2007 RESEARCH PERMITS

Charles Schelz / SEUG Ecologist

ARCHES NATIONAL PARK

2007 Research Permits

1) Permit #: ARCH-2007-SCI-0001

Study Title:
THE MOAB SITE ENVIRONMENTAL AIR MONITORING PROGRAM - CONDUCTED BY THE U.S. DEPARTMENT OF ENERGY'S OFFICE OF ENVIRONMENTAL MANAGEMENT LOCATED IN GRAND JUNCTION, COLORADO.

Primary investigator contact information:

Name: Mr. Joel Berwick, U.S. Department of Energy (DOE)
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Project Summary:
DOE's environmental air monitoring program will monitor local and background air quality for various radio-particulates (U-nat, Th-230, and Ra-226), radon-222, and opacity (i.e., fugitive dust emissions). This project was initiated following concerns the Atlas tailings pile might be contributing to declining air quality.

Collections:
Only air samples will be collected at a station set up near the Arches visitor center. No other sampling allowed.

2004 Findings and Status:
Monitoring data collected during 2004 indicate that concentrations of airborne radioparticulates (i.e., Po-210, Ra-226, Th-230, and natural [total] Uranium), atmospheric radon-222, and direct gamma radiation levels observed at the Arches National Park monitoring location are indistinguishable from background (naturally occurring) concentrations and levels. None of the 2004 data collected at this location exceeded any regulatory limit, threshold, or guideline that is applicable to this study. The uranium mill tailings stockpiled at the former Atlas mill site (located approximately 0.75 miles south of the Arches National Park entrance) do not appear to have any significant impact upon air quality and public radiation dose/exposure levels, as measured at the entrance to Arches National Park. DOE is required to conduct environmental monitoring and surveillance at sites where DOE activities have the potential to release contaminants to either the public and/or the environment. DOE will continue to monitor air quality and public exposure limits at this location to document negative exposure and public impacts, and to better understand variations in seasonal air quality conditions.

2005 Findings and Status:
Monitoring data collected during 2005 indicate that concentrations of airborne radioparticulates (i.e., PO-210, Ra-226, Th-230, and natural [total] Uranium), atmospheric radon-222, and direct gamma radiation levels observed at the Arches National Park monitoring location are indistinguishable from naturally occurring concentrations and levels. None of the 2005 data collected at this location exceeded any regulatory limits, thresholds, or guidelines that are applicable to this study. According the measurements taken during this reporting period at the monitoring station near the park entrance, the uranium mill tailing stockpile at Moab UMTRA Project site (located approximately 1/2 mile south of the Arches National Park entrance) does not appear to have any significant impact on the air quality or public radiation dose and exposure levels. DOE is required to conduct environmental monitoring at sites where its activities have the potential to release contaminants to the public and/or to the environment. DOE will continue to monitor the air quality and public exposure limits at this location for the duration of the Moab UMTRA Project to document any exposure impacts and to better understand variations in seasonal air quality conditions.

2006 Findings and Status:
Monitoring data collected during 2006 indicate that concentrations of airborne radioparticulates (i.e., PO-210, Ra-226, Th-230, and natural [total] Uranium, atmospheric radon-222, and direct gamma radiation levels observed at the Arches National Park monitoring location are indistinguisable from natural occuring concentrations and levels. None of the 2006 data collected at this location exceeded any regulatory limits, thresholds, or guidelines that are applicable to this study. According to the measurements taken during this reporting period at the monitoring station near the park entrance, the uranium mill tailing stockpile at Moab UMTRA Project site (located approximately 1/2 mile south of the Arches National Park entrance) does not appear to have any significant impact on the air quality or public radiation dose and exposure levels. DOE is required to conduct environmental monitoring at sites where it's activities have the potiential to release contaminants to the public and/or to the environment. DOE will continue to monitor the air quality and public exposure levels at this location for the duration of the Moab UMTRA Project to document any exposure impacts and to better understand variations in seasonal air quality conditions.

2) Permit #: ARCH-2007-SCI-0002

Study Title:

SOIL SURVEY OF ARCHES NATIONAL PARK, UTAH

Primary investigator contact information:

Name: Mr Victor Parslow, USDA Natural Resources Conservation Service
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Project Summary:
To provide an updated soil and ecological site inventory for Arches National Park (ARCH), that meets National Cooperative Soil Survey (NCSS) standards and park management and planning needs.

The existing soil survey was conducted in the 1970s's and the early 1980's as part of the Henry Mountains, Utah soil survey and the Arches Soil Survey. These inventories was primarily designed as a tool for use in managing grazing lands and has been found to be too general to be useful in managing the park. Information is insufficient to model salt movement, mitigate visitor impacts, identify and protect habitat of Threatened and Endangered species, and other park responsibilities.

In 2003, reprensentatives of the National Park Service approached the Natural Resources Conservation Service to update the existing soil surveys within Arches and Canyonlands National Parks and Natural Bridges and Hovenweep National Monuments and the Orange Cliffs section of the Glen Canyon Recreation Area. The Plan of Work and contract were approved in 2004. This application is seeking permission to carry out the field work necessary to complete the contract.

Collections:
Soil sampling allowed: 200 to 300 gram soil samples only. Archeologist must be present when digging any holes in ground. Some clipping of vegetation is allowed but must be kept to a minimum. Majority of soil samples will be destroyed in analysis. No collection of plants is allowed. Photos of plants for identification purposes is allowed.

2006 Findings:
The Natural Resources Conservation Service (NRCS) began field work to provide an updated soil and ecological site inventory for Arches National Park in 2005. This is a summary of the activities for the year 2006: 1. Soil inventory activities Soil survey activities were conducted in Arches National Park in 2006. Traverses and transects of the landscape were conducted, and soil descriptions and plant inventory data recorded, in order to further develop the soil-plant-landscape-geology models which will be essential to the completion of the update of the Soil Survey and Ecological Site Descriptions. 241 soil/landscape observations were documented in FY 2006, and soil samples were collected from 175 of these locations. These samples have been catalogued, and are stored in the Richfield USDA Service Center. Field activities are substantially complete in the park, data is being analyzed, and a report is in the process of being produced. 2. Dynamic Soil Properties (DSP) Pilot and Study Data and soil samples were collected during a pilot study on randomly selected plots (20 m by 20 m) in Arches National Park during calendar year 2005. These soil samples were sent to the National Soil Survey Laboratory in Lincoln, Nebraska for characterization. The lab analysis is complete on these samples. Other data collected consists of soil aggregate stability, herbaceous and woody production, plot vegetation/erosion patterns, and canopy and basal gap of the plant community. Lab and other field data collected are now being analyzed, and this data, along with conclusions/study summary, will be made available to the Park at the earliest possible date. 3. Archaeological Activities As a result of the field work of 2006, fifty-one archaeological sites as well as nine isolated occurrences were recorded in Arches National Park. Diagnostic artifacts were collected from three sites. Details of these resources including locations and descriptions of their contents can be referenced in a more complete report, Summary Report of Cultural Resources Support Provided to the Soil Surveys Of Natural Bridges National Monument, Arches National Park, Canyonlands National Park and Hovenweep National Monument For the Year 2006, at the SEUG office in Moab, Utah. All cultural resources were successfully avoided. No cultural material was unearthed during the course of soil sample collection. 4. Geophysical Field Study July 31 through August 4, 2006, a special study was conducted in Arches and Canyonlands National Parks utilizing remote sensing equipment to assist in characterization of the soils in the parks. Ground penetrating radar and EM38 meters were used to help characterize bedrock and electrical conductivity patterns in the parks. This data is currently being analyzed in order to provide a summary to the Park.

3) Permit #: ARCH-2007-SCI-0003

Study Title:

IMPACTS OF CLIMATIC CHANGE AND LAND USE ON THE SOUTHWESTERN U.S.

Primary investigator contact information:

Name: Dr. Jayne Belnap, USGS, Canyonlands Field Station
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Project Summary:
The population of the southwestern United States has grown rapidly over the past two decades and is projected to increase greatly over the next several decades. As the population has grown, climatic variations that would have affected relatively few people in the past will impact the lives of millions. Rapid and wide-spread climatic changes, such as those seen thousands and hundreds of years ago in the region and those projected for the future, may profoundly change the character of the region. Arid and semi-arid regions of the southwestern U.S. are among the most sensitive regions to changes in climate and land use, but the potential interactions between climatic change and land use are largely unknown (http://climweb.cr.usgs.gov/info/sw_new/swmap.html).

U.S. Geological Survey and collaborating scientists are seeking to understand how climate and how land use have influenced surficial geologic processes that modify landscapes and ecosystems. Such understanding is then used to model the landscape's response to future changes in climate and land use over time scales of seasons, of a few years, and of a few decades, so that information and interpretations can be applied by federal, state, and local agencies, as well as by Native American governments, for their land-use planning and management of resources.

Project scientists work with ecologists, hydrologists, geographers, cartographers, and archeologists to address questions about (bold titles indicate activity at Canyonlands and Arches National Parks):
(1) the causes and timing of changes in alluvial environments (rivers, streams, hillslopes), such as flooding, the cutting and filling of arroyos, and sediment discharge;
(2) the role of eolian dust for soil fertility, invasion of exotic species, hydrology, and surface stability in deserts;
(3) the interaction of physical and biologic processes critical for ecosystem functions;
(4) how climate in the southwest has varied over decades, centuries, and millennia;
(5) how future climatic variations will affect the Southwestern land surface (in terms of erosion, sand-dune activity, dust-storm frequency, flooding, landslides,);
(6) how past climatic changes and environments affected prehistoric cultures.

General Project Goals
1 Understand how past climatic change affected land surface: soil loss, fluvial erosion and alluviation, sand-dune mobilization, ecosystems, under time frames of past decades, centuries, and millennia.
2 Understand today's interplay among climate, land use and surface processes (geologic and ecologic).
3 Understand the impacts of future climate on land surface under the following time frames: seasons; El Nino/La Nina cycles; multi-year wet/drought periods; and decades, as atmospheric CO2 increases.

A major goal is to interact with federal, state, and local government agencies as well as non-governmental organizations to provide information useful for management decisions regarding land-surface vulnerability to wind erosion. Another goal is to provide to managers and other

parties ongoing remote sensing and meteorological monitoring bearing on the vulnerability of the land to natural and human disturbances.

Specific goals for Arches NP work

1 Understand geologic origins of soil nutrients and the interactions of soil compounds and plants.
2 Understand geomorphic controls on plant distribution
3 Understand the recent (past several decades, centuries, millennia) geologic/geomorphic evolution of the ecosystem to reveal patterns of surface stability and instability.
4 Recognize areas vulnerable to wind erosion and soil loss.
5 Understand conditions of cheatgrass (and other exotic plants) invasion to predict areas most vulnerable to expansion and to help devise mitigation strategies.

