NATIONAL PARK SERVICE

Southeast Utah Group
Arches
Canyonlands
Hovenweep
Natural Bridges

2001 RESEARCH PROJECTS
Compiled by Charlie Schelz / Biologist
Resource Management Division
Southeast Utah Group - National Park Service

CANYONLANDS NATIONAL PARK

1) Active Geologic Extension at the Grabens of Canyonlands National Park

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Name of institution represented: Western Washington University

Purpose of study
The grabens in the Needles District of Canyonlands are unique, active geologic features. The sedimentary rock units in that region of the Park are broken by normal faults that define the uplifted horsts and down-dropped grabens, and by fissures that have opened in response to geologic extension across the region. This faulting and fissuring is the result of ductile deformation of the underlying evaporite (salt) layers, as the entire sequence stretches and slides slowly towards the Colorado River. Our principal objective is to measure the current rate of movement of the grabens at Canyonlands and identify locations of especially fast or slow motion. We will: 1) evaluate the rate and spatial variation in vertical deformation using interferometric synthetic aperture radar (satellite images); 2) determine the rate and direction of horizontal extension along two orthogonal traverses across the Canyonlands using Global Positioning System measurements on the ground; and 3) monitor the contribution of individual faults directly with strain gauges and detailed field mapping. Study results will enable prediction of the future landscape evolution of the grabens at Canyonlands. The work will also contribute to understanding of faulting hazards in other, more populated areas

2) Long-term Assessment of Changes in Biological and Geomorphic Resources along the Green and Colorado Rivers in Canyonlands National Park

Name of principal investigator: Robert Webb **Email:** rhwebb@usgs.gov

Name of institution represented: USGS-Water Resources Division

Purpose of study

The riverine environment along the Green and Colorado Rivers through Canyonlands National Park has changed historically owing to natural and anthropogenic factors. The Green and Colorado Rivers have a riverine environment that is relatively harsh to terrestrial and aquatic ecosystems because of the high sediment loads and large, annual stage fluctuations of these rivers. In addition, the arid and semiarid climate of the region, combined with relatively saline sedimentary rocks that form the substrate of terrestrial ecosystems, creates a desert shrubland/parkland away from the immediate influence of the river.

Historically, the riverine environment of the Green and Colorado Rivers has been affected by climate, which jointly affects direct precipitation and annual temperature fluctuations as well as river flows, and land-use practices, particularly grazing and periodic fires. Both the Green and Colorado Rivers are partially regulated through Cataract Canyon by large dams, all of which are hundreds of miles upstream from the national park.

The purpose of this project is to document long-term changes in the desert and riverine environment along the Green and Colorado Rivers using a variety of techniques. Repeat photography will be used to assess species-specific changes to vegetation as well as changes to the geomorphic framework of Cataract Canyon. These photographs will be taken in formats from digital cameras and 35 mm to 4x5 film (the primary format)and will be stored in the Desert Laboratory Photographic Collection at the U.S. Geological Survey in Tucson, Arizona. Changes will be interpreted using qualitative inspection, quantitative counting of individual species, and digital analysis of historical and modern photography.

Aerial photography will be used to map Quaternary deposits along the river corridor, rim-to-rim, in Cataract Canyon. The purpose of this work is to evaluate the ages of geomorphic surfaces within Cataract Canyon and to determine their significance to questions concerning both the evolution of the canyon and its geomorphic stability. These maps will be digitized into Arc/Info for use by other researchers. The ages of individual deposits in Cataract Canyon and for selected deposits along both approaches to the canyon will be determined using a variety of techniques, particularly cosmogenic age dating of exposed surfaces.

Other techniques will be used to evaluate time-series of changes. These include analysis of repeated aerial photography and collection and analysis of tree rings from samples collected from Cataract Canyon. In particular, Celtis reticulata (netleaf hackberry) is a long-lived species from Cataract Canyon that appears to have annual rings that are related to river flows. Previous studies indicate that trees may live 200 years or more in the canyon, and dead stumps of trees that germinated 350 years ago have been located. Using standard dendrochronological techniques, combined with time series analysis, we will attempt to reconstruct historical and prehistoric river flows using tree rings from Celtis.

3) Effects of Plant Invasion on an Arid Ecosystem

Name of principal investigator: Jayne Belnap **Email:** jayne_belnap@usgs.gov

Name of institution represented: U.S. Geological Survey

Purpose of study

The decomposition of soil organic matter plays an important role in the cycling of nutrients essential to plant growth. Of these essential nutrients nitrogen (N) is often the most limiting in many terrestrial ecosystems. Plant species have been shown to influence soil N dynamics by controlling the quantity and quality of above and belowground litter inputs. Furthermore, changes in the plant species composition of an ecosystem can potentially alter soil N dynamics and in the end, ecosystem productivity. Several years ago it was observed that the annual grass, Bromus tectorum, invaded an undisturbed section of Canyonlands National Park called Virginia Park. Because this site is undisturbed it provides a unique opportunity to study how the invasion of Bromus alters soil N dynamics without the confounding influence of disturbances, such as livestock grazing.

