

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 07-140					FOR NSF USE ONLY	
NSF 07-569			09/13/07		NSF PROPOSAL NUMBER	
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)					0755059	
DBI - BIO - Research Experiences for Undergraduates Sites (Biological Sciences)						
DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION	
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EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)		SHOW PREVIOUS AWARD NO. IF THIS IS <input type="checkbox"/> A RENEWAL <input type="checkbox"/> AN ACCOMPLISHMENT-BASED RENEWAL		IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES <input type="checkbox"/> NO <input checked="" type="checkbox"/> IF YES, LIST ACRONYM(S)		
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NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE			ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE			
University of New Mexico			University of New Mexico SCHOLES HALL RM 102 ALBUQUERQUE, NM. 871310001			
AWARDEE ORGANIZATION CODE (IF KNOWN)						
0026633000						
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IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)		<input type="checkbox"/> SMALL BUSINESS <input type="checkbox"/> FOR-PROFIT ORGANIZATION		<input type="checkbox"/> MINORITY BUSINESS <input type="checkbox"/> WOMAN-OWNED BUSINESS		<input type="checkbox"/> IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE
TITLE OF PROPOSED PROJECT REU Site: New Mexico Sevilleta LTER REU Site Program						
REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE			
\$ 267,465	36 months	04/01/08				
CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW						
<input type="checkbox"/> BEGINNING INVESTIGATOR (GPG I.G.2)		<input type="checkbox"/> HUMAN SUBJECTS (GPG II.D.6) Human Subjects Assurance Number _____				
<input type="checkbox"/> DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)		Exemption Subsection _____ or IRB App. Date _____				
<input type="checkbox"/> PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)		<input type="checkbox"/> INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)				
<input type="checkbox"/> HISTORIC PLACES (GPG II.C.2.j)		_____				
<input type="checkbox"/> SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)		<input type="checkbox"/> HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)				
<input type="checkbox"/> VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date _____		_____				
PHS Animal Welfare Assurance Number _____						
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CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 07-140). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency?

Yes

No

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding \$100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding \$150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

- (1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.
- (3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

- (1) community in which that area is located participates in the national flood insurance program; and
- (2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

- (1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
- (2) for other NSF Grants when more than \$25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE		SIGNATURE		DATE	
NAME Gloria Cordova		Electronic Signature		Sep 13 2007 1:02PM	
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*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

Project Summary: REU Site – Sevilleta LTER REU Site Program

Summary: Three years of support is requested to establish on a more solid footing an interdisciplinary REU Site Program at the Sevilleta LTER in central New Mexico. Our goals, in summary, are to (1) recruit 30 undergraduates from across the nation, targeting underrepresented students at three partner institutions and through the ESA SEEDS program. Our REU students will (2) be immersed for 10 weeks in research under the guidance of a faculty in the Departments of Biology and Earth and Planetary Sciences; (3) gain hands-on training through conducting their own research; (4) attend weekly seminars and informal workshops on the responsible conduct of research (see Supplement), and professional development issues; (5) participate in field trips throughout the region, and (6) maintain a collaborative relationship with their faculty mentor after the field season to complete the research and publish results.

Intellectual Merit of the Program. Two fundamental experiences characterize our REU Site Program—interdisciplinarity and the research setting. This Program includes faculty who conduct research across the spectrum of ecology, the geosciences, and meteorology. Students, as well as participating faculty, postdocs, and graduate students, will have numerous opportunities to share ideas and explore issues across these disciplines about scientific methods, the kinds of questions asked, and connections among the different topics that can be investigated. This will enhance the excitement of the setting for all participants as results are shared both informally and during symposia and workshops. The LTER is a perfect location; it invites one-on-one interactions among students and faculty advisors, and graduate student peer mentors, during field data collection and laboratory research. This setting and learning with “hands on” activities will promote greater interest in and understanding of the research process. The conceptual comprehension of hypothesis testing, data analysis and interpretation also increase as students become engaged in scientific study. Their confidence and self-identity as scientists will grow under the guidance of faculty advisors, especially because with the faculty advisor’s assistance, each student will design and implement their research study, and gain additional experience in reporting scientific results and making real contributions to their field through their research.

The Broader Impacts of the Program are numerous. With this proposed Sevilleta LTER REU Site Program, like our REU supplements of the past two years, we believe the students we recruit and train will help to fill two immediate national scientific workforce needs. The program will increase the number of students pursuing careers in interdisciplinary research that combine the various areas of study in biology, the geosciences and meteorology, and it will also increase the participation of underrepresented minorities in these fields. With funding for our Sevilleta LTER REU Site, we believe that we can (1) provide comprehensive exposure to a large, multidisciplinary research program, (2) inspire students to continue their professional careers in these scientific fields, and (3) better prepare these students for the rigors of graduate school and professional research activities. They will also be exposed to the importance of research ethics and the responsible conduct of research—and this will have a long-lasting impact on them in whatever field they choose, as well as helping them to be better informed citizens about ethical issues in research.

An additional benefit comes from the fact that our program exemplifies the **integration of research and education** at a very basic level. As students conduct research, they will learn what it means to be a scientist, and also about many technical, methodological and ethical issues that arise in research. They will learn that some of these can hinder or facilitate the ability to do research, and that *how* research is conducted is regulated and for very good reasons. Our students will leave this research experience prepared to raise questions if they view potential violations, and they will know where they might find the answers. Our hope is that they, like several of our recent REU Supplement students, will leave the Sevilleta armed with a confident self-identity as research scientists, and with plans to return.

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Table of Contents	1	_____
Project Description (Including Results from Prior NSF Support) (not to exceed 15 pages) (Exceed only if allowed by a specific program announcement/solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)	15	_____
References Cited	_____	_____
Biographical Sketches (Not to exceed 2 pages each)	34	_____
Budget (Plus up to 3 pages of budget justification)	6	_____
Current and Pending Support	18	_____
Facilities, Equipment and Other Resources	0	_____
Special Information/Supplementary Documentation	0	_____
Appendix (List below.) (Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)	_____	_____
Appendix Items:		

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

A. Overview.

Intellectual merit. During the past two summers, Sevilleta LTER investigators from the University of New Mexico (UNM) have pieced together an REU program via various funding sources to support 7 students in 2006, and 8 students in 2007. We wish to formalize that effort through an REU Site Program because, with appropriate funding for 3 years, we believe we can attract at least 10 talented students each year, several of whom will be from groups underrepresented in the sciences. We also believe that our program will encourage students to consider STEM research careers even though they may be first-generation college students. We believe an REU Sites program would expand the options available to students, by exposing them to field-based research in related ecological (population, community and ecosystems) and geological (climate, soils, and hydrology) sciences.

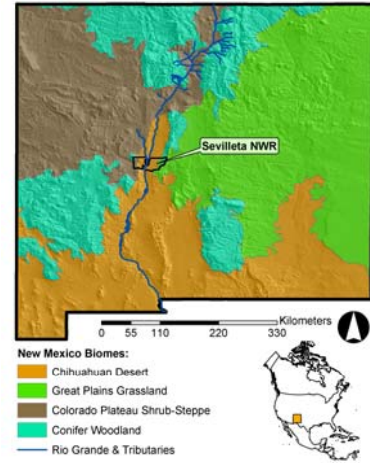


Figure 1. Location of the Sevilleta National Wildlife Refuge, central New Mexico, with respect to the major regional biomes and the Rio Grande.