Collections:

Only the collection of eolian dust is allowed. This will be destroyed in analysis. Research activities will take place in study sites in Cache Valley and the Devils Garden Maintenance Area.

Logistics:

Dust samples will be collected periodically by USGS-Moab Station staff. No assistance from park staff is needed.

2005 Findings and Status:

Report from USGS Project Effects of climatic variability and land use on American Drylands.

The project conducts research on linkages among geologic substrates and their origins; biogeochemical nutrient cycling; weathering of substrate; soil moisture and water infiltration; weather events and climate; surface dynamics, including erosion; as well as past and current land uses. A large component of research is devoted to understanding how geologic substrates influence plant community distributions, including the distribution of cheatgrass and other invasive plants. Another focus is on the effects of historical grazing on soil nutrients. Substantial progress has been made in both topics as summarized in publications listed below that are available at the project website. Progress has also been made in developing remote sensing techniques to track invasion of Park lands by invasive plants. Another major effort last year resulted in publication of a document that describes conceptual models for dryland ecosystems to inform the vital signs selection process. Much project work is designed to address land-management priorities.

Activities of work done in and near Canyonlands National Park are summarized in the project website http://climchange.cr.usgs.gov/info/sw/index.html

Project members completed several studies that resulted in publications.

Multi-decadal impacts of grazing on soil physical and biogeochemical properties in southeast Utah
J.C. Neff, R.L. Reynolds, J. Belnap, and P. Lamothe, 2005, Multi-decadal impacts of grazing on soil physical and biogeochemical properties in southeast Utah: Ecological Applications, 15(1), 2005, pp. 87-95.

Atmospheric dust in modern soil on aeolian sandstone, Colorado Plateau (USA): Variation with landscape position and contribution to potential plant nutrients
R.L. Reynolds, J.C. Neff, M. Reheis, P. Lamothe, 2006, Atmospheric dust in modern soil on aeolian sandstone, Colorado Plateau (USA): Variation with landscape position and contribution to potential plant nutrients: Geoderma, v. 130, p. 108-123.

Late Quaternary eolian response to paleoclimate, Canyonlands, southeastern Utah
M.C. Reheis, R.L. Reynolds, H. Goldstein, H.M. Roberts, J.C. Yount, Y. Axford, L. Cummings, and N. Shearin, 2005, Late Quaternary eolian and alluvial response to paleoclimate, Canyonlands, southeastern Utah: GSA Bulletin, v.117, no. 7/8, p. 1051-1069.

2006 Findings and Status:
This study is ongoing, but periodic summaries are made and published. The following publications report findings from this study: Reynolds, R., J. C. Neff, et al. (2006). "Atmospheric dust in modern soil on aeolian sandstone, Colorado Plateau (USA): Variation with landscape position and contribution to potential plant nutrients." Geoderma 130: 108-123. Reynolds, R. L., M. C. Reheis, et al. (2006). "Late Quaternary eolian dust in surficial deposits of a Colorado Plateau grassland: Controls on distribution and ecologic effects." CATENA 66(3): 251-266.

4) Permit #: ARCH-2007-SCI-0004

Study Title:
CARBON AND NITROGEN CYCLES IN ARID LANDS: THE ROLE OF BIOLOGICAL SOIL CRUSTS AS INFLUENCED BY SOIL SURFACE DISTURBANCE, CLIMATE CHANGE AND ANNUAL GRASS INVASION

Primary investigator contact information:

Name: Dr Jayne Belnap, USGS Canyonlands Field Station
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Phone: 435-719-2333 **Email:** jayne_belnap@usgs.gov

Project Summary:
Models indicate the presence of a large carbon (C) sink at temperate latitudes in the northern hemisphere. Over thirty percent of lands both globally and in the United States consist of semi-arid or arid landscapes. Very little is known about carbon dynamics in these regions. Biological soil crusts, composed primarily of cyanobacteria, algae, lichens and mosses, can completely cover plant interspaces in undisturbed areas, and constitute 70 percent or more of the living ground cover. These soil crusts can be the dominant source of nitrogen (N) for vascular plants. They fix C at a high rate and are critical for soil stability and aggregate formation, which is important in C storage. They also absorb significant amounts of CH4. In areas where precipitation is low and soils have low fertility, native plants often rely on intact biological soil crusts to provide increased water and nutrient flow to the broadly scattered vegetation. Thus, there are many ways in which biological soil crusts influence biogeochemical cycles and the structure and productivity of the vascular plant community.
Soil surface disturbance, invasive plants, and climate change have the potential to dramatically alter the structure and function of biological soil crusts. The current combination of recreational use and livestock grazing is resulting in unprecedented levels of surface disturbance on many arid lands. In regions that did not have substantial amounts of surface disturbance in the Holocene, biological soil crusts disappear readily when trampled by animals or vehicles. Exotic annual grasses are invading many of these areas. Trampling and invasion results in reduced cover and changes in the species composition of biological soil crusts. This, in turn, leads to changes in processes such as decomposition, N and C fluxes, soil moisture, and nutrient availability to vascular plants. Decreases of only 1 percent of soil organic carbon in the top 10 cm of rangeland soils is equivalent to the total C emissions from all croplands nation-wide.

Changes in climate regimes, such as a shift in the summer monsoonal boundaries in the western United States, are expected to influence the composition and physiological functioning of biological soil crusts. Various crust components have different photosynthetic and respiration responses to temperature and moisture. In addition, different crusts have different methane fluxes. Therefore, changes in the timing or amount of temperature and precipitation is expected to alter soil C and N fluxes through changes in physiological response or crustal composition. This, in turn, can significantly impact vascular plant productivity.

This project will establish how alterations in species composition by surface disturbance, invasive grasses, and/or climate change may affect N and C inputs and fluxes, in different soils under different climatic regimes. Because current and expected changes in land use and climate will occur over millions of acres in western rangelands, impacts to soil crusts have the potential for dramatically affecting C cycles, N cycles, and vascular plant productivity over much of the western United States. In addition, semi-arid and arid ecosystems represent over one-third of the Earth's terrestrial surface, and most are covered by biological soil crusts. As human impacts are escalating both regionally and globally in these drier regions, the research questions posed in this proposal have significant implications for global C budgets as well.

Collections:
Soils from the top 10 cm of the soil surface will be collected using a small (<1" diameter) soil auger. At each site, approximately 20 auger samples will be haphazardly collected from an area approximately 20x20 m. Holes are small enough that they self-fill shortly after the disturbance. These samples will be taken once each year.

Activities will continue at the trample experiment plots established in 1994 in the area just north of Panorama Point.

All samples will be destroyed in analysis.

2005 Findings and Status:
STRUCTURE AND FUNCTION OF SOIL BACTERIAL AND FAUNAL COMMUNITIES AROUND A GRASS AND SHRUB AS INFLUENCED BY BIOLOGICAL SOIL CRUSTS . Vascular plants and soil crusts provide resources directly to soil bacteria and faunal grazers, and indirectly to other soil fauna that feed on them. Plants and soil crusts may also shape the structure and function of soil communities by controlling inputs of carbon, nitrogen, water and light into the soil. Because soil resource availability is expected to decline with decreased plant and crust cover, and differ by plant and crust type, we examined two plant and crust types to quantify underlying soil chemistry and bacterial and faunal communities. In two separate locations, containing both early successional (Microcoleus dominant) and later successional (Nostoc/Scytonema/Collema) soil crusts, we sampled three microsites (stem, dripline, and interspace) around a dominant shrub (Coleogyne ramosissima) and grass (Stipa hymenoides). Soil chemistry analyses revealed N availability typically was greater at the plant stem, while P availability was greater in interspaces around Coleogyne. Microsites closer to the plant had greater abundance of rhizosphere-dependent bacteria and nematodes, regardless of crust type. Soil protists, however, rarely differed by microsite in either crust type, indicating that soil crusts may more strongly influence their distribution than vascular plants. Abundance of soil biota also differed by plant species, with Coleogyne supporting more bacteria and fauna than Stipa. Overall, these results support the hypothesis that plants and biological soil crusts affect the structure and function of soil bacterial and faunal communities. Global change induced shifts in plant community composition or losses of biological soil crusts in the southwestern US will likely result in reduced soil nutrient cycling via declines in plants, biological soil crusts, and their dependent organisms.

2006 Findings and Status:
This study is ongoing, and we continue to collect data on an annual basis. Data have been entered and verified, but no compilation or analyses have been undertaken. As this study attempts to look at long-term consequences of human impacts, we want measurements taken from a large range of climatic variables in order to separate multiple stressors.

5) Permit #: ARCH-2007-SCI-0005

Study Title:

ANNUAL FOREST LAND INVENTORY OF UTAH.

Primary investigator contact information:

Name: Renee O'Brian
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Project Summary:
Gather long-term information on the quantity and quality of forest resources, growth, mortality, removals, and forest health. We will visit only two sites in Canyonlands National Park, located at : T 30-1/2S R18E Sec32, T 31S R 17E Sec18.

Collections:
Photographing plants for identification only. No specimens shall be collected. No coring of trees allowed.

2005 Findings and Status:
The Annual Forest Land Inventory of Utah project is an ongoing natural resource inventory. Results of the inventory are periodically updated and made available at www.fs.fed.us/rm/ogden.

2006 Findings and Status:
The Annual Forest Land Inventory of Utah project is an ongoing natural resource inventory. Results of the inventory are periodically updated and made available at www.fs.fed.us/rm/ogden.

6) Permit #: ARCH-2007-SCI-0006

Study Title:

RIPARIAN AND AQUATIC INVERTEBRATE MONITORING PROTOCOL AND DEVELOPMENT (NPS I&M PROGRAM)

Primary investigator contact information:

Name: Dr Anne Brasher, USGS, Water Science Center
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Project Summary:
The objective of the study is to develop a rigorous, well-integrated set of protocols for long-term riparian and macroinvertebrate monitoring across the Colorado Plateau. Another objective is to evaluate the utility of aquatic macroinvertebrates and riparian ecosystems as reliable indicators of aquatic ecosystem conditions in dryland systems characteristic of the Colorado Plateau.

Collections:
In general, macroinvertebrate samples are destroyed during analysis. Upon arrangement with the Park curator, a voucher collection from the sampling effort can be maintained at an established (museum) location following NPS repository standards.

Only the collection of aquatic invertebrates allowed. All will be destroyed in analysis.

2005 Findings:

No activity was conducted during this report year.

