

Southeast Utah Group

National Park Service
U.S. Department of the Interior



Arches National Park
Canyonlands National Park
Hovenweep National Monument
Natural Bridges National Monument

2005 RESEARCH PERMITS

Charles Schelz / SEUG Ecologist

ARCHES NATIONAL PARK

2005 Research Permits

1) Permit #: ARCH-2005-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).

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 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 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.

2) Permit #: ARCH-2005-SCI-0002

Study Title:
BCS PROJECT / BARRIER CANYON STYLE ROCK ART DOCUMENTATION.

Primary investigator contact information:

Name: Mr. David Sucec, BCS PROJECT
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Project Summary:

The objectives of the BCS PROJECT documentation project are to record all Barrier Canyon Style rock art images with archival photographic prints (gelatin-silver and ultra-stable color prints), to create a complete inventory of the documented sites, and to generate a scholarly description and analysis of the imagery.

2005 Results and Status

No work was performed in ARCH in 2005

3) Permit #: ARCH-2005-SCI-0003

Study Title:
THE FORMATION OF CONJUGATE DEFORMATION BANDS AT THE GARDEN AREA

Primary investigator contact information:

Name: Ms. Kimberly Artita, University of Nevada, Reno
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Project Summary:

A special type of strike-slip fault forms in the porous Entrada Sandstone at the Garden Area. The purpose of this study is to: 1) re-evaluate the map constructed by Zhao and Johnson, 2) take samples for thin sections (to determine what type of deformation bands they are), 3) assess the relative stress magnitudes and orientation at the time of deformation, 4) determine the dilatancy angle of the Entrada Sandstone, and 5) re-evaluate the interpretations of Zhao and Johnson.

4) Permit #: ARCH-2005-SCI-0004

Study Title:
RECORDING BARRIER CANYON STYLE ROCK ART

Primary investigator contact information:

Name: Mr. Michael Firnhaber, University of Colorado, Boulder

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Project Summary:

The purpose of the proposed study is to record, for the purpose of analysis and interpretation, the Barrier Canyon Style rock art tradition.

2005 Findings and Status:

No activity was conducted this report year.

5) Permit #: ARCH-2005-SCI-0005

Study Title:

VISITOR IMPACT STUDY WITH THE USE OF AERIAL PHOTOGRAPHY

Primary investigator contact information:

Name: Craig Randall

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Project Summary:

This study will test a non-intrusive program for monitoring visitor impact in the parks. It may provide an effective way to monitor visitor impact on soil conditions, vegetation, and social trails. This data will be acquired through the use aerial photos obtained by cost effective UAV's. (Unmanned Aerial Vehicles) These quiet, electric remote controlled aircraft will obtain the necessary photo's in a non-intrusive way, using established roads or trails to fly from. The UAV's are light, small and easily portable in a small vehicle from one photo location to another.

These UAV's will give the ecologist a bird's eye view of the areas most prone to impact from visitors. Over a repeat period of time these aerial photos may be able to show visitor effects on the parks resources.

2005 Findings and Status:

Photos were taken throughout Arches NP but no analysis has been performed. This is a good baseline set for future trend analysis.

6) Permit #: ARCH-2005-SCI-0006

Study Title:

HERBARIUM AND FIELD STUDIES OF VASCULAR PLANT FLORA OF ARCHES NP FOR NATIONAL PARK SERVICE INVENTORY AND MONITORING PROGRAM

Primary investigator contact information:

Name: Walter Fertig

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Project Summary:

The purpose of this study is to document the vascular plant flora of Arches National Park (ARCH) and develop a plant distribution database using the National Park Service's NPSpecies system.

2005 Findings and Status:

As a first step in developing an updated species list and distribution database for the park, I examined all specimens in the Arches NP herbarium to correct misidentifications, update species nomenclature (following Welsh et al. 2003, "A Utah Flora, third edition"), and add variety or subspecies names if needed. Of the 623 specimens currently deposited in the collection, 32 were misidentified (5.1%), 28 had their names updated (4.5%), 122 had variety names added (19.6%), and 441 were confirmed as correctly identified (70.8%). Another 259 specimens reported in the park's museum database (ANCS+) are presently on loan and could not be verified. The Arches herbarium currently contains 365 vascular plant taxa collected within the park (plus an additional 14 species from outside park boundaries). At least 122 additional plant species have been reported for Arches NP by Schelz and Moran (2005 SE Utah Group Plant list) and Harrison et al. (1964 "Plants of Arches National Monument, BYU Biological Series 5(1):1-23) but are not represented by collections in the Arches herbarium. Based on the Atlas of the Utah Flora (Albee et al. 1988), 229 additional species are reported from comparable habitats in the vicinity of Arches NP, but have not yet been documented within the park. These results suggest that the Arches NP herbarium is missing a significant number of plant taxa known or likely to occur in the park. In particular, fall-flowering and wetland species appear to be under-represented. Targeted inventory work to fill gaps in the Arches NP vascular plant collection is recommended so that park manager's will have an improved understanding of the composition and status of the flora of the park and a more complete reference collection for researchers and staff interested in plant identification.

7) Permit #: ARCH-2005-SCI-0007

Study Title:

AMPHIBIAN RESEARCH AND MONITORING INITIATIVE (ARMI): PACIFIC NORTHWEST AND ADJACENT ARIDLANDS—ARCHES NATIONAL PARK INDEX SITE

Primary investigator contact information:

Name: Tim Graham, USGS

Address: 2290 West Resource Blvd, Moab, UT 84532

Phone: 435 719-2339

Email: tim_graham@usgs.gov

Project Summary:

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 Arches National Park. Integrate findings in Arches National Park with a national amphibian monitoring program.

2005 Findings and Status:

No activity was conducted in Arches NP in 2005 related to this project.

8) Permit #: ARCH-2005-SCI-0008

Study Title:

IMPACT OF INTRODUCED GRASSES ON GRASSHOPPER COMMUNITIES IN COLORADO PLATEAU GRASSLANDS: IMPLICATIONS FOR POPULATION VIABILITY OF NATIVE PERENNIAL GRASSES

Primary investigator contact information:

Name: Dr. Tim Graham, USGS

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Email: tim_graham@usgs.gov

Project Summary:

The change from native to non-native grasses affects quality, quantity and timing of available food for grasshoppers and other herbivores. Grasshopper community composition changes, and pressure on remaining native perennial grasses increases. Insectivores also respond

negatively to dominance by non-native grasses, primarily because of a simplification of plant architecture. Predation on grasshoppers and other herbivores thus decreases, resulting in additional consumption of remaining native species. It has been suggested that increased herbivory reduces competitive ability of native grasses enough that non-native species are able to maintain dominance even after the disturbances that allowed establishment have ceased.

The proposed study will document differences in grasshopper community structure in native and cheatgrass dominated grasslands of the Colorado Plateau, and correlate these differences with characteristics of the grassland vegetation communities such as amount of bare ground, grass height, cover of perennial and annual grasses, etc. Implications for interactions between cheatgrass and native perennial grasses will be explored as well. In particular, the effect of maturing cheatgrass on grasshopper survival and fecundity, and thus population size, will be tested, and experiments on competitive abilities of cheatgrass vs. selected native grasses with and without grasshopper herbivory will be conducted. The study could be expanded to the Great Basin and Columbia River Basin, which are also being overrun by cheatgrass and other introduced plants, to see if herbivory plays a role in continued dominance by these exotic species in other arid and semi-arid grasslands.

2005 Findings and Status:

No activity was conducted in Arches NP in 2005 related to this project.

9) Permit #: ARCH-2005-SCI-0009

Study Title:

**VEGETATION DATA COLLECTION IN SUPPORT OF THE U.S. GEOLOGICAL SURVEY
NATIONAL PARK SERVICE VEGETATION CLASSIFICATION AND MAPPING PROGRAM
AT ARCHES NATIONAL PARK**

Primary investigator contact information:

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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).

2005 Findings and Status:

While no field data collection was performed in ARCH in 2005, several other vegetation classification and mapping tasks were conducted. An illustrated field key of the 62 plant associations for ARCH was produced with photos and a dichotomous key. Photo interpretation created a vegetation map with a legend key that was digitized. Also, local descriptions of the 62 plant associations identified for ARCH were produced describing the environmental conditions and species present for the associations within the park.

10) Permit #: ARCH-2005-SCI-0010

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:

Purpose of study: 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 late 1970's and the early 1980's as part of the Grand County, Utah soil survey. This inventory was primarily designed as a tool in managing grazing lands and has been found to be too general to be useful for managing the park. Information is lacking to model salt movement, mitigate visitor impacts, identify and protect habitat of Threatened and Endangered species, and other park responsibilities.

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

2005 Findings and Status:

The Natural Resources Conservation Service (NRCS) began field work for providing an updated soil and ecological site inventory for Arches National Park in 2005.

1. Soil inventory activities

Pre-survey activities were conducted in Arches National Park in 2005, as well as data collection on soils and plants.

This included evaluation of the existing Soil Survey and Ecological Site Descriptions (ESD's). Relationships between the geology and associated soils were discussed, and theories on soil-geology-plant-landscape models were developed.

Field work in Arches National Park was initiated in 2005. Traverses of the landscape were conducted, and soil descriptions and plant inventory data recorded, in order to further develop the soil-plant-landscape-geology models.

2. Dynamic Soil Properties (DSP) Pilot and Study

In addition to traditional soil survey activities in Arches National Park, NRCS developed a pilot project in conjunction with the NRCS National Soil Survey Center and the Jornada Experimental Range-Agricultural Research Service (ARS), and the National Park Service. The objectives of this project are to summarize selected dynamic soil properties of the Begay soil for plant communities within various states of the Semidesert Sandy Loam (Fourwing Saltbush) ecological site; to determine if statistically or ecologically significant differences in the mean and variation of these soil properties exist between plant communities or states; to determine if any correlations exist between dynamic soil property values, plant community characteristics, and terrain characteristics; and to describe any relationships between the dynamic soil properties of the Begay soil and the plant community characteristics of different states of the Semidesert Sandy Loam (Fourwing Saltbush) ecological site.

This is a pilot study for developing new methodologies for collecting and interpreting data related to near-surface, dynamic soil properties, such as aggregate stability, compaction, organic matter, and other properties which may change depending on use and management. Although only one soil type (Begay) and one ecological site (Semidesert Sandy Loam) were selected for inclusion in this pilot, the information gathered will be used to determine how to integrate collection of dynamic soil data into traditional soil survey activities, thus adding value to the updated Soil Survey.

Some benefits to the managers of Arches National Park include:

1. Information about the correlation between dynamic soil properties, plant community characteristics (cover, production), and terrain characteristics.

2. Supporting data for the ecological site description including the rangeland health reference worksheet, the description of ecological dynamics, and a refined state and transition model.
3. A list of potential indicators (dynamic soil properties) for assessment and monitoring projects.
4. A report of point and summary data for dynamic soil properties and terrain characteristics under selected plant communities on the Begay soil. Data will be summarized by soil map unit component, elevation (low and high), and plant community (state).

Data was collected during the pilot study on randomly selected plots (20 m by 20 m) in Arches and Canyonlands National Parks. Soil descriptions and associated soil samples were collected from these plots, and sent to the National Soil Survey Laboratory in Lincoln, Nebraska for characterization. Data was collected in the field regarding soil aggregate stability, herbaceous and woody production, plot vegetation/erosion patterns, canopy and basal gap of the plant community, and other information which will be analyzed for correlations between dynamic soil properties and existing plant communities. The data, laboratory results, and any conclusions which may be drawn from this study will be made available to National Park personnel.

11) Permit #: ARCH-2005-SCI-0011

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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Project Summary:

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.

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.