Our philosophical approach to undergraduate education in scientific research reflects our personal experiences and the spirit of the NSF REU program. We believe that one-on-one interactions between students and faculty advisors, and graduate student peer mentors, during actual data collection activities in field and laboratory situations promotes greater understanding and interest in scientific research. In contrast to university lecture halls, we know that student enthusiasm is markedly greater when they learn through “hands on” activities. Conceptual comprehension of hypothesis testing, data analysis and interpretation also increase as students become fully engrossed in the processes of scientific study. In the natural sciences, we have found that student participation in a full range of coordinated activities, focusing on both abiotic and biotic components of ecosystems, enhances their understanding of processes from population genetics through ecosystem structure and functioning. Under the guidance of faculty advisors, our REU students will design, implement, analyze, orally report and potentially publish their independent studies, thereby gaining additional experience in reporting scientific results and making real contributions to ecological and geosciences research.

The **broader impacts** of our proposed REU Site Program at the Sevilleta LTER and of our previous REU activities are (1) to help students gain a greater appreciation for the research process, (2) to increase students’ knowledge of aridland environments, (3) to increase the participation of underrepresented minorities in science, and ultimately, (4) to recruit talented students into the science workforce. Based on our experiences the past two summers, we are confident that our REU program will increase the number of students pursuing careers in ecology and our training opportunities will be greatly expanded by including opportunities for geosciences research, a key component of the Sevilleta LTER Program. Thus, in collaboration with the Sevilleta LTER, our REU Site Program will (1) provide comprehensive exposure to a large, multidisciplinary research program, (2) inspire students to continue their professional

careers in these fields, and (3) better prepare them for the rigors of graduate school and professional research.

A.1 Goals and Objectives. As an expansion of our successful experiences during the past two years, we propose the following objectives for our 3-year REU Site Program. As noted above, one of our goals is to increase the number of graduate level students in ecological and geosciences research, and another is to diversify the demographic composition of this group of scientists. Our objectives are as follows:

- A.1.1 We will recruit 30 undergraduate students (10 per year) with a special emphasis on underrepresented minorities to participate in a coordinated multidisciplinary research program associated with the Sevilleta LTER Program.
- A.1.2 REU students will be involved in all aspects of research, from planning their projects and collecting data through data management, analysis and presentation. Students will work closely with a faculty mentor and graduate student peer mentors on a 10-week research project that they collaboratively design.
- A.1.3 Participants will gain hands-on training through conducting independent research while learning about their colleagues' projects. Together these activities will expose students to a broad range of ecological and geosciences research.
- A.1.4 Students will attend weekly research seminars along with informal workshops in the responsible conduct of research, and on professional and career development.
- A.1.5 Students will be encouraged to participate in weekend field trips to experience first-hand the broad array of cultural and natural environments in New Mexico.
- A.1.6 Students will present their research results at the August Undergraduate Research Symposium, and potentially at regional and national scientific meetings. When appropriate, students will publish their research in refereed scientific journals. As part of our outreach, parents will be invited to attend the August Undergraduate Research Symposium as part of a Parents' Weekend at the Sevilleta.

A.2 Targeted Student Participants. We will recruit undergraduate students for a 10-week research experience during the summer before they enter their sophomore through senior year of studies. As described in Section D, our recruitment efforts are nationwide, but we will target the following institutions: Diné (Navajo) College, Northern Arizona University, University of New Mexico, University of Texas at El Paso, and Ecological Society of America (ESA) SEEDS (Strategies for Ecology Education, Development, and Sustainability) program. Each has a large number of underrepresented students and dedicated faculty to partner with us in this effort.

SEEDS is sponsored by ESA to diversify the profession of ecology via targeted opportunities for underrepresented minority students. Through 42 Campus Ecology Chapters nationally, SEEDS sponsors hands-on experiences to introduce students to the field of ecology and also distributes information about research opportunities such as our Sevilleta LTER REU program. Although it is common for REU Site proposals to recruit SEEDS students, UNM and the Sevilleta LTER have established a strong and lasting partnership with ESA SEEDS. Our SEEDS Campus Chapter was established in 2005 (PI Collins is the Advisor). The Sevilleta LTER hosted the Annual SEEDS Workshop in November 2005. Collins was a participant in the 2006 SEEDS Leadership Workshop at Arizona State University. In 2007, Collins mentored a SEEDS Fellow at the

Sevilleta. In 2008, two SEEDS Fellows are scheduled to conduct research at the Sevilleta. Finally, the Sevilleta LTER will host the 2008 SEEDS Leadership Workshop. Thus the Sevilleta LTER has a strong relationship with ESA SEEDS beyond recruiting REU students. As part of this partnership, we not only recruit REU students from SEEDS, but also support our students to participate in SEEDS activities during the annual ESA Meetings.

Diné (Navajo) College was established in 1968 by The Navajo Nation to meet the long unmet postsecondary educational needs of Native Americans. Diné College was the first college established by Native Americans for Native Americans, and to date remains the oldest and largest with 6 campuses in Arizona and 2 in New Mexico. In 1976, Diné College was accredited as the first tribally-controlled two-year college by the North Central Association (NCA) Commission on Institutions of Higher Education. Governed by an eight-member Board of Regents confirmed by the Government Services Committee of the Navajo Nation Council, Diné College has the responsibility to serve residents of the 26,000 square mile Navajo Nation spanning Arizona, New Mexico and Utah. Diné College awards Teacher Education Bachelor's degrees, Associate degrees and Certificates in areas important to the economic and social development of the Navajo Nation, and prepares students in Math and Science and other fields for entry to four-year colleges. Through articulation agreements, Diné College students can transfer to four-year colleges throughout New Mexico.

Northern Arizona University was established in 1899 as Northern Arizona Normal School, and then in 1925 it was renamed Northern Arizona State Teachers College, a four-year institution able to grant bachelor of education degrees. In 1937, ASTC added a master of arts in education degree. In 1939, Ida Mae Fredericks became the first Hopi to receive a college degree. In the 1950s, ASTC added an education specialist degree, Master's Degrees in the arts and sciences, and a Forestry Program. In 1966, it was renamed Northern Arizona University, and in 1968 received authorization to offer Doctorates of Philosophy and Education. NAU has about 20,000 students at its main campus in Flagstaff, plus students at over 35 sites statewide. NAU was ranked 96th out of 242 institutions in the *Washington Monthly*, "The 2007 College Guide."

The University of New Mexico (UNM) is one of eight Minority-Serving institutions; and one of only two Hispanic-Serving Institutions that are Carnegie Doctoral/Research Extensive Universities. Founded in 1889, UNM has more Native American students than any of its peer minority-serving institutions. UNM's student demographics of nearly 27,000 students (Table 1) reflect New Mexico's diversity. New Mexico is the first majority-minority state in the lower 48: 42% Hispanic, 11% Native American, 2% African American, 44% Anglo and 1% Other. UNM offers 12 programs rated among the best nationally (*U.S. News and World Report*, 2005), is in the top 25 institutions nationwide for minority graduate student enrollment (18% of 3,915) and number of graduate degrees conferred to Hispanics (*Hispanic Outlook in Higher Education*, 2005), and is ranked 5th for the number of Hispanic faculty (*Black Issues in Higher Education*, 2000).

University of Texas at El Paso (UTEP). Founded in 1914 as the Texas State School of Mines and Metallurgy, UTEP has been a leader in higher education, gaining national recognition for its innovative teaching methods and programs designed to help students, especially its majority Mexican-American students, succeed. In 1966, UTEP – then named Texas Western College – changed the face of collegiate athletics, by being the first southern state to integrate its athletic

teams. An upstart squad of five African-American players beat Kentucky to win the NCAA basketball championship, breaking color barriers in college sports (featured in the 2006 movie, *Glory Road*). UTEP is the only major research university in the country whose diverse student body is 73% Mexican-American, largely from the El Paso region. UTEP is gaining a reputation as a national research center of excellence in the education of minorities.