4) Controls on Nitrogen Dynamics in Arid Ecosystems in Response to Global Climate Change

Name of principal investigator: Jayne Belnap **Email:** jayne_belnap@usgs.gov

Name of institution represented: U.S. Geological Survey

Purpose of study

Knowing how nitrogen (N) enters, leaves, and cycles within arid ecosystems is critical to our understanding of ecosystem structure and function, as well as predicting responses to perturbations such as global change. Dynamics of carbon

(C) and nitrogen in an ecosystem are often controlled by the availability of the most limiting of the suite of ecosystem resources. In arid and semi-arid ecosystems, N is thought to be the second most limiting resource next to water. The relatively low resource availability in these systems means that slight perturbations in ecosystem parameters (e.g. precipitation, atmospheric CO2 concentration) can have large effects on the dynamics of other resources.
The objectives of this project are to: 1) assess the relative contribution of the crust versus the bulk soil organisms to several key N transformations in the overall N cycle, 2) characterize the spatial heterogeneity or landscape distribution of these key processes, 3) assess the effect of a possible change in C availability on these key N cycling processes. By characterizing the partitioning between crust and soil, landscape distribution, and response of these ecosystem processes to potential changes in C availability we can gain an improved understanding of the structure and function of arid ecosystems and how they may respond to various types of perturbations.

5) Impacts of Biological Soil Crusts on Ecosystem Nitrogen Cycling

Name of principal investigator: Jayne Belnap **Email:** jayne_belnap@usgs.gov

Name of institution represented: U.S. Geological Survey

Purpose of study
The interaction between biological systems and physical environments influence the ability of ecosystems to respond to disturbance, a key aspect in maintaining ecosystem integrity. One of the lesser known but critically important components of the biophysical system is cycling of limiting nutrients, particularly nitrogen (N). Nitrogen availability often limits net primary production in terrestrial ecosystems, therefore biogeochemical N cycles are an important indicator of ecosystem integrity. It is well known that organisms within biological soil crusts fix N, but the contribution of biological soil crusts to ecosystem N is poorly understood. In this research project we will study the impact of biological soil crusts on ecosystem N budgets. We will examine N inputs and loss pathways on darker, well-developed lichenized soil crusts as compared to lighter crusts that are dominated by free-living cyanobacteria. Biological soil crusts are an important component of arid regions in the western US, and are currently used as indicators of physical resource conditions in several National Park management programs. In this research program, we will provide land managers the scientific link between biological soil crusts and ecosystem N cycling.

6) Impacts of Climatic Change and Land Use on the Southwestern U.S.

Name of principal investigator: Jayne Belnap **Email:** jayne_belnap@usgs.gov

Name of institution represented: U.S. Geological Survey

Purpose of study

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

· 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.
· Understand today's interplay among climate, land use and surface processes (geologic and ecologic).
· Understand the impacts of future climate on land surface under the following time frames: seasons; El NiÔo/La NiÔa 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
· Understand geologic origins of soil nutrients and the interactions of soil compounds and plants.
· Understand geomorphic controls on plant distribution
· Understand the recent (past several decades, centuries, millennia) geologic/geomorphic evolution of the ecosystem to reveal patterns of surface stability and instability.
· Recognize areas vulnerable to wind erosion and soil loss.
· Understand conditions of cheatgrass (and other exotic plants) invasion to predict areas most vulnerable to expansion and to help devise mitigation strategies.

7) 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

Name of principal investigator: Jayne Belnap **Email:** jayne_belnap@usgs.gov

Name of institution represented: U.S. Geological Survey

Purpose of study
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.

8) Exotic Annual Grasses in Western Rangelands: Predicting Resistance and Resilience of Native

Ecosystems to Invasion

Name of principal investigator: Jayne Belnap **Email:** jayne_belnap@usgs.gov

Name of institution represented: U.S. Geological Survey

Purpose of study

Introduced Mediterranean annual grasses currently comprise 50-85 percent of vascular plant cover in over two-thirds of the West. One of these species, Bromus tectorum, alone dominates over 100 million acres the Intermountain West, with an additional 62 million at high risk from invasion (EPA-EMAP, unpublished; Whisenant 1990). On-going conversion of native vascular plant communities to annual grasses is a threat to the population viability of many native plant and animal species, through direct plant replacement or changes in habitat characteristics, such as timing and quantity of food and cover and altered nutrient cycles.

It has long been thought that surface disturbance is a necessary prerequisite for annual grass invasions into established perennial plant communities. However, annual grasses have been seen to invade undisturbed ecosystems as well. In addition, annual grass invasions are often patchy, with some soils apparently uninvadable. Agronomists have long known that one of the most important soil characteristics affecting plants is the availability of soil nutrients. The relative levels of specific soil nutrients, rather than disturbance, successfully explained site-specific patterns of Bromus invasion in SE Utah grasslands. This project will determine if invasion susceptibility of other ecosystems in other geographic regions can be similarly predicted by variations in soil characteristics attributable to geomorphic and pedogenic processes within a given watershed. Experiments will be be conducted to determine if managers can alter soil chemistry in a way to favor native grass establishment. In addition, Bromus may alter many ecosystem components that prevent native plant re-establishment. This project will monitor soils in a newly-invaded area, and document what alterations in soil chemistry and biology occur. Results from this project will be used to develop management strategies to avoid new Bromus invasions, and for already-invaded areas, to develop techniques to enhance native plant re-establishment.