12) Permit #: ARCH-2005-SCI-0012

Study Title:**NORTHERN AND SOUTHERN COLORADO PLATEAU NPS SPRINGS ECOSYSTEMS
INVENTORY****Primary investigator contact information:****Name:** Dr. Abraham Springer, Northern Arizona University**Address:** P.O. Box 4099, Flagstaff, AZ 86011**Phone:** 928.523.7198**Email:** abe.springer@NAU.EDU**Project Summary:**

As part of the joint Northern and Southern Colorado Plateau Parks Networks collaboration on springs ecosystems, we are conducting a comprehensive physical and biological inventory of springs ecosystems on NPS units on the Colorado Plateau. This project will be conducted by staff from Northern Arizona University, Flagstaff, Arizona with funds from the National Park Service (Cooperative Agreement Number: CA 1200-99-009, attached below). We would like to conduct an inventory of several springs on your NPS unit to test our methods and provide you with information on the ecological condition of your springs.

This inventory will be conducted by Abraham Springer and Lawrence Stevens of the Geology Department at Northern Arizona University, and their assistants. These two researchers recently produced a springs ecosystem conceptual model, a comprehensive springs classification system, and a suite of springs inventory protocols that we are testing for further use in assessing the health of springs ecosystems. Their curriculum vitae are available upon request.

These inventories will require approximately one half day / site, and will involve mapping the site and its vegetation, and collecting water, soil, and biological specimens (especially plants and invertebrates). We have extensive experience inventorying springs ecosystems on National Park lands in Grand Canyon, Lake Mead National Recreation Area, Glen Canyon National Recreation Area, and other NPS lands. Through this experience, we have learned how to minimize researcher impacts on these delicate ecosystems, and we will use that knowledge to make sure we minimize our impacts to the sites visited.

The study sites will include those that best represent the variety of springs habitats on your NPS land unit. Selection criteria include diverse settings, elevations, and water chemistries, and the sites inventories will hopefully include both pristine and human altered sites. Your staff may have recently provided a list of candidate springs for this analysis, and we will follow up on that site selection by personally contacting the appropriate staff to better understand the timing and access to the sites. We are providing a comprehensive list of study sites in this permit application, which will be refined once we discuss priority and access with appropriate NPS staff and confirm the collection dates. The data collected will be incorporated into a newly created comprehensive NPS database and the researcher's classification system. Data will be provided back to your NPS unit for your information and use.

The draft protocols to be used during the springs inventories are attached. The Northern and Southern Colorado Plateau networks are jointly developing a database into which the data will be compiled. Specimens collected through this project will be sacrificed for analysis (e.g., water quality samples), or prepared and housed at the Museum of Northern Arizona in Flagstaff, an approved NPS repository.

2005 Findings and Status:

During 2005, 75 springs were inventoried in 26 units of the National Park Service for the Northern and Southern Colorado Plateau Inventory and Monitoring Network. The inventories included site descriptions, environmental and climate conditions, vegetation and invertebrate surveys, wildlife observations, water-quality analyses, geomorphology descriptions, and water-quantity measurements. We inventoried Poison Ivy Spring and Willow springs at Arches National Monument. A final project report to be submitted to the I&M Network in spring 2006 will include a summary of the inventories of these springs.



13) Permit #: ARCH-2005-SCI-0013

Study Title:

**INTERPRETING 250M MODERATE RESOLUTION IMAGING SPECTRORADIOMETER
NORMALIZED DIFFERENCE VEGETATION INDEX IN THE COLORADO PLATEAU**

Primary investigator contact information:

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Project Summary:

The National Park Service (NPS) Southern and Northern Colorado Plateau Networks (SCPN and NCPN) intend to implement remotely sensed programs to monitor long-term ecosystem status and to detect the occurrence of abnormal ecosystem states and/or processes. A key element of this work will be use of the 250m resolution data from the moderate resolution imaging spectroradiometer (MODIS). These data include the normalized difference vegetation index (NDVI), red (620-670 nm), and near infrared (NIR, 841-876 nm) bands. For the purposes of this scope of work, the term MODIS data refers to the combined suite of NDVI and red and near infrared bands.

Prior to implementing these data in any management context, the NPS requires a clear understanding of the relationship between NDVI data and ground conditions at specific parks. While NDVI is known to be related to the fraction of photosynthetically active radiation absorbed by plant canopies (FPAR), leaf area index (LAI), and green fractional cover (GFC), it is also strongly influenced by soil conditions, canopy geometry, and the presence of senescent vegetation. Thus, across a spectrum of NPS units, it is probable that the same NDVI value could represent different ground conditions. These uncertainties are especially important for the SCPN and NCPN, in which semi-arid conditions dominate and vegetation fractional cover tends to be low.

The goal of the proposed work is therefore to conduct a proof-of-concept field campaign in which intensively measured ground conditions will be compared with MODIS data. The comparison will be conducted in the following ecosystems: (1) grass, (2) mixed shrub/grass, and (3) woodland (consisting of a mixed pinyon-juniper overstory with possible understory grass and shrubs).

Specific objectives of this effort are:

- Using ground-based measures, characterize with- and among-season trends in vegetation condition of grasslands, shrublands, and woodlands. Ground-based measures will include Plant Area Index (PAI, similar to LAI but includes stem material) and GFC.
- Determine which scales are appropriate for use of MODIS data by investigating correlations of ground measures with MODIS data at multiple spatial scales (1 MODIS pixel, 2 x 2 pixels, 3 x 3 pixels).

To accomplish these objectives, the project will consist of five main tasks:

1. Site selection.
2. Sampling design and logistics.
3. Field measurements.
4. Remote sensing.
5. Analysis.



14) Permit #: ARCH-2005-SCI-0014

Study Title:

BIOLOGY AND DISTRIBUTION OF THE BUTTERFLIES OF ARCHES NATIONAL PARK

Primary investigator contact information:

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Project Summary:

To create an Expanded Checklist of the Butterflies of Arches and Canyonlands National Parks which will include distribution in space and time, documented larval foodplants, limited developmental histories, and some behavioral traits. (Some information on plants will be included, but only as required to emphasize the butterflies' story. I know the bfs' plants fairly well, so the collection of plants will be extremely limited.)

2005 Findings:

No field work was performed in 2005.

15) Permit #: ARCH-2005-SCI-0015

Study Title:

FIELD-BASED EVALUATIONS OF MEASURES AND MEASUREMENT TECHNIQUES TO SUPPORT LONG-TERM MONITORING OF TERRESTRIAL ECOSYSTEMS IN COLORADO PLATEAU NATIONAL PARK SERVICE UNITS

Primary investigator contact information:

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Project Summary:

This project involves field-based evaluations of a limited suite of measures and measurement techniques for long-term monitoring of terrestrial ecosystems characteristic of the Colorado Plateau region. The project is designed to support the Northern and Southern Colorado Plateau Networks (NCPN and SCPN, respectively) of the National Park Service's Inventory and Monitoring Program (NPS I&M Program). In conjunction with the I&M Program, ecoregional networks of NPS units have been charged with the task of identifying "vital signs" to be monitored for the purpose of tracking long-term trends in the "health" or condition of park ecosystems. Collectively, the NCPN and SCPN have identified an integrated suite of vital signs for tracking resource conditions in 35 NPS units located in the Colorado Plateau region of Utah, Arizona, Colorado, and New Mexico. To inform the selection of monitoring methods most suited to NPS monitoring objectives for these parks, the NCPN and SCPN have a need for field-based evaluations of measures and measurement techniques across the range of ecosystems likely to be monitored. In addition, the NCPN and SCPN require detailed standard operating procedures (SOPs) for methods selected for implementation.

Following are general objectives for this project.

1. Collect and analyze field data to evaluate a limited suite of measures and measurement techniques for their relative suitability in effectively and efficiently meeting NPS monitoring needs across the range of ecosystems likely to be monitored.
2. Characterize within- and among-site variability in monitoring measures to inform NPS planning for operational monitoring.
3. On the basis of site soil, landscape, and vegetation characteristics, evaluate the accuracy of stratification data used to select field sites for sampling.
4. Following USGS-NPS guidelines (Oakley et al. 2003), prepare SOPs for methods selected for implementation.

2005 Findings and Status:

During the 2005 field season, we sampled 48 1-ha macroplots located in seven Colorado Plateau NPS units, including five macroplots in Arches National Park. Sampling was designed to (1) evaluate different methods for sampling vegetation and soil attributes and (2) document within- and among-macroplot variability in sampling measures to inform decisions about monitoring design. In the blackbrush-dominated macroplots sampled in Arches National Park, we found that vegetation sampling by the line-point-intercept method generally was more efficient (in terms of the amount of time required for a given level of precision) than sampling with 10-m² quadrats or 1-m² quadrats. All cover measures were more variable within macroplots than among macroplots. All three methods were found to yield results which were repeatable by different observers. Sampling with 10-m² quadrats greatly increased the detection of rare plant species, but this method also tended to result in a large degree of soil disturbance due to trampling.

A full report describing these results in greater detail will be provided to the NPS Inventory and Monitoring Program.

16) Permit #: ARCH-2005-SCI-0016

INVESTIGATION OF PALEOFLOOD DEPOSITS OF THE COLORADO RIVER ABOVE THE MOAB URANIUM MILL SITE

Primary investigator contact information:

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Project Summary:

Paleoflood deposits have been observed on the Arches National Park side of the Colorado River, opposite of the boat launch at Milepost 10.3, Highway 128. We propose to collect samples and map these deposits to determine the volume of a probable maximum flood on the Colorado River. This information will be provided to the agencies which manage the water resources of the Colorado River.

17) Permit #: ARCH-2005-SCI-0017

Study Title:

VERTEBRATE SPECIES IN UTAH NATIONAL PARKS

Primary investigator contact information:

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Project Summary:

The principal purpose of this research is to increase basic knowledge and understanding of biological inventories with specific vertebrate species verification. This is one component of the biological inventories being conducted within the units of the NCPN as part of a national emphasis on inventory and monitoring within the National Park Service. Species verification will benefit the NPS and UDWR and the entire scientific community through updated information housed in the Automated National Catalog System (ANCS+), the NPS national biodiversity database, NPSpecies, and the UDWR state biodiversity database.

The purpose of the biological inventories is to document 90 percent of the vascular plant and vertebrate animal species in the units of the NCPN. Data collected from these inventories are incorporated into the national bio-diversity database, NPSpecies. In order to verify the existence of a species in a park unit, the NCPN requires a voucher specimen, a photograph, or an authoritative observation for each species listed in the database.

Species verification may be obtained from a number of sources such as NCPN inventories; existing voucher data housed in the ANCS+; from data mining efforts at other museums and herbaria; and from review of technical reports and publications. The taxonomic nomenclature associated with these verification sources is often outdated or incorrect; for example, museums may mistakenly list a particular species as collected from a Utah park, leaving the verification process in question. Once all sources have been reviewed, there are often gaps remaining in the species verification process which need to be filled.

The NPS and UDWR agree to work cooperatively toward obtaining voucher, photographic or observational data for the herpetofauna, mammalian, and avian species currently lacking complete information, and to standardize the taxonomic nomenclature for all species in the Utah units of the NCPN.

2005 Findings and Status:

No activity was conducted this report year.

18) Permit #: ARCH-2005-SCI-0018

Study Title:

FACTORS INFLUENCING DISTRIBUTION & MORTALITY OF A DOMINANT RIPARIAN TREE

Primary investigator contact information:

Name: Alicyn Gitlin, Northern Arizona University

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Project Summary:

This project is investigating drought-related mortality in cottonwood trees (*Populus* sp.). Research begun in 2003 & 2004 yielded 2 major findings: 1) the presence of the invasive species tamarisk (*Tamarix* sp.) is correlated with increased levels of cottonwood mortality, and 2) the first generation hybrid of Fremont cottonwood (*P. fremontii*) and narrowleaf cottonwood (*P. angustifolia*) is experiencing less mortality than its parent species. We believe that tamarisk is acting as an agent of selection during this drought, removing all but the most salinity- and drought-tolerant tree genotypes. We also predict that hybrid trees will survive prolonged drought conditions more successfully than narrowleaf or Fremont cottonwood.