2006 Findings:
Pilot studies assessing habitat characterization and evaluating benthic macroinvertebrate collection techniques were conducted in Courthouse Wash in 2006. This is an ongoing project as part of the National Park Service Inventory and Monitoring Program of the Northern and Southern Colorado Plateau.

7) Permit #: ARCH-2007-SCI-0007

Study Title:

DELICATE ARCH TRAILHEAD RESTORATION PROJECT

Primary investigator contact information:

Name: **Tamsin McCormick,** Plateau Restoration, Inc.
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Project Summary:
The proposed habitat enhancement project is part of a larger effort by our conservation organization toward improving wildlife habitats along critical waterways in the high deserts at the heart of the Colorado Plateau. We hope to increase public awareness about the consequences of unchecked noxious weed invasions and how members of the public can be a part of the solution, while performing hands-on restoration of a degraded riparian area in Arches National Park. We have targeted the area of the Delicate Arch trailhead, a major international tourist destination, to launch a demonstration project. The project includes rehabilitating an area of Salt Wash that has been subjected to previous tamarisk control treatments.

Methods:
1. Removal of excess slash, tamarisk duff and remaining tamarisk stumps will start in early Spring 2007 utilizing volunteers recruited through our Conservation Adventures Service-Learning programs.

2. We propose to collect seed and native plants, to be used for seeding and transplanting, from ANP and adjacent BLM lands within the Salt Creek and Courthouse Wash drainages, according to the guidelines presented by the SEUG biologist. These will be staged at our facility in Moab for planting at approporiate times.

3. Initial planting of willow pole cuttings will take place along the edge of Salt Creek in April, 2007. Approximately 50 cuttings of Salix exigua will be collected from Courthouse Wash for this initial planting.

4. Plantings will be monitored for success throughout the year.

Logistics:
Work will be performed primarily by volunteer groups. No assistance from NPS staff is needed. A group will be in the Delicate Arch trailhead area the week of April 9-13.

Collections:
No specimens will be collected for curation. All collections are for transplanting to the Delicate Arch Trailhead area only.

The following conditions will be incorporated:

Plants can be collected from the roadside in Arches National Park with the following conditions:
1) No plant shall be completely removed.
2) Only a maximum of 25% of any bunchgrass can be removed.
3) Cuttings are limited to only one per plant.
4) Cuttings shall not exceed 2 feet in length.

Riparian plants may be collected only from the riparian zone in Salt Wash and Courthouse Wash with the following conditions:
1) No plant shall be completely removed.
2) Shrub and tree cuttings are limited to only one per plant.
3) Shrub cuttings shall not exceed 4 feet in length.
4) Only ten cuttings may be removed per 500 foot section of creek.
5) Rushes may be dug up but only one spadefull may be taken every 300 feet

8) Permit #: ARCH-2007-SCI-0008

Study Title:

INTERMOUNTAIN WEST NATIVE PLANT POLLINATION PROJECT

Primary investigator contact information:

Name: Janes Cane, Utah State University, USDA-ARS Bee Biology and Systematics Lab
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Project Summary:
Native bees and/or honey bees are needed to pollinate most of the wildflower species considered for Great Basin rehabilitation. The pollinator faunas of many candidate plant genera include one or more bee genera with potentially manageable species. After pollinator needs are evaluated by comparing fruit and seed sets at caged flowers and openly visited flowers we can assess whether plant reproduction is pollinator limited. If plant reproduction proves to be pollinator limited, then native bee faunas need to be surveyed and evaluated at managed and wild flowering populations. One of the candidate flower genera that we have been working with as a potential for seed production is Sphaeralcea spp. Based on data we collected from our 2006 experimentation, we have determined that these plants require a pollinator for successful reproduction. The primary purpose of our data collection, within the parks, is to investigate and quantify the pollinators that are associated with Sphaeralcea spp. This information will be used to identify bees that are important pollinators of these species and whether the pollinators are potential candidates for management. We hope to develop sustainably managed pollinators that can be used on farms which will grow native Sphaeralcea spp. for BLM restoration purposes.

Intended use of results - This information will be used to identify bees that are important pollinators of these species and whether the pollinators are potential candidates for management. We hope to develop sustainably managed pollinators that can be used on farms which will grow native *Sphaeralcea* spp. for restoration purposes.

Objective:
Extend pollinator breeding biologies and management to additional native flowering species being considered for revegetation on federal lands in the Intermountain West. To identify species of bees that currently pollinates native *Sphaeralcea munroana, S. grossularifolia* and *S. ambigua*. Characterize the plants' pollinator faunas and identify pollinators with management potential

Collections:
Collection of 50 bees and 1 plant specimen per site allowed. Maximim of 3 sampling sites in Arches NP allowed for this project.

We will collect bee fauna on stands of *Sphaeralcea grossularifolia*. Depending on the number of wild stand locations found, we intend to sample at approximately 2-3 stands and collect a maximum of 50 individual bees at each location. Individual bees will be collected and removed from the collecting site and the pinned specimens will receive an ascension number and be housed in the United States National Pollinating Insect Collection at the USDA-ARS Pollination Insect Biology, Management and Systematics Laboratory facilities in Logan UT. We do not anticipate collection of any rare bee species. We will also collect 1 plant voucher specimen at each sampling location.

Logistics:
Collection will occur during the months of May and June. At the end of the year we will submit a report of our research which will include the locations of each plant species stand we collect on and a number of associated pollinator fauna collected.

We have been working with NPS staff to determine plant stand locations within and adjacent to the park boundaries.

CANYONLANDS NATIONAL PARK
2007 Research Permits

1) Permit #: CANY-2007-SCI-0001

Study Title:

Incision and exhumation history of the Colorado Plateau in the Canyonlands to Book Cliffs Region, Utah

Primary investigator contact information:

Name: Markella Hoffman, University of Kansas
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Project Summary:
The dramatic landscape of the Colorado Plateau draws visitors from all over the world and attracts researchers from many disciplines. This relatively intact, thick block of crust, surrounded by deformation associated with the Sevier-Laramide orogenies and Basin and Range extension, with its high elevations has sparked much discussion and debate yet remains an enigma to scientists. The mechanism, timing, and amount of uplift and erosion are poorly constrained and several hypotheses for uplift mechanisms of the Colorado Plateau exist including flat-slab subduction, crustal thickening, and mantle anomalies such as early Cenozoic Laramide uplift and late Cenozoic epeirogeny, each having distinct temporal and spatial characteristics. We hope to determine the exhumation history of the plateau by combining apatite (U-Th)/He thermochronology with numerical modeling. Uplift drives erosional exhumation processes such as stream incision, escarpment retreat, and wholesale erosion, all of which will produce distinct cooling signatures in exhumed rocks. Low temperature thermochronology will establish the thermal history of Colorado River in response to incision and escarpment retreat in the heart of the Colorado Plateau between the Colorado River (Canyonlands NP) and the Book Cliffs of east-central Utah, constraining both the timing and magnitude of erosion and incision of the Colorado Plateau and thus elucidating the long-term (<10 Ma) landscape evolution of the region.

Methods
Rock specimens (~3-5 kg) will be sampled from outcrops along trails and roads in northern Canyonlands National Park (north of the Colorado River), such as in Lanthrop and Buck Canyons, adjacent to the Colorado River. Approximately 40-50 sandstone and siltstone samples will be collected from Pennsylvanian to Jurassic sedimentary strata. Sample collection will be carried out to ensure minimum environmental and visual impact along roads and trails. Subsequent laboratory preparation and analysis will take place at the Isotope Geochemistry Laboratories of the University of Kansas Geology Department. **Samples will be ground and milled (destroyed)** during mineral separation (apatite) for isotopic analysis. Apatite (U-Th)/He thermochronometry is a relatively new and powerful technique to quantitatively reconstruct the thermal history of samples to constrain the timing and magnitude of erosion and to elucidate the long-term (<10 Ma) landscape evolution of the Colorado Plateau during the Cenozoic.

This NSF-sponsored and peer-reviewed project has been under way for almost two years on the Colorado Plateau (incl. Grand Canyon NP) and partially builds on work by Stockli and collaborators from the University of Arizona (incl. Capitol Reef NP). Work in Canyonlands NP

and the region to the north (incl. Book Cliffs) will begin as soon as a sampling permit for northern Canyonlands NP is granted. Additional fieldwork may be required in the spring or summer of 2007. Data collection will be finished by summer of 2007. Data analysis will begin immediately after samples are processed at the University of Kansas. Numerical modeling and presentation of data will continue through the following year. The project will be completed by the summer of 2008. Funding for travel, supplies, and lab expenses is provided through the aforementioned NSF grant to Stockli (KU portion), whose proposal is attached here. All samples will be destroyed during analytical procedures.

Collections:
Small loose rock samples only are allowed for collection, size no greater than 5 kilograms. No chipping from larger rocks allowed. The only rock samples approved for collection are those loose on the ground. Limited to a total of 50 samples for the entire project. No tools are allowed for dislodging or splitting rocks. All specimens shall be destroyed in analysis.

Products
Analytical results, interpretations, and conclusions of this research will be disseminated both through conference proceedings (e.g., Geological Society of America and American Geophysical Union annual conferences) and peer-reviewed scientific journals. Results will also be compiled with other published data on Cenozoic rock uplift into a geographical information system (GIS) and reconstructions of the Colorado Plateau. This information will be made accessible over the Internet to other researchers and the general public for further education and interpretation of the Colorado Plateau landscape. Canyonlands NP will be furnished with a detailed sample map, data repository, and copies of any publications after conclusion of the study. We would also be happy to collaborate with the National Park Services at Canyonlands to work on disseminating resulting conclusions of our research to the general public and park visitors.

Special Concerns
We will ensure that our research rock sampling in northern Canyonlands NP will have minimal impact on the park and its visitors. Sampling will largely be carried out along roads and trails with minimal visual impact, but some backcountry sampling to our study sites may be necessary in order to collect rock samples to ensure optimal geographical sample distribution. Hiking in such areas will mainly be in wash bottoms and rock surfaces to avoid damaging vegetation and delicate soil crusts. Backcountry camping may also be required for periods of a few days with 2-3 participants. We will adhere to the wilderness "minimum requirement" plan by carrying out all trash, abstaining from any fires, and restricting the use of any vehicles to designated roads. No hazardous activities are planned, and no mechanized equipment, field markers, or chemicals will be used. In addition, there will be no ground disturbance or animal interference during the course of this research. **No assistance from the NPS is required.**

2) Permit #: CANY-2007-SCI-0002

Study Title:

ASSESSMENT OF UPLAND ECOSYSTEM CONDITIONS IN THE SALT CREEK WATERSHED, CANYONLANDS NATIONAL PARK

Primary investigator contact information:

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Project Summary:

The project will be conducted in a 63,116-ha area located in the southeastern corner of CNP. The assessment area is defined hydrologically, consisting of hydrologic units all of the Salt Creek, Butler Wash, and Elephant Canyon watersheds.

