from different trophic levels, and to quantify the processes underlying this natural variation;

(3) to construct models that

- Link the ecosystem processes to the physical environmental variables,
- Simulate the spatial/temporal relationships between representative populations, and
- Predict and validate the impacts of altered periodicities in the annual extent of pack ice on ecosystem dynamics.

The Palmer LTER is presently composed of five components led by principal investigators from two universities (see table). Each year the core LTER measurements will include results from a sampling program based at Palmer Station throughout the austral spring and summer, and an annual cruise covering a mesoscale study region of about 400 kilometers by 200 kilometers. Two cruises are planned for the austral fall and austral spring of 1993 to define the temporal/spatial variability in biological, chemical, optical, and physical characteristics of the mesoscale study region, and to study processes underlying the interactions between ice cover and the marine ecosystem.

Some preliminary results from the first field season are presented in accompanying articles in this series. During our first season the Palmer LTER staged two major research efforts: an austral spring cruise on the R/V *Polar Duke* from 7 to 21 November 1991, and a nearshore monitoring and experimental program centered at Palmer Station from 15 October 1991 to 7 March 1992.

Components of the Palmer LTER

Research area	Principal investigator(s)
Remote sensing, climatology, environmental optics, hydrography, and bio-optical modeling of primary production	Ray Smith (Department of Geography, University of California at Santa Barbara)
Phytoplankton and inorganic nutrient dynamics; photosynthetic regulation of bio-optical modeling of primary production	Barbara Prezelin (Department of Biological Sciences, University of California at Santa Barbara)
Distribution, abundance and ecological physiology of secondary producers; biological/physical modeling	Robin Ross and Langon Quetin (Marine Science Institute, University of California at Santa Barbara)
Seabird population dynamics and reproductive ecology; population modeling	William Fraser and Wayne Trivelpiece (Center for Coastal Physical Oceanography, Old Dominion University)
Oceanic circulation, biological/physical and population modeling	Eileen Hofmann and John Klinck (Center for Coastal Physical Oceanography, Old Dominion University)

During the austral spring cruise, mesoscale variability of hydrographic and optical characteristics of the water column, phytoplankton biomass, photosynthetic potential and community composition, and distribution, abundance, and physiological condition of selected secondary producers (particularly antarctic krill, *Euphausia superba*) was successfully documented (Dallmann Bay, Palmer Basin, and Renaud transect lines, Waters and Smith). Heavy ice cover and westerly winds locked the ship in ice a few miles from Palmer Station for the first 4 days of the cruise, and also prevented the ship from occupying the inshore stations on both the Palmer Basin and Renaud lines.

The annual nearshore program (within 2 nautical miles of the station) includes research on the hydrography, chemistry, and biology of waters surrounding Palmer Station, and the population dynamics and ecology of Adélie penguins and south polar skuas that nest on nearby islands. This year heavy ice cover in early spring made Zodiac operations difficult, slowing some aspects of the nearshore research program, although scuba divers successfully collected young antarctic krill from under the ice for assays of physiological condition. Once Arthur Harbor cleared of pack ice in early December, access to the seabird colonies improved, and weekly surveys of the nearshore waters with well-equipped Zodiacs (transects in Waters and Smith) began. To add essential information to the Palmer LTER long-term data base, an automatic weather station was installed on the end of Bonaparte Point to the southeast of Palmer Station. Additional automatic weather stations will be installed at locations throughout the mesoscale study region as funding and logistical support permits.

This work was supported by National Science Foundation grant DPP 90-901127, and is Palmer LTER Publication No. 3.

References

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