In order to determine whether the removal of tamarisk from a site improves conditions for cottonwood survival and growth, areas of tamarisk infestation and restoration areas where tamarisk has been removed will be compared. Branch growth, stand mortality, and soil salinity will be measured at restored and non-restored sites. This will require the collection of soil samples and may require some branch clipping, but we will try to minimize cuttings and will agree to not cut branches at the park's request.

The outcome of these studies will be a greater understanding of the benefits of riparian restoration and the ways that soils affect the distribution of cottonwood trees.

19) Permit #: ARCH-2005-SCI-0019

Study Title:

PALAEOENVIRONMENTAL SETTING OF TETRAPOD TRACKS IN THE CEDAR MOUNTAIN FORMATION, ARCHES NATIONAL PARK

Primary investigator contact information:

Name: Dr. Joanna Wright, University of Colorado at Denver

Address: Department of Geography & Environmental Sciences, Campus Box 172, PO Box 173364
Denver, CO 80217

Phone: 303-556-6007 **Email:** joanna.wright@cudenver.edu

Project Summary:

To examine the mode of preservation and environmental setting of terrestrial tetrapod trace fossils in the Cedar Mountain Formation of Arches National Park with a view to assessing the diversity and paleoecology of the trace fossil assemblage in comparison to other track assemblages of similar age in the western United States and elsewhere. Preliminary reports (Lockeley et al 2004) has indicated that the assemblage may be unusually diverse but detailed prospecting for tracks and analysis of track-bearing layers within the section has not yet been carried out (Kirkland pers.comm.).

This project seeks to rectify this situation with the production of a detailed stratigraphic section and more extensive prospecting for tracks in the Cedar Mountain Formation.

Collections:

No specimens will be collected for this project. This is a survey only.

20) Permit #: ARCH-2005-SCI-0020

Study Title:

Determining the effect of tamarisk invasion on stream invertebrate communities on the Colorado Plateau

Primary investigator contact information:

Name: Angie Moline, COLORADO STATE UNIVERSITY

Address: Department of Biology, E330 Anatomy-Zoology Bldg., Fort Collins, CO 80523

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Project Summary:

The rate of exotic species invasion in North America has drastically increased since European settlement. Non-native invasion is one of the most important causes of species endangerment in the US and is a major component of anthropogenic global change. In the western US, native cottonwood-willow floodplain forests are being replaced by exotic species such as tamarisk (*Tamarix* sp.) and Russian olive (*Elaeagnus angustifolia*). Riparian vegetation occurs on <1% of the western North America landscape, yet it provides habitat for more species of birds than all other vegetation types combined. Riparian vegetation influences stream communities by shading, contributing leaf litter, and stabilizing the stream banks. Stream nutrients are transferred to riparian ecosystems when terrestrial predators, such as riparian birds and lizards, consume emergent aquatic mayflies, such as mayflies.

The effect of tamarisk and Russian olive invasion on stream-riparian ecosystems is poorly understood, but could be dramatic as tamarisk alone dominates over 600,000 riparian and wetland hectares. These exotics are probably changing stream geomorphology and hydrology, modifying aquatic insect communities, and threatening native bird populations. These problems are particularly pressing in the arid west where water managers attempt to meet the ever increasing needs of society and maintain habitat for federally threatened and endangered aquatic life.

Macroinvertebrates are commonly used as ecological indicators in streams for three reasons. 1) They are an important link in stream-riparian food webs. Invertebrates form a critical link between primary producers and consumers because they are able to utilize a variety of food sources, such as algae, detritus, wood, and invertebrate prey. 2) Different taxa tolerate different levels of habitat and water quality degradation. 3) They are relatively easy to collect and identify.

The purpose of my research is to develop an understanding of how stream invertebrate communities are altered by invasive riparian vegetation and to determine the mechanisms behind these changes. I will look at the effect of tamarisk invasion on western stream-riparian ecosystems through comparative natural experiments, field experiments, and lab experiments. This research will increase our understanding of how riparian vegetation structures stream invertebrate communities and will yield useful information on the community- and ecosystem-level effects of non-native vegetation.

Under this permit, I would like to conduct a natural experiment to determine the changes that occur in aquatic invertebrate communities when tamarisk invades a stream-riparian ecosystem. I will examine 20 sites on the Colorado Plateau on streams with varying degrees of tamarisk infestation. Sites will be chosen that have approximately 0%, 25%, 50%, 75%, and 100% tamarisk cover with the remainder of the riparian forest consisting of native trees. Abiotic conditions will be characterized and aquatic invertebrates, algae, and leaf packs will be collected from each site. Leaf pack samples will be used to determine aquatic macroinvertebrate colonization of leaf material and to assess which types of leaves are being retained in leaf packs in the stream. Multivariate statistics (MANOVA) will be used to determine whether invertebrate community parameters (e.g. invertebrate diversity, biomass) are related to riparian vegetation type.

This will be the first broad scale study to look at the effects of non-native vegetation on stream invertebrates in the U.S. In other parts of the world (e.g., Portugal, Spain, Australia) studies of invertebrate assemblages in streams draining native and exotic forests have found differences in abundance, richness, and taxonomic composition. In general, these studies found more diverse and abundant insect communities at sites dominated by native rather than exotic vegetation.

Collections:

At each site, I will collect benthic invertebrates, leaf packs, and algae in order to determine the algal abundance and invertebrate community structure in streams flowing through native and exotic riparian forest. Each site will be visited only once, in autumn after leaf packs have formed in streams. Five invertebrate samples will be collected at each site with a Hess sampler. Ten leaf packs, and associated invertebrates, will be collected from the stream. Five algal samples will be collected by scraping algae from a 10x10 cm patch from five cobbles. At a subset of sites (approximately half) I will collect additional algae, stream detritus, leaf pack, aquatic invertebrate and riparian leaf samples for stable isotope analysis. At these sites I will collect three additional Hess samples, three additional leaf pack samples, and three additional algae samples. I will also collect 20 g of leaves from each of the dominant riparian trees and 500 ml of water and stream detritus

Invertebrate species data will reside in the C. P. Gillette Museum of Arthropod Biodiversity at Colorado State University in Fort Collins, CO. The data will also be published in my dissertation and therefore archived at the Colorado State University Library.

2005 Findings and Status:

We collected benthic invertebrates from Salt Wash and Courthouse Wash in Arches NP. These invertebrate samples are still being processed. A final report will be submitted next year.

CANYONLANDS NATIONAL PARK
2005 Research Permits

1) Permit #: CANY-2005-SCI-0001

Study Title:

BCS PROJECT / BARRIER CANYON STYLE ROCK ART DOCUMENTATION.

Primary investigator contact information:

Name: Mr David Sucec, BCS PROJECT

Address: 832 Sego Avenue, Salt Lake City, UT 84102

Email: davids@networld.com **Phone:** 801-359-6904

Project Summary:

The objectives of the BCS PROJECT documentation project are to record all Barrier Canyon Style rock art images with archival photographic prints (gelatin-silver and ultra-stable color prints), to create a complete inventory of the documented sites, and to generate a scholarly description and analysis of the imagery.

2) Permit #: CANY-2005-SCI-0002

Study Title:

MONITORING THE COLORADO PIKEMINNOW POPULATION IN THE MAINSTEM COLORADO RIVER VIA PERIODIC POPULATION ESTIMATES.

Primary investigator contact information:

Name: Doug Osmundson, U.S. Fish and Wildlife Service

Address: 764 Horizon Dr., Bldg. B, Grand Junction, CO 81506

Phone: 970-245-9319 **Email:** doug_osmundson@fws.gov

Project Summary:

To periodically provide population estimates of the Colorado River population of the endangered Colorado pikeminnow. Such estimates were made during 1991-1994 and 1998-2000. Our office initiated a new three-year study beginning in 2003. The study area extends from Palisade, Colorado to the confluence with the Green River in Utah (185 miles). The lower 40 miles of the study area is within Canyonlands National Park.

2005 Findings and Status:

The Interagency Standardized Monitoring Program (ISMP) was developed in 1986 to monitor population trends of endangered Colorado pikeminnow in the Upper Colorado River basin including mark-recapture-based estimates of population abundance. Population estimates were conducted annually during 1991-1994 and 1998-2000. A third, three-year field effort begun in 2003 was completed in 2005. For 2003-2005, annual field effort was expanded in hopes of producing more accurate and reliable estimates. In 2005, work began the first week of April and ended in July. Five full sampling passes were completed throughout the 185-mile study reach using both electrofishing and trammel-netting. A total of 306 different pikeminnow were captured (all > 250 mm), almost double the number caught in either of the two previous years (162 in 2003 and 157 in 2004). There were 48 recaptures in 2005 versus 5 in 2003 and 13 in 2004. Preliminary abundance estimates were produced using Program CAPTURE (White et al. 1982). Model Mo (the null

model) and Mt produced similar point estimates. According to model Mo there was an estimated 931 individuals > 250 mm; 870 individuals > 450 mm; 703 individuals > 500 mm. The 95% confidence interval for pikeminnow > 450 mm was 684-1142 (Model Mo). The probability of capture (p) was somewhat lower than in 2004 (0.07 in 2005; 0.10 in 2004; 0.03 in 2003) for individuals > 450 mm. However, the coefficient of variation (CV), a measure of precision of a point estimate, was better than in previous years (13% in 2005; 24% in 2004; 47% in 2003). A 'rule of thumb' for acceptable precision is to achieve a CV of 20% or less (Pollock et al. 1990). Hence, our level of precision for the 2005 estimate met this goal. Averaging the three annual estimates provided a preliminary estimate of 712 (95% CI = 535-977) fish > 450 mm TL for the three-year period. Pikeminnow inhabiting Canyonlands National Park accounted for an unknown percent of these river-wide estimates.

A large cohort became evident in 2003. Many of these young fish first appear in reaches downstream of Moab Utah, including river reaches within Canyonlands National Park. These fish appeared to be from one year-class, and based on their size, probably were hatched in 1998. In 2003, about half of this cohort fell into the size range that qualified them as subadults about to recruit, i.e., those 400-449 mm long, according to Recovery Goal criteria (USFWS 2002). By 2004, some of these had become larger than 450 mm, while most of the remainder had moved up into the subadult size range. By 2005, most if not all of this group were 450 mm TL or larger.

Data were too sparse to partition out the subadult-sized fish and develop a separate mark-recapture estimate of their abundance. Therefore, length frequency was used to estimate that 23 captured subadults (400-449 mm) in 2003 represented about 14% of the estimated population of pikeminnow >250 mm that year, providing an estimate of 203 subadults. In 2004, these calculations resulted in an estimate of 110 subadults. In both cases, the estimates were larger than the number of adults expected to die in each year (118 in 2003 and 72 in 2004), assuming an annual mortality rate of 15% (see Osmundson et al. 1997). Hence, in 2003 and 2004, eminent recruitment (as measured by the number of subadults) exceeded expected adult mortality. Such accounting lead to anticipated net gains to the adult population. In 2005, only seven of the 306 different fish captured fell between 400 and 449 mm in length, representing about 2.3% of the population, or 21 of the estimated 931 pikeminnow > 250 mm. Recruitment of these individuals will be insufficient to balance out the estimated 131 expected to die in 2005 (assuming an annual adult mortality rate of 15% and a population size of 870 adults).

3) Permit #: CANY-2005-SCI-0003

Study Title:

ANNUAL FOREST LAND INVENTORY OF UTAH.

Primary investigator contact information:

Name: Michael Wilson

Address: Rocky Mtn. Research Station, 507 25th Street, Ogden, UT 84401

Phone: 801.625.5388

Email: mjwilson@fs.fed.us

Project Summary:

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

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.