Sample stratification and density. Point locations for assessments ("sample points") will be identified during pre-planning on the basis of a stratified, random sampling design. Digital hydrologic units and soil map units (U.S.D.A. Soil Conservation Service 1991) will be used to define sample strata. An automated GIS procedure will be used to allocate random sample points among strata. Sample points will be allocated among strata in proportion to area (excluding rock outcrops), although soil map units associated with grassland and sagebrush ecosystems (systems most degraded by past land-used activities) will be sampled more intensively.

Approximately 54 percent of the study area consists of rock-outcrop exposures. Overall sample density will be about 1 sample per 100 ha in the remaining 29,045-ha sample area. Each assessment will characterize a 1-ha area centered on the sample point.

Assessment technique / field methods. Assessments will be conducted using a peer-reviewed technique developed specifically for assessing the condition (health) of rangeland ecosystems. This technique involves the qualitative evaluation of 18 ecological indicators and the use of these indicators to gauge the functional status of three attributes of rangeland (ecosystem) health – soil / site stability, hydrologic function, and biotic integrity (vegetation structure / composition). Indicators are evaluated on the basis of conditions observed at a reference area (i.e., an actual benchmark site), and/or on the basis of expected benchmark conditions described by the assessment team on the basis of field experience and information presented in ecological site descriptions prepared by NRCS. Examples of indicators include the presence of rills, gullies, and water-flow patterns; amount of bare ground; degree of soil stability; evidence of aeolian soil loss / deposition; and composition and structure of vegetation and biological soil crust communities (emphasizing key structural / functional groups).

In this project, several additional types of information will be gathered to support the evaluation, documentation and interpretation of ecological indicators at each sample point. A field kit will be used to measure soil aggregate stability beneath plant canopies and in interspaces among plants. Quantitative data on proportional cover of bare ground, vascular plants (canopy cover by species), biological soil crusts (by morphological group), litter, and rocks will be collected along line-intercept transects. (The number and lengths of transects required for site characterization will be determined during pilot studies conducted at the beginning of the field season.) Soil (e.g., surface texture, effervescence, and inferred depth) and geomorphic (e.g., landform type and landscape position) characteristics will be described at each sample point following the NRCS field manual for describing soils. At least four digital photographs (three oblique and one vertical) will be taken at each site using standardized documentation techniques to facilitate future repeat photography. Additional photographs will be taken to illustrate indicators, if required. A GPS datalogger will be used to record the sample point location and evaluation scores for indicators and attributes. Aerial photographs (1:12,000, true-color, 2002 vintage) will be reviewed prior to conducting field work to look for erosional features or other landscape characteristics that should be investigated and documented for purposes of the project.

Objectives:

1. To assess the functional condition of upland ecosystems in the Salt Creek watershed and surrounding portions of CNP;
2. To analyze / synthesize results of this assessment and describe park-specific management implications pertaining to restoration, long-term monitoring, and other management activities;
3. To analyze / synthesize results of this assessment and describe implications pertaining to the use of this technique in the design of long-term monitoring in 35 NPS units of the Northern Colorado Plateau and Southern Colorado Plateau Inventory & Monitoring Networks (NCPN and SCPN);

4. To train NPS resource-management staff in the performance and interpretation of the assessment technique;
5. To establish reference areas applicable as benchmarks for assessment and monitoring elsewhere in the Colorado Plateau region (e.g., on lands managed by BLM);
6. To acquire / provide data in support of the development of ecological models describing dynamics of rangeland ecosystems on the Colorado Plateau, in cooperation with NPS, BLM, TNC, and the U.S.D.A. Natural Resources Conservation Service (NRCS).

Collections:
10 g of green leaf tissues from common, dominant vascular plant species at each of 210 sample sites in Park. Probable species include Coleogyne ramosissima, Stipa hymenoides, Stipa comata, Hilaria jamesii, Bromus tectorum, Atriplex canescens, Ceratoides lanata, Sporobolus cryptandrus, and Sporobolus contractus.

All material collected will be destroyed in analysis. No soil samples will be collected.

2005 Findings and Status:
No activity was conducted this report year. Field work for this study was postponed by one year and will be conducted during the 2006 and 2007 field seasons.

2006 Findings and Status:
During the 2006 field season, approximately 100 assessments were conducted in the lower, middle, and upper Salt Creek watersheds. Preliminary analyses suggest that approximately 17 percent of sites show indications of diminished soil stability and accelerated wind- and/or water-driven erosion, relative to reference conditions. Approximately 23 percent of sites show indications of accelerated run-off, and 15 percent of sites have diminished "biotic integrity" – as indicated by the relative dominance by invasive exotic plants and/or by shifts in the relative abundances of plant functional types. Within the Salt Creek watershed, most (but not all) sites with diminished soil stability occur on Bureau of Land Management lands adjacent to the Park. Emerging patterns suggest that particular soils and types of ecosystems are highly susceptible to long-term dominance by invasive exotic plants. Information collected to date will allow NPS staff to evaluate current conditions in relation to management objectives and "desired future conditions," as well as to begin establishing priorities for restoration or other management actions. These data also will enable USGS and NPS to work together to form hypotheses concerning the resistance and resilience of particular soils / ecological sites to effects of land-use activities. Field work will continue in FY2007, with approximately 100 additional assessments to be conducted.

3) Permit #: CANY-2007-SCI-0003

Study Title:

TESTING HYPOTHESES FOR THE ORIGIN OF UPHEAVAL DOME, CANYONLANDS NATIONAL PARK, UTAH, USING DEFORMATION BANDS

Primary investigator contact information:

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Project Summary:
Upheaval Dome is a prominent circular depression located within the Island in the Sky district of Canyonlands National Park, Utah (Huntoon et al., 1982). This 5.5-km wide, multi–ringed structure exposes Permian to Early Jurassic–aged sedimentary rocks (Huntoon et al., 1982;

2000). Few age constraints have been reported for Upheaval Dome, which may have formed during the Late Cretaceous to Early Tertiary (Shoemaker and Hirkenhoff, 1984) or in the Middle Jurassic (Alvarez et al., 1998).

A consensus on the origin of Upheaval Dome has remained elusive. Two commonly cited origins for Upheaval Dome are bolide impact (Shoemaker and Hirkenhoff, 1984; Huntoon and Shoemaker, 1995; Kriens et al., 1999; Huntoon, 2000; Kanbur et al., 2000; Kenkman, 2003) and salt diapirism from the underlying Pennsylvanian Paradox Formation (McKnight 1940; Joesting and Plouff, 1958; Mattox, 1968; Jackson et al., 1998). Alternatively, Upheaval Dome has been interpreted to be the result of igneous intrusion (McKnight 1940; Joesting and Plouff, 1958), volcanic explosion (Bucher, 1936) or tectonically–driven fluid overpressure (Kopf, 1982), however these three latter mechanisms are not supported by recent literature.

In this study, the observed microstructure of deformation bands (localized inelastic deformation) within Wingate Sandstone at Upheaval Dome will be used to calculate a corresponding range of causative stress magnitudes. These stress magnitudes provide quantitative constraints on the types of geologic processes that could have led to the growth of these deformation bands, and by extension Upheaval Dome.

This proposal presents work that is a continuation of a previous NPS study (Study # CANY-00095, Permit # CANY-2005-SCI-0030, "Testing hypotheses for the origin of Upheaval Dome, Canyonlands National Park, Utah, using deformation bands."). This work focuses on quantifying geologic evidence that supports a meteoritic impact origin for Upheaval Dome. The previous study found that the style of faulting within the Wingate Sandstone is indicative of a meteoritic impact, and supports a post–Early Jurassic age for this impact. This work is currently under review for publication in the journal Earth and Planetary Science Letters. The work proposed here builds upon these previous results and will quantify the distribution and microstructure of cataclastic dikes of Wingate Sandstone at Upheaval Dome. This work will evaluate the validity these cataclastic dikes as an additional line of evidence that supports an impact event at Upheaval Dome.

This study will entail identifying and mapping the locations of cataclastic dikes of Wingate Sandstone at Upheaval Dome. Areas to be mapped are the upper and lower stratigraphic boundaries of the Wingate Sandstone. The lower boundary (Fig. 2, red line) will be accessed on foot via the Syncline trail, starting at either the Upheaval Dome overlook parking lot, or the Labyrinth campsite via Upheaval Canyon. The Syncline campsite may also be used for overnight stays in Upheaval Dome. The upper boundary (Fig. 2, blue line) will be accessed on foot via the Syncline trail, starting at the Upheaval Dome overlook parking lot.

This proposal also seeks permission to collect a small amount of loose surficial material from outcroppings of Wingate Sandstone for microstructural analysis. Petrographic thin sections will be made of the collected material in order to measure changes in inter–granular volume and grain crushing that are expected to be associated with formation of the cataclastic dikes within the Wingate Sandstone. These changes in inter–granular volume, as well as measurements of grain size, will reveal the magnitudes of causative mean stress that are required to cause the formation of these dikes. These results help to show whether or not these cataclastic dikes are additional evidence of an impact event at Upheaval Dome. These results may also yield insight into the timing of the impact event, as well as the size of the impacting object.

This study will yield valuable insight into one of the most prominent geologic structures in the Island in the Sky district of Canyonlands National Park. Placards at the outlooks to Upheaval Dome detail the scientific debate over the origin of this structure and attest to the importance of this issue. An improved understanding of the origin of Upheaval Dome will help to better educate the public on the significance and importance of conserving the natural resources of the Park. This study seeks to improve scientific understanding of Upheaval Dome through innovative analyses that will yield fresh insight into the origin of this important geologic structure.

Collections:
Researcher will be encouraged to keep the collection of rocks to an absolute minimum. Only the collection of rock samples will be allowed. All samples shall be loose, surfucial, hand–sized fragments of Wingate Sandstone only. No drilling or other mechanical extraction shall be used to collect these samples. No more than 20 lbs. in total allowed. All collections will be destroyed in analysis.

No other collections allowed.

Logistics:
Researcher will have own vehicle and will not camp in the perk.

2005 Findings and Status:
Microstructural analyses of thin sections cut from collected samples of Wingate Sandstone show that the deformation bands in the study area are compactional in nature. This indicates that the bands formed under magnitudes of mean stress that are consistent with a meteoric impact, and a tectonic/salt dome origin for these bands is untenable. Therefore we find that the deformation bands within the Wingate Sandstone at Upheaval Dome are clear evidence of an impact event. This finding strongly supports meteoric impact as the origin for Upheaval Dome. These findings will be fully documented and submitted for publication in a peer-reviewed journal in mid-2006.

