

## Supplement to the Jornada Basin LTER Program: Field Station Connectivity

### Project Summary

The scientific program of the Jornada Basin LTER focuses on understanding biotic and abiotic processes of desertification in arid ecosystems. This program is based upon extensive scientific collaborations among several universities, primarily New Mexico State University (NMSU) and Duke University, and federal research agencies, primarily the Agricultural Research Service (ARS). The Jornada Basin LTER field site is located in the Jornada del Muerto Plain in southern New Mexico on over 100,000 hectares of adjacent lands administered by NMSU at the Chihuahuan Desert Range Research Center (CDRRC) and by the ARS at the Jornada Experimental Range (JER). The headquarters for the JER provides field station services for the Jornada Basin LTER. These field station services are tangible, extensive and crucial to the current and future LTER research program at the Jornada. Though this station is 40 km from Las Cruces, New Mexico, and the campus of NMSU, the site is classified as remote and only basic telephone service is routinely supplied. This existing system is antiquated, consists of only four telephone lines and cannot be upgraded or expanded. The demand upon this existing communication system is increasing, and it is now unable to effectively service Jornada Basin scientists. This proposed project would provide data and voice communications through T1 connectivity with U.S. West to the Jornada LTER personnel at the JER headquarters field station. We are requesting support for installation of 14 km of fiber optics cable from an existing service point on the border of lands associated with the Jornada Basin LTER to field station facilities at the JER headquarters. U.S. West telecommunications in this region are entirely fiber fed. We are also requesting support for a digital telephone system through NMSU Telephone Communications for distribution of T1 connectivity at our field station.

Required easements for installation of the cable have been completed. Technical staff of the JER will provide cable installation labor services (a \$60,000 cost share), and the ARS will contribute required line connection and service costs. Dedicated service for LTER personnel for T1 connectivity will be provided in existing field laboratory and office facilities, current residence areas and proposed expanded laboratory and residence facilities to be constructed at this site. We also request hardware support to connect one of our three Schoolyard LTER sites, Sierra Middle School, to the high speed network. Sierra is the only magnet school program in New Mexico, and science teachers from Sierra are being interned in 1999 at the JER as part of the NSF supported First Step Program in collaboration with the ARS. This proposed program will provide Jornada Basin LTER personnel and our new Schoolyard LTER site with routine and ready access from field sites to modern data and voice communication systems at basically no cost other than the basic equipment described in this supplement.

### Project Science

The Jornada LTER was first conceived in 1981, when a group of scientists from New Mexico State University proposed a program of research to gain a better understanding of the processes that determine the structure and function of Chihuahuan Desert ecosystems. When we began our work, ecologists were pointing an accusatory figure at the historical cattle industry in southern New Mexico as major contributors to the conversion of grasslands into shrublands, but in reality there was little formal, mechanistic understanding of what might have caused the complete reconfiguration of vegetation on the Jornada landscape. It was equally possible that fire suppression, rising concentrations of atmospheric carbon dioxide and changes in the seasonal distribution of rainfall had contributed to the large changes in ecosystem structure and function that had occurred in just a few decades. Today, NSF support for the Jornada LTER is supplemented by cooperative efforts and funding from the USDA's Agricultural Research Service (ARS). The LTER efforts in the Jornada Basin build on the century-long efforts by ARS scientists to understand rangeland conditions in the Jornada Basin and on studies conducted as part of the International Biological Program (IBP) at the Jornada in the early 1970's.

Our research group has focused on changes in the distribution of essential soil resources during the transition from grassland to shrubland habitats. Ecologists have long-recognized that patches, or "islands," of fertility develop under shrub vegetation, which leads to a heterogeneous distribution of soil resources in deserts. What was new in our work was our hypothesis that the desertification of semiarid grasslands may not be so much associated with a change in vegetation production as with an increase in the spatial heterogeneity of soil resources. This heterogeneity created by invading shrubs is followed by a further localization of soil resources under shrub canopies promoted by the invasion and persistence of shrubs. The patchy distribution of soil resources leads to heterogeneity in the distribution of soil microbial biomass, nematodes and micro arthropods. Barren areas between shrubs are increasingly subject to the physical removal of soil resources by water and wind erosion and the potential for long-term depletion or loss of soil resources.

We consider all of these factors as allogenic--acting from outside the ecosystem to cause changes in the structure and function of the Chihuahuan Desert. The allogenic factors are reinforced by autogenic factors, including the development of soil heterogeneity and islands of fertility, which act internally to reinforce the invasion and persistence of shrubs in the ecosystem.