4) Permit #: CANY-2005-SCI-0004

Study Title:

RECORDING BARRIER CANYON STYLE ROCK ART

Primary investigator contact information:

Name: Mr. Michael Firnhaber, University of Colorado, Boulder

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Phone: 970.586.2695 or 970.586.2695 **Email:** m.firnhaber@ucl.ac.uk

Project Summary:

The purpose of the proposed study is to record, for the purpose of analysis and interpretation, the Barrier Canyon Style rock art tradition.

2005 Findings and Status:

Nine BCS sites were visited and recorded in the Maze District, and a further ten BCS sites were visited and recorded in the Needles District. Data gathered includes descriptions, measurements, site maps, and photographs. All sites have been previously recorded by the NPS. No new rock art was discovered.

5) Permit #: CANY-2005-SCI-0005

Study Title:

HERBARIUM AND FIELD STUDIES OF VASCULAR PLANT FLORA OF CANY FOR NATIONAL PARK SERVICE INVENTORY AND MONITORING PROGRAM

Primary investigator contact information:

Name: Walter Fertig

Address: 1117 West Grand Canyon Dr., Kanab, UT 84741

Phone: 435-644-8129 **Email:** walt@kanab.net

Project Summary:

The purpose of this study is to document the vascular plant flora of Canyonlands National Park (CANY) and develop a plant distribution database using the National Park Service's NPSpecies system.

2005 Findings and Status:

As a preliminary step in developing an updated species list and distribution database for the park, I examined all specimens in the Canyonlands NP herbarium to correct misidentifications, update species nomenclature (following Welsh et al. 2003, "A Utah Flora, third edition"), and add variety or subspecies names if needed. Of the 1199 specimens currently deposited in the collection (not including 363 specimens out on loan) 65 were misidentified (5.4%), 62 had their names updated (5.2%), 115 had variety names added (9.6%), and 957 were confirmed as correctly identified (79.8%). The Canyonlands NP herbarium currently contains 451 vascular plant taxa collected within the park. Three additional species have been documented for Canyonlands NP based on collections at other herbaria and another 134 taxa are reported for the park (without vouchers) by Schelz and Moran (2005 SE Utah Group Plant list) and Welsh (1970 "Canyonlands Flora", Great Basin Naturalist 21(1):26-37). Based on the Atlas of the Utah Flora (Albee et al. 1988), 368 additional species are reported from comparable habitats in the vicinity of Canyonlands, but have not yet been documented within the park. These results suggest that the Canyonlands NP herbarium is missing between 23-44% of the plant taxa known or likely to occur in the park. In particular, fall-flowering, non-native, and wetland species appear to be under-represented. Targeted inventory work to fill gaps in the Canyonlands NP vascular plant collection is recommended so that park manager's will have an improved understanding of the composition and status of the flora of the park and a more complete reference collection for researchers and staff interested in plant identification.

6) Permit #: CANY-2005-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: Mr. James Von Loh, Engineering-Environmental Management, Inc.

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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).

2005 Findings and Status

Local descriptions for 151 plant associations identified for Canyonlands National park were completed and included the environmental conditions and species present for those associations.

7) Permit #: CANY-2005-SCI-0007

Study Title:

**GEOMETRIES OF SEDIMENTARY BODIES WITHIN THE PERMIAN CEDAR MESA
SANDSTONE, SE UTAH.**

Primary investigator contact information:

Name: Dr. Richard Langford, University of Texas at El Paso

Address: Dept. of Geological Sciences, El Paso, Texas 79968

Phone: 915.747.5501

Email: Langford@geo.utep.edu

Project Summary:

This project will describe the three dimensional geometries of the depositional environments of sediments in the Cedar Mesa Sandstone, including exposures in the Needles district of Canyonlands National Park.

2005 Findings and Status:

Activities

These largely involved mapping of strata within the needles district. We mapped two units within the park as well as 22 interdune ponds. A 20-25 m thick unconformity-bound eolian sandstone was mapped in three dimensions over a 5 km² area in the Needles District of the Canyonlands using GPS. After correcting for a regional tectonic dip of 1° to the northeast, 3-D maps of surfaces within the sandstone were evaluated to deduce paleotopography of the dune field. 234 GPS points delineate bounding surfaces which envelop packages of eolian dunes, interdunes and fluvio-lacustrine units. We also collected approximately 20 hand specimens from loose rubble for petrographic thin section analysis.

Results

The results were revolutionary for the science of sedimentology. Most dune strata, such as those making up the Cedar Mesa, have long been thought to form relatively continuous layers by migrating steadily through an area. We have been able to document that at least in some layers in the Canyonlands, dunes formed large complex sand mounds termed draas

that grew to over 25 meter tall, 500 m across and over 1 km long. The mounds were elongate perpendicular to the sand-transporting winds and migrated to the SE. These large sand mounds ceased to migrate and then were buried under sand sheets and other dunes. At least some of the continuous layers observed at Canyonlands formed through a two stage process. First the sand mounds were formed and then the low interdunes between them were later filled. This process is similar to the processes observed in modern deserts and explains much of the complexity observed in ancient strata.

During the coming year, we will complete our study of the interdunes ponds and the second sand layer, which is about half mapped. We have constructed a probe air permeameter that allows us to determine the ability of the sandstone to transport fluids and we will attempt to determine which eolian sands would make the best reservoir in the subsurface.

8) Permit #: CANY-2005-SCI-0008

Study Title:

**AMPHIBIAN RESEARCH AND MONITORING INITIATIVE (ARMI):
PACIFIC NORTHWEST AND ADJACENT ARIDLANDS
CANYONLANDS NATIONAL PARK INDEX SITE**

Primary investigator contact information:

Name: Tim Graham, USGS

Address: 2290 West Resource Blvd, Moab, UT 84532

Phone: 435 719-2339

Email: tim_graham@usgs.gov

Project Summary:

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. Integrate findings in Canyonlands National Park with a national amphibian monitoring program.

2005 Findings and Status:

A new set of segments were randomly selected in 2005 to augment the 27 segments surveyed in 2004 that were determined to have amphibian habitat during the spring season. A total of 83 sites were visited, including the 27 segments identified in 2004 as containing amphibian habitat. Of these, 40 contained amphibian habitat, and there were amphibians detected in 22 of these segments. The 2004 sites identified as containing habitat were among those surveyed in 2005, and provided 16 of the 21 segments with amphibians. However, about a third of the segments with habitat (= water or moist sediment at the time of survey) in 2004 did not meet these conditions in 2005. The sites identified in 2003-2005 will be used as the set of monitoring sites for future monitoring. Some of these may not represent amphibian habitat (will be dry) when visited each year, but we should have enough sites each year with habitat to evaluate PAO each year.

9) Permit #: CANY-2005-SCI-0009

Study Title:

**IMPACT OF INTRODUCED GRASSES ON GRASSHOPPER COMMUNITIES IN COLORADO
PLATEAU GRASSLANDS: IMPLICATIONS FOR POPULATION VIABILITY OF NATIVE
PERENNIAL GRASSES**

Primary investigator contact information:

Name: Dr. Tim Graham, USGS

Address: 2290 West Resource Blvd, Moab, UT 84532

Phone: 435 719-2339

Email: tim_graham@usgs.gov

Project Summary:

The proposed study will document differences in grasshopper community structure in native and cheatgrass dominated grasslands of the Colorado Plateau, and correlate these differences with characteristics of the grassland vegetation communities such as amount of bare ground, grass height, cover of perennial and annual grasses, etc.

2005 Findings and Status

No activity associated with this permit was conducted in Canyonlands NP in 2005.

10) Permit #: CANY-2005-SCI-0010

Study Title:

AMPHIBIAN POPULATION DYNAMICS AND INVERTEBRATE DIVERSITY OF SALT CREEK CANYON, CANYONLANDS NATIONAL PARK: DIFFERENCES CORRELATED WITH PRESENCE/ABSENCE OF 4WD VEHICLE USE.

Primary investigator contact information:

Name: Dr. Tim Graham, USGS

Address: 2290 West Resource Blvd, Moab, UT 84532

Phone: 435 719-2339

Email: tim_graham@usgs.gov

Project Summary:

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 areas.

2005 Findings and Status:

Fieldwork was conducted in May and June of 2005, planned for September, but massive flash floods prevented access, much less work. A significant number of samples have been sorted to order, and some progress has been made at finer taxonomic levels for some groups. All ants collected from 3 sites (one each in open-, closed-, and no-road segments, from 2000-2004, have been identified to genus. All beetles from these sites have been identified to family, and some to genus and species. Flies from June 2005 RO3 and CL1 were identified to morphospecies. Orthoptera from June and September 2000 from RO3, CL1 and NR2 were identified to family (subfamilies for Acrididae).

Results of some of these analyses were presented at conferences: George Wright Society, March 2005, Ecological Society of America, August, International Orthopterists' Society, August, 8th Biennial Conference of Research on the Colorado Plateau, November.

11) Permit #: CANY-2005-SCI-0011

Study Title:

NORTHERN AND SOUTHERN COLORADO PLATEAU NPS SPRINGS ECOSYSTEMS INVENTORY

Primary investigator contact information:

Name: Dr. Abraham Springer, Northern Arizona University

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Phone: 928.523.7198

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Project Summary:

As part of the joint Northern and Southern Colorado Plateau Parks Networks collaboration on springs ecosystems, we are conducting a comprehensive physical and biological inventory of springs ecosystems on NPS units on the Colorado Plateau. This project will be conducted by staff from Northern Arizona University, Flagstaff, Arizona with funds from the National Park Service (Cooperative Agreement Number: CA 1200-99-009, attached below). We would like to conduct an inventory of several springs on your NPS unit to test our methods and provide you with information on the ecological condition of your springs.

This inventory will be conducted by Abraham Springer and Lawrence Stevens of the Geology Department at Northern Arizona University, and their assistants. These two researchers recently produced a springs ecosystem conceptual model, a comprehensive springs classification system, and a suite of springs inventory protocols that we are testing for further use in assessing the health of springs ecosystems. Their curriculum vitae are available upon request.

These inventories will require approximately one half day / site, and will involve mapping the site and its vegetation, and collecting water, soil, and biological specimens (especially plants and invertebrates). We have extensive experience inventorying springs ecosystems on National Park lands in Grand Canyon, Lake Mead National Recreation Area, Glen Canyon National Recreation Area, and other NPS lands. Through this experience, we have learned how to minimize researcher impacts on these delicate ecosystems, and we will use that knowledge to make sure we minimize our impacts to the sites visited.

The study sites will include those that best represent the variety of springs habitats on your NPS land unit. Selection criteria include diverse settings, elevations, and water chemistries, and the sites inventories will hopefully include both pristine and human altered sites. Your staff may have recently provided a list of candidate springs for this analysis, and we will follow up on that site selection by personally contacting the appropriate staff to better understand the timing and access to the sites. We are providing a comprehensive list of study sites in this permit application, which will be refined once we discuss priority and access with appropriate NPS staff and confirm the collection dates. The data collected will be incorporated into a newly created comprehensive NPS database and the researcher's classification system. Data will be provided back to your NPS unit for your information and use.

The draft protocols to be used during the springs inventories are attached. The Northern and Southern Colorado Plateau networks are jointly developing a database into which the data will be compiled. Specimens collected through this project will be sacrificed for analysis (e.g., water quality samples), or prepared and housed at the Museum of Northern Arizona in Flagstaff, an approved NPS repository.

2005 Findings and Status:

During 2005, 75 springs were inventoried in 26 units of the National Park Service for the Northern and Southern Colorado Plateau Inventory and Monitoring Network. The inventories included site descriptions, environmental and climate conditions, vegetation and invertebrate surveys, wildlife observations, water-quality analyses, geomorphology descriptions, and water-quantity measurements. We inventoried Little Spring, Cave Spring, and Alcove Spring at Canyonlands National Park. A final project report to be submitted to the I&M Network in spring 2006 will include a summary of the inventories of these springs.

