LTER NETWORK NEWS

Newsletter of the Long-Term Ecological Research Network Issue 18, Fall/Winter 1995-6

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Editor: Stephanie Martin

McMURDO DRY VALLEYS

An Overview of 1993-1995 Research Activities

Robert Wharton, Jr.

The McMurdo Dry Valleys LTER site is far colder and drier than any of the 17 other established LTER sites. The perennially ice-covered lakes, ephemeral streams, and extensive areas of soil within the valleys are subject to low temperatures, limited precipitation, and salt accumulation. In the LTER continuum of ecosystems, the dry valleys
represent "end-member" environments which contain microbially dominated ecosystems. An important aspect of the McMurdo LTER (MCM) research is its potential contribution to general ecological understanding through
studies of processes that may be better resolved in these relatively simplified ecosystems. The two key hypotheses addressed are: 1) The structure and function of the Taylor Valley ecosystems are differentially constrained by physical and biological factors, and 2) The structure and function of Taylor Valley ecosystems are modified by material transport.

The McMurdo LTER is addressing these hypotheses and the five LTER core research areas through a program of systematic environmental data collection, long-term experiments, and model development. Research activities encompass several disciplines, including physical, chemical, biological, modeling and information science. During the first six years of the project, MCM is focusing its efforts on Taylor Valley.

The 1993-95 Field Seasons
The McMurdo LTER project has successfully completed two field seasons (October through February) during 1993-94 and 1994-95. During the 1993-94 field season, 18 scientists deployed to McMurdo Station and Taylor Valley to conduct research associated with the LTER project. These scientists initiated core measurement programs to obtain baseline
ecologically-relevant data from the atmosphere, glaciers, streams, soils and lakes. During the 1994-95

field season, 26 LTER scientists visited the dry valleys to continue the core measurements and research program. One of the first objectives of the MCM was to establish a meteorological network that would gather representative weather data year-round from the dry valleys. The McMurdo LTER Automatic Weather Network (LAWN) currently consists of nine stations with two new stations planned for deployment during the 1995-96 field season. Stations are now operational at
Explorer's Cove, on the shores of lakes Fryxell, Hoare, Bonney, Brownworth and Vanda, and on the Commonwealth, Howard and Taylor glaciers. The new stations to be deployed are on the shore of Lake Vida and the surface of the Canada Glacier.

Since the McMurdo Dry Valleys lacks significant precipitation, glacier meltwater is the primary source of water to the streams and lakes. In addition to recharging the lakes, this water carries dissolved gases and solutes. A major objective of the LTER glaciological program is to determine the mass balance and meltwater runoff of the glaciers in Taylor
Valley that contribute water to the lakes. During the 1993-94 field season, the project established a network of surface-based measurements on the Commonwealth, Canada, and Howard glaciers to determine mass balance and meltwater flow. The following season, LTER scientists measured the major contributions to the surface energy budget of the Canada Glacier in Taylor Valley. Their measurements and modeling of glacier energy fluxes in Taylor Valley are comparable to other regions of the Antarctic. They conclude that the role of sublimation in the mass balance of dry valley glaciers is significant.

Soils in the dry valleys are influenced by a variety of factors including climate, glacial movement, parent material and site characteristics. In Taylor Valley, the oldest soils are found at higher elevations while those at lower elevations were probably deposited during relatively recent glacial activity. During the 1993-94 field season, LTER scientists
established an elevational transect on the south shore of Lake Hoare to examine spatial variation in soil properties and nematode abundance. Using observations and samples collected during 1994-95, it appears that the distribution of nematodes in the dry valleys may be governed by pH and concentration of soluble salts.

Numerous ephemeral streams link the glaciers and lakes within the dry valleys for six to ten weeks during the austral summer. These glacial meltwater streams recharge the dry valley lakes, are important sources of nutrients, and support the growth of moss and microbial mat communities. The McMurdo LTER now has in place an extensive network of gauging stations where stream flow is measured continuously throughout the austral summer. During the first two field seasons, LTER scientists focused efforts on determining the influence of stream channel characteristics on stream flow
and annual water budgets for lakes in Taylor Valley. Their results show that there is interannual variation in relative flow, even among streams where stream length and location in the basin are similar. They also found that longer streams have generally higher concentrations of major ions due to greater interaction with the hyporheic zone. In parallel studies, LTER scientists have examined the role of stream gradient, sediment transport, and substrate stability on the distribution of mosses and microbial mats in streams. Results show that the range in abundance of algae and mosses
appears to be controlled by gradient and flow conditions.