### Role of Field Facility

Since 1994, the Jornada Basin LTER has established field sites throughout the basin with numerous research projects located on the ARS administered lands of the JER (72,000 ha). Some of the pre- 1994 sites are on lands of NMSU's CDRRC and are supported by a limited infrastructure at those specific locations. However, primary support for research project establishment (e.g., fencing, trenching, treatment applications), specialized equipment construction (e.g., flumes, meteorological instruments), data collection (e.g., dust collectors, vegetation responses), site maintenance (e.g., road repairs, security services), personnel support (e.g., special equipment needs, field vehicle use), and educational programs (e.g., visitor tours, annual symposium) depend upon the personnel and facilities at the JER headquarters. A nine person technical staff operates daily at the JER field station. These staff provide labor and technical support for all research activities on the JER, including LTER research. They are increasingly providing data to LTER scientists from the headquarters field station. The field station provides full shop facilities for manufacture, repair and storage of field equipment and supplies. Presently, limited facilities are available for housing. However, in September 1999, a three bedroom facility will be provided for on-site residence. Small conference, laboratory and office areas are provided to LTER personnel. Limited email, data transfer and Internet connectivity is provided for local and off-site scientists through the existing antiquated communication system. The need for these functions continues to escalate with expanded LTER research at the JER and expanded cross-site studies. Additional residence and laboratory facilities are proposed for this field station. The plan for proposed expansion of our existing station is in development. This expansion will utilize ARS, NMSU and NSF resources.

### Current Connectivity

The existing field station is classified as remote. Only basic telephone service through U.S. West is provided via above ground telephone lines, and only four lines are available through this antiquated service. Presently, 2 telephone lines are dedicated to site residences, 1 telephone line is dedicated to scientific instruments that are networked to a national UV-B monitoring system, and the remaining line is shared for voice and data communications by ARS and LTER personnel. The bulk of voice communications are now serviced via cellular telephones provided to all ARS personnel and a pool of cellular telephones available to LTER researchers and technicians. The existing system cannot be further expanded or upgraded by U.S. West.

Data communications are generally serviced from personal computers at the field station connected via modem to the shared telephone line. Most field data are electronically collected using portable computers which download data from remote instruments, or manually collect data following established protocols. Field

staff at the headquarters site transmit data in limited fashion using the existing system. Offsite personnel are generally required to use the system after hours. Presently, most manually collected data are entered and processed through the LTER data management system on the campus located site office. However, cross-site studies and studies conducted by off-site LTER personnel are increasingly requesting access from the field station.

In 2001, the LTER site office (including site manager offices, GIS offices and work areas, and data management facilities) will be located in the new ARS headquarters building on the NMSU campus. This new facility is currently being designed for construction and will provide support to LTER personnel at no cost to the site LTER program. This new facility will be equipped for modern communications with our remote field station.

### Proposed Connectivity

We are proposing to replace the current antiquated telephone service to the JER headquarters with a 200 pair fiber optic cable. This cable would connect to existing fiber optics service through U.S. West located on the southern border of the JER. The fiber optics cable would be installed below ground along an existing 14 km route to the JER headquarters. This route has been surveyed and a signed easement between the ARS and U.S. West providing U.S. West access to this right-of-way on federal land is on file in the Dona Ana County, New Mexico, Courthouse. The ARS will cost-share this project by providing labor and equipment for installation. U.S. West is requiring payment for the fiber optics cable. All associated reusable hardware for modern connectivity will be provided at no cost by U.S. West.

Fiber optics will be distributed via an NMSU contracted telephone system with cable distributed to all necessary buildings at the JER headquarters. The ARS will provide connecting hardware to existing equipment, and computer connection points in the existing and proposed residences, laboratories and offices utilized by LTER personnel.

Sierra Middle School will be provided the necessary hardware for connectivity of this Schoolyard LTER to the Internet via the regional telephone company, U.S. West.

### Connectivity Benefits

Our current system is unable to effectively meet the increasing demands for data communications by Jornada Basin scientists. This antiquated system cannot be upgraded by U.S. West, the regional telephone communications provider. U.S. West has converted this area entirely to a fiber fed system.