12) Permit #: CANY-2005-SCI-0012

Study Title:

**INTERPRETING 250M MODERATE RESOLUTION IMAGING SPECTRORADIOMETER
NORMALIZED DIFFERENCE VEGETATION INDEX IN THE COLORADO PLATEAU**

Primary investigator contact information:

Name: Dr. Michael White, Utah State University
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Project Summary:

The National Park Service (NPS) Southern and Northern Colorado Plateau Networks (SCPN and NCPN) intend to implement remotely sensed programs to monitor long-term ecosystem status and to detect the occurrence of abnormal ecosystem states and/or processes. A key element of this work will be use of the 250m resolution data from the moderate resolution imaging spectroradiometer (MODIS). These data include the normalized difference vegetation index (NDVI), red (620-670 nm), and near infrared (NIR, 841-876 nm) bands. For the purposes of this scope of work, the term MODIS data refers to the combined suite of NDVI and red and near infrared bands.

Prior to implementing these data in any management context, the NPS requires a clear understanding of the relationship between NDVI data and ground conditions at specific parks. While NDVI is known to be related to the fraction of photosynthetically active radiation absorbed by plant canopies (FPAR), leaf area index (LAI), and green fractional cover (GFC), it is also strongly influenced by soil conditions, canopy geometry, and the presence of senescent vegetation. Thus, across a spectrum of NPS units, it is probable that the same NDVI value could represent different ground conditions. These uncertainties are especially important for the SCPN and NCPN, in which semi-arid conditions dominate and vegetation fractional cover tends to be low.

The goal of the proposed work is therefore to conduct a proof-of-concept field campaign in which intensively measured ground conditions will be compared with MODIS data. The comparison will be conducted in the following ecosystems: (1) grass, (2) mixed shrub/grass, and (3) woodland (consisting of a mixed pinyon-juniper overstory with possible understory grass and shrubs).

Specific objectives of this effort are:

- Using ground-based measures, characterize within- and among-season trends in vegetation condition of grasslands, shrublands, and woodlands. Ground-based measures will include Plant Area Index (PAI, similar to LAI but includes stem material) and GFC.
- Determine which scales are appropriate for use of MODIS data by investigating correlations of ground measures with MODIS data at multiple spatial scales (1 MODIS pixel, 2 x 2 pixels, 3 x 3 pixels).

To accomplish these objectives, the project will consist of five main tasks:

1. Site selection.
2. Sampling design and logistics.
3. Field measurements.
4. Remote sensing.
5. Analysis.

13) Permit #: CANY-2005-SCI-0013

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:

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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.

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.

14) Permit #: CANY-2005-SCI-0014

Study Title:

**INTERACTIONS OF CLIMATE CHANGE AND OTHER ENVIRONMENTAL FACTORS ON
INVASIVE PLANT INFESTATION IN THE ARID WEST**

Primary investigator contact information:

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Project Summary:

Invasive, non-native plants dominate terrestrial and riparian landscapes in the arid western United States and are an increasingly important challenge for land and water managers. Abundance of invasive species and their native competitors is influenced both by coarse-scale factors like climate and fine-scale factors like soil chemistry, grazing, and flood timing. Understanding the interplay of these factors is essential for predicting the effects of land use and global change on invasive plant distributions. We propose to address three groups of invasive species: annual grasses, forbs, and riparian trees. We will use existing, recently collected databases documenting the distribution of these species to develop models predicting the likelihood of invasion at any site as a function of both climatic and non-climatic factors. For annual grasses and tamarisk (*Tamarix* spp.) we will carry out physiological experiments to identify critical biological mechanisms controlling susceptibility to invasion. Finally, we will use General Circulation Model Predictions to assess potential changes in susceptibility under various potential future global climate change scenarios. This proposal integrates all of the ongoing BRD Global Change research on invasive plants in the arid and semi-arid west. Our results will provide land and water managers with general and site-specific information on site susceptibility to invasion and factors controlling abundance of invasive species. This information is essential for developing and prioritizing realistic cost-effective strategies for dealing with invasive species in a changing climate.

2005 Findings and Status:

1. SOIL BIOTA CAN CHANGE AFTER EXOTIC PLANT INVASION: DOES THIS AFFECT ECOSYSTEM PROCESSES? Invasion of the exotic annual grass *Bromus tectorum* into stands of the native perennial grass *Hilaria jamesii* significantly reduced the abundance of soil biota, especially microarthropods and nematodes. Effects of invasion on active and total bacterial and fungal biomass were variable, although populations generally increased after 50+ years of invasion. The invasion of *Bromus* also resulted in a decrease in richness and a species shift in plants, microarthropods, fungi, and nematodes. However, despite the depauperate soil fauna at the invaded sites, no effects were seen on cellulose decomposition rates, nitrogen mineralization rates, or vascular plant growth. When *Hilaria* was planted into soils from not-invaded, recently-invaded, and historically-invaded sites (all currently or once dominated by *Hilaria*), germination and survivorship were not affected. In contrast, aboveground *Hilaria* biomass was significantly greater in recently-invaded soils than in the other two soils. We attributed the *Hilaria* response to differences in soil nutrients present before the invasion, especially soil nitrogen, phosphorus, and potassium, as these nutrients were elevated in the soils that produced the greatest *Hilaria* biomass. Our data suggests that it is not soil biotic richness per se that determines soil process rates or plant productivity, but instead that either 1) the presence of a few critical soil food web taxa can keep ecosystem function high, 2) nutrient loss is very slow in this ecosystem, and/or 3) these processes are microbially-driven. However, the presence of *Bromus* may reduce key soil nutrients over time and thus may eventually suppress native plant success.

2. Soil lichen and moss cover and species richness can be highly dynamic: the effects of invasion by the annual exotic grass *Bromus tectorum*, precipitation, and temperature on biological soil crusts in SE Utah. Biological soil crusts are an essential part of desert ecosystems throughout the world, as they are important in soil stabilization and soil fertility. Despite their importance, there have been few efforts to examine the population dynamics of the dominant species comprising these crusts or the effect of exotic plant invasions on these dynamics. In this study, we followed changes in lichen and moss cover for eight years in plots dominated by native grasses or invaded by the exotic annual grass *Bromus tectorum* and across sites representing a range of land use histories. Our data showed that cover of both lichens and mosses can increase dramatically over short time periods, often going from just above 0% cover to as high as 9% cover in only six months. Cover of the nitrogen-fixing lichen *Collema* declined throughout the study, going from 19% in 1996 to as low as 2% in 2003, likely in response to an increase in monthly maximum temperatures during the study period. Changes in chlorolichen cover (lichens with green algal phycobionts), on the other hand, appeared related to precipitation patterns. Past grazing may be responsible for declines in species richness for both mosses and lichens and decline in cover for lichens. A recent *Bromus* invasion did not affect species richness in never-grazed plots, but a 50-year invasion appeared to be related to lower species richness in the previously intermittently-grazed plots. *Bromus* invasion was related to lower cover of *Aspicilia*, *Collema*, *Placidium*, yellow lichens combined (*Caloplaca tominii*, *Candelariella terigena*, *Fulgensia bracteata*, and *Fulgensia desertorum*), total lichens, and total mosses in some plots in some years. Extended drought was likely responsible for a large decline of all species in 2003. Loss of lichen and moss cover is expected to affect many aspects of this ecosystem. Of special concern is the loss of *Collema*, as it is the dominant source of nitrogen for this region.

15) Permit #: CANY-2005-SCI-0015

Study Title:

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

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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 Niño/La Niña 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.

2005 Findings and Status:

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

Canyonlands National Park

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.

16) Permit #: CANY-2005-SCI-0016

Study Title:

INVENTORY FOR BATS AT CANYONLANDS NATIONAL PARK

Primary investigator contact information:

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Project Summary:

To obtain biological inventory data on bats at CANY. The overall goal is to assess occurrence for bats at CANY with the goal of documenting 90% of the potential species. This inventory is part of a broader Inventory and Monitoring Program on vertebrate animals and vascular plants in all National Park System units with significant natural resources.

2005 Findings and Status:

In total, we amassed 226 person-days of effort, 169 net-nights of capture effort, and 17 “acoustic nights” during the study. As a result of these efforts we confirmed the presence of 16 species of bats at CANY. The earliest capture effort was in April of 2005 and the latest was in October of 2005. We worked at 34 different sites across all three districts of the park. Six of these sites (BGMSCG, CABNSG, MZOVLK, NECKSG, SYNCLP, and WLFTCG) were used only for acoustic surveys, three sites (BIGSG1, GRWATR, and LAVEN1) for both mist net and acoustic surveys, and the remainder used only for mist-net surveys. The most frequently visited site was SALTHO (10 visits), followed by SALT3 (6), SALT2 and GRWATR (5), and SALT1 (4, Table 5). Elevations of the sites ranged from 1,417m (Horseshoe Canyon, Lower 2, and the 2 sites on Indian Creek) to 1,990m at French Spring at GCNRA.

Overall, we captured 1,717 bats, 1,715 of which were released unharmed at the site of capture; two voucher specimens (*M. californicus* and *C. townsendii*) were retained. These bats represented 14 different species. The maximum catch on a single event was 134 bats (SALTHO, 3 July 2005), minimum was zero (GRANSG, IDNCK2, SQUCN1 and SQUCN2), and average catch was just over 26 bats per night. The maximum number of species captured on a single event was 10 (SALTHO, 3 July 2005) and the average number of species captured per event was slightly greater than 4.

The most commonly captured species was the western pipistrelle (912 individuals, 53.1% of total), followed by pallid bat (278, 16.2%), California myotis (250, 14.6%), fringed myotis (64, 3.7%), big brown bat (57, 3.3%), Allens big-eared bat (36, 2.1%), silver-haired bat (35, 2.0%), Townsends big-eared bat (23, 1.3%), Yuma myotis (22, 1.3%), long-legged myotis (17, 1.0%), hoary bat (10, 0.6%), long-eared myotis (9, 0.5%), big free-tailed bat (3, 0.2%), and Brazilian free-tailed bat (1, 0.1%).

The most prevalent species during mistnetting was California myotis (76.9%), followed by western pipistrelle (73.8%), pallid bat (61.5%), fringed myotis (38.5%), Allens big-eared bat (32.3%), big brown bat (29.2%), Yuma myotis (23.1%), and Townsends big-eared bat (20.0%). The least prevalent species were Brazilian free-tailed bat (1.5%), big free-tailed bat (4.6%), silver-haired bat and long-eared myotis (12.3%), hoary bat (13.8%), and long-legged myotis (16.9%).

We identified a total of 3,751 recordings of 11 species. The maximum number of identifiable individual calls recorded from a single night was 825; the greatest number of species was 9. Average values were, respectively, 250.1 calls and 5.7 species; minimum values, 8 calls and 4 species. California myotis accounted for more than half (52.3%) the calls, western pipistrelle was second (42.9%), and pallid bat was a very distant third (1.9%). No other species contributed more than 1.0% of the total recorded calls. Recordings of California myotis and western pipistrelle were taken from every location (100% prevalence), while pallid bat and big brown bat were less widely distributed (80%). Of the remaining species, only Brazilian free-tailed bat was recorded at more than half (53.3%) the sampling sites. The western

small-footed myotis was the only species detected acoustically and not netted. The audible call of spotted bats were heard by field investigators. See Final Report for details.

17) Permit #: CANY-2005-SCI-0017

Study Title:

SOIL SURVEY OF CANYONLANDS NATIONAL PARK, UTAH

Primary investigator contact information:

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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, representatives 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.

18) Permit #: CANY-2005-SCI-0018

Study Title:

EVALUATION OF THE RESTORATION POTENTIAL ASSOCIATED WITH PROHIBITING MOTOR VEHICLE USE IN SALT CREEK CANYON.