With many millions of acres currently dominated by non-indigenous annual grasses, and 62 million acres of rangeland habitat highly susceptible to conversion, annual grasses are emerging as a major factor to be considered as we contemplate the future of rangeland ecosystems. It is critical that we understand whether managers can stop or buffer these invasions, and/or restore habitats after conversion. Determining factors that precipitate or facilitate invasion may provide management tools for preventing dominance of aliens in areas where the population viability of species is of concern, and facilitate re-establishment of lost habitat. In addition, understanding how annual grass invasion changes natural ecosystem processes, such as nutrient availability, water availability, and soil microbial systems and how these changes affect re-establishment of native perennial plants, will enhance efforts to restore lost habitat

9) Nitrogen Deposition and UV Stressor Impacts in Canyonlands National Park as Affected by Climatic Pulse Events

Name of principal investigator: Jayne Belnap **Email:** jayne_belnap@usgs.gov

Name of institution represented: U.S. Geological Survey

Purpose of study

Historically, arid systems in the western US and arctic are thought to have derived much of their nitrogen from nitrogen-fixing components of the biological soil crusts. These crusts, which can represent up to 70 percent of the living cover (often referred to as cryptobiotic crusts), are consolidated matrices of cyanobacteria, lichens, mosses, algae and fungi that are ubiquitous on undisturbed soil surfaces. Increased nitrogen deposition, increased UV-B, and land-use change are likely to cause large changes in the integrity and sustainability of the arid ecosystems through impacts of these stressors on the biological crusts. Altering the function of cryptobiotic crusts will directly affect critical ecosystem processes such as soil carbon and nitrogen transformations, and this in turn will have a direct impact on productivity of higher plants. Through a series of field nitrogen-deposition and UV-augmentation experiments, we will quantify the direct impacts of these stressors on biological crusts, soil carbon and nitrogen dynamics, and higher plants within Canyonlands NP. We will also identify and quantify the anthropogenic sources of nitrogen deposition that are likely to impact ecosystem dynamics. Canyonlands National Park is an ideal site because of several long-term (30 yr) research and monitoring efforts directed at understanding the response of arid ecosystems to anthropogenic change. The proposed research will provide the scientific basis for understanding the response of arid ecosystems to the interaction of anthropogenic nitrogen deposition, increased UV-B radiation, and land-use change. Biological soil crusts are the keystone component of arid ecosystems in the western United States and will provide large-scale information about the "health" of these arid ecosystems. The research results will improve our understanding of anthropogenic stressors by quantifying and further defining the relationships between biological crusts, soil carbon and nitrogen transformations, and higher plant sustainability-performance in arid lands. Results will apply to 65 National Park units and 300 million acres of federal land, including 4 national parks with UV-B monitors (Canyonlands, Denali, Big Bend, and Grand Canyon National Parks).

10) Dating of Barrier Canyon Style Rock Art

Name of principal investigator: Alan Watchman **Email:** rpreed@compuserve.com

Name of institution represented: National Pictographic Society

Purpose of study

To date, using AMS carbon^14 techniques, a chipped section of paint from a section of fallen rock in Horseshoe Canyon. This fallen rock is near the Great Gallery panel of Barrier Canyon style rock art. The purpose is to obtain a reliable date for the painting of this section of panel, using small chips of paint that will be physically separated from underlying sandstone and possibly contaiminating overlayer. The use of very small paint chips precludes the incorporation of any portion of the base rock (that also contains carbon) in the specimen to be analyzed.

11) Downstream Effects of Flaming Gorge Dam on riparian vegetation along the Green River

Name of principal investigator: David Cooper **Email:** davidc@cnr.colostate.edu

Name of institution represented: Colorado State University

Purpose of study

To understand the effects of current and past Green River regulation by Flaming Gorge Dam on riparian vegetation along the Green River. My initial work will focus on the Fort Bottom area as a significant hydrologic data set has been developed by the National Park Service Water Resources Division. I will establish homogenous plots to represent the main vegetation types in the area. Each plot will be identified with a GPS location, and can then be analyzed within the hydrologic framework established by NPS hydrologist Brian Cluer. This data set will allow me to analyze the composition of vegetation along hydrogeological gradients. This vegetation composition will be compared with the vegetation from other Green River locations in Lodore Canyon, Whirlpool Canyon, Split Mountain Canyon, Ouray National Wildlife Refuge, Island Park, and Gray Canyon, as well as Deerlodge Park and Yampa Canyon along the unregulated Yampa River in Dinosaur National Monument. The overall goal is to develop an analysis of the riparian vegetation for the entire middle and lower Green River. We will investigate patterns of vegetation that reflect adjustment to Flaming Gorge Dam regulation. I will also excavate tamarisk and young cottonwood to accurately determine the year each plant established. The goal of this investigation is to understand whether Flaming Gorge Dam has created more suitable conditions for tamarisk invasion, and the role of tamarisk in sediment accumulation and channel narrowing.

12) Amphibian Research and Monitoring Initiative (ARMI): Pacific Northwest and Adjacent Aridlands--Canyonlands National Park Index Site

Name of principal investigator: Tim Graham **Email:** tim_graham@usgs.gov

Name of institution represented: USGS--Canyonlands Field Station

Purpose of study

1. To develop effective monitoring protocols that will provide the proportion of habitat units that host breeding populations of amphibians within selected survey areas, in a design that allows broad inference to all of Canyonlands National Park.
2. To develop methods to effectively estimate population density and abundance in sentinel sites that will be worked intensively over each season.

3. Work with Southeast Utah Group NPS staff to enhance and expand existing water monitoring program to ensure amphibian habitats are being monitored, and to add any parameters of importance to amphibians that may not be included in current park monitoring program (e.g., dissolved organic matter, and community attributes such as plankton composition).
4. Monitor the incidence of disease in Canyonlands amphibians.
5. Integrate findings in Canyonlands National Park with a national amphibian monitoring program.
6. Make latest monitoring data available to the NPS via web accessible database within 3 months of data collection.
7. Compile and interpret trend information on amphibians that we collect at regular intervals and place findings into local, regional, and national contexts.