Institution	American Indian	Asian/Pac Isl.	Black	Hispanic	Other Ethnic	White	TOTAL
Diné (Navajo) College	1,896				39		1,935
Northern Arizona University	943	275	393	1,795	725	10,385	14,516
University of Texas at El Paso**	46	240	480	13,947	2,132*	2,277	19,122
UNM** Undergraduates	1,190	682	566	6,361	1,014	8,386	18,199
TOTAL by Ethnicity	4,075	1,197	1,439	22,103	1,778	21,048	51,640
plus ESA SEEDS members							

* International (largely Mexican Nationals) **UTEP and UNM have SEEDS Chapters

A.3 Intellectual Focus. The Sevilleta LTER REU Site Program will be built around the long-term interdisciplinary research program of the Sevilleta LTER. The Sevilleta LTER site is located 80 km south of Albuquerque, New Mexico, in and around the Sevilleta National Wildlife Refuge (SNWR)(Fig 1). The SNWR (managed by the US Fish and Wildlife Service) and its surroundings are positioned at the intersection of several major biotic zones: Chihuahuan Desert grassland and shrubland, Great Plains grassland, piñon-juniper woodland, Colorado Plateau shrub-steppe, and riparian vegetation along the middle Rio Grande (Fig 1, 2). Because of the

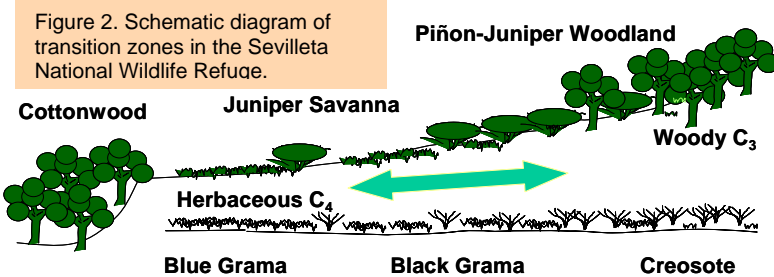


Figure 2. Schematic diagram of transition zones in the Sevilleta National Wildlife Refuge.

confluence of these major biotic zones, the SNWR and the Middle Rio Grande present an ideal setting to investigate how environmental change and climate variability interact to affect ecosystem dynamics at biome boundaries in the southwestern US.

The Sevilleta LTER is a long-term, comprehensive, research program addressing key hypotheses on pattern and process in aridland ecosystems. Our LTER research is centered on studies in desert grassland, shrubland, piñon-juniper and riparian ('bosque') woodlands, and riverine systems. Each landscape component is governed by key abiotic and biotic drivers, especially soils, climate variability, fire, hydrologic variability, nutrient dynamics, and herbivory. Given the emerging research interest in ecohydrology of aridlands, our focus on the effects of biotic and abiotic drivers on spatial and temporal dynamics of aridland ecosystems forms the basis for a strong collaboration between faculty in the Biology and Earth and Planetary Sciences departments at UNM. This collaboration allows us to conduct long-term research that addresses important basic research questions and yet has significant relevance to

state, regional, national, and international priorities. The LTER provides a broad range of opportunities for 10 undergraduate students per year (30 during the 3-year program) to conduct research with faculty mentors on various topics in ecology, climatology and the geosciences.

Through their research experiences, students can address numerous hypotheses on topics in ecology and the geosciences. For example, a potential research experience might entail a study of the relationships among plant species diversity and net primary productivity as influenced by differences in soil depth and texture. The Sevilleta has established several long-term climate manipulation experiments in grassland, shrubland and woodland habitats. Thus, a student could investigate how rainfall variability affects soil C fluxes in shrub and woodland communities. Yet another student could investigate the influence of soil parent material variability on the development of soils and their related landforms and dominant plant cover. The major emphases of student training will include biotic and abiotic drivers and constraints on plant and animal population dynamics, community structure and trophic interactions, and ecosystem processes, soil and landscape evolution, ecohydrology and the impact of climate change on ecological pattern and process. Meteorological studies could emphasize the well-recognized regional phenomena that affect this region, such as El Niño, to evaluate how such phenomena affect plant communities, channel erosion, or deposition. Through these and other research topics, students will receive extensive guidance on hypothesis development, sampling design, data collection and analysis, and written and oral presentation skills.

Our proposed REU Program--expanding upon our successful REU Supplements program of the past two years--will consist of the following student activities: (1) orientation and progress meetings, (2) weekly scientific seminars; (3) journal club; (4) field and laboratory experiences in sampling and data collection, coupled with mentor-student one-on-one instruction on the scientific method and hypothesis testing; (5) development of independent research in collaboration with the faculty mentor and graduate student peer mentors; (6) ethics and professional development seminar; (7) oral presentations at the annual Sevilleta REU Symposium; and (8) when appropriate, preparation and submission of manuscripts to peer reviewed journals.

A.4. Organizational Structure. The Sevilleta LTER REU Site Program will be administered by *PI Scott Collins*, Professor of Biology and Director of the Sevilleta LTER, and *Co-PI Leslie McFadden*, Professor of Earth and Planetary Science and Director of the Quaternary Studies Lab. The PIs will recruit mentors from their respective departments and also serve as mentors. The PIs will be assisted extensively by *Program Manager Jennifer Johnson (M.S.)*. Ms. Johnson has been a Research Scientist at the Sevilleta since 2001. As in the past two years for the REU supplements, Ms. Johnson will send out notices about this opportunity, review applications for completeness, contact references, assist with student selection, send notices of acceptance and declination, help students with travel arrangements, arrange pickup from the airport, assign rooms at the Field Station, and coordinate vehicle use. During setup, Ms. Johnson will assist the PI and Co-PI with linking students and faculty mentors, and ensure that REU students have ample opportunities to network with one another and with graduate students and postdocs, as well as speakers who come to the Sevilleta. During implementation, Ms. Johnson will coordinate all activities, monitor progress, meet with students to identify needs and logistics for

their field studies, conduct evaluations, teach them how to use equipment and conduct specific kinds of research procedures, help students with data collection and analysis, teach students how to prepare poster presentations, and numerous other tasks.

A.5. Annual Timetable and Logistics (April 2008 - March 2011). See details in Section B, below.

A.5.1. Student Recruitment and Selection (January – April) – see Section D

A.5.2. Student and Program Preparation (March - May) – see Section D

A.5.3. Logistics: Students Arrive, Orientation (June 1-2, 2008, June 7-8, 2009, June 6-7, 2010)

A.5.4. Research (June - August) – see Section C

A.5.5. Education and Field Trips (June - August) - see Section B

A.5.6. Annual Student Symposium and Parents' Day (Early August each year) – see Section B

A.5.7. Project Wrap-up and Data Management Archive (August - Early September)

A.5.8. Evaluation, Dissemination and Follow-up Activities – see Section E

A.6. Institutional Commitment. A total of 16 faculty have committed themselves to this REU Site Program as PI, Co-PI, and mentors. As we have done in the past for students, REU housing costs per student are reduced from the standard \$20/day (\$1400 for 10 weeks) to a flat rate of \$500 representing a substantial cost savings. Costs of food and housing (2 nights) for parents on Parent's Day will be covered by the Sevilleta Field Research Station. Thus, their only costs will be travel to and from the Sevilleta.

B. Student Activities

B.1. Pre-Program Activities.

B.1.1 Students notified about selection. Students are notified about selection in early April, and are sent information about transportation, lodging at the Sevilleta LTER, and what to bring. They will also receive a list of mentors and ongoing research projects so students can think about potential projects before they arrive, the schedule of activities, invitations for their parents for the August Symposium and Parents' Day activities, safety information, and U.S. Fish and Wildlife regulations since the site for research and lodging is in a National Wildlife Refuge.