Primary investigator contact information:

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Project Summary:

Salt Creek supports one of the most important riparian ecosystems in Canyonlands National Park. Previous studies have indicated that vehicular traffic has caused substantial alteration to the natural ecosystem, significantly impairing a resource that the Park is mandated to protect. Prohibition of vehicular traffic along sections of the stream has resulted in potential restoration

of the biological and physical components of the stream system. This study will evaluate restoration of naturally functioning riparian and aquatic habitats and processes following road closure. Using comparisons between three sections of the stream 1) with current vehicular traffic, 2) vehicles prohibited since 1998, and 3) no vehicular traffic since the mid-1970s, this study will evaluate the interaction of physical, chemical, and biological components critical to the structure and function of the system. Results of this study will allow managers to assess the effectiveness of road closure for restoration of the Salt Creek ecosystem.

2005 Findings:

No activity was conducted during this report year. NPS Funding currently unavailable.

19) Permit #: CANY-2005-SCI-0019

Study Title:

PALEONTOLOGICAL RESOURCE MANAGEMENT FIELD INVESTIGATIONS

Primary investigator contact information:

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Project Summary:

This project was initiated by Resource Management staff at Canyonlands National Park and is funded by the CANY Fee Demo Program. The primary goal of this project is to establish baseline paleontological resource data for Canyonlands National Park. This inventory/survey will include numerous components which will be provided to the park in the form of written reports, maps, and photographs. The survey components are directly linked to specific goals/objectives.

Collections:

Only the collection of fossils is allowed. These may be taken for for verification and identification. All kinds of fossils are anticipated: vertebrate, invertebrate, paleobotanical, and perhaps samples for microfossils. All fossils shall be collected as surface disturbance only, with little or no disturbance to soils or bedrock. Sample sizes shall be hand-samples that can be easily carried out. Special permission is needed for larger fossil sizes.

2005 Findings and Status:

Field work conducted in 2005 was concentrated in the Green River and Colorado River corridors, in canyons and exposures in the Island in the Sky, and in the Needles District. Field work consisted of on-the-ground pedestrian surveys, especially along trails and on exposures that are accessible on foot. Field crews of two to four paleontologists searched for fossil resources. The most significant results were the recognition of many sites in Paleozoic formations that have important marine invertebrates. A few sites in Triassic formations (Moenkopi and Chinle Formations) have vertebrate fossils or likelihood of vertebrate fossils and tracks. None of the fossils we located were imperiled by erosion or human impacts to the extent they should be collected. Many camping sites along the river corridors are close to sites with invertebrate fossils, and sites in side canyons accessible by trails used for day hikes and recreation. The survey has been a sample of all of the formations in the park in Island in the Sky and the Needles District to the extent they are accessible on foot. The survey will be expanded in 2006 to include the Maze Distrit. To date no critical fossils have been discovered that require immediate attention, or that warrent additional research.

20) Permit #: CANY-2005-SCI-0020

Study Title:

INVENTORY OF INVASIVE NON-NATIVE PLANTS IN PARKS OF THE NORTHERN COLORADO PLATEAU NETWORK- 2005 CANYONLANDS NATIONAL PARK ADDENDUM

Primary investigator contact information:

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Project Summary:

The purpose of this study is to collect baseline information on the location and occurrence of invasive plant species of high management concern in the Maze District of Canyonlands National Park. This information will be used in part to direct the control and eradication activities of the new Colorado Plateau Exotic Plant Management Team as well as park based efforts and in the developing invasives component of the I&M Program. This project is being conducted jointly between Utah State University and NPS with both entities providing field crews for this effort. Field inventory and data management protocols for this project have been standardized and tested in work conducted last year in the network. This project also contributes to a regional mapping efforts launched by IMR last year.

2005 Findings and Status:

Field crews inventoried 7,091.7 acres in Canyonlands National Park during the summer of 2005, an amount representing approximately 2.1 percent of the entire 337,598-acre Park. An average of 120.1 acres was inventoried per person per 10-hr day during the season. Areas inventoried include: Spanish Bottom, North Flat, Doll's House, Water Canyon, Jasper Canyon, Horse Canyon, Andersen Bottom, Horseshoe Canyon, and the North Trail Canyon.

Invasive plants infested a total of 88.468 acres, an amount equal to 1.3 percent of the land inventoried. Of the 14 targeted species, only *Centaurea repens*, *Cirsium vulgare*, *Lepidium latifolium*, and *Tamarix ramosissima* were found in those portions of the Park inventoried in 2005. No infestations of *Carduus nutans*, *Centaurea diffusa*, *Centaurea maculosa*, *Centaurea solstitialis*, *Centaurea squarrosa*, *Cirsium arvense*, *Elaeagnus angustifolia*, *Lythrum salicaria*, *Onopordum acanthium*, or *Ulmus pumila* were discovered. The only non-target species mapped was *Halogeton glomeratus*.

The most abundant target species found in the Park in 2005 was *Tamarix ramosissima*. This species, which was especially common along much of Horse Canyon, the lower half of Jasper Canyon, Water Canyon, Shot Canyon, and portions of Anderson Bottom, comprised more than 96.1 percent of the total infested acreage inventoried. *Centaurea repens* made up 3.4 percent of the infested acres. The remaining infestations (0.5 % of the total infested acreage) were comprised of *Cirsium vulgare*, *Lepidium latifolium*, and *Halogeton glomeratus*.

21) Permit #: CANY-2005-SCI-0021

Study Title:

BIOLOGY AND DISTRIBUTION OF THE BUTTERFLIES OF CANYONLANDS NATIONAL PARK

Primary investigator contact information:

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Project Summary:

To create an Expanded Checklist of the Butterflies of Arches and Canyonlands National Parks which will include distribution in space and time, documented larval foodplants, limited developmental histories, and some behavioral traits. (Some information on plants will be included, but only as required to emphasize the butterflies' story. I know the bfs' plants fairly well, so the collection of plants will be extremely limited.)

22) Permit #: CANY-2005-SCI-0022

Study Title:

FIELD-BASED EVALUATIONS OF MEASURES AND MEASUREMENT TECHNIQUES TO SUPPORT LONG-TERM MONITORING OF TERRESTRIAL ECOSYSTEMS IN COLORADO PLATEAU NATIONAL PARK SERVICE UNITS

Primary investigator contact information:

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Project Summary:

This project involves field-based evaluations of a limited suite of measures and measurement techniques for long-term monitoring of terrestrial ecosystems characteristic of the Colorado Plateau region. The project is designed to support the Northern and Southern Colorado Plateau Networks (NCPN and SCPN, respectively) of the National Park Service's Inventory and Monitoring Program (NPS I&M Program). In conjunction with the I&M Program, ecoregional networks of NPS units have been charged with the task of identifying "vital signs" to be monitored for the purpose of tracking long-term trends in the "health" or condition of park ecosystems. Collectively, the NCPN and SCPN have identified an integrated suite of vital signs for tracking resource conditions in 35 NPS units located in the Colorado Plateau region of Utah, Arizona, Colorado, and New Mexico. To inform the selection of monitoring methods most suited to NPS monitoring objectives for these parks, the NCPN and SCPN have a need for field-based evaluations of measures and measurement techniques across the range of ecosystems likely to be monitored. In addition, the NCPN and SCPN require detailed standard operating procedures (SOPs) for methods selected for implementation.

Following are general objectives for this project.

1. Collect and analyze field data to evaluate a limited suite of measures and measurement techniques for their relative suitability in effectively and efficiently meeting NPS monitoring needs across the range of ecosystems likely to be monitored.
2. Characterize within- and among-site variability in monitoring measures to inform NPS planning for operational monitoring.
3. On the basis of site soil, landscape, and vegetation characteristics, evaluate the accuracy of stratification data used to select field sites for sampling.
4. Following USGS-NPS guidelines (Oakley et al. 2003), prepare SOPs for methods selected for implementation.

2005 Findings and Status:

During the 2005 field season, we sampled 48 1-ha macroplots located in seven Colorado Plateau NPS units, including four macroplots in Canyonlands National Park (two desert grassland macroplots and two blackbrush macroplots in the Needles District). Sampling was designed to (1) evaluate different methods for sampling vegetation and soil attributes and (2) document within- and among-macroplot variability in sampling measures to inform decisions about monitoring design. In the blackbrush-dominated macroplots, we found that vegetation sampling by the line-point-intercept method generally was more efficient (in terms of the amount of time required for a given level of precision) than sampling with 10-m² quadrats or 1-m² quadrats. In the desert grassland macroplots, sampling with 10-m² quadrats tended to be more efficient. All cover measures were more variable within macroplots than among macroplots. All three methods were found to yield results which were repeatable by different observers. Sampling with 10-m² quadrats greatly increased the detection of rare plant species, but this method also tended to result in a large degree of soil disturbance due to trampling.

A full report describing these results in greater detail will be provided to the NPS Inventory and Monitoring Program.

23) Permit #: CANY-2005-SCI-0023

Study Title:

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

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Project Summary:

This project involves the assessment of upland ecosystem conditions (soil stability, hydrologic function, and vegetation composition/structure) in the Salt Creek watershed and surrounding portions of Canyonlands National Park (CNP). Salt Creek is the only perennial stream in CNP other than the Colorado River itself. Riparian and aquatic resources associated with the Salt Creek drainage are key to the ecological integrity of this dryland park, and the condition of these riverine resources is linked to overall watershed condition. CNP has virtually no information concerning impacts of past livestock activities, recurring trespass livestock, on-going visitor-use activities, high mule-deer numbers, and recent drought on upland watershed

conditions. This assessment project – which is equivalent to an inventory of ecosystem function – will fill an important need in that regard, and it will provide information required for determining the necessity for restoration, monitoring, and/or other management activities.

Understanding and mitigating past and current impacts of visitors and livestock on soils, vegetation, and watersheds are high-priority resource-management issues identified in CNP's 1993 Statement for Management and in the 1994 Resource Management Plan. This project supports NPS servicewide goals for vital-signs monitoring by assessing the condition of park ecosystems to allow managers to make better-informed decisions and to develop effective mitigation measures (<http://science.nature.nps.gov/im/monitor/>). It also supports the number one resource-protection goal identified in the U.S. Department of Interior's Draft Revised Strategic Plan for FY 2003-2008 (February 2003 draft) – "...improve the health of watersheds, landscapes, and marine resources that are DOI managed or influenced...."

Specific objectives of this project are:

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); and
7. To acquire / provide data to support on-going vegetation-mapping efforts at CNP (NPS-USGS program).

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.

24) Permit #: CANY-2005-SCI-0024

Study Title:

**LANDSCAPE MONITORING PROTOCOLS USING SATELLITE, AIRBORNE,
AND GROUND-BASED INSTRUMENTATION**

Primary investigator contact information:

Name: Mr. Pat Chavez, U. S. Geological Survey

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Email: pchavez@usgs.gov

Project Summary:

The objective of this project is to research, design, and develop procedures that use very high-resolution multi-temporal satellite and airborne imaging, along with low cost ground-based soil moisture sensors and stand-alone digital camera stations to help monitor federal lands. The study sites are on the Colorado Plateau and include both NPS and BLM managed lands. Besides

satellite and airborne remotely sensed images the project will also use historical aerial photos, DOQs, and DEMs, as well as field-based automatic digital camera and soil moisture stations.

Within DOI agencies responsible for the management of federal lands that range in size from large tracks of BLM land to large and small national parks a common critical need is a way to help monitor the landscape at temporal resolutions ranging from days to decades and from very-local to regional scales (USGS Information Fact Sheet, 2003). The capability to map physical and biological resources within federal lands is very important to federal land managers as highlighted in the BLM/FS National Resource Management and Geo-Spatial Tools Conference held in Phoenix, Arizona during April 2005. An important theme throughout this conference was the need by federal land managers to have the tools and data sets to monitor and detect change within and around federal lands.