4) Permit #: CANY-2007-SCI-0004

Study Title:

Aquatic macroinvertebrate survey of Cataract Canyon

Primary investigator contact information:

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Project Summary:
The purpose of the study is to compile an aquatic macroinvertebrate species list of Stillwater Canyon. We would like to catalog the current biodiversity of aquatic insects, especially potential rare species of Mayflies (Ephemeroptera) and other uncommon Southwest taxa. This qualitative survey of aquatic macroinvertebrate diversity in Stillwater Canyon will increase our understanding of the distribution and relative abundance of invertebrates in Canyonlands National Park. Additionally, it will assist in determining the role of aquatic macroinvertebrates in the entire river foodweb/ecosystem. Lastly, the survey will assist in understanding the regional distribution of invertebrates over the entire Southwest, by contributing to the regional database of the National Aquatic Monitoring Center.

This work will be accomplished by using standard macroinvertebrate sampling protocols, such as kick and sweep nets. This will limit habitat disturbance while maximizing the amount of data collected. Additionally, the samples will be sorted in the field, with only a subset of taxa preserved in Ethanol. The excess invertebrates not retained will be returned to the river, minimizing the number of individuals killed. The retained specimens will be identified to the lowest taxonomic level possible by the staff of the National Aquatic Monitoring Center. Standard collection data will also be taken (e.g. GPS coordinates, date, locality name, collector, etc.).

Collections:
Specimens collected will be aquatic macroinvertebrates in the insect orders of: Ephemeroptera, Diptera, Plecoptera, Trichoptera, Heteroptera, and Coleoptera. Samples will be taken from the Colorado River in Cataract Canyon. A total of 6 to 8 samples will be taken depending on accessibility to the different habitats (i.e. riffles, eddies, and pools). The invertebrates will be stored at the National Aquatic Monitoring Center at Utah State University and cataloged with Canyonlands National Park.

2006 Findings and Status:
No activity was conducted this report year.

5) Permit #: CANY-2007-SCI-0005

Study Title:

Chronostratigraphy of alluvium in Horseshoe Canyon: Paleoenvironments and indirect dating of Barrier Canyon rock art

Primary investigator contact information:

Name: Dr Joel Pederson, Utah State University, Geology Department
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Project Summary:
A well-documented theme in the history of science is that technical advances introduce new research tools, and these then stimulate a pulse of exciting research to gather previously unobtainable data. This, in turn, enables the testing of hypotheses and the recognition of patterns that were previously unresolvable. Here I propose to follow this pattern by applying new luminescence dating techniques to document and date the geomorphic history of the Horseshoe drainage of Canyonlands National Park and constrain the age of Barrier Canyon style rock art in its type locality.

The Horseshoe catchment holds a series of preserved alluvial fill terraces that record the history of stream deposition and incision in response to late Pleistocene and Holocene environmental changes. This alluvial history also directly relates to the burial and exposure of the alcove that now hosts the Great Gallery and other rock art panels, bracketing the window of time when it was physically possible to create the art. Recent advances in geologic dating, specifically single-aliquot and single-grain optically stimulated luminescence (OSL) dating, now make it possible to date nearly any sediment exposed to a few seconds of sunlight before burial. With this new scientific tool, we can gain a new level of understanding about this changing landscape and its ancient artists.

Project Goals:
This proposed research has two goals: 1) develop a chronstratigraphy of alluvial deposits along the Horseshoe drainage by field mapping and OSL dating, and 2) bracket the age of Barrier Canyon-style rock art in the study area by documenting and dating its relations to the stratigraphy.

Methods and Collections:
Optically-stimulated luminescence dating Solid geochronology for the Horseshoe deposits is essential to meet the research goals. I am confident and excited about the great potential for the application of OSL dating to these sandy deposits. Geochronologic samples will be precisely

placed within the documented stratigraphic context at key localities, and through careful sampling, the timing and duration of incision and aggradation events can be determined. Previous OSL-based studies conducted by the Utah State University lab, University of Nebraska lab, and the U.S. Geological Survey on alluvium in the region assures that the application of the technique in the study area will be successful (e.g. Anders et al., 2005; Reheis et al., 2005; Pederson et al., 2006). OSL provides a numerical age estimate for the last exposure of sand to silt-sized mineral grains to sunlight during transport (Aitken, 1998). After burial, the luminescence signal grows with time due to exposure to radioactive isotopes in the surrounding sediment. The OSL technique has considerable advantages over older thermoluminescence (TL) techniques, since only seconds of exposure are required for solar resetting as compared to hours for TL. Systematic and random errors for the technique are fully incorporated into precision calculations and reported errors commonly range from 5-10% of the age depending on individual sample characteristics. Horseshoe deposits are especially suited for OSL dating because bedrock sources in the catchment dictate that alluvium is fine-grained and almost entirely quartz, the target mineral for the OSL technique. To test for problems associated with partial bleaching, we will use the single-aliquot regenerative-dose protocol of Murray and Wintle (2000), which allows for the detection and correction of partial bleaching. Procedures for sampling, processing and analysis of OSL samples will follow those outlined in Rittenour et al. (2005). Samples will be collected from carefully described, stratigraphically constrained outcrops, from the base and top of each deposit to determine the duration of aggradation. OSL samples will be collected from natural exposures targeting beds with medium sand to coarse silt. Each sample will be taken in a single opaque sample tube that is 1" x 6" in dimension. A small sample placed in a plastic bag for environmental dose rate will be collected from within a 30-cm radius of each OSL sample and will be analyzed by mass spectrometry and high resolution gamma spectrometry methods. Importantly, sampling will be concentrated into one or two field trips at the end of the field campaign, after the best, necessary sample locations in the study reach are fully identified. I am requesting that staff from the archaeology office of Canyonlands National Park be present in order to be assured that all samples be taken clear of any cultural features. Finally, OSL samples will be processed in the USU Luminescence Lab under the direction of Dr. Tammy Rittenour. Preparation and analysis consumes the samples, and therefore no archiving of materials will be necessary.

Collections:
The collection of soil samples only will be allowed. All samples shall be destroyed in analysis. An archeologist must clear site before sampling occurs.

Logistics:
All transportation will be provided by the researcher. Camping will not occur within Canyonlands National Park.

6) Permit #: CANY-2007-SCI-0006

Study Title:
VEGETATION DATA COLLECTION IN SUPPORT OF THE U.S. GEOLOGICAL SURVEY NATIONAL PARK SERVICE VEGETATION CLASSIFICATION AND MAPPING PROGRAM AT CANYONLANDS NATIONAL PARK

Primary investigator contact information:

Name: Ms. Janet Coles, National Park service
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Project Summary:

The National Park Service (NPS) and U.S. Geological Survey (USGS) are cooperating to produce detailed vegetation classifications and digital databases, including vegetation maps, as part of the National Biological Information Infrastructure Program (NBII). Approximately 250 national parks and monuments will benefit from this cooperative effort upon successful program completion. The National Park Vegetation Classification and Mapping Program is a strong component of the NPS Inventory and Monitoring Program, established in 1991, and is based on a repeatable set of standards and flexible protocols.Sampling will be conducted in accordance with the Vegetation Classification and Mapping Work Plan developed for Arches National Park in February 2003, which has been reviewed by USGS-NPS Vegetation Classification and Mapping Program leaders, Northern Colorado Plateau Network (NCPN), and/or Arches ecologists. This work plan will serve as the basis for all such efforts at the park, including sampling methodology, and should be considered as the study proposal. Copies of the work plan, both electronic and hard-copies, are available through the NCPN Inventory and Monitoring Program, or from the park ecologist.

The field work to be performed this spring is related to accuracy assessment of the vegetation map. Following completion of the vegetation map, a random sample of points will be determined by Gery Wakefield and Aneth Wight that will be used to test the accuracy of mapped data. At this time I do not know the exact number of points or their locations, but would expect them to be in the range of 800-1,000. Field biologists (Vegetation mapping crews from NCPN led by Liz Ballenger) will download the AA point UTM coordinates into GPS receivers and navigate to the point. They will complete an accuracy assessment form that provides location, environmental, and vegetation cover information and will also key the vegetation of the area around the point (40 m radius circle) to a plant association using an illustrated field key. Two or more photographs will be taken to adequately document the site. These data will be entered into a database and analyzed to produce a contingency table illustrating the accuracy of each plant association tested and will also provide the overall map accuracy. The national map accuracy standard is 80% accuracy for each map unit and 80% accuracy for the entire map.

Collections:
Collection of parts of plants for identification purposes only allowed. These must be destroyed in analysis. Plant species that are very uncommon or are legally protected under the Endangered Species Act will not be collected but will have digital photos taken for documentation. No curation of plants is allowed.

Logistics:
No assistance from Canyonlands National Park personnel is needed.

2006 Findings and Status:
No field activity was conducted this report year. Photo-interpretation work done by Gerald Manis.

7) Permit #: CANY-2007-SCI-0007

Study Title:

UPLAND MONITORING PROTOCOL DEVELOPMENT

Primary investigator contact information:

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Project Summary:

This study is the initial implementation of the NCPN Integrated Upland Monitoring effort.

Specific objectives of the NCPN Integrated Upland Monitoring Protocol are:

1) Determine annual status and trends in ground cover (live and standing dead vegetation, litter, rock, biological soil crust [BSC], and bare ground); soil aggregate stability and compactions as indicators of soil/site stability, hydrologic function, and nutrient cycling.

2) Determine annual status and trends in cover of biological soil crusts by species or morphological group.

3) Determine annual status and trends in cover of exotic plants in upland areas.

Methods:
In August-September 2006, 31 permanent monitoring plots were established in Canyonlands. In April-June 2007, 17 more plots will be established in Needles and Island in the Sky districts. Establishment and data collection protocols this year will be similar to 2006 protocols, except that fewer and smaller nails will be used in marking vegetation quadrat boundaries along the transects. Researchers will try to minimize damage to biological soil crusts while hiking to and from monitoring plots and while collecting data in plots. In addition, sites will be approved by archeology personnel before plots are installed.

Collections:
For unknown plant species, plant parts (dead stems and leaves, reproductive parts) will be extracted from areas other than a sampling plot for identification in the office. In many cases, plant parts will be dissected or otherwise altered in the identification process, and thus, will be discarded. The amount of material per species will be minimal. The number of unknown plant species, and thus, material collected, is anticipated to be nominal. Will be destroyed through analysis or discarded after analysis.

Small soil samples (no larger than 3mm by 8mm), not exceeding a depth of 2.8 cm will be collected to determine soil aggregate stability. Will be destroyed through analysis or discarded after analysis. In addition, sites will be approved by archeology personnel before holes are dug.