B.1.2 Students select research project and mentor. Student participants who are selected will begin preparing for their summer research experience as soon as their participation is finalized in April, before they arrive at the Sevilleta in early June. Students select 3 research areas and mentors from those posted on the web. Program Manager Johnson facilitates the interactions of students with prospective mentors, and helps them make their decision, ensuring that everyone finds a good fit with their interests. The students will then begin to communicate with their selected mentor to narrow down the focus of their research study. This will enable the Program Manager to identify and purchase materials and supplies. The mentor will assign papers for the student to read to prepare in advance for the summer research experience.

B.1.3 Students come to the Sevilleta Field Research Station. All students will begin their activities in early June, at the start of our summer field season. Jennifer Johnson will communicate with students about their transportation needs, and will provide transportation from the Albuquerque Sunport for those flying to New Mexico. She will arrange for them to be checked in to their houses at the Field Station, and will assist them and monitor their progress during the summer.

B.2. REU Site Program Activities. Our REU students will have a 10-week experience that will immerse them in science at the Sevilleta, with research projects and presentations, symposia, speakers' events, workshops, field trips, and networking with faculty, graduate students, postdoctorates, as well as their peers in this and other programs. The expectation is that most of them will emerge from this experience excited about scientific research, knowledgeable about aridland environments, and interested in and more qualified for graduate school and other professional careers in the environmental sciences.

B.2.1 Orientation. On the first day, students will be welcomed to the program, meet with their mentors, and learn about the REU Program's organization and schedule. Logistical considerations, such as field site orientation, safety, housing, cooking, transportation, seminar and speakers' schedules, research projects and procurement, will all be discussed. A staff member from the SNWR will welcome the group and explain the goals of the Refuge and its management. PI Collins will discuss the connection between research and academic success, and provide an overview of the Sevilleta LTER Program and the many research opportunities in and around the Refuge. Co-PI McFadden will describe geoscience and meteorological studies that are being conducted at the LTER. UNM Field Station Manager, John DeWitt, will cover



Figure 3. Sevilleta 2007 REU student Rene Aguilera measuring net ecosystem exchange in the monsoon rainfall manipulation experiment.

Field Station and Refuge regulations, and student responsibilities regarding housing and behavior; Mike Friggens, LTER Project Manager, will cover field safety and responsible conduct of research and other activities in the Refuge. Program Manager Johnson will outline the weekly activities, describe her role, and give a presentation on preventing sexual harassment. Students also receive UNM defensive driver training so they can drive UNM Field Station Vehicles.

B.2.2 Research. Several components are planned that will enrich the REU summer research experience. These activities are designed to promote a sense of community at the field station and responsible conduct of research.

i. Research Experience. Each student will conduct their own independent research designed in consultation with his/her mentor. Past projects have included a study of arthropod abundance and diversity in areas with and without kangaroo rats, the effect of nighttime warming on seedling growth and establishment, soil C flux in piñon-juniper woodland, the distribution and abundance of grasshoppers at three spatial scales, and the effect of rainfall variability on net ecosystem production (Fig. 3), among others. While conducting their research, students will also be able to consult with scientists, graduate students and postdocs in residence or visiting the Field Station. As part of their research protocols, each student must submit an FWS Research Permit application at the end of their first week in residence. These are reviewed by a committee that includes UNM and FWS personnel. The committee then offers feedback and

advice to each student. This activity helps them to appreciate the issues facing researchers on federal property and helps to focus their research goals. All of these interactions broaden and enhance the REU experience and provide opportunities for students to communicate their work to others.

ii. Weekly Updates. Ms. Johnson meets weekly with the entire group to discuss progress and to hear about interactions with mentors, housemates, etc. This is a time when needs are addressed to ensure that research is progressing well—does the student need a truck, supplies or equipment, or field help? Has the student communicated with their mentor? How is the research progressing? Do they have fundamental field method questions?

iii. Ethics Training Workshops. Weekly workshops will be held on a variety of relevant topics. Details are provided in Supplementary Materials.

iv. Weekly Seminar and BBQ. A weekly seminar will be held every Thursday evening throughout the summer with faculty members, postdoctoral researchers, and graduate students presenting their research, followed by a question and discussion period. In 2007, we had presentations by, among others, Enrico Yopez (Biology Postdoc), Dan Brecker (EPS Graduate Student), Robin Warne (Biology Graduate student), Scott Collins (Professor, UNM Biology), Renee Brown (SEV LTER Systems Administrator), Nancy Grimm (Professor, Arizona State), and Alan Knapp (Professor, Colorado State). For this program, REU students will at times be asked to present preliminary results of their research, and/or to summarize the results of new findings in the fields of research being conducted at the LTER. These seminars will be followed by a potluck BBQ on the patio providing opportunities for additional informal discussion and networking with the speakers. This is frequently followed by movie night on the patio.

v. Journal Club. After the weekly update meeting, students discuss an article they have selected on specific topics of interest to them. In 2007, topics included overpopulation, genetically modified food, marine conservation, and “rewilding,” among others. All sessions are moderated by Ms. Johnson, and plied with home-made cookies.

vi. August Symposium. The final summer research event is the Annual REU Research Symposium during which each REU Site student will present the results of their research. This symposium is attended by all students and mentors, FWS personnel, UNM faculty, and scientists in residence. This year, a local reporter from Socorro, a town south of the Sevilleta, attended and wrote a nice article for the *El Defensor Chieftain* about the REU Program and various student research projects.

vii. Parents’ Science Weekend. Although we have not done this in the past, a new component of our summer program will be the Parents’ Science Weekend at the Sevilleta. Students’ parents will be invited to attend the Annual Symposium. We cannot cover their travel costs, but two nights of housing at the Field Station will be provided at no cost and all meals during the Symposium event will be provided as well. Parents will tour the SNWR and learn about the research conducted by REU students and the Sevilleta LTER, providing an important outreach opportunity for the LTER and the Refuge. This also will give our REU students the chance to practice the famous adage, “You must be able to explain to your parents what your research is about and why it is important.”

B.2.3 Career Development Workshops. Biweekly workshops will be conducted to enable our REU students to prepare for the symposia, learn proper data management techniques and about

professional practices (networking, mentoring, publicizing research results), and how to apply for and fund graduate school. Led by the PI and Co-PI, faculty mentors, postdocs, and graduate students will assist with these workshops. Topics include: *Networking and Interdisciplinary Collaborations in Research and Teaching*; *How to be a Good Mentor*; *How to Resolve Conflict*; *Collecting, Recording, and Analyzing Data*; *Disseminating Research Results* (e.g., How to prepare a Poster and/or Give an Oral Presentation; Writing in Science and Manuscript Preparation); *Preparation for Graduate School* (e.g., GRE Preparation, How to Select a Graduate School, How to Select a Mentor, Application Processes, Interview Skills, How to finance graduate school).

B.2.4 Field Trips. During the 10-week program, our REU students will be encouraged to participate in weekend field trips throughout New Mexico – to introduce them to the natural history and cultural richness in the state and region. Students will conduct organized visits to the UNM campus (80 km north of the Sevilleta), including the Museum of Southwestern Biology, the Biology Greenhouse, the Geology Museum, Meteoritics Museum and Institute of Meteoritics, the Maxwell Museum, both Zimmerman and Centennial Science & Engineering libraries, and the Institute of Ethics. One of these visits will coincide with an event during which our REU students can meet the Program Directors and students from other programs at UNM, including MARC, IMSD, PREP, GK-12, URM-UNO, AMP, etc. Additional Albuquerque area sites that they can visit include the Indian Pueblo Cultural Center, the Hispanic Cultural Center, the Rio Grande Nature Center, the Natural History Museum Lodestar Astronomy Center and Observatory, the Petroglyphs and the Atomic Energy Museum. Among many sites in New Mexico that the students could visit are the Rio Grande Gorge, Valle Caldera National Preserve, El Moro National Monument, White Sands National Monument, the Very Large Array, Bandelier National Monument, Carlsbad Caverns, and Chaco Canyon National Historic Park.