13) Amphibian Population Dynamics and Invertebrate Diversity of Salt Creek Canyon, Canyonlands National Park: Differences Correlated with Presence/Absence of 4WD Vehicle Use

Name of principal investigator: Tim Graham **Email:** tim_graham@usgs.gov

Name of institution represented: USGS--Canyonlands Field Station

Purpose of study
The objectives of this study are to: 1) establish riparian and aquatic invertebrate and amphibian monitoring locations in the vicinity of vegetation monitoring stations; 2) evaluate a variety of sampling methods for invertebrates and amphibians to determine which provides the best estimates of community structure (relative abundance and species composition); 3) identify which taxa, guilds, functional groups of invertebrates and/or amphibians will make optimum indicators of riparian and aquatic ecosystem recovery in Salt Creek; 4) recommend the best monitoring techniques for target indicator groups based on results of this research; 5) work with CANY staff to develop, test and refine a monitoring plan that will guide sampling, analysis, and interpretation of the data collected over time, and that can be extended to other parts of CANY as well as other units of SEUG.

14) Western States Visibility Assessment Program: Visibility and Economic Impact Modeling Based on Source Identification of Energy-Related Pollution Affecting Visibility in Selected Protected Visual Environments

Name of principal investigator: Carl Popp **Email:** flyfish@nmt.edu

Name of institution represented: New Mexico Institute of Mining And Technology

Purpose of study

This research program will extend the DOE's involvement in air quality modeling by improving visibility models, conforming updated baseline projections of energy use, pollutant emissions and visibility effects, and improving models that simulate the effects of changes in energy policy on the economy, on emissions, and on visibilty at national parks, wilderness areas and other protected environments. The program will enhance the capabilities at existing monitoring sites by providing information on sources of constituent aerosols; enhance models linking economics, energy production and use; and link emissions and visibility by incorporating updated baseline information; and provide source-receptor data based on measurement of aerosols, gases and aerosol precursors. The sites selected to enhance monitoring capability include Grand Canyon and either Canyonlands or Mesa Verde national parks. Final site selection will be based on visits to the sites.

15) Triassic Pre-Dinosaurian Communities National Park's Land, The Oldest Megatracksite In North America

Name of principal investigator: Debra Mickelson **Email:** mickelsd@ucsu.colorado.edu

Name of institution represented: University of Colorado - Boulder

Purpose of study

During the summer of 2000, tetrapod tracks were observed on fallen blocks and in situ host beds of Early/Middle? Triassic Moenkopi Formation (Torrey Member) in remote washes at Capitol Reef National Park, Glen Canyon National Recreational Area. Lateral correlations of the track bearing horizons are extensive and have been traced to BLM and private land's adjacent to Arches and

Canyonlands National Park's. For that reseason the possiblity of lateral correlations of tracing these track bearing horizons within the Park's boundaries is essential. Most of the tracks are the typical and common "swim tracks" observed and documented previously from the Moenkopi Formation in Western North America. However, in addition to swim tracks of (Chirotherium), new terrestrial "walking" vertebrate footprints have been found in association with invertrbrates and plant trace fossils. Rare, fish fin drag marks (Undichnia) have been identified with swim tracks of small lizard-like (Rhynchosauroides) and (Chirotherium).

The research proposed here will be conducted to document the three dimensional size and shape of the tracks exposed on fallen blocks and on the undersides of track bearing units. Also to identify important invertebrate and plant trace fossils found to occur in association with vertebrate swim tracks and footprints. Latex molds and casts of the tracks will be collected to further document the tracks and permit later construction of plaster casts in a laboratory. Latex molds and casts do not damage the tracks or the host bed surfaces, and the tracks themselves will be left in place. Selected footprints and trackways will be traced using Duralar (.003 clear plastics). The footprints will be photographed extensively. Park Service personnel will be made aware of the exact location of the tracks and invited to participate in any or all aspects of the study.

To place the tracks within a stratigraphic framework, the research team will determine the source of the fallen blocks and investigate, in situ, host beds. Because of the high density of tracks observed on the fallen blocks, it is likely that additional tracks will be found in place and aid in the identification and lateral extension of the host beds. Measured stratigraphic sections will be constructed to document the locations of the trackways.

To understand the paleoecology of the trackmakers the research team will observe, photograph, and in some cases, collect rock samples and/or plant material and invertebrate trace or body fossils (surface collecting only) from stratigraphic units containing and surrounding the tracks and trackways. (No vertebrate tracks will be collected). The lithologys and depositional environments of the host beds and the surrounding units will be determined.

Because fossils are rare from the Early/Middle? Triassic in the Western United States, these vertebrate tracksites could contribute important information about the early evolution of pre-dinosaurian communities and the environments in which they lived.

16) Annual Forestland Inventory of Utah

Name of principal investigator: Dwane Van Hooser **Email:** dvanhooser@fs.fed.us

Name of institution represented: USDA FOREST SERVICE

Purpose of study

Gather information on the quantity and quality of forest resources, growth, mortality, removals, and forest health.

17) Impact of Introduced Grasses on Grasshopper Communities in Colorado Plateau Grasslands: Implications for Population Viability of Native Perennial Grasses

Name of principal investigator: Tim Graham **Email:** tim_graham@usgs.gov

Name of institution represented: USGS--Canyonlands Field Station

Purpose of study
This study will document differences in grasshopper community structure in native and cheatgrass dominated grasslands of the Colorado Plateau.

18) Stream Gaging of the Green River in Potato Bottom, Canyonlands NP.

Name of principal investigator: Eric Moser **Email:** eric_moser@nps.gov

Name of institution represented: National Park Service

Purpose of study
They propose to install stream gage instrumentation in the Green River at Potato Bottom to continuously measure river stage for approximately eight months beginning in March or April of 2001. In addition during this time, discharge of the Green River will be measured three to four times by WRB staff. These stage—discharge data pairs will be used as boundary conditions in a two –dimensional model of the reach from Hardscrabble to Potato bottoms that is being developed by WRB.