It is impossible with the resources available to federal land managers to have field crews visit each square mile at a temporal resolution that allows adequate monitoring to be done. Satellite and airborne remote sensing can be used to image relatively large land areas at various temporal and spatial resolutions, and combined with digital image change detection techniques, can be used to detect change with direct application to landscape monitoring. However, the operational use by land managers of remotely sensed data has often not occurred for several reasons, including problems associated with the spatial resolution being too low and not having straight forward and easy to use procedures and data analyses tools to use on multi-temporal image sets. The improvement in satellite image spatial resolution in recent years and new readily available airborne imaging systems with very-high spatial resolution capabilities dramatically impact the low-resolution problems encountered to monitor landscapes at local scales. The emphasis of the research and development being done in this project is to help solve these limitations by taking advantage of the new improvements on spatial resolution and developing remote sensing/image processing algorithms and procedures designed for more operational landscape monitoring.

A component of our work during the first year (fy05) has been to build partnerships and have other disciplines and bureau scientists join us as collaborators. Discussions and meetings have included Mark Miller (he was with the NPS and is now with BRD in SE Utah), Rich Reynolds (he is with GD's Earth Surface Dynamics program and is Co-PI in our Mojave Desert work and has been working on the Colorado Plateau with Mark Miller and Jane Belnap), Lisa Thomas (NPS coordinator for the Southern Colorado Plateau/I&M Network) and Chris Lauver (NPS ecologist); both Lisa and Chris are stationed at Northern Arizona University in Flagstaff. Contacts have also been made (or will be made) with the BLM biologist and NPS ecologist stationed at the federal lands that contain our two study sites (Tammy Wallace/BLM and Charlie Schelz/NPS).

Collections:

No collection of specimens is allowed

Logistics:

Much data will be collected by helicopter flying at elevation of 2000 feet.

25) Permit #: CANY-2005-SCI-0025

Study Title:

ANALYSIS AND AMS DATING OF THE GREAT GALLERY FOOD AND TOOL BAG

Primary investigator contact information:

Name: Phil Geib, Navajo Nation Archaeology Department

Address: NAU Box 6013, Flagstaff, AZ 86011

Phone: 928-523-7270 **Email:** phil.geib@nau.edu

Project Summary:

An animal skin bag was recently recovered eroding from a small dune just to the left of the Great Gallery in Horseshoe Canyon, Utah within Canyonlands National Park. The bag was divided into two sections by a wide strap of leather with the bottom and largest section filled with unidentified seed and the smaller upper section containing three small animal skin bags, two of which were empty with the third filled with 41 flakes and a probable mountain sheep flaking tool. Underneath all three of these interior skin bags was a small river cobble.

The purpose of this study is to provide a detailed analysis and description of this entire cache, to place it in time by AMS dating, and to provide an interpretation of the findings within the context of SE Utah prehistory and the role of caches in general for mobile populations. The final result will be a publishable paper that will be submitted to an archaeological journal. This analysis will benefit the park by providing information that it could not otherwise obtain, information that will be of value for interpreting the find and perhaps for inclusion in a public display of the cache should the Park desire to do so.

2005 Findings and Status:

Seeds have been positively as *Iva xanthifolia* (marshelder).

The three minute samples from the cache have been AMS radiocarbon dated. All three assays are statistically the same and thus can be averaged. The date average has a calibrated 2 sigma range of AD 770-970. This fits quite well with the notion that the flakes in the pouch were selected for arrow point production.

26) Permit #: CANY-2005-SCI-0026

Study Title:

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

Primary investigator contact information:

Name: Dr Anne Brasher, USGS

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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.

2005 Findings:

No activity was conducted during this report year.

27) Permit #: CANY-2005-SCI-0027

Study Title:

VERTEBRATE SPECIES IN UTAH NATIONAL PARKS

Primary investigator contact information:

Name: Mr George Oliver, Utah Natural Heritage Program

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UT 84116-3154

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Project Summary:

The principal purpose of this research is to increase basic knowledge and understanding of biological inventories with specific vertebrate species verification. This is one component of the biological inventories being conducted within the units of the NCPN as part of a national emphasis on inventory and monitoring within the National Park Service. Species verification will benefit the NPS and UDWR and the entire scientific community through updated information housed in the Automated National Catalog System (ANCS+), the NPS national biodiversity database, NPSpecies, and the UDWR state biodiversity database.

The purpose of the biological inventories is to document 90 percent of the vascular plant and vertebrate animal species in the units of the NCPN. Data collected from these inventories are incorporated into the national bio-diversity database, NPSpecies. In order to verify the existence of a species in a park unit, the NCPN requires a voucher specimen, a photograph, or an authoritative observation for each species listed in the database.

Species verification may be obtained from a number of sources such as NCPN inventories; existing voucher data housed in the ANCS+; from data mining efforts at other museums and herbaria; and from review of technical reports and publications. The taxonomic nomenclature associated with these verification sources is often outdated or incorrect; for example, museums may mistakenly list a particular species as collected from a Utah park, leaving the verification process in question. Once all sources have been reviewed, there are often gaps remaining in the species verification process which need to be filled.

The NPS and UDWR agree to work cooperatively toward obtaining voucher, photographic or observational data for the herpetofauna, mammalian, and avian species currently lacking complete information, and to standardize the taxonomic nomenclature for all species in the Utah units of the NCPN.

2005 Findings and Status:

No activity was conducted this report year.

28) Permit #: CANY-2005-SCI-0028

Study Title:

DEEP THERMAL STATE OF THE COLORADO PLATEAU TECTONIC PROVINCE, UTAH

Primary investigator contact information:

Name: Dr Phil Wanamaker, University of Utah / EGI

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Project Summary:

We propose to acquire three (3) magnetotelluric (MT) geophysical sites within Canyonlands National Park in the June-Dec/05 time frame as part of a long east-west traverse supported by the U.S. National Science Foundation. The purpose of the overall survey is to assess deep temperatures and tectonic activity beneath the Colorado Plateau physiographic province and its transition to the Great Basin of western Utah and eastern Nevada. The MT method provides information on such matters through the recording of naturally-occurring magnetic and electric fields produced by solar and atmospheric processes. The proposed survey has two stages. In the first, the three sites have installed data loggers to record the field fluctuations for a total duration of 1-2 days. In the second, 1 of the sites (White Crack area) is re-occupied at a later date with a different style of recorder running in unattended mode for about 2 months. All equipment is removed following recording and small soil disturbances leveled according to Park instructions.

In 2004, a long-term MT monitoring site was installed near the road to Panorama Point. It consists of a sensitive magnetometer and earth-contacting electric field bipoles recording on a computer-controlled module. The field time series are downloaded every two months. The module is running on solar panels with battery backup. The data to date have been combined with existing results and a computer image of underground electrical conductivity to a depth near 300 km was achieved. It shows the region beneath Canyonlands to be extremely stable while that under the transition zone to the Great Basin to the west is thermally active.

2005 Findings and Status:

Clearance of the sites with GC personnel Mary Moran and Chris Goetze was done and the three sites were acquired in September/05. The WGS84 UTM locations of the sites are:

(12,4235683,585447,1512)

(12,4237296,590616,1515)

(12,4236687,598983,1560)

Interpreted in the context of the entire MT transect, these sites show that Glen Canyon and Canyonlands National Park overlie the most stable and least tectonically active subdomain of the Colorado Plateau province at least at the latitude of our study. Thermally active Great Basin type crust extends as far east as Thousand Lake Mtn at the west margin of Capitol Reef NP.

29) Permit #: CANY-2005-SCI-0029

Study Title:

REMOTE DETECTION AND GEOCHEMICAL STUDIES FOR FINDING HYDROCARBON-INDUCED ALTERATIONS IN WINGATE AND NAVJO SANSTONE, UTAH

Primary investigator contact information:

Name: Dr Shuhab Khan, University of Houston,

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Project Summary:

Long-term leakages of hydrocarbon microseepages develop diverse array of chemical and mineralogical changes in the form of alterations of rocks and soils. The resulting alterations could include: the formation of kaolinite, calcite, pyrite, uraninite, certain magnetic iron oxides and iron sulphides, bleaching of red beds, clay mineral alteration, geomorphic anomaly, etc. Some of alterations formed by microseepages were reported from Wingate formation and Navajo Sandstone, Utah. A graduate student will develop a methodology for using spectroscopy, AVIRIS hyperspectral remote sensing data and geochemical studies to identify and map these alterations and confirm the hydrocarbon microseepages source in Canyonland and surrounding areas for her MS thesis.

Field work in Canyonland and surrounding areas is needed for collecting several types of field data. This includes:

- Mapping alteration zones using GPS.
- Spectral data collection using FieldSpec Pro (Portable Spectroradiometer) and 400MHz GPR.
- Few sample collections from altered and unaltered sandstones. Samples will be collected from calcite cement of sandstone, in order to do use them for geochemical studies and for carbon isotopes (which will confirm the presence of hydrocarbons).

Collections: Three sandstone samples for carbon isotope studies. Will be destroyed through analysis or discarded after analysis

30) Permit #: CANY-2005-SCI-0030

Study Title:

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

Primary investigator contact information:

Name: Dr Chris Okubo, University of Arizona,

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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 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.

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.

31) Permit #: CANY-2005-SCI-0031

Study Title:**Active Geologic Extension at the Grabens of Canyonlands National Park****Primary investigator contact information:**

Name: Dr Juliet Crider, Western Washington University

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Project Summary:

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.

No collection of specimens is allowed.

32) Permit #: CANY-2005-SCI-0032

Study Title:**Determining the effect of tamarisk invasion on stream invertebrate communities on the Colorado Plateau****Primary investigator contact information:**

Name: Angie Moline, COLORADO STATE UNIVERSITY

Address: Department of Biology, E330 Anatomy-Zoology Bldg., Fort Collins, CO 80523

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Project Summary:

The rate of exotic species invasion in North America has drastically increased since European settlement. Non-native invasion is one of the most important causes of species endangerment in the US and is a major component of anthropogenic global change. In the western US, native cottonwood-willow floodplain forests are being replaced by exotic species such as tamarisk (*Tamarix* sp.) and Russian olive (*Elaeagnus angustifolia*). Riparian vegetation occurs on <1% of the western North America landscape, yet it provides habitat for more species of birds than all other vegetation types combined. Riparian vegetation influences stream communities by shading, contributing leaf litter, and stabilizing the stream banks. Stream nutrients are transferred to riparian ecosystems when terrestrial predators, such as riparian birds and lizards, consume emergent aquatic mayflies, such as mayflies.

The effect of tamarisk and Russian olive invasion on stream-riparian ecosystems is poorly understood, but could be dramatic as tamarisk alone dominates over 600,000 riparian and wetland hectares. These exotics are probably changing stream geomorphology and hydrology, modifying aquatic insect communities, and threatening native bird populations. These problems are particularly pressing in the arid west where water managers attempt to meet the ever increasing needs of society and maintain habitat for federally threatened and endangered aquatic life.

Macroinvertebrates are commonly used as ecological indicators in streams for three reasons. 1) They are an important link in stream-riparian food webs. Invertebrates form a critical link between primary producers and consumers because they are able to utilize a variety of food sources, such as algae, detritus, wood, and invertebrate prey. 2) Different taxa tolerate different levels of habitat and water quality degradation. 3) They are relatively easy to collect and identify.

The purpose of my research is to develop an understanding of how stream invertebrate communities are altered by invasive riparian vegetation and to determine the mechanisms behind these changes. I will look at the effect of tamarisk invasion on western stream-riparian ecosystems through comparative natural experiments, field experiments, and lab experiments. This research will increase our understanding of how riparian vegetation structures stream invertebrate communities and will yield useful information on the community- and ecosystem-level effects of non-native vegetation.

Under this permit, I would like to conduct a natural experiment to determine the changes that occur in aquatic invertebrate communities when tamarisk invades a stream-riparian ecosystem. I will examine 20 sites on the Colorado Plateau on streams with varying degrees of tamarisk infestation. Sites will be chosen that have approximately 0%, 25%, 50%, 75%, and 100% tamarisk cover with the remainder of the riparian forest consisting of native trees. Abiotic conditions will be characterized and aquatic invertebrates, algae, and leaf packs will be collected from each site. Leaf pack samples will be used to determine aquatic macroinvertebrate colonization of leaf material and to assess which types of leaves are being retained in leaf packs in the stream. Multivariate statistics (MANOVA) will be used to determine whether invertebrate community parameters (e.g. invertebrate diversity, biomass) are related to riparian vegetation type.