B.3. Post-Program Activities

B.3.1 See Research through to Publication – After the 10-week REU experience, we expect that collaborative work will continue among the students and their mentors to prepare and present research results as the student’s senior thesis, for presentation at regional and national scientific meetings, or at a student conference sponsored by organizations such as SACNAS, SEEDS, etc. In 2006, we took six REU students to the ESA Annual Meeting in Memphis, where two of our students began their involvement with SEEDS. Two students attended the meeting in 2007. Andrew Romenger (Stanford), gave an oral presentation on his summer research for which he won an undergraduate best student paper award. Andrew has also prepared a draft manuscript for publication based on his REU research. SEV REU and SEEDS Fellow Jarrod Blue (Davidson College) also attended the ESA meeting in 2007 and helped lead an urban ecology field trip for Bay Area high school students. Next year Jarrod will return to the Sevilleta and also present the results of his research at the ESA Annual Meeting.

B.3.2 Tracking Students – As indicated in the Evaluation Plan, we will continue to track the REU students beyond their participation in this project. In the past, Jennifer Johnson has regularly communicated with former REU students. Of our 2006 cohort, only 2 have since graduated. Caitlin Smith (Mt Holyoke) received a one year Fulbright to work in Canada and Shawn Whiteman (Hollins University) started graduate school at UNM this fall. In addition, we expect each mentor to contact their former students. Although this sounds somewhat informal,

in our experience, it is quite common for former students to remain in contact and request letters of recommendation from their mentors. This should yield reliable information not only about their completion of the bachelor's degree, but also their graduate training, and their career accomplishments. Over time, prior students could be invited to be seminar speakers.

C. The Research Environment

We believe that the UNM faculty mentors, with their broad range of research interests and extensive mentoring experience, as well as their commitment to student success, offer students an outstanding opportunity to acquire experience and knowledge in ecology, the geosciences and meteorology. The students come from different institutions, which will enrich their experience and encourage them to continue networking after the summer REU experience is completed. They will also be exposed to speakers from many different fields and institutions through the summer seminars, and they will also be able to interact with researchers from other universities working at the Sevilleta.

C.1. Experience with Mentoring REU and Other Students. As the attached biosketches and C.2 paragraphs indicate, faculty participating in our REU Site Program have broad mentoring experience. Here we briefly summarize their research areas and mentoring experience.

C.2. Faculty Mentors and Research Areas - The PI and Co-PI will be responsible for ensuring that REU Site students have an outstanding summer experience. The mentors are listed below with an expression of the research activities the students may select from. Our mentors include a majority of faculty with extensive experience mentoring REU undergraduates: see Bio Sketches for additional information on mentoring background and recent publications.

Scott Collins, PI. (Professor, Biology). I am Director of the Sevilleta Long-term Ecological Research (LTER) Program and Deputy Director of the Sevilleta Field Research Station. In 2005, I worked to establish an ESA SEEDS Chapter in the UNM Biology Department with founding Student Rep. Jolene Trujillo (now a graduate student at Arizona State). In 2005, the Sevilleta LTER hosted the annual SEEDS field trip at the Field Station, and we will host the SEEDS Leadership conference in March 2008. I am also PI on a GK12 Program (Ecohydrogeology in the Middle Rio Grande Environment) in collaboration with Laura Crossey (Professor, EPS) where Graduate Fellows from the departments of Biology and Earth and Planetary Sciences work with middle school science teachers in three rural New Mexico communities—Belen, Socorro, and Laguna Pueblo. The GK12 Fellows are planning 5 day summer field camps at the Sevilleta which will provide an opportunity for the REU students to interact with middle school students interested in science. In addition, several of our GK12 Fellows have co-mentored REU students. My research investigates the role of climate variability, fire and herbivores on plant community structure and ecosystem processes in mesic and arid grassland. I am involved in several long-term manipulative experiments at the Sevilleta that address the impact of global change on community structure and ecosystem functioning. Potential REU projects may link resource availability, species interactions and community structure in the complex, dynamic and variable environments found at the Sevilleta.

Les McFadden, Co-PI. (Professor, EPS). I am Director of the Quaternary Studies Laboratory. The interdepartmental focus of this REU Site Program will promote more interdisciplinary partnerships in research and education between both departments, and with the student's home institution. I conduct research on soil morphology and soil genesis and their application to landscape evolution, environmental (seismic, volcanic, mixed waste) hazards, paleoclimate, archeology and ecology. As the Earth Sciences become more integrated with ecology, meteorology and geography, they will play an important role in "Earth System Science." Students who in the past would have focused on more conventional "geologic"

research can now develop research problems involving both the geo- and ecological sciences. This REU-sponsored program will expose students to exciting, innovative interdisciplinary research and help them attain important research and critical thinking skills.

Laura Crossey – (Professor, EPS). My research focuses on aqueous geochemistry and geomicrobiology to understanding water quality, as well as using sedimentary geochemistry to unravel paleohydrology. REU students will have the opportunity to engage in surface and groundwater water sampling and analysis in conjunction with my ongoing research about the role of rift tectonics on the geomicrobiology of springs and groundwaters. I am a Co-PI on the E-MRGE GK12 program with Scott Collins and was Co-PI on the recent Freshwater Sciences IGERT with Cliff Dahm.

Cliff Dahm - (Professor, Biology). I am an ecosystems ecologist with a background in aquatic ecology, chemistry, and oceanography. My research interests include interactions between surface and groundwaters, and climate dynamics and ecosystem responses, with emphasis on riverine landscapes. REU students could work on projects along the Rio Grande, Rio Salado, and Rio Puerco. Infrastructure studies include groundwater well fields, eddy covariance flux systems, water quality networks, ongoing riparian zone restoration projects, culture independent techniques for studying microbial communities, and analytical facilities for biogeochemical studies. REU students could participate in research on the water use of native and non-native riparian plant communities, the impact of riparian zone restoration on water use, biogeochemical processes along flow paths in shallow alluvial aquifers, the geomicrobiology of rift valley springs and seeps, and the fate of nutrients in river water along an urban and agricultural riverine corridor. I was PI on the Freshwater Sciences IGERT with Laura Crossey.

Joseph Galewsky – (Assistant Professor, EPS). My research focuses on the links and feedbacks between Earth’s land surface and climate. There is evidence for multiple scales of feedbacks in the Desert Southwest between plant ecology, soil hydrology, and summertime climate. Undergraduate students working with me would be able to synthesize a variety of data sources and numerical model approaches to better understand these links. My research is inherently interdisciplinary, so students working with me would develop skills in meteorology, climate, hydrology, and numerical modeling.

David Gutzler - (Professor, EPS). I study the processes that govern climate variability and change on seasonal and longer time scales, the predictability of climate derivable from such processes, and impacts on society of climate variability and change. Since 1995 much of my research has been focused on Southwestern North America, with particular emphasis on the North American monsoon circulation. I would work with REU students on projects involving the Sevilleta LTER's extensive meteorological database. Such projects could examine local climate-vegetation or climate-landscape interactions, or could tie locally observed variability of flora and fauna to large-scale atmospheric processes (e.g. moisture transport) and climatic fluctuations.

Marcy Litvak – (Assistant Professor, Biology). Semi-arid ecosystems are characterized by long periods of drought separated by precipitation pulses. I am currently measuring whole ecosystem responses to

precipitation pulses in desert grass, shrub, and woodland ecosystems using tower-based micrometeorological techniques. Detailed physiological studies of the dominant components of the ecosystem (soil respiration, leaf-level gas exchange, and chamber measurements of net ecosystem exchange) are used to interpret ecosystem-scale responses. Potential REU projects include quantifying how various ecosystem components respond to changes in light availability, soil moisture, and



Figure 3. Research foci of the Sevilleta LTER and REU research mentors.

temperature. These will provide hands-on training in established techniques used commonly in the fields of physiological ecology and ecosystem ecology.