The two dimensional model for the reach will help determine floodplain area for various discharges, particularly for levee management scenarios, assess habitat for several aquatic and riparian species, and determine stability of features such as islands.

The following description is typical of the sites constructed by the WRB. Such a site currently exists at Hardscrabble Bottom, and this instrumentation would be removed to Potato bottom. A stream gage typically consists of a submersible pressure transducer, a datalogger, and three semi-permanent survey points—usually rebar—set in the ground. In addition, a staff plate in the channel may be useful at Potato Bottom if park personnel transiting on the river could easily read

it. Given overall variation in stage, a staff plate may be placed only at the higher end of the range.

The transducer is typically attached to some kind of support in the stream such as a steel post, and the electrical lead is buried 3-6", and sometimes contain in flexible conduit, to the weather box containing the datalogger. The box is typically mounted on a steel post as well, but if a site is well drained, it can rest on the ground. A solar panel is also used, and can be set up on the ground if there is an adequate southern aspect.

At the time of site visits by WRB staff, water surface elevation would be measured, either by reading the staff plate, using a tape-down point such as a bolt in a rock, or surveying from the survey points.

River discharge would also be measured using a boat. Usually this includes setting up a tagline from bank to bank, perpendicular to the stream flow for the duration of the measurement, about two- three hours, and using current meters on sounding reels. If an acoustic doppler is purchased by the WRB, then a tagline would be unnecessary and a discharge measurement could be taken in as little as five-ten minutes. In any case, several days to even weeks notice could be provided to the park as to the date of visits, to help avoid conflict with boaters.

At least one discharge should be measured at the gage transect, in order to sound the channel. The others could be done anywhere within a reasonable distance from the gage where flow is not significantly different from that passing the gage.

It is important to have the gage set up before spring high flows. At that time a discharge would also be measured. At least one discharge should be measured during the spring melt hydrograph, and more if feasible. And finally, at least one discharge should be measured during summer baseflow.

19) Proposed Upheaval Dome Sample Collecting for Development of Denver Museum of Nature and Science "Craters of the Southwest" Field and Educational Guide and Research.

Name of principal investigator: Frank Sanders **Email:** fsanders@its.bldrdoc.gov

Name of institution represented: Denver Museum of Nature and Science

Purpose of study

For the past five years, the Denver Museum of Nature and Science (DMNS) Department of Earth and Space Science (DESS) has been developing a public-

education curriculum in space science.[1] This development has focussed on the natural history of meteorites, fireballs (bolides), and meteoroid and asteroid impact events. Tangible products of this program have been a series of museum workshops on meteors and fireballs; a museum class on meteorites, impacts, and related phenomena; and a very active museum program in which volunteers collect data on Colorado bolides to determine probable fall coordinates of meteorites. The tracking program has resulted in the recent recovery of a (possibly rare) type of stony meteorite.[2] A project is also currently under way to deploy all-sky observation cameras at selected schools in Colorado to collect quantitative data on bolide events.

An extension of this educational program is a DMNS field guide, "Craters of the Southwest," that is currently under development and is to be published by DMNS in 2001. The field guide will be used as class material for future DMNS meteorite/asteroid classes. It will also be used on an annual or biannual basis for participants in a newly developed DMNS field trip of the same title. The museum field guide and associated DMNS field trip are designed to examine the morphology, geology, mineralogy, and likely physical origins of four structures: a positively identified impact crater (Barringer, near Flagstaff, AZ); a positively identified volcanic cone (Sunset Crater, at Wupatki National Monument, AZ); and a pair of more enigmatic structures. The last two structures are Yellowslide Gulch, near Rifle, CO [1, 2]; and Upheaval Dome, in Canyonlands National Park, UT. The origin of Upheaval Dome has been argued as either an impact structure [3] or a modified salt structure [4, 5].

One of the goals of the field guide, classes, and field trip is to encourage students/participants to critically analyze physical evidence at purported impact localities to evaluate alternative hypotheses for the origins of the Upheaval Dome and Rifle structures. The students are thus encouraged to use their previously established knowledge of geology, mineralogy, and impact physics as they survey these localities. (E.g., they will use materials such as [6, 7] in their analyses.)

Need for Collection of Hand Specimens from Upheaval Dome.
Unfortunately, direct physical examination of critically important features of one of the structures, Upheaval Dome, is hindered by the difficulty of access into the bottom, where key evidence needs to be examined by the students. The hike may be too difficult physically for some, and in any event may be too time-consuming for the field trip itinerary. More importantly, hand samples from the bottom of Upheaval Dome and from a particular locality described by Kriens, et. al., from near the rim are required for classroom studies of Upheaval Dome at the museum in Denver.

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[1] Under the direction of Jack Murphy, DMNS Curator of Geology.

20) The BCS PROJECT / Barrier Canyon Style Documentation

Name of principal investigator: David Sucec **Email:** davidsu@uswest.net

Name of institution represented: BCS Project

Purpose of study:
Documentation of Barrier Canyon style (BCS) rock art on the northern Colorado Plateau, primarily in Utah. Recording BCS imagery with large-format cameras for the maximum clarity and detail. Documentation will exist as archival photographic prints (including both gelatin silver [black/white] and ultra-stable color (Both processes have estimated shelf-lives of 400-500 years). The entire documentation (photographs, inventory and scholarly discourse) will be archived in the Special Collections Division, Marriott Library, University of Utah, Salt Lake City.