This proposal addresses both short-term and long-term goals of the Jornada Basin LTER program for field site voice and data communications. These goals are either met in an extremely limited fashion or are not met with the existing field communication systems. Short-term goals are to: 1) create the capability to electronically transfer data from the field to the Jornada LAN, 2) provide routine electronic mail access to LTER personnel in the field, and 3) improve availability and quality of existing telephone service. Our long-term goals are to: 1) establish on-line connectivity to instrumented field sites, 2) provide Internet access to all personnel in the field, 3) allow interaction with existing data bases, especially spatially referenced information, to personnel while in the field, 4) remotely maintain, upgrade and install software to field station systems, 5) more timely provided data collection, storage and back-up from our field based activities, and 6) provide direct linkages among field sites and our Schoolyard LTER sites.

Though the JER field station for the Jornada Basin is located within 40 km of the NMSU campus, the site has attributes which can be considered as remote. Field technicians stationed at the JER headquarters are required to transmit data electronically to the Jornada LTER LAN. Visiting LTER scientists reside at the field station and require routine email and Internet access. Instruments at remote field sites require on-line

connectivity. These requirements are best met by providing modern connectivity to the JER field station.

### Schoolyard LTER Program and Connectivity

Schoolyard LTER's have been established at Jornada Elementary School in Las Cruces, New Mexico (for use by fifth grade students), and at Franklin High School in El Paso, Texas (for use

by eleventh graders), giving the project a regional breadth that will increase visibility and public support. In 1999, an additional school, Sierra Middle School, will be developed as a Schoolyard LTER.

*Site descriptions:* Schools are within walking distance of topographically diverse undeveloped land currently dominated by creosotebush (*Larrea tridentata*). Areas retain the basic structural elements of the creosote plant community represented in the three Jornada LTER NPP sites, but have been more severely affected by human or off-road vehicle use. We have used the Jornada Elementary site for the past three years for teaching desert ecology, geology and natural history. However, no permanent plots have yet been established. The middle school site is <5 ha, the elementary site is approximately 5 ha in size, while the high school has access to an area covering over 30 ha, including a hilltop, arroyo system and retention basin. These sites are not slated for development.

*Site establishment:* Permanent plots have been established at two schools on two sites: upland and arroyo bottom. Students are preparing basic site vegetation maps using aerial photos. An automated weather station has been installed at each site and linked directly to computers in the classrooms. The site at Sierra Middle School will follow this pattern.

*Project description:* Students will monitor climate, net primary production (NPP) and associated variables at each site. These parameters were selected because they can be easily 1) related to other ecosystem processes (conceptually, at least), 2) related to each other, 3) compared between the two sites, and 4) compared with data from other LTER sites on the web. NPP will be measured using the standard Jornada methods.

*Data analysis, interpretation and presentation:* Elementary students will use graphical methods, and the high school students will use statistics to analyze the data. The students will work together on the project, allowing mentoring relationships to develop between the older and younger students. These relationships will be facilitated through a joint visit to the Jornada LTER site at the beginning of the academic year, through reciprocal site visits by each group to the other school, and through email contact coordinated by the Chihuahuan Desert Nature Park (CDNP).

Students at both Franklin High and Jornada Elementary have email access. Each class will post a bi-weekly progress report and data to a list-server. In the future, this will be done using a web page. CDNP educators will contact or visit each school at least once per month and will arrange LTER scientist visits as required. We are proposing hardware support in this proposal to connect Sierra Middle School to this network.

### Proposed Program

Three distinct actions are proposed. First, under contract with U.S. West, ARS technical staff will install underground 14 km of 200 pair fiber optics cable. The cable will be purchased from U.S. West at a cost of \$181,895. Installation will occur during summer 1999. U.S. West will provide all associated reusable equipment to allow for modern communications connectivity. This includes the multiplexer which will provide T1 connectivity.

All communication systems in this region serviced by U.S. West are now fiber fed. Though other communication options are possible, they would be: 1) independent of the U.S. West system, 2) require substantial annual maintenance costs, 3) provide lower quality communications, and 4) consist of less

reliable communications. We regard fiber optics as the best possible system to supply communications to our field station.

Second, NMSU Telecommunications will install a digital telephone system at the JER field station with service to all required locations. This system will be installed immediately after the fiber optics cable is installed in summer 1999. The equipment is immediately available.

NMSU telecommunications is supporting existing on-campus communication support and services for LTER and ARS facilities. NMSU will also provide communication services for the new ARS building that will house LTER site facilities in 2000.

Third, a computer and associated hardware for high speed Internet connectivity will be purchased for placement at our newest Schoolyard LTER site at Sierra Middle School. This is our third Schoolyard site, funded under our second Schoolyard LTER supplement. This site will be established during spring 1999.