Timothy Lowrey (Professor of Biology, Regent's Lecturer, Curator of the Herbarium). I focus on the reproductive biology and evolutionary systematics of arid land vascular plants. Students could work on a wide range of projects utilizing the varied plant communities encountered at the Sevilleta LTER.

Diane Marshall – (Professor, Biology). My expertise is in plant reproductive ecology using field, greenhouse and lab studies. A major emphasis of my work uses paternity analysis to elucidate male reproductive success. I teach students to use sound, interesting experimental designs, strong statistical analysis, and how to put their work in a larger context.

Grant A. Meyer – (Associate Professor, EPS). I am a geomorphologist with expertise in hillslopes and fluvial systems, and specific interests in the geomorphic effects of forest fires; natural and anthropogenic influences on fluvial systems, including downstream effects of dams, and vegetative controls on bank erosion and channel morphology; impacts of Holocene climatic change on geomorphic processes and landscapes; microclimatic and vegetative controls on slope erosion; and geomorphic controls on ecosystem processes. Undergraduate research in geomorphology at the Sevilleta LTER will familiarize students with the fundamentals of designing and carrying out an independent research project. In addition, REU students can learn a variety of field and laboratory skills including GPS and laser-based surveying techniques, collection of sediment and soil data and lab analysis, streamflow data collection, computer analysis of topographic and geomorphic data, and writing of effective scientific reports.

William Pockman – (Associate Professor, Biology). My research addresses the role of plant physiological processes in determining species distribution and abundance and by extension the effect of plant responses to the environment on ecosystem function. These projects manipulate some combination of precipitation, temperature and nutrient availability to assess likely responses to climate change. REU students will find many opportunities to develop their own projects within or outside the context of these ongoing studies.

Zachary Sharp – (Professor, EPS). My research covers all aspects of stable isotope geochemistry and biochemistry. I have conducted studies on a range of topics, including bird migration, soil carbonates and gases, meteorites, volcanic gases, metabolic transfer of ultrafine particles throughout the body, to name a few. Our laboratory is set up for the routine analysis of the common stable isotopes of most organic and inorganic materials.

Robert Sinsabaugh – (Professor, Biology). The focus of my research is the organization of microbial communities in relation to the ecological processes of decomposition and element cycling. As part of the Sevilleta LTER program our lab has described the composition and distribution of microorganisms and measured rates of carbon and nitrogen transformation and translocation in desert grassland. This information contributes to the development of ecosystem models that better represent the dynamic responses of aridlands to global climate changes.

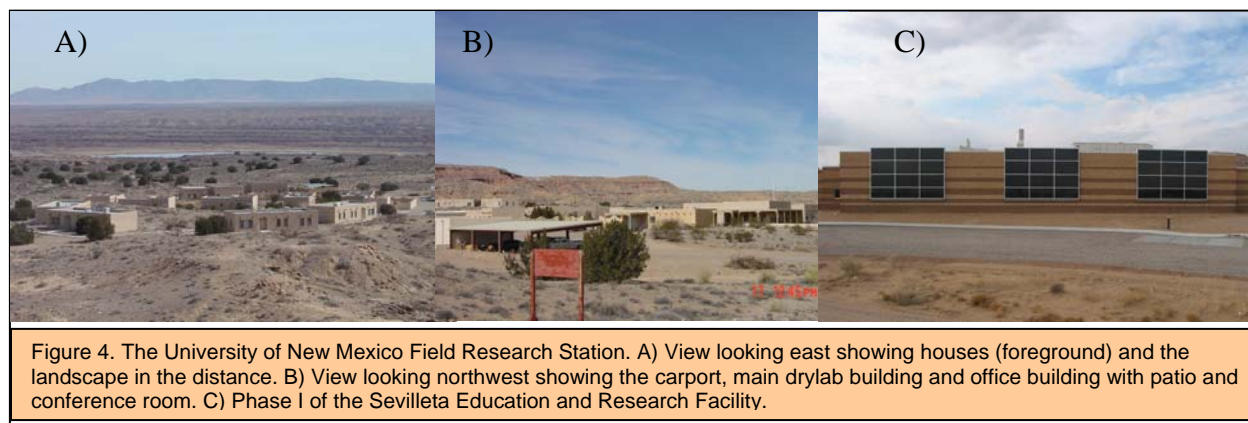
Felisa Smith – (Associate Professor, Biology). My research aims to understand why organisms are the size they are, what the ecological and evolutionary consequences are of being a certain size, and the complex and dynamic tradeoffs between physiology, life history, environment, phylogeny, and past history, all of which interact to influence the ultimate size of an organism. Ongoing studies include contemporary examination of life history tradeoffs of populations in extreme environments, to examination of the local and regional adaptation of animals to late Quaternary climate change, to comparisons of continental and global distributions of mammals over the past 50 million years.

Eric Toolson – (Professor, Biology). The approach I take to mentoring students is motivated by my philosophy that a summer REU field research experience affords the opportunity for students to experience a certain degree of independence in the design and implementation of ecological experiments, and should foster development of a student's own critical thinking skills. Accordingly, after I provide a thorough on-site introduction to the system I have selected for study, I give my student a minimal set of

instructions and allow him/her to formulate an initial research plan. Subsequent discussion is used to refine the proposal, but I step in with suggestions only as necessary. Finally, since I teach mathematical biology, I am ever alert for opportunities to introduce students to the possibility of incorporating modeling into their summer's research.

Blair Wolf – (Associate Professor, Biology). (Associate professor of Biology, currently a senior scientist with the Sevilleta Long-Term Ecological Research Program). I investigate how short and long-term climate variability affects productivity and the dynamics of resource use by consumers. My work also looks at the physiological ecology of animals and the importance of specific resources to consumer nutritional ecology and energetics.

C.4. Facilities and Equipment.



The UNM Sevilleta Field Research Station. Established in 1990, the UNM Field Station has eight comfortable residences for visiting scientists and students (Fig. 4). Each residence accommodates six persons. The residences have fully equipped kitchens with reverse osmosis drinking water, linen service, clothes washers, dining, and living areas. Wired (T1) and wireless internet access is available throughout the Field Station. Plans are underway to expand our guest capacity to 92 by adding dormitory housing by late 2008.

The new, state-of-the-art UNM Sevilleta Education and Research Facility (SERF) is an incomparable laboratory facility. Phase I construction (ca 10,000 sq ft) was completed in 2007. Phase II construction (ca 10,000 sq ft) will be finished in late 2008. The completed facility will include research and teaching labs for work in animal and plant physiology, molecular biology, infectious diseases, environmental sensing, and plant, water and soil chemistry. Phase II will also include a computer and information management training lab, an institutional kitchen, a conference room, and space for plant and animal voucher collections, in addition to support rooms and equipment (growth chambers, autoclaves, high-purity water, etc.). When complete, SERF will provide an outstanding facility for lab-based REU research.

In addition to SERF, the Field Station has: (1) a laboratory facility with two general dry labs, an entomology collection room, a small herbarium, two offices, and a conference room with spacious outdoor patio; (2) a computer center with 23 independent carrels, each equipped with a desktop computer, and a library with an extensive reference collection of books and journals on ecology, zoology, geology, soils, and climatology; and (3) a dry lab building used for plant and soil processing and as a staging area for construction of small equipment items employed in field studies. This laboratory has deionized and ultra-pure water production with a 100-gallon

storage tank for purified water, open laboratory benches, medium and high temperature drying ovens, a range of scales and glassware, and storage space for specimens. It is also equipped with a wide variety of power and hand tools and construction equipment and supplies. Also, it has (4) a storage building that houses research equipment, archived samples, supplies and tools.