Lakes Program

The McMurdo LTER lakes program is focused on understanding the environmental conditions and ecological processes of former and present lakes in the dry valleys. The perennially ice-covered lakes support both phytoplankton and benthic microbial communities. The chemistry of each lake profoundly effects the biota within the lake. The LTER project is collecting major element and nutrient chemistry for lakes Fryxell, Hoare and Bonney in Taylor Valley at least three times per field season. One early result of this effort shows that the depth profiles of K^+, Mg^{2+}, Na^+ and SO_4^{2+} normalized to the conservative ion Cl^- are extremely different among the lakes. Project scientists suggest that these differences cannot be explained by differences in current solute sources or in-lake biogeochemical processes. It appears that the climatological and hydrological histories of each lake need to be closely studied before definitive statements can be made about the overall geochemical evolution of the Taylor Valley lakes.

The LTER lakes project is also investigating phytoplankton nutrient deficiencies. Early results show that the nutrient concentrations are quite different among lakes Fryxell, Hoare, and Bonney (both lobes), as well as vertically within lakes, and suggest that phytoplankton biomass within a lake and levels of productivity between lakes are strongly
related to the upward flux of dissolved inorganic nitrogen from deep water pools.

In a study of the benthic cyanobacterial mats in Lake Hoare during the 1994-95 field season, LTER scientists determined photosynthesis versus photon flux curves, the absorption spectra of the mats, and biomass mats from a range of depths. Preliminary results show that the benthic mats are light limited and that there is a decrease in mat biomass with depth in the lake. LTER scientists have developed a mathematical model that simulates the productivity patterns of benthic microbial mats as a function of light intensity.

The McMurdo LTER is an explicitly synthetic effort--a comprehensive, multidisciplinary ecosystem study. Much of the data collected is being incorporated into a geographic information system (GIS) for data management and spatial analysis. LTER scientists have developed a GIS for Taylor Valley which now includes a number of thematic coverages. These include: base map, control points, topography, soils, geomorphology, lakes (with and without bathymetry, drill holes), glaciers (including stake locations), Taylor Valley drainage basin, streams (reach, transects, catchment area), and a coverage of station sites (met, melt holes, stream gauges, stream and soil transects, geodetic control points).

The 1995-1996 Field Season

The McMurdo LTER project is currently conducting its third field season, with 27 scientists scheduled for deployment to the site to continue its program of systematic environmental data collection and long-term experiments. One important new focus for the 1995-96 field season is data collection during the austral winter and spring. In late August 1995,
LTER scientists began field activities focused on the changes in lake chemistry and biology during the transition between total winter darkness and the return of light in the spring.

Growing rapidly in size as well as visibility, the project has expanded to include wider student and scientist participation, now involving several undergraduate and graduate students and three postdoctoral positions. This September, MCM welcomed Dr. Valery Galchenko, Russian Academy of Sciences Institute of Microbiology, Moscow, who will be studying biogeochemistry of benthic communities in the lakes. Data Manager Jordan Hastings, currently teaching Computer Science classes at the University of Nevada-Reno, has implemented the Taylor Valley GIS and
takes classtime opportunities to introduce the project to student volunteers for hands-on experience. The McMurdo maintains an ftp server which provides public access to datasets collected, and is developing an on-line Internet presenceÑthe site bibliography was recently added to the LTER All-Site Bibliography at LTERnet.edu.

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PALMER STATION

The impact of sea ice on the structure and function of a pelagic marine ecosystem
By Robin Ross & Langdon Quetin

The Palmer LTER (PAL) was established in late 1990 and focuses on the pelagic marine ecosystem west of the Antarctic Peninsula. Although the Palmer LTER is the only fully marine (from coastal to pelagic) site in the
LTER Network, it shares with other sites the unifying hypothesis that physical factors control the biology of the system. The general hypothesis for PAL is that the annual advance and retreat of sea ice is a major physical factor governing the structure and function of this ecosystem, and the variability seen at all levels of the food web. A key challenge is
to characterize and understand the linkages among the different spatial and temporal scales of the various physical (solar radiation, atmospheric and oceanographic circulation, and sea ice coverage) and biological components (key predators, secondary and primary consumers and microbial loop) of the Antarctic ecosystem.