21) Colorado Pikeminnow and Humpback Chub Monitoring

Name of prin. investigator: Mathew Anderson **Email:** nrdwr.manderse@state.ut.us

Name of institution represented: State of Utah, Division of Natural Resources

Purpose of study:
To develop annual indices of the relative abundance of Colorado pikeminnow and Humpback chub.

22) Population Estimates of Colorado Pikeminnow in the Lower Green River.

Name of prin. investigator: Mathew Anderson **Email:** nrdwr.manderse@state.ut.us

Name of institution represented: State of Utah, Division of Natural Resources

Purpose of study:
To obtain a reasonable estimate of adult Colorado pikeminnow abundance and survival in the Lower Green River.

23) Bonytail Reintroduction.

Name of prin. investigator: Mathew Anderson **Email:** nrdwr.manderse@state.ut.us

Name of institution represented: State of Utah, Division of Natural Resources

Purpose of study:
To re-establish bonytail in the Upper Colorado River Basin.

24) Fault Growth and Drainage Development in the Canyonlands Grabens

Name of prin. investigator: Dierdre Cummins **Email:** d.commins@ic.ac.uk

Name of institution represented: Imperial College of Science at Cardiff University

Purpose of study:
The aim of the proposed research is to better understand the evolution of faults as they grow and the influence this will have on drainage development. During the evolution of the surface expression of a fault, there are significant topographic changes that directly influence the ambient fluvial system. The Canyonlands Grabens are a natural laboratory for this type of study. The region offers excellent exposure of faults in varying stages of growth and interaction. The drainage pattern has clearly been influenced by fault growth. The objective of this research is to observe the nature of the drainage development, with a view to gaining information both on the structural evolution of faults and the distribution of sediment in these regions. This information will be incorporated into a general model that will be applied to other regions that undergo extensional faulting.

25) Reconstructing the Geometry and Palaeo-climate of the Cedar Mesa and White Rim Sandstones (Permian), Southeast Utah

Name of prin. investigator: Nigel Mountney **Email:** n.p.mountney@keele.ac.uk

Name of institution represented: Keele University, United Kingdom

Purpose of study:
This research aims to determine the mechanism by which aeolian strata deposited in aeolian desert systems accumulate and become preserved in the long-term rock record. This will involve the sedimentological and stratigraphic analysis of the Permian Cedar Mesa and White Rim Sandstones, Utah. Quantitative surveying will establish the spatial arrangement of genetically related aeolian dune, interdune and fluvial strata. The original aeolian bedform morphology of the system will be reconstructed through the geometric analysis of major aeolian bounding surfaces. Stratigraphic analysis will enable deposits relating to aeolian bedform migration events to be distinguished from externally controlled episodes of erg termination related to regional changes in climate and sediment supply patterns. Sedimentary characteristics of the accumulation will be used to support either a deflationary, bypass or stabilisation mechanism for periodic termination of aeolian dune accumulation and preservation.

26) Visions of a Sculptured Paradise: The Colorado Plateau as American Sacred Space.

Name of prin. investigator: Sam Schmiedling **Email:** ecolage@phnx.uswest.net

Name of institution represented: Arizona State University

Purpose of study:
A region-wide study of the Colorado Plateau .

27) Avian Monitoring on the Colorado and Green Rivers in Canyonlands National Park

Name of prin. investigator: Matt Johnson **Email:** Matthew.Johnson@nau.edu

Name of institution represented: Northern Arizona University

Purpose of study:
To set up and survey permanent avian monitoring plots on the Colorado and Green Rivers.

ARCHES NATIONAL PARK

1) Effects of Resource Availability and Food Preferences on Home Range Use and Caching Behavior of Ord's Kangaroo Rats (*Dipodomys ordii*).

Name of principal investigator: Janene Auger **Email:** auger@unr.nevada.edu

Name of institution represented: University of Nevada – Reno

Purpose of study

Food resources can affect all aspects of a species' natural history including physiology, foraging and other behaviors, space use, and population demography. In communities where food resources exhibit high between-year variation these effects may be readily observed under natural conditions. In this study I will investigate the correlation between home range size and food availability for Dipodomys ordii in a habitat dominated by a mast-seeding shrub, blackbrush (Coleogyne ramosissima). I predict that home ranges should contract under conditions of high seed abundance. I will also determine the preferences of D. ordii for various native seeds preparatory to an experiment on caching behavior. The experiment will test the notion that kangaroo rats should conform more strictly to predictions derived from theory on optimal cache spacing when they are storing a highly preferred seed than when they are storing a less preferred seed. More specifically, caches of a highly preferred seed should be small and spread out in exclusive areas of the individual=s home range, thereby reducing the risk of pilferage. Methods will include aerial photography, radio telemetry, cafeteria-style food preference trials, and flourescent powder tracking.

2) Geological Evaluation to Determine the Nature of and Recharge Area for Two Springs in Arches NP.

Name of principal investigator: James Harte **Email:** james_harte@nps.gov

Name of institution represented: National Park Service

Purpose of study

The Utah Geological Survey (UGS) herein proposes to provide information to determine (1) the recharge area(s) and geologic controls of one spring in Courthouse Wash and one spring in Sevenmile Canyon Wash (figure1), both located near the southwestern boundary of Arches National Park, and (2) whether wells used in currently existing development are completed in the

aquifer(s) supplying water to one or both of the springs.

3) Picturing National Parks

Name of principal investigator: Emily Scott **Email:** emeliza@hotmail.com

Name of institution represented: University of California - Los Angeles

Purpose of study
In an effort to broaden understanding of our relationships to nature in the late twentieth and early twenty-first centuries, I intend to investigate national park tourist culture, scenic vision, and photographic practice. Specifically, I want to study how our vision of national parks is influenced by mediated images we see before ever arriving in the parks themselves (through advertisements, film, photography, the internet, etc.) and secondly, the act of picture-taking as central to the "national park experience."