Logistics:
No assistance from Canyonlands National Park personnel will be required.

8) Permit #: CANY-2007-SCI-0008

Study Title:

SOIL SURVEY OF CANYONLANDS NATIONAL PARK, UTAH

Primary investigator contact information:

Name: Mr Victor Parslow, USDA Natural Resources Conservation Service
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Project Summary:
To provide an updated soil and ecological site inventory for Canyonlands National Park (CANY), that meets National Cooperative Soil Survey (NCSS) standards and park management and planning needs.

The existing soil survey was conducted in the 1970s's and the early 1980's as part of the Henry Mountains, Utah soil survey and the Canyonlands soil Survey. These inventories was primarily designed as a tool for use in managing grazing lands and has been found to be too general to be useful in managing the park. Information is insufficient to model salt movement, mitigate visitor impacts, identify and protect habitat of Threatened and Endangered species, and other park responsibilities.

In 2003, reprensentatives of the National Park Service approached the Natural Resources Conservation Service to update the existing soil surveys within Arches and Canyonlands National Parks and Natural Bridges and Hovenweep National Monuments and the Orange Cliffs section of the Glen Canyon Recreation Area. The Plan of Work and contract were approved in 2004. This application is seeking permission to carry out the field work necessary to complete the contract.

Collections:
Soil sampling allowed: 200 to 300 gram soil samples only. Archeologist must be present when digging any holes in ground. Some clipping of vegetation is allowed but must be kept to a minimum. Majority of soil samples will be destroyed in analysis. No collection of plants is allowed. Photos of plants for identification purposes is allowed.

2006 Findings and Status:
The Natural Resources Conservation Service (NRCS) began field work to provide an updated soil and ecological site inventory for Canyonlands National Park in 2006. This is a summary of the activities for the year 2006: 1. Soil inventory activities Soil survey activities were conducted in Canyonlands National Park in 2006. Traverses and transects of the landscape were conducted, and soil descriptions and plant inventory data recorded, in order to further develop the soil-plant-landscape-geology models which will be essential to the completion of the update of the Soil Survey and Ecological Site Descriptions. 80 soil/landscape observations were documented in FY 2006, and soil samples were collected from 71 of these locations. These samples have been catalogued, and are stored in the Richfield USDA Service Center. Field activities are continuing in the park, and data is being analyzed. 2. Archaeological Activities As a result of the field work of 2006, fifty-one archaeological sites as well as nine isolated occurrences were recorded in Arches National Park. Diagnostic artifacts were collected from three sites. Details of these resources including locations and descriptions of their contents can be referenced in a more complete report, Summary Report of Cultural Resources Support Provided to the Soil Surveys Of Natural Bridges National Monument, Arches National Park, Canyonlands National Park and Hovenweep National Monument For the Year 2006, at the SEUG office in Moab, Utah. All cultural resources were successfully avoided. No cultural material was unearthed during the course of soil sample collection. 3. Geophysical Field Study July 31 through August 4, 2006, a special study was conducted in Arches and Canyonlands National Parks utilizing remote sensing equipment to assist in characterization of the soils in the parks. Ground penetrating radar and EM38 meters were used to help characterize bedrock and electrical conductivity patterns in the parks. This data is currently being analyzed in order to provide a summary to the Park.

9) Permit #: CANY-2007-SCI-0009

Study Title:

IMPACTS OF CLIMATIC CHANGE AND LAND USE ON THE SOUTHWESTERN U.S.

Primary investigator contact information:

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Project Summary:
The population of the southwestern United States has grown rapidly over the past two decades and is projected to increase greatly over the next several decades. As the population has grown, climatic variations that would have affected relatively few people in the past will impact the lives of millions. Rapid and wide-spread climatic changes, such as those seen thousands and hundreds of years ago in the region and those projected for the future, may profoundly change the character of the region. Arid and semi-arid regions of the southwestern U.S. are among the most sensitive regions to changes in climate and land use, but the potential interactions between climatic change and land use are largely unknown (http://climweb.cr.usgs.gov/info/sw_new/swmap.html).

U.S. Geological Survey and collaborating scientists are seeking to understand how climate and how land use have influenced surficial geologic processes that modify landscapes and ecosystems. Such understanding is then used to model the landscape□s response to future changes in climate and land use over time scales of seasons, of a few years, and of a few decades, so that information and interpretations can be applied by federal, state, and local agencies, as well as by Native American governments, for their land-use planning and management of resources.

Project scientists work with ecologists, hydrologists, geographers, cartographers, and archeologists to address questions about (bold titles indicate activity at Canyonlands National Park):
(1) the causes and timing of changes in alluvial environments (rivers, streams, hillslopes), such as flooding, the cutting and filling of arroyos, and sediment discharge;
(2) the role of eolian dust for soil fertility, invasion of exotic species, hydrology, and surface stability in deserts;
(3) the interaction of physical and biologic processes critical for ecosystem functions;
(4) how climate in the southwest has varied over decades, centuries, and millennia;
(5) how future climatic variations will affect the Southwestern land surface (in terms of erosion, sand-dune activity, dust-storm frequency, flooding, landslides,);
(6) how past climatic changes and environments affected prehistoric cultures.

General Project Goals
1 Understand how past climatic change affected land surface: soil loss, fluvial erosion and alluviation, sand-dune mobilization, ecosystems, under time frames of past decades, centuries, and millennia.
2 Understand today's interplay among climate, land use and surface processes (geologic and ecologic).
3 Understand the impacts of future climate on land surface under the following time frames: seasons; El Nino/La Nina cycles; multi-year wet/drought periods; and decades, as atmospheric CO2 increases.

A major goal is to interact with federal, state, and local government agencies as well as non-governmental organizations to provide information useful for management decisions regarding land-surface vulnerability to wind erosion. Another goal is to provide to managers and other parties ongoing remote sensing and meteorological monitoring bearing on the vulnerability of the land to natural and human disturbances.

Specific goals for Canyonlands work
1 Understand geologic origins of soil nutrients and the interactions of soil compounds and plants.
2 Understand geomorphic controls on plant distribution
3 Understand the recent (past several decades, centuries, millennia) geologic/geomorphic evolution of the ecosystem to reveal patterns of surface stability and instability.
4 Recognize areas vulnerable to wind erosion and soil loss.

5 Understand conditions of cheatgrass (and other exotic plants) invasion to predict areas most vulnerable to expansion and to help devise mitigation strategies.

Collections:
Only the collection of eolian dust is allowed. This will be destroyed in analysis. Research activities will take place in the Needles district in previously established study sites in Squaw Flat, adjacent to the ranger housing, and in Virginia Park.

Logistics:
Dust samples will be collected periodically by USGS-Moab Station staff. No assistance from park staff is needed.

2005 Findings and Status:
Report from USGS Project Effects of climatic variability and land use on American Drylands.

The project conducts research on linkages among geologic substrates and their origins; biogeochemical nutrient cycling; weathering of substrate; soil moisture and water infiltration; weather events and climate; surface dynamics, including erosion; as well as past and current land uses. A large component of research is devoted to understanding how geologic substrates influence plant community distributions, including the distribution of cheatgrass and other invasive plants. Another focus is on the effects of historical grazing on soil nutrients. Substantial progress has been made in both topics as summarized in publications listed below that are available at the project website. Progress has also been made in developing remote sensing techniques to track invasion of Park lands by invasive plants. Another major effort last year resulted in publication of a document that describes conceptual models for dryland ecosystems to inform the vital signs selection process. Much project work is designed to address land-management priorities.

Activities of work done in and near Canyonlands National Park are summarized in the project website http://climchange.cr.usgs.gov/info/sw/index.html

Project members completed several studies that resulted in publications.

Multi-decadal impacts of grazing on soil physical and biogeochemical properties in southeast Utah
J.C. Neff, R.L. Reynolds, J. Belnap, and P. Lamothe, 2005, Multi-decadal impacts of grazing on soil physical and biogeochemical properties in southeast Utah: Ecological Applications, 15(1), 2005, pp. 87-95.

Atmospheric dust in modern soil on aeolian sandstone, Colorado Plateau (USA): Variation with landscape position and contribution to potential plant nutrients
R.L. Reynolds, J.C. Neff, M. Reheis, P. Lamothe, 2006, Atmospheric dust in modern soil on aeolian sandstone, Colorado Plateau (USA): Variation with landscape position and contribution to potential plant nutrients: Geoderma, v. 130, p. 108-123.

Late Quaternary eolian response to paleoclimate, Canyonlands, southeastern Utah
M.C. Reheis, R.L. Reynolds, H. Goldstein, H.M. Roberts, J.C. Yount, Y. Axford, L. Cummings, and N. Shearin, 2005, Late Quaternary eolian and alluvial response to paleoclimate, Canyonlands, southeastern Utah: GSA Bulletin, v.117, no. 7/8, p. 1051-1069.

2006 Findings and Status:
This study is ongoing, but periodic summaries are made and published. The following publications report findings from this study: Reynolds, R., J. C. Neff, et al. (2006). "Atmospheric dust in modern soil on aeolian sandstone, Colorado Plateau (USA): Variation with landscape position and contribution to potential plant nutrients." Geoderma 130: 108-123. Reynolds, R. L., M. C. Reheis, et al. (2006). "Late Quaternary eolian dust in surficial deposits of a Colorado Plateau grassland: Controls on distribution and ecologic effects." CATENA 66(3): 251-266.

10) Permit #: CANY-2007-SCI-0010

Study Title:

THE ROLE OF BIOLOGICAL SOIL CRUSTS IN SOIL NUTRIENT CYCLES AS INFLUENCED BY SOIL SURFACE DISTURBANCE, CLIMATE CHANGE AND ANNUAL GRASS INVASION

Primary investigator contact information:

Name: Dr. Jayne Belnap, USGS, Canyonlands Field Station
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Project Summary:
Models indicate the presence of a large carbon (C) sink at temperate latitudes in the northern hemisphere. Over thirty percent of lands both globally and in the United States consist of semi-arid or arid landscapes. Very little is known about carbon dynamics in these regions. Biological soil crusts, composed primarily of cyanobacteria, algae, lichens and mosses, can completely cover plant interspaces in undisturbed areas, and constitute 70 percent or more of the living ground cover. These soil crusts can be the dominant source of nitrogen (N) for vascular plants. They fix C at a high rate and are critical for soil stability and aggregate formation, which is important in C storage. They also absorb significant amounts of CH4. In areas where precipitation is low and soils have low fertility, native plants often rely on intact biological soil crusts to provide increased water and nutrient flow to the broadly scattered vegetation. Thus, there are many ways in which biological soil crusts influence biogeochemical cycles and the structure and productivity of the vascular plant community.