The PAL study region surrounds Palmer Station (64 degrees 40'S, 64 degrees 03'W), located in a protected harbor on the southwest side of Anvers Island midway down the Antarctic Peninsula. To structure long-term regional observations, a sampling grid along the west coast of the peninsula (see figure, next page) was created which reflects the scale of atmospheric, oceanic and sea ice interactions with populations in the marine ecosystem. Within the large-scale grid are embedded smaller-scale grids encompassing the foraging ranges of the predators (seabirds) nesting
near Palmer Station and where time series data can be obtained throughout the season. The following are routinely sampled within the LTER sampling grids: sea ice, in situ bio-optical water properties, temperature and salinity (conductivity), photosynthetic pigments, macro-nutrient concentrations, phyto-plankton and bacterio-plankton production, secondary production, sedimentation and seabird ecology.

Spatial sampling has included annual and seasonal cruises covering most portions of the large scale grid and temporal sampling has included at least weekly observations in the vicinity of Palmer Station.

Climatology

Several factors make the Palmer LTER study region ideally sited for investigations of the response of polar ecosystems to global change: a historical climate record, a strong response to climate change, a persistent pattern of sea ice and temperature anomalies, and a northern area intermittently covered and a southern area consistently covered every
winter by sea ice. Although by standards in the northern hemisphere the climate record in the Antarctic is relatively short, scattered expedition records for the region west of the Antarctic Peninsula start in the early 1900s and predate the consistent, quality-controlled records of the British Antarctic Survey from the mid-1940s. There is a statistically
significant warming trend in this region over the past 45 years which is larger than elsewhere in the Antarctic. Winter temperatures show the strongest warming trend, with a 5.5 degree C increase in June (winter) temperatures over the 48-year record. Within the long-term record, air temperature at Faraday, a former British station only 40 km from Palmer, and the Southern Oscillation Index (SOI) show significant coherence.

Combined with the anticorrelation between temperature and sea-ice coverage, this supports the possibility for a coherence between LTER ice extent and SOI. Since the El Nino/Southern Oscillation phenomenon is a large-scale source of climate variability, understanding this linkage is of considerable importance for the global connections of the Palmer LTER to the Southern Hemisphere. While there are complex linkages between cyclonic activity, air temperature and sea ice which have yet to be elucidated, observations to date suggest that the western Antarctic Peninsula may be an area which is especially sensitive to greenhouse-gas warming.

In the Palmer LTER region, both air temperature and sea-ice extent show persistent anomalies which appear as consecutive high ice/low temperature years followed by consecutive low ice/high temperature years. These
anomalies appear to impact the survival rates, distributions and life histories of a number of dominant species in the pelagic marine ecosystem. High interannual variability in these physical factors provides a study site where "natural" experiments will test the sensitivity of ecological processes to climate variability and change.

Highlights from Recent Research

The interaction between the Adelie penguin and its primary prey, Antarctic krill, provides an example of research across variable space/time scales associated with the Palmer LTER. During the past three summers, we have
conducted investigations (making use of both ship and shore based observations) during a critical period of chick rearing of the relationship between prey availability and penguin at-sea foraging behavior, and the reproductive ecology of the Adelies nesting in the nearby rookeries. During this critical period, prey biomass has varied by more than an order of magnitude, with parallel changes in foraging duration and adult behavior necessary to feed the chick(s). Two

interactive possibilities exist to explain this variability in krill availability, variability in recruitment leading to decreases in the stock, and/or shifts in population distributions linked to changes in atmospheric and oceanic circulation. Factors that affect the population dynamics and distribution of krill populations on the mesoscale and over
its seven-year life span affect prey availability on small time (critical period during chick rearing) and space (foraging range) scales for the Adelies. Prey availability in turn impacts reproductive success in the Adelies that season. Krill recruitment success has been highly variable in the Palmer LTER region, and is strongly correlated with the timing and
magnitude of winter ice, a physical factor operating on regional scales.