4) Faulting, Fault Zone Processes and Fluid Flow In Three Dimensional Basin Models

Name of principal investigator: Stuart Clarke **Email:** s.m.clarke@esci.keele.ac.uk

Name of institution represented: University of Keele, England

Purpose of study
To provide a three-dimensional geological model of faults in Arches NP.

5) 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

Name of principal investigator: Jayne Belnap **Email:** jayne_belnap@usgs.gov

Name of institution represented: U.S. Geological Survey

Purpose of study

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.

6) GypsES West: Providing Phenologically Based Decision Support for Timing Effective Management Actions.

Name: Steve Munson **Email:** smunson@fs.fed.us

Name of institution represented: USDA FOREST SERVICE

Purpose of study
The models and decision support tools that will be developed from this project will facilitate the most efficacious gypsy moth control/eradication programs within the Intermountain west with the least possible impacts on non-target organisms. The project has 3 major objectives:
1. Validate improved egg hatch and larval phenology models.
2. Produce validated decision support tools for field application within western regional climates.
3. Evaluate probability of gypsy moth establishment in Utah which includes the production of probability of establishment maps. The probability of establishment maps will produce categories of risk for all vegetative types associated with various elevations within the state of Utah.

7) Trassic Pre-Dinosaurian Communities National Park's Land, The Oldest Megatracksite In North America

Name of principal investigator: Debra Mickelson **Email:** mickelsd@ucsu.colorado.edu

Name of institution represented: University of Colorado - Boulder

Purpose of study
Document the three-dimensional size and shape of the tracks exposed on fallen blocks and on the undersides of track bearing units of the Moenkopi Formation. And to identify important invertebrate and plant trace fossils found to occur in association with vertebrate swim tracks and footprints

8) Survey of Dinosaur Tracks, Arches National Park

Name of prin. investigator: Martin Lockley **Email:** Mlockley@Carbon.CUDenver.edu

Name of institution represented: University of Colorado - Denver

Purpose of study
This is a follow up to the NPS Paleontological Survey conducted in the year 2000 under the guidance of by Vince Santucci (NPS) and Jim Kirkland (Utah State Geologist). In essence we have been encouraged to follow up by documenting

tracks found during this survey last year.

9) Visions of a Sculptured Paradise: The Colorado Plateau as American Sacred Space.

Name of prin. investigator: Sam Schmiedling **Email:** ecolage@phnx.uswest.net

Name of institution represented: Arizona State University

Purpose of study:
A region-wide study of the Colorado Plateau

10) Faulting, Fault Zone Processes & Fluid Flow In Three Dimensional Basin Models

Name of prin. investigator: Stuart Clarke **Email:** stu.clarke@virgin.net

Name of institution represented: Keele University, United Kingdom

Purpose of study:
Faults are key controlling elements in fluid flow systems in sedimentary basins. When faults undergo displacement, they change their fluid transmissibility properties by juxtaposing varying lithologies across the fault, by pumping or valving diagenetic fluids, and by smearing semi-permeable or impermeable clays and shales within fault zones.

Three-dimensional sequential modelling of fault displacement has enabled the building of earth models with time-varying structural geometries. Based on the geometries of strata that are cut by faults, their juxtaposition relationships and their physical properties, various cross fault relationships have been modelled in three-dimensional space. Structural restoration, or retro-deformation provides 'snapshots' of fault and stratal geometries through time. These are used in forward modelling from the undeformed state of the rock volume to its present-day structural architecture. The evolution of cross fault relationships is dynamically calculated and forward modelling allows a prediction of the development of fault zone smears, gouges and cataclasis.

Cross fault juxtaposition of strata and fault zone processes such as smearing and cataclasis have been incorporated into three-dimensional transmissibility models involving invasion percolation (IP). The effects fault zone processes on fluid flow are incorporated into four-dimensional forward models which, through the IP algorithm, calculate hydrocarbon fluid flow pathways controlled by lithology (transmissibility distribution) and structural geometries in rock volumes. The controls of fluid flow by lithology distribution and variations in cross-fault sealing capacity have been modelled both spatially and with time.

11) Triassic Pre-Dinosaurian Communities National Park's Land, The Oldest Megatracksite In North America

Name of principal investigator: Debra Mickelson **Email:** mickelsd@ucsu.colorado.edu

Name of institution represented: University of Colorado - Boulder

Purpose of study

During the summer of 2000, tetrapod tracks were observed on fallen blocks and in situ host beds of Early/Middle? Triassic Moenkopi Formation (Torrey Member) in remote washes at Capitol Reef National Park, Glen Canyon National Recreational Area. Lateral correlations of the track bearing horizons are extensive and have been traced to BLM and private land's adjacent to Arches and Canyonlands National Park's. For that reseason the possiblity of lateral correlations of tracing these track bearing horizons within the Park's boundaries is essential. Most of the tracks are the typical and common "swim tracks" observed and documented previously from the Moenkopi Formation in Western North America. However, in addition to swim tracks of (Chirotherium), new terrestrial "walking" vertebrate footprints have been found in association with invertrbrates and plant trace fossils. Rare, fish fin drag marks (Undichnia) have been identified with swim tracks of small lizard-like (Rhynchosauroides) and (Chirotherium).