Soil surface disturbance, invasive plants, and climate change have the potential to dramatically alter the structure and function of biological soil crusts. The current combination of recreational use and livestock grazing is resulting in unprecedented levels of surface disturbance on many arid lands. In regions that did not have substantial amounts of surface disturbance in the Holocene, biological soil crusts disappear readily when trampled by animals or vehicles. Exotic annual grasses are invading many of these areas. Trampling and invasion results in reduced cover and changes in the species composition of biological soil crusts. This, in turn, leads to changes in processes such as decomposition, N and C fluxes, soil moisture, and nutrient availability to vascular plants. Decreases of only 1 percent of soil organic carbon in the top 10 cm of rangeland soils is equivalent to the total C emissions from all croplands nation-wide.

Changes in climate regimes, such as a shift in the summer monsoonal boundaries in the western United States, are expected to influence the composition and physiological functioning of biological soil crusts. Various crust components have different photosynthetic and respiration responses to temperature and moisture. In addition, different crusts have different methane fluxes. Therefore, changes in the timing or amount of temperature and precipitation is expected to alter soil C and N fluxes through changes in physiological response or crustal composition. This, in turn, can significantly impact vascular plant productivity.

This project will establish how alterations in species composition by surface disturbance, invasive grasses, and/or climate change may affect N and C inputs and fluxes, in different soils

under different climatic regimes. Because current and expected changes in land use and climate will occur over millions of acres in western rangelands, impacts to soil crusts have the potential for dramatically affecting C cycles, N cycles, and vascular plant productivity over much of the western United States. In addition, semi-arid and arid ecosystems represent over one-third of the Earth's terrestrial surface, and most are covered by biological soil crusts. As human impacts are escalating both regionally and globally in these drier regions, the research questions posed in this proposal have significant implications for global C budgets as well.

Collections:
The collection of soil samples is allowed and has been cleared by the SEUG Archeologist. The collection of leaf samples will also be allowed. All samples will be destroyed in analysis.

Activities will only be allowed in previously allowed sites.

2005 Findings and Status:
In July 2004, our group installed a solar-powered system including 6 in-situ sensors at two depths in the soil (5 and 15 cm) to monitor carbon dioxide amounts in the soil gas profile. These were inserted from the surface and did not require digging.

Also in July 2004, Belnap's group installed a solar-powered system including two automatically-closing aboveground chambers which allowed direct measurement of the flux of CO2 leaving the surface of the soil.

We found strong seasonal patterns in CO2 amounts belowground, and in the CO2 flux, that were driven primarily by soil moisture and soil temperature. The period of maximum belowground activity was in June following an unusual rain event, somewhat later than we expected based on aboveground plant productivity which peaks in April-May.

Both systems were removed in December 2005 and we do not expect to reinstall them during 2006. Some soil sampling at the site will be required to establish physical parameters for soil diffusion modeling and we anticipate this sampling will occur in spring or summer 2006. We are currently analyzing the data and expect to submit it for publication sometime in 2006.

2006 Findings and Status:
This study is ongoing, but periodic summaries are made and published. The following 2006 publications report findings from this study:

Belnap, J., S. L. Phillips, et al. (2006). "Soil lichen and moss cover and species richness can be highly dynamic: The effects of invasion by the annual exotic grass Bromus tectorum and the effects of climate on biological soil crusts." Applied Soil Ecology 32(1): 63-76.

Hawkes, C. V., J. Belnap, et al. (2006). "Arbuscular mycorrhizal assemblages in native plant roots change in the presence of invasive exotic grasses." Plant and Soil 281(1-2): 367-379.

Miller, M. E., J. Belnap, et al. (2006). "Effects of water additions, chemical amendments, and plants on in situ measures of nutrient bioavailability in calcareous soils of southeastern Utah, U.S.A." Plant and Soil 288(1-2): 19-29.

Sperry, L. J., J. Belnap, et al. (2006). "Bromus tectorum invasion alters nitrogen dynamics in an undisturbed arid grassland ecosystem." Ecology 87(3): 603-615.

11) Permit #: CANY-2007-SCI-0011

Study Title:

RIPARIAN AND AQUATIC INVERTEBRATE MONITORING PROTOCOL AND DEVELOPMENT (NPS I&M PROGRAM)

Primary investigator contact information:

Name: Dr Anne Brasher, USGS, Water Science Center
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Project Summary:
The objective of the study is to develop a rigorous, well-integrated set of protocols for long-term riparian and macroinvertebrate monitoring across the Colorado Plateau. Another objective is to evaluate the utility of aquatic macroinvertebrates and riparian ecosystems as reliable indicators of aquatic ecosystem conditions in dryland systems characteristic of the Colorado Plateau.

Collections:
In general, macroinvertebrate samples are destroyed during analysis. Upon arrangement with the Park curator, a voucher collection from the sampling effort can be maintained at an established (museum) location following NPS repository standards.

Only the collection of aquatic invertebrates allowed. Most will be destroyed in analysis. Those curated will be stored according to NPS regulations at the Utah State University Bug Lab.

2005 Findings:
No activity was conducted during this report year.

2006 Findings:
Pilot studies assessing habitat characterization and evaluating benthic macroinvertebrate collection techniques were conducted in Salt Creek in 2006. This is an ongoing project as part of the National Park Service Inventory and Monitoring Program of the Northern and Southern Colorado Plateau.

12) Permit #: CANY-2007-SCI-0012

Study Title:

ABUNDANCE ESTIMATES FOR COLORADO PIKEMINNOW IN THE GREEN RIVER BASIN, UTAH AND COLORADO

Primary investigator contact information:

Name: Dr. Patrick Goddard, Utah Division of Wildlife Resources
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Project Summary:
Obtain an accurate (unbiased) and reliable (precise) estimate of the adult population abundance and survival of Colorado pikeminnow that occupy the Green River study area.

Objectives:
1. Complete a minimum of three sampling passes through five Green River Basin reaches to capture sub-adult and adult Colorado pikeminnow:
a) Green River between the confluence of the White River upstream to the lower end of Whirlpool Canyon (i.e., upper Rainbow Park).
b) White River between the confluence of the Green River upstream to Taylor Draw Dam,
c) Yampa River between Deerlodge Park and Craig, excluding Cross Mountain Canyon,
d) Green River from the White River confluence downstream to near Green River, Utah, and,
e) Green River from downstream of Green River, Utah, to the confluence with the Colorado River.

2. Obtain highest possible rates of capture of Colorado pikeminnow within concentration habitats and maximize number of individuals marked and captured on each sampling occasion.

3. Obtain estimates of probability of capture and abundance for Colorado pikeminnow in each of the five reach and for the entire study area.

End Product: The end products are abundance and survival estimates for sub-adult and adult Colorado pikeminnow for each of the White, Yampa, and Green River populations. An overall estimate will also be calculated.

Collections:
Collection of specimens is allowed only for data collection. Catch and release only. Trammel netting and electrofishing allowed. PIT tagging allowed.

Logistics:
Researchers will provide their own aluminum boats with motors. No assistance from NPS will be required. Three electrofishing passes were completed during late May through June.

2006 Findings and Status:
Three electrofishing passes were completed during late May through June. All endangered fish captured were PIT tagged, physical data collected, and returned to their location of capture. In total 598 Colorado pikeminnow were captured marked and returned to the river. All data management, analysis, and reporting is overseen by Kevin Bestgen with the Larval Fish Laboratory at Colorado State University. Poplution estimates will be tabulated in the spring of 2007.

13) Permit #: CANY-2007-SCI-0013

Study Title:
RECONSTRUCTING THE GEOMETRY AND PALAEOCLIMATE OF THE CEDAR MESA AND WHITE RIM SANDSTONE (PERMIAN)

Primary investigator contact information:

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Project Summary:
Although desert margin sedimentary systems are known to be highly sensitive to climate change, the response of these systems to such changes is currently only poorly understood. This project seeks to investigate the sedimentological and stratigraphic response of an ancient desert margin system to climate change. This will be achieved through an outcrop based study of mixed aeolian, fluvial, lacustrine and marine successions exceptionally well exposed in the Permian Cutler Group of southern Utah and will involve extensive phases of field-based data collection. The Cutler Group comprises a series of mixed aeolian, fluvial, lacustrine and shoreline successions that accumulated under a regime of oscillating arid to semi-arid climatic cycles, somewhat analogous to those of the late Quaternary period of parts of the Sahara Desert. This project will provide information on the preserved sedimentary expression of cyclical climate changes within various desert margin sub-environments (e.g. aeolian dune, interdune, fluvial and lacustrine). Importantly it will document how transitions between these various sub-environments respond to the external modifying influence of climate change. Additionally, this project will devise generic models that explain the dynamics of sediment accumulation and long term preservation at erg margins. It will document how aeolian sand seas form, are accumulated as strata, and are preserved in the rock record for a marginal sand sea area subject to high magnitude climate change. Work for 2004 will focus on the Lower Cutler Beds that immediately underlie the Cedar Mesa Sandstone within the Canyonlands National Park region (Jagger, 2003, Mountney and Jagger, 2004).

Aims and Objectives:
1. Quantitatively determine the spatial arrangement of genetically related sets of aeolian, fluvial and lacustrine strata and establish 3D geometric relationships between genetically related stratal packages in adjoining erg margin sub-environments.
2. Identify cyclic episodes of sedimentation across a variety of sub-environments that are indicative of progressive drying- or wetting-upward climatic trends.
3. Distinguish key stratal surfaces related to autocyclic bedform migration from those related to allocyclic (externally forced) episodes of erg shutdown.
4. Develop a generic model to explain how the dynamics of sediment accumulation and preservation are modified by the influence of a periodically changing climatic regime across a range of desert margin aeolian, fluvial and lacustrine sub-environments.
5. Establish techniques for the correlation of marine and non-marine strata in desert systems and test current models that equate non-glacial global sea level high-stands with restricted erg activity and stabilization.