Primary production and phytoplankton standing stock also vary on several time and space scales. Temporal observations in the nearshore Palmer grid over the production season and spatial observations in the larger
regional grid during a restricted period show strong seasonal and interannual variability. The two seasons following winters with high ice coverage developed overall phytoplankton biomass during bloom periods five times greater than two other seasons, on both the fine- and regional scale grids. On/offshore gradients were present in all years, and there
is evidence that this gradient is modulated alongshore by latitudinal variability and the annual advance and retreat of sea ice.

Results from the first four field seasons support the hypothesis that interannual variability in physical factors such as sea ice impact all levels of the ecosystem and that this provides the Palmer LTER with the means to investigate the impact of these physical factors on the structure and function of the pelagic marine ecosystem.

For more information see the PAL web site at
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INSTITUTE OF NORTHERN FORESTRY TO CLOSE

By Les Viereck, Bonanza Creek LTER
Last month, the director of the U.S. Forest Service Pacific Northwest (PNW) Experiment Station announced that the Institute of Northern Forestry (INF) in Fairbanks, Alaska will be permanently closed as a result of Forest Service budget cuts in FY '96. All permanent employees at the Institute received letters on September 7 stating that their
positions were abolished. The Forest Service estimates that it will take from four to six months to completely close the Institute and building.

The closure announcement came as a surprise to LTER investigators at INF: they had believed that the December 1995 Memorandum of Understanding between the Forest Service (FS) and NSF pledging cooperation in the LTER Program would insure that the FS research being carried out as part of the Bonanza Creek Experimental Forest LTER would be continued. The Bonanza Creek site is one of five LTER sites located in FS Experimental Forests (others are Hubbard Brook, Coweeta, Luquillo and H.J. Andrews).

The INF has been an active partner with the University of Alaska in the Bonanza Creek LTER program (BNZ) and Les Viereck, Principal Plant Ecologist at INF, has served as BNZ co-principal investigator for the past six years. The INF was first established on the campus of the University of Alaska Fairbanks (UAF) in 1963. At the peak of its operation in the early 1980s, there were 13 scientists and an equal number of supporting staff. The Institute has been the principal federal research laboratory in the United States devoted to research in the Northern Boreal Forest. Since the mid-1980s, INF has seen a continued decline in its budget and a continued erosion of scientists and programs. There are presently six scientists, three permanent technicians, several seasonal technicians, and a support staff of three at the Institute.

Scientists at INF have been active in the BNZ program since it was established in 1987. In addition to several research projects, Institute personnel have been responsible for the management and operation of the two research areas associated with the BNZ; Bonanza Creek Experimental Forest and Caribou-Poker Creek Research Watershed. They have also maintained the associated climate and vegetation monitoring. Three scientists and three technicians presently devote a large share of their time to the program.

At press time, Hermann Gucinski, PNW Program Manager for the Ecosystems Processes Program, was working on a Memorandum of Agreement between PNW and UAF to establish a Forest Research Cooperative Unit on the Fairbanks
campus. This unit would contain two FS scientists and would preserve the FS commitment to the LTER program, provide for some continuity in the FS role in the program, and support continued operation of the two LTER research sites.

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NEW BRIDGE AT CARIBOU-POKER CREEKS WATERSHED

By Les Viereck

Access to the Caribou-Poker Creeks Research Watershed (CPCRW) became easier this summer with the construction of a new bridge across the Chatanika River. Since the establishment of CPCRW, one of the two research sites of the Bonanza Creek LTER program (BNZ) in the Alaska boreal forest, getting researchers into the site had been a major
problem. In summer, vehicle access was limited to fording the Chatanika River or by a long and arduous four-wheeler trail over Haystack Mountain.

In periods of high water and during break-up and freeze-up, individual researchersÕ only access across the river was via a 50-meter-long cable strung between a tree on each bank. Researchers rode in a basket, hung beneath the cable on a pulley, and pulled themselves to the other side. In winter, access was by snow machine across the frozen river.