D. Student Recruitment and Selection. In A.2 above, we described our targeted student population, identifying the demographics of recruitment partners (Diné, NAU, UTEP, UNM, SEEDS) to help us attract underrepresented students to the Sevilleta LTER REU Site Program. The PIs will work closely with Jennifer Johnson on student recruitment and selection.

D.1. Student Recruitment. Our recruitment plan is modeled on our successes during the past two summers. Recruitment brochures and notices will be distributed nationally, with special emphasis on ESA SEEDS, and our REU contacts at Diné (Navajo) College (Marnie Carroll), Northern Arizona University (Nancy Johnson), University of Texas at El Paso (Craig Tweedie), and our home departments at UNM. We will target college freshman through juniors interested in conducting summer research in one of the fields offered by prospective mentors at the Sevilleta LTER. Our recruitment plan will emphasize (but is not restricted to) underrepresented minority students from our cooperating partners, as well as students from other institutions nationwide. We will ask our contact persons to post notices, inform individual students, and announce this opportunity at appropriate events at their institutions. We will also distribute the notice by email to UNM Biology and EPS undergraduate student listservs and announce opportunities in our classes. The PIs and Program Manager will communicate and provide program information by email, and answer questions from prospective students. Although we have had excellent success with our recruiting efforts in the past, experience suggests that recruitment of minority students occurs best through personal contact and outreach visits. Therefore, we will conduct personal visits to our regional partner institutions and ESA SEEDS each year. In fact, Collins has already scheduled a visit to UTEP for spring 2008 and a regional SEEDS Chapter meeting to be held at NAU is being planned for this spring, as well. As in the past we will use the Sevilleta LTER website to post potential research topics along with the list of faculty mentors, program activities, application guidelines, and application forms.

D.2. Student Selection. To apply, students will submit their application packets, including the application form, statement of research interests and career plans, a list of three references, contact information, and copy of their transcripts, to Program Manager Johnson. To qualify, students must have a minimum 2.5 GPA, have expressed an interest in a STEM field, and be a citizen or permanent resident of the US. Jennifer Johnson will review the applications to ensure completion. For those who meet the qualifications and have appropriate research interests, she will speak with their references and ask them to complete the reference form. Collins, McFadden and Johnson will then select the students for the program, using the following criteria (1) academic credentials, (2) statement of research interests, (3) references, and (4) the availability of research projects and mentors. When the students (and alternates) have been selected, Johnson will send notices of acceptance with information packets. Johnson will then ask the selected students to choose up to three research areas or projects they would like to work on, and will facilitate the communication between students and mentors about potential research projects and help them to make the decision about which project to pursue.

E. Project Evaluation and Reporting. To the extent we can, it is important to assess the program and students' success rates following their participation in our REU Site Program. A comprehensive evaluation with follow-up data will enable us to detect changes in long-term trends with all students who participate in our program. We are most interested in learning about the fate of our underrepresented minority students and their level of comfort with the science community and environment.

E.1. Comprehensive Assessment. Evaluation will be formative and summative, by gathering qualitative and quantitative information from students, faculty, graduate students, and staff, to assess the success of the program in achieving our goals, and to enable us to make changes as needed while we implement the program. Formative evaluation will begin early and will continue throughout involving pre- and post-program assessment to identify whether the program is making a difference in the students' knowledge, skills, and interest in graduate level study. It also reveals areas in which relationships, among the partnering institutions, students and faculty mentors, can be improved as well as highlighting strengths of the program that should be preserved. The formative evaluation will reveal areas in which relationships among the recruiting partners (as well as among students and mentors), and staff support require improvement or to highlight strengths that should be preserved or expanded. These results will provide information for the summative evaluation as the basis for the final report that will be prepared at the end of the project.

The summative evaluation will measure the program's ultimate success in meeting its goals and objectives: the strength of the recruitment and mentoring relationships, the various student activities, and the level of success of the program in motivating students to pursue graduate studies or employment as an environmental scientist. For this review all participants will be asked to submit an anonymous program evaluation assessing all aspects of the program, and inviting suggestions for improvement. Student participants will also be interviewed individually so they can provide suggestions, and to field any questions they may have.

E.2. Post-Program Tracking and Analysis. We will track the students beyond their participation in this project. To gauge the extent to which the Sevilleta LTER REU Site experience influenced our students, we expect each mentor to contact their students at the end of each academic year, as part of their own academic tracking process, and to update the PI about the status of each student. This will involve tracking their progress through graduation and any postgraduate activities. We will compile data not only on their graduate training and, if possible, on their long-term career accomplishments (e.g., positions attained, publications, grants funding, etc.).

E.3. Dissemination of Results. Our annual reports to NSF will describe recruitment activities, research and training experiences of the students, and assessment of the impact of these components as part of the overall program and outcomes. Annual reports will be posted on the Sevilleta LTER website and will be used as supplementary materials in future years for prospective REU students. We will share the results of our experiences at national science education conferences, forums, and in publications. We will also seek to continue the project beyond the three-year funding period.

Ethics in Science Component for Sevilleta LTER REU Site

The Sevilleeta LTER REU Site Program will include an ethics component that introduces students to issues involved in research, including advisor/advisee roles in REU and advanced degree programs; collaboration, data sharing, and intellectual property; experimentation on living organisms and experimental use of invasive species; the peer review and publication process; and relationships between scientific findings and environmental policy and advocacy. Ethical issues will be addressed in weekly 2-hour focused seminars and workshops, as well as during a campus visit to UNM. An Ethics Instructor will be hired to implement the Ethics in Science component. This individual will have doctorate-level training in an appropriate field, and experience teaching undergraduates about the foundations of ethics and responsible conduct in research. The texts to be used for this component are *Research Ethics* by Deni Elliott and Judy E. Stern (Eds), University Press of New England, 1997; the *Students' Guide to Research Ethics* by Paul Oliver, Open University Press, 2004. and ORI "Introduction to RCR" by Nicholas Steneck.

A. Seminars. Students will be assigned materials from the textbooks and articles and each student will present a specific topic at each seminar and participate fully in the discussions. The topics will include:

A.1 Introduction to Research Misconduct. We will first introduce our REU students to the History of research ethics - The Nuremberg Code, Directives for Human Experimentation; Hippocratic Oath; The Belmont Report, April 18, 1979; and the Declaration of Helsinki, World Medical Association. We will then provide an overview of the issues that comprise research ethics, and students will discuss the basis for determining whether a breach occurred, specifically the sources for definitions, regulations, procedures for handling allegations, and historical cases. Students will read the National Academy of Science Booklet, "On Being a Scientist: Responsible Conduct in Research," and cover the following topics: Current Guidelines and Federal Regulations:

"Federal Policy on Research Misconduct" – OSTP; "Research Misconduct" 45 CFR 689 – NSF;

"Key Regulations: Misconduct in Science and Engineering and Research Misconduct" – NSF

"Misconduct in Science Policy" - Public Health Service Office of Research Integrity (ORI)

"Policy on Plagiarism" – ORI

"Whistleblower's Bill of Rights and Guidelines for Institutions and Whistleblowers" – ORI

"Integrity and Misconduct in Research," Report of the Commission on Research Integrity, 1995

UNM Research Policies and Procedures: Students will learn all research institutions monitor research with directives such as UNM's "Research Misconduct Policy," and IACUC and IRB review panels.

Online Instructions: Students will also learn about several sites on the web that provide additional information about research ethics and the responsible conduct of research. We will encourage them to take time to look these over, especially the online ethics instructional modules," such as the "Research Ethics Modules" of the North Carolina State University.