Methods:
Research in 2006 field excursions to Southeast Utah at localities within the Shafer Basin near Moab and within Canyonlands National Park. The orientation of the present-day canyon walls within these regions provides near-continuous exposure of the succession. This will enable the architecture of genetically related rock units to be established in 3D. A leveling instrument will be used to trace-out key bounding surfaces across the area. The position of these surfaces will be recorded in x,y,z space and viewed using dedicated visualization software, thus revealing the three dimensional geometry of the depositional system. The spatial arrangement of minor bounding surfaces and cross-stratification planes will be used to reconstruct the morphology of the original aeolian bedforms using the procedure of Rubin and Hunter (1983). The spatial arrangement of major aeolian bounding surfaces and their relationship to adjacent fluvial deposits will be used to distinguish surfaces related to autocyclic bedform migration from those related to allocyclic episodes of erg termination, thus testing the models proposed by Kocurek and Havholm (1993). Vertical sedimentary logs will be established at key localities. These will act as 'marker posts' to which the architectural data can be tied. Both the vertical logs and the architectural data will be used to investigate the detailed sedimentology of the succession. Sedimentary evidence to support a deflationary mechanism for the periodic termination of aeolian dune preservation would include the presence of laterally persistent horizons of coarse-grained lags or wavy laminae. Aeolian bypass would be signified by evidence of dune migration (but not climb) coincident with fluvial encroachment into surrounding interdune areas. The preservation of degraded (relict) dune topography and the presence of rooted horizons on dune flanks would signify stabilisation of the sedimentary system. Careful sedimentary observation

allied to quantitative surveying of the set architecture will enable theoretical models for erg margin development and termination to be devised, tested and refined.

The proposed research for 2007 will involve the collection of sedimentological data from the Lower Cutler Beds, the Cedar Mesa Sandstone, and the Organ Rock Formation exposed on the western side of the Colorado River in Canyonlands National Park and in Glen Canyon National Recreation Area. Outcrop exposures of all three of these successions have not hitherto been extensively studied in this region and their analysis is important because initial reconnaissance indicates important lateral changes in sedimentary style from the equivalent outcrops to the east of the Colorado River. Methods will include sedimentary logging, regional key surface tracing and the construction of detailed architectural panels. No specimens will be collected and none of the proposed methods employ destructive or invasive techniques such as drilling for core plugs.

Collections:
This work will not require any destructive sampling such as trenching or hammering. Neither will this work require the removal of any rock samples. No specimens will be collected.

Expected outcomes
Outcomes of this work will include the development of generic sedimentary behavior and response models that can then be applied to further our understanding of climate change in ancient, Quaternary and modern desert systems. Furthermore, this work will document how climatically-forced sedimentary signatures expressed in the ancient rock record can potentially be used for chronostratigraphic correlation purposes. This has potential for application in subsurface correlation of analogous units, which are notoriously difficult to correlate with either radiometric or biostratigraphic techniques.

Logistics:
No assistance from park personnel is anticipated.

14) Permit #: CANY-2007-SCI-0014

Study Title:

INTERMOUNTAIN WEST NATIVE PLANT POLLINATION PROJECT

Primary investigator contact information:

Name: Janes Cane, Utah State University, USDA-ARS Bee Biology and Systematics Lab
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Project Summary:
Native bees and/or honey bees are needed to pollinate most of the wildflower species considered for Great Basin rehabilitation. The pollinator faunas of many candidate plant genera include one or more bee genera with potentially manageable species. After pollinator needs are evaluated by comparing fruit and seed sets at caged flowers and openly visited flowers we can assess whether plant reproduction is pollinator limited. If plant reproduction proves to be pollinator limited, then native bee faunas need to be surveyed and evaluated at managed and wild flowering populations. One of the candidate flower genera that we have been working with as a potential for seed production is Sphaeralcea spp. Based on data we collected from our 2006 experimentation, we have determined that these plants require a pollinator for successful reproduction. The primary purpose of our data collection, within the parks, is to investigate and quantify the pollinators that are associated with Sphaeralcea spp. This information will be used to identify bees that are important pollinators of these species and whether the pollinators are potential candidates for management. We hope to develop sustainably managed pollinators that can be used on farms which will grow native Sphaeralcea spp. for BLM restoration purposes.

Intended use of results - This information will be used to identify bees that are important pollinators of these species and whether the pollinators are potential candidates for management. We hope to develop sustainably managed pollinators that can be used on farms which will grow native Sphaeralcea spp. for BLM restoration purposes.

Objective:
Extend pollinator breeding biologies and management to additional native flowering species being considered for revegetation on federal lands in the Intermountain West. To identify species of bees that currently pollinates native *Sphaeralcea munroana, S. grossularifolia* and *S. ambigua*. Characterize the plants' pollinator faunas and identify pollinators with management potential

Collections:
Collection of 50 bees and 1 plant specimen per site allowed. Maximim of 3 sampling sites in Canyonlands NP allowed for this project.

We will collect bee fauna on stands of *Sphaeralcea grossularifolia*. Depending on the number of wild stand locations found, we intend to sample at approximately 2-3 stands and collect a maximum of 50 individual bees at each location. Individual bees will be collected and removed from the collecting site and the pinned specimens will receive an ascension number and be housed in the United States National Pollinating Insect Collection at the USDA-ARS Pollination Insect Biology, Management and Systematics Laboratory facilities in Logan UT. We do not anticipate collection of any rare bee species. We will also collect 1 plant voucher specimen at each sampling location.

Logistics:
Collection will occur during the months of May and June. At the end of the year we will submit a report of our research which will include the locations of each plant species stand we collect on and a number of associated pollinator fauna collected.

We have been working with NPS staff to determine plant stand locations within and adjacent to the park boundaries. If possible, we would like assistance of a river ranger to access plant locations beyond the confluence of the Colorado and Green River.

NATURAL BRIDGES NATIONAL MONUMENT
2007 Research Permits

1) Permit #: NABR-2007-SCI-0001

Study Title:
SOIL SURVEY OF NATURAL BRIDGES NATIONAL MONUMENT, UTAH

Primary investigator contact information:

Name: Mr Victor Parslow, USDA Natural Resources Conservation Service
Address: 340 North 600 East, Richfield, UT 84701.
Phone: 435.896.6441 ext. 134 **Email:** Vic.Parslow@ut.usda.gov

Project Summary:
To provide an updated soil and ecological site inventory for Natural Bridges National Monument (NABR), that meets National Cooperative Soil Survey (NCSS) standards and monument management and planning needs.

The existing soil survey was conducted in the late 1970s's and the early 1980's as part of the San Juan County, Utah, Central Part soil survey. This inventory was primarily designed as a tool for use in managing grazing lands and has been found to be too general to be useful in managing the park. Information is insufficient to model salt movement, mitigate visitor impacts, identify and protect habitat of Threatened and Endangered species, and other park responsibilities.

In 2003, reprensentatives of the National Park Service approached the Natural Resources Conservation Service to update the existing soil surveys within Arches and Canyonlands National Parks and Natural Bridges and Hovenweep National Monuments. The Plan of Work and contracted were approved in 2004. This application is seeking permission to carry out the field work necessary to complete the contract.

Collections:
Soil sampling allowed: 200 to 300 gram soil samples only. Archeologist must be present when digging any holes in ground. Some clipping of vegetation is allowed but must be kept to a minimum. Majority of soil samples will be destroyed in analysis. No collection of plants is allowed. Photos of plants for identification purposes is allowed.

2006 Findings and Status:
The Natural Resources Conservation Service (NRCS) completed the majority of the field work for providing an updated soil and ecological site inventory for Natural Bridges National Monument in 2005. A summary of the activities for the year 2006 follows: Soil inventory activities The majority of field soil survey activities are complete in Natural Bridges National Monument. During 2006, activities were limited to checking map unit delineation lines in the monument, and reviewing map unit composition concepts. A field review will be conducted in Spring of 2007. The draft manuscript will be complete at this time. Plans are also in place for a special study in high visitor impact areas, and a classification of the canyon bottoms based on Rosgen's model. Soil samples were collected from five sites, and will be sent to the National Soil Survey Laboratory in Lincoln, Nebraska for analysis. Archaeological Activities As a result of the field work of 2006, one archaeological site and one isolated occurrence were recorded in Natural Bridges National Monument. Details of these resources including locations and

descriptions of their contents can be referenced in a more complete report, Summary Report of Cultural Resources Support Provided to the Soil Surveys Of Natural Bridges National Monument, Arches National Park, Canyonlands National Park and Hovenweep National Monument For the Year 2006. All cultural resources were successfully avoided. No cultural material was unearthed during the course of soil sampling activities.

2) Permit #: NABR-2007-SCI-0002
Study Title:

RIPARIAN AND AQUATIC INVERTEBRATE MONITORING PROTOCOL AND DEVELOPMENT (NPS I&M PROGRAM)

Primary investigator contact information:

Name: Dr Anne Brasher, USGS, Water Science Center
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Phone: (435) 259-3866 **Email:** abrasher@usgs.gov

Project Summary:
The objective of the study is to develop a rigorous, well-integrated set of protocols for long-term riparian and macroinvertebrate monitoring across the Colorado Plateau. Another objective is to evaluate the utility of aquatic macroinvertebrates and riparian ecosystems as reliable indicators of aquatic ecosystem conditions in dryland systems characteristic of the Colorado Plateau.

Collections:
In general, macroinvertebrate samples are destroyed during analysis. Upon arrangement with the Park curator, a voucher collection from the sampling effort can be maintained at an established (museum) location following NPS repository standards.

Only the collection of aquatic invertebrates allowed. Most will be destroyed in analysis. Those curated will be stored according to NPS regulations at the Utah State University Bug Lab.

2006 Findings and Status:
No activities are reported for 2006.

HOVENWEEP NATIONAL MONUMENT
2007 Research Permits

1) Permit #: HOVE-2007-SCI-0001

Study Title:
SOIL SURVEY OF HOVENWEEP NATIONAL MONUMENT, UTAH

Primary investigator contact information:

Name: Mr Victor Parslow, USDA Natural Resources Conservation Service
Address: 340 North 600 East, Richfield, UT 84701.
Phone: 435.896.6441 ext. 134 **Email:** Vic.Parslow@ut.usda.gov

Project Summary:
To provide an updated soil and ecological site inventory for Hovenweep National Monument (NABR), that meets National Cooperative Soil Survey (NCSS) standards and monument management and planning needs.

The existing soil survey was conducted in the late 1970s's and the early 1980's as part of the San Juan County, Utah, Central Part soil survey. This inventory was primarily designed as a tool for use in managing grazing lands and has been found to be too general to be useful in managing the park. Information is insufficient to model salt movement, mitigate visitor impacts, identify and protect habitat of Threatened and Endangered species, and other park responsibilities.

In 2003, reprensentatives of the National Park Service approached the Natural Resources Conservation Service to update the existing soil surveys within Arches and Canyonlands National Parks and Natural Bridges and Hovenweep National Monuments. The Plan of Work and contracted were approved in 2004. This application is seeking permission to carry out the field work necessary to complete the contract.

Collections:
Soil sampling allowed: 200 to 300 gram soil samples only. Archeologist must be present when digging any holes in ground. Some clipping of vegetation is allowed but must be kept to a minimum. Majority of soil samples will be destroyed in analysis. No collection of plants is allowed. Photos of plants for identification purposes is allowed.

2006 Findings and Status:
No activity was conducted this report year.