All of that changed in July 1995 when, through the efforts of the U.S. Forest ServiceÕs Pacific Northwest station and the U.S. Army Cold Regions Research Laboratory (CRREL), a bridge was constructed across the Chatanika River. The successful completion of the bridge project is the Army units guarding the construction site. The completed bridge will
remain the property and responsibility of CRREL, an agency with many long-term research projects in the research watershed. Ironically, the completion and dedication of the bridge occurred during the same week that PNW administrators were in Fairbanks announcing that the Institute of Northern Forestry would be closed due to recent Forest Service budget cuts. Fortunately, the bridge was completed before this closure and is now available to LTER and other researchers, making access to their research sites much easier on a year-round basis.

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EXPERIMENTAL TREATMENT AT COWEETA RIPARIAN SITE

By Brian D. Kloeppel
On August 29, 1995, the long-awaited removal of the heavy rhododendron subcanopy was conducted on a riparian site at the Coweeta LTER site in North Carolina. This experiment will be used to assess the functional role that Rhododendron maximum L. plays on the hydrological, nutrient, and light components of riparian sites in the Southern Appalachians. The area occupied by rhododendron in this region continues to increase over time and is expected to play a large role as a link between terrestrial and aquatic ecosystems. The removal treatment was preceded with more than
two years of baseline data collection in both control and treatment plots and will be followed by at least two years of post-treatment data collection.

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McMURDO DRY VALLEYS BEGINS SOLA PROJECT
Working in the Antarctic environment poses numerous challenges, but also provides unique

opportunities. One critical opportunity for the McMurdo LTER (MCM) is organizing and providing access to the site's Data and Information (D&I) resources across an international community of 50-plus project scientists, colleagues and students working at one of the most remote field stations on Earth. There is a high level of public interest in Antarctic projects in general and the anomalous, exotic Dry Valleys area in particular.

The MCM grant proposal was written with the intention that, to the largest extent possible, the project's D&I resources would be integrated and displayed interactively via a Geographic Information System (GIS) operating across the global Internet. In ways which could barely have been imagined five years ago when the proposal was in preparation, both
D&I management and GIS technologies have advanced to make this goal feasible.In August 1995, the MCM was awarded joint support by the NSF Database Activities Programs and Office of Polar Programs to formally begin the
development of its GIS-based D&I management system. The overall project is referred to as SOLA (Science On-Line Antarctica). The first phase, requirements analysis, will proceed during fall and winter 1995-96 with assistance from the National Center for Geographic Information and Analysis, and will culminate in a planning review workshop in April 1996.
This invitational workshop, to be held at the Biosphere 2 facility in Tucson, Arizona, is co-sponsored by the LTER Climate and Synthesis committees, with participation of the LTER Data Managers. The goals of the workshop are to solicit comments and suggestions from the entire LTER community on McMurdo's SOLA prototype efforts, and to provide the community with an opportunity to be involved in the ongoing SOLA development process, which also may hold promise for the LTER Network as a whole.
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VIRGINIA COAST RESERVE
Marsh/Upland Groundwater Monitoring of Agricultural Inputs
Steve Macko & R.J. Tapper, Graduate Student
On the Eastern Shore of Virginia, upland agricultural areas are linked to adjacent wetland areas by the flux of groundwater nutrients. As such, there is great potential for groundwater discharge to alter nutrient cycling, trophic structure, and secondary production in this environment.
In this study, groundwater was monitored at a series of nested wells installed in the center and perimeter of an agricultural field which borders a tidal creek and is adjacent to a salt marsh. Nitrate concentrations are higher on the creek side of the field than on the marsh side (mean NO_3^- = 373 uM/L and <2 uM/L, respectively). Ammonium
concentrations are greater on the marsh side of the field than on the creek side (mean NH_4^+ = 23 uM/L and 2 uM/L, respectively). Concentrations of nitrate generally decrease and ammonium concentrations increase in the
direction of ground water flow. The observed nitrate concentrations can be as high as 700 uM/L and suggest possible contamination from human activity.

Del15 nitrate analyses suggest no simple relationship between isotopic composition and concentrations of ammonium and nitrate. The d15N ammonium values of selected samples suggest that ammonium is formed by mineralization of organic nitrogen. The d15N values of selected samples suggest that nitrate is derived from soil or fertilizer sources, and is modified by denitrification. The marsh/upland ecotone is a sharp ecosystem N-economy transition which, at the Virginia Coast Reserve, is not yet overwhelmed by heavy agricultural input.