A.2 Conflict of Interest and Peer Review of Manuscripts and Grant Applications. Our REU students will learn the importance of understanding and avoiding conflicts of interest both in the conduct of research, and in processes for peer-reviewed publishing and extramural research funding awards. Among the documents they will review are "Academia, Industry, and the Bayh-Dole Act: An Implied Duty to Commercialize," the AAU Reports on Individual and Institutional Financial Conflict of Interest, "Various Policies on Conflict of Interest and Extramural Commitments and Consulting," "Council of Science Editors Conflicts of Interest and the Peer Review Process," and responsibilities for ensuring objectivity by editors and authors, grantors and grantees.

A.3 Research Involving Human Subjects. Numerous complex ethical issues arise with human subjects research and, although our REU students will not conduct research that involves human subjects, we believe a research ethics course should include materials on this subject. They will be introduced to the various issues when using human subjects in research, such as ensuring health, safety and confidentiality;

the mental capacity (children, mental illness) and informed consent; use of human genetic materials, and respecting cultural differences. Building on the first session history lesson, we will talk about the role of Institutional Review Boards; what IRBs must review before research begins; and various directives: Guidebook and directive (45 CFR 46) on the Protection of Human Subjects from the DHHS Office for Human Research Protections; Protection of Participants in Behavioral and Social Science Research; NIH's kiosk on Confidentiality; Research on Human Specimens: Are You Conducting Research Using Human Subjects? and NAP's Responsible Research: A Systems Approach to Protecting Research Participants.

A.4 Research Involving Animals. Discussion in this seminar session will cover a broad range of issues in the ethical use and treatment of animals in research, focusing on four questions. Each student will be assigned to present an overview of the role or position of an organization for each question. First, the question, "Why use animals in research" will be discussed in the context of advances in science (human and animal) using the materials posted by the American Physiological Society, "Questions People Ask about Animals in Research." Second, the related question, "Are there alternatives to the use of animals in research" will be considered in light of positions held by various organizations, including Americans for Medical Progress, Foundations for Biomedical Research, Johns Hopkins University Center for Alternatives to Animal Testing, UC-Davis Center for Animal Alternatives, and the Humane Society. Third, an overview will be given of the kinds of ethical issues that can arise in the use of animals and research, and the role of regulation. Finally the question, "How do we ensure the humane care and use of laboratory animals" will be discussed noting the roles of several regulatory bodies and measures. These will include the Animal Welfare Act of 1966, The Health Research Extension Act of 1985, the NIH Office of Laboratory Animal Welfare (OLAW) policies in the "Institutional Animal Care and Use Committee Guidebook," the "Animal Welfare Act," the USDA's Animal and Plant Health Inspection Service and the Animal Welfare Information Center, the National Academy of Science Institute for Laboratory Animal Research, the National Research Council's Guide for the Care and Use of Laboratory Animals, and the roles of the Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC) and the American Association for Laboratory Animal Science (AALAS). To exemplify how institutions meet these guidelines, students will review the roles of the UNM Office of Animal Research Ethics, Care, and Compliance (OARECC), and the UNM Guidelines for Ethical Conduct in the Care and Use of Animals

A.5 Collaborative Research and The Advisor/Trainee Relationship. This seminar will cover various issues that can arise in student-student, student-faculty mentor, student-other faculty/postdoc relationships. We will encourage the Sevilleta LTER REU Site mentors (faculty, postdocs and graduate students) to participate by presenting brief scenarios of positive and negative encounters. All participants will review the responsibilities of students, advisors, post-doctoral fellows, mentors and others toward one another and toward creating an environment that promotes responsible conduct in science. They will also be made aware of the CGS Guidelines for Mentoring Student, and the guidelines posted by the Association for Women in Science (AWIS), and the prerequisites for conflict resolution.

B. Workshops. Students will be introduced to technical details in the process of conducting research and disseminating results. Students will read relevant materials and then will have opportunities to identify (and rectify) discrepancies and other issues in data management, financial management, research safety, and in publication of results. Workshops will cover the following topics:

B.1 Data Management. Our REU students will learn about responsible data collection, recording, retention, and analysis; data ownership and access; intellectual property rights and responsibilities--patents, trademarks, copyright. This will include reviewing the "Ethical Guidelines regarding Statistical Practices," and noting that most research institutions have policies regarding these issues.

B.2 Research Safety. Our students will learn about responsibilities for safety that investigators assume in conducting research and for research results; legal issues in using new technology, and creating entities and substances in the laboratory; how to prevent risks when using high-risk (hanta virus, etc.) organisms in research, and about the roles in ensuring research safety of the UNM Biohazard Compliance Office.

B3. Financial Management. Fiscal responsibility in implementing funded research is also a topic that our REU students will address. This will be presented in conjunction with their introduction to the world of extramural funding. They will learn about the function of the NIH Grants Policy Statement, the NSF Grant Policy Manual (and the Grant Proposal Guide), how fringe benefit and F&A rates are established and the use of F&A funds at institutions, and the obligation of investigators to report results of research and use of the funds to the organization that provided financial support. Examples of how institutions communicate with faculty researchers about these grants topics, students will view the “UNM Guide for Principal Investigators,” and the “UNM Business Policies and Procedures Manual,” plus documents outlining the UNM F&A rate agreement, and fringe benefit rates on proposals.

B4. Responsible Authorship and Peer Review for Publication. The primary ethical issues that students will learn about include avoiding plagiarism and giving due credit for others’ published works, research and ideas; avoiding redundant publication of the same results; honoring copyright; meeting accepted guidelines on authorship credit (identifying who did what) and authorship order on co-authored papers; and avoiding skewing the data to suit preconceived objectives for documenting the results. They will review relevant cases and documents such as the Office of Research Integrity Policy on Plagiarism.

B5. Responsibility to Society. Our REU students will learn that the authority and impetus as well as most resources for research come from the public domain, and that this requires accountability on the part of researchers who benefit. Among the obligations they will learn about – through case studies and news reports - are truth in reporting how funding was spent and the results, not being influenced by corporate interests; the obligation to report the results and how it will benefit (or harm) the public and society at large; and why, how, and what to communicate to the public through the media, noting the Research!America approach to educating the public about benefits of science.

C. Campus Tour. Among the activities of our REU Site Program, students will tour the UNM campus. During these tours, staff at designated locations will augment the Ethics Component by speaking with REU students about the following topics: Copyright, plagiarism - Zimmerman Library; Scientific writing, collaborative research, coauthoring - Centennial Science & Engineering Library; Human subjects research - Institute of Ethics; Conflict of interest: Pauline M. Cupit-Cunningham, Conflict of Interest Specialist; IRB, IACUC: Bill Gannon, Director of Campus IRB and UNM IACUC; Animal care and use: Kevin O’Hair, Campus Veterinarian; Intellectual property – Mary Ann Copas, STC IP Coordinator; Biosafety Compliance – Timothy Muller, Biosafety Specialist; Cultural issues in research - Maxwell Museum; and Other ethical Issues in the Laboratory - Museum of Southwestern Biology, in two or more of the nine divisions: Amphibians & Reptiles, Arthropods, Birds, Fishes, Genomic Resources, Herbarium, Mammals, USGS Vertebrate Collection, and Natural Heritage New Mexico.

D. Formative Evaluation Plan. The REU Site Evaluation Plan will assess the Ethics Component while it is being implemented to determine if these activities are accomplishing the overall goal to inform our REU students about the various issues in Research Ethics. It will also determine whether the proposed activities occurred and the extent to which students found these engaging and informative, and whether the selected topics—and related materials and speakers—were effective in presenting these topics. The results of these evaluations will be included in the Evaluation Reports for the Sevilleta LTER REU Site Program that will be prepared for the PI, Co-PI and NSF REU Program.