The research proposed here will be conducted to document the three dimensional size and shape of the tracks exposed on fallen blocks and on the undersides of track bearing units. Also to identify important invertebrate and plant trace fossils found to occur in association with vertebrate swim tracks and footprints. Latex molds and casts of the tracks will be collected to further document the tracks and permit later construction of plaster casts in a laboratory. Latex molds and casts do not damage the tracks or the host bed surfaces, and the tracks themselves will be left in place. Selected footprints and trackways will be traced using Duralar (.003 clear plastics). The footprints will be photographed extensively. Park Service personnel will be made aware of the exact location of the tracks and invited to participate in any or all aspects of the study.

To place the tracks within a stratigraphic framework, the research team will determine the source of the fallen blocks and investigate, in situ, host beds. Because of the high density of tracks observed on the fallen blocks, it is likely that additional tracks will be found in place and aid in the identification and lateral extension of the host beds. Measured stratigraphic sections will be constructed to document the locations of the trackways.

To understand the paleoecology of the trackmakers the research team will observe, photograph, and in some cases, collect rock samples and/or plant material and invertebrate trace or body fossils (surface collecting only) from stratigraphic units containing and surrounding the tracks and trackways. (No

vertebrate tracks will be collected). The lithologys and depositional environments of the host beds and the surrounding units will be determined.
Because fossils are rare from the Early/Middle? Triassic in the Western United States, these vertebrate tracksites could contribute important information about the early evolution of pre-dinosaurian communities and the environments in which they lived.

NATURAL BRIDGES NATIONAL MONUMENT

1) Re-evaluation of Long-Term Monitoring Populations of the Kachina Daisy Populations in Natural Bridges National Monument.

Name of principal investigator: Loreen Allphin Woolstenhulme
Email: loreen_woolstenhulme@byu.edu

Name of institution represented: Brigham Young University

Purpose of study
The research is a follow-up to studies on the ecology, genetics, and reproductive biology of the Kachina daisy (*Erigeron kachinenesis*). The principle investigator will assess size-specific mortality, growth, and reproductive success across six natural populations of the species in NBNM. Any vegetative community and abiotic changes in the populations will be determined through comparison of data with earlier studies.

2) Effects of Cattle Grazing and Fire on the Birds of Pinyon-Juniper Woodlands

Name of principal investigator: Scott Schlossberg **Email:** schlssbr@uiuc.edu

Name of institution represented: University of Illinois At Urbana-Champaign

Purpose of study
Fire suppression and the introduction of large grazers have dramatically altered the disturbance dynamics of ecosystems in western North America. Apart from how these disturbances affect soils and vegetation, little is known about how fire and cattle grazing impact wildlife (1). The purpose of my study is to understand

how birds respond to altered disturbance regimes in southwestern pinyon-juniper woodlands. Prior to the 1860's, these woodlands were open savannas, maintained by frequent low-intensity fires (2). Since that time, cattle grazing and fire suppression have allowed trees to colonize formerly open areas (3). Consequently, pinyon-juniper woodlands today are more like forests than savannas, with closed canopies and unproductive understories. Furthermore, unnaturally high tree densities have lead to intense fires that destroy all vegetation (4). Such major changes in habitat structure and productivity are likely to have significant effects on wildlife. My proposed research will examine the nature of those effects.

This summer, I will census birds in pinyon-juniper woodlands on the southern Colorado Plateau to estimate densities and habitat preferences of breeding species. Sites will range from pristine, ungrazed woodlands to areas that have been grazed for decades and will include areas with varying histories of recent fire. Study plots will be located within 1000-ha or larger tracts of pinyon-juniper woodland selected using GAP analysis databases. On each plot, I will estimate bird densities using point counts, and I will measure vegetation to describe the habitat used by individual bird species as well as the overall conditions of the habitat.

As an additional measure of habitat quality, I will compare relative food abundance for a few focal species in areas with different disturbance histories. I will combine data that I collect on the foraging locations and food items selected by birds with measurements of food (seed and arthropod) abundance in the environment to determine relative food availability for each species. Food abundance data can be combined with vegetation data to identify important habitat features for different bird species.

This project will have significant implications for the conservation of pinyon-juniper birds. Quantitative descriptions of birds' habitats may be used to suggest management practices to benefit individual species. Moreover, assessment of how grazing and fire influence bird abundances will provide valuable information on how these disturbances affect bird species. In summary, this research will provide crucial baseline data for the conservation and management of the pinyon-juniper woodland avifauna.

HOVENWEEP NATIONAL MONUMENT

1) Floristic Study of Hovenweep National Monument.

Name of principal investigator: Charles Schelz **Email:** charlie_schelz@nps.edu

Name of institution represented: National Park Service

Purpose of study
To obtain a complete list of plants at each unit of Hovenweep National Monument. Plant communities will be defined and mapped. Provide biological inventory data on vascular plants in parks of the Northern Colorado Plateau Inventory and Monitoring Network

2) Biological inventory of National Parks on the Northern Colorado Plateau – Amphibians and Reptiles.

Name of principal investigator: Erika Nowak **Email:** erika.nowak@nau.edu

Name of institution represented: Northern Arizona University

Purpose of study
Provide biological inventory data on vertebrate animals and vascular plants in

parks of the Northern Colorado Plateau Inventory and Monitoring Network. This proposal addresses the inventory of reptiles and amphibians at HOVE.

3) Biological inventory of National Parks on the Northern Colorado Plateau - Mammals.

Name of principal investigator: Mike Bogan **Email:** Mbogan@unm.edu

Name of institution represented: U.S. Geological Survey

Purpose of study

Provide biological inventory data on mammals in parks of the Northern Colorado Plateau Inventory and Monitoring Network. This proposal addresses the inventory of mammals at HOVE.