This will be the first broad scale study to look at the effects of non-native vegetation on stream invertebrates in the U.S. In other parts of the world (e.g., Portugal, Spain, Australia) studies of invertebrate assemblages in streams draining native and exotic forests have found differences in abundance, richness, and taxonomic composition. In general, these studies found more diverse and abundant insect communities at sites dominated by native rather than exotic vegetation.

Collections: At each site, I will collect benthic invertebrates, leaf packs, and algae in order to determine the algal abundance and invertebrate community structure in streams flowing

through native and exotic riparian forest. Each site will be visited only once, in autumn after leaf packs have formed in streams. Five invertebrate samples will be collected at each site with a Hess sampler. Ten leaf packs, and associated invertebrates, will be collected from the stream. Five algal samples will be collected by scraping algae from a 10x10 cm patch from five cobbles. At a subset of sites (approximately half) I will collect additional algae, stream detritus, leaf pack, aquatic invertebrate and riparian leaf samples for stable isotope analysis. At these sites I will collect three additional Hess samples, three additional leaf pack samples, and three additional algae samples. I will also collect 20 g of leaves from each of the dominant riparian trees and 500 ml of water and stream detritus

Invertebrate species data will reside in the C. P. Gillette Museum of Arthropod Biodiversity at Colorado State University in Fort Collins, CO. The data will also be published in my dissertation and therefore archived at the Colorado State University Library.

2005 Findings and Status:

No activity was conducted this report year.

33) Permit #: CANY-2005-SCI-0033

Study Title:

Sound Levels in Canyonlands National Park

Primary investigator contact information:

Name: Skip Ambrose,

Address: HC 64 Box 2205 Castle Valley, UT 84532

Phone: 435-259-0401 or 970.227.8154 **Email:** skipambrose@frontiernet.net

Project Summary:

To determine natural ambient sound levels in the primary vegetation types in CANY, and the relative influence of human-caused sounds on natural sound levels.

The only collections will be the collection of recorded sound data.

The National Park Service (NPS) is concerned with degradation of natural soundscapes in units of the National Park system. NPS Management Policies (4:9; 2001) states: "The National Park Service will preserve, to the greatest extent possible, the natural soundscapes of parks. Natural soundscapes exist in the absence of human-caused sound. The natural soundscape is the aggregate of all natural sounds that occur in parks, together with the physical capacity for transmitting natural sounds. Natural sounds occur within and beyond the range of sounds that humans can perceive, and can be transmitted through air, water, or solid materials."

"Using appropriate management planning, superintendents will identify what levels of human-caused sound can be accepted within the management purposes of the parks. The frequencies, magnitudes, and durations of human-caused sound considered acceptable will vary throughout the park, being generally greater in developed areas and generally lesser in undeveloped areas. In and adjacent to parks, the Service will monitor human activities that generate noise that adversely affects park soundscapes, including noise caused by mechanical or electronic devices. The Service will take action to prevent or minimize all noise that, through frequency, magnitude, or duration, adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified as being acceptable to, or appropriate for, visitor uses at the sites being monitored" (NPS 2001).

OBJECTIVES

The objectives of this study are to:

1. Determine natural ambient sound levels in the primary habitats/acoustic zones in Canyonlands National Park, during the summer and winter seasons; and
2. Assess the influence of man-made noise on natural ambient sound levels.

The primary objective of this project is to provide basic acoustic data necessary for preparation of a Soundscape Management Plan for Canyonlands National Park. A secondary objective is to collect acoustic data which will be useful in assessing the influence of man-made noise on natural sounds.

2005 Findings and Status:

Data collection initiated at four locations in CANY. No data analysis as of 12-31-2005.

NATURAL BRIDGES NATIONAL MONUMENT

2005 Research Permits

1) Permit #: NABR-2005-SCI-0001

Study Title:

HERBARIUM AND FIELD STUDIES OF VASCULAR PLANT FLORA OF NABR FOR NATIONAL PARK SERVICE INVENTORY AND MONITORING PROGRAM

Primary investigator contact information:

Name: Walter Fertig

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Phone: 435-644-8129

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Project Summary:

The purpose of this study is to document the vascular plant flora of Natural Bridges National Monument (NABR) and develop a plant distribution database using the National Park Service's NPSpecies system.

2005 Findings and Status:

As a preliminary step in developing an updated species list and distribution database for the park, I examined all specimens in the Natural Bridges NM herbarium to correct misidentifications, update species nomenclature (following Welsh et al. 2003, "A Utah Flora, third edition"), and add variety or subspecies names if needed. Of the 449 specimens currently deposited in the collection (not including 396 specimens out on loan) 10 were misidentified (2.2%), 38 had their names updated (8.5%), 34 had variety names added (7.6%), and 367 were confirmed as correctly identified (81.7%). The Natural Bridges NM herbarium currently contains 208 vascular plant taxa collected within the monument. Sixteen additional species have been documented for Natural Bridges based on collections at other herbaria and another 181 taxa are reported for the park (without vouchers) by Schelz and Moran (2005 SE Utah Group Plant list) and Welsh and Moore (1968 "Plants of Natural Bridges National Monument", Proceedings Utah Academy Sciences 45:220-248). Based on the Atlas of the Utah Flora (Albee et al. 1988), 309 additional species are reported from comparable habitats in the vicinity of Natural Bridges, but have not yet been documented within the monument. These results suggest that the Natural Bridges NM herbarium is missing between 49-60% of the plant taxa known or likely to occur in the park. In particular, fall-flowering, non-native, and wetland taxa appear to be under-represented. Targeted inventory work to fill gaps in the Natural Bridges NM vascular plant collection is recommended so that park manager's will have an improved understanding of the composition and status of the flora of the park and a more complete reference collection for researchers and staff interested in plant identification.

2) Permit #: NABR-2005-SCI-0002

Study Title:

NORTHERN AND SOUTHERN COLORADO PLATEAU NPS SPRINGS ECOSYSTEMS INVENTORY

Primary investigator contact information:

Name: Dr. Abraham Springer, Northern Arizona University

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Project Summary:

As part of the joint Northern and Southern Colorado Plateau Parks Networks collaboration on springs ecosystems, we are conducting a comprehensive physical and biological inventory of springs ecosystems on NPS units on the Colorado Plateau. This project will be conducted by staff from Northern Arizona University, Flagstaff, Arizona with funds from the National Park Service (Cooperative Agreement Number: CA 1200-99-009, attached below). We would like to conduct an inventory of several springs on your NPS unit to test our methods and provide you with information on the ecological condition of your springs.

This inventory will be conducted by Abraham Springer and Lawrence Stevens of the Geology Department at Northern Arizona University, and their assistants. These two researchers recently produced a springs ecosystem conceptual model, a comprehensive springs classification system, and a suite of springs inventory protocols that we are testing for further use in assessing the health of springs ecosystems. Their curriculum vitae are available upon request.


These inventories will require approximately one half day / site, and will involve mapping the site and its vegetation, and collecting water, soil, and biological specimens (especially plants and invertebrates). We have extensive experience inventorying springs ecosystems on National Park lands in Grand Canyon, Lake Mead National Recreation Area, Glen Canyon National Recreation Area, and other NPS lands. Through this experience, we have learned how to minimize researcher impacts on these delicate ecosystems, and we will use that knowledge to make sure we minimize our impacts to the sites visited.

The study sites will include those that best represent the variety of springs habitats on your NPS land unit. Selection criteria include diverse settings, elevations, and water chemistries, and the sites inventories will hopefully include both pristine and human altered sites. Your staff may have recently provided a list of candidate springs for this analysis, and we will follow up on that site selection by personally contacting the appropriate staff to better understand the timing and access to the sites. We are providing a comprehensive list of study sites in this permit application, which will be refined once we discuss priority and access with appropriate NPS staff and confirm the collection dates. The data collected will be incorporated into a newly created comprehensive NPS database and the researcher's classification system. Data will be provided back to your NPS unit for your information and use.

The draft protocols to be used during the springs inventories are attached. The Northern and Southern Colorado Plateau networks are jointly developing a database into which the data will be compiled. Specimens collected through this project will be sacrificed for analysis (e.g., water quality samples), or prepared and housed at the Museum of Northern Arizona in Flagstaff, an approved NPS repository.

2005 Findings and Status:

During 2005, 75 springs were inventoried in 26 units of the National Park Service for the Northern and Southern Colorado Plateau Inventory and Monitoring Network. The inventories included site descriptions, environmental and climate conditions, vegetation and invertebrate surveys, wildlife observations, water-quality analyses, geomorphology descriptions, and water-quantity measurements. We inventoried Kachina Alcove Spring and Kachina Bridge Spring at Natural Bridges NM. A final project report to be submitted to the I&M Network in spring 2006 will include a summary of the inventories of these springs.



3) Permit #: NABR-2005-SCI-0003

Study Title:

SOIL SURVEY OF NATURAL BRIDGES NATIONAL MONUMENT

Primary investigator contact information:

Name: Mr Victor Parslow, USDA Natural Resources Conservation Service

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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 park 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, representatives 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.

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 follows:

Soil inventory activities

2005 Results and Activities:

Pre-survey activities were conducted in Natural Bridges National Park, as well as data collection on soils and plants.

Pre-survey activities included reconnaissance of the park, and evaluation of the existing Soil Survey and Ecological Site Descriptions (ESD's) to be updated. Relationships between the geology and associated soils were researched, and theories on soil-geology-plant-landscape models were developed.

Materials were gathered to be used in the inventory, such as aerial photographs, topographic maps, and various GIS coverages which were developed into a geodatabase.

Soil survey and plant inventory field equipment was obtained, and the appropriate personnel were hired for the project, including a soil scientist, range conservationist, and archaeologist. After pre-survey preparation was complete, a field soil survey was conducted in Natural Bridges National Monument, which consisted of more 50 full soil profile descriptions, and accompanying plant composition and production data. Ecological Site Descriptions (ESD's), and state and transition models will be developed from the vegetation data gathered. From these various

observations, soil map units were developed, and transects were conducted on these map units to document their composition. Maps are presently being produced for the 7,636 acres surveyed; showing the spatial extent and location of these map units, as well as the points where supporting documentation was gathered. All data will be provided to Natural Bridges National Monument, as well as other soil survey products as they are developed and become available.

4) Permit #: NABR-2005-SCI-0004

Study Title:

VERTEBRATE SPECIES IN UTAH NATIONAL PARKS

Primary investigator contact information:

Name: Mr George Oliver, Utah Natural Heritage Program

Address: Utah Division of Wildlife Resources, 1594 W. North Temple, Salt Lake City, UT 84116-3154

Phone: 801-538-4820

Email: georgeoliver@utah.gov

Project Summary:

The principal purpose of this research is to increase basic knowledge and understanding of biological inventories with specific vertebrate species verification. This is one component of the biological inventories being conducted within the units of the NCPN as part of a national emphasis on inventory and monitoring within the National Park Service. Species verification will benefit the NPS and UDWR and the entire scientific community through updated information housed in the Automated National Catalog System (ANCS+), the NPS national biodiversity database, NPSpecies, and the UDWR state biodiversity database.

The purpose of the biological inventories is to document 90 percent of the vascular plant and vertebrate animal species in the units of the NCPN. Data collected from these inventories are incorporated into the national bio-diversity database, NPSpecies. In order to verify the existence of a species in a park unit, the NCPN requires a voucher specimen, a photograph, or an authoritative observation for each species listed in the database.

Species verification may be obtained from a number of sources such as NCPN inventories; existing voucher data housed in the ANCS+; from data mining efforts at other museums and herbaria; and from review of technical reports and publications. The taxonomic nomenclature associated with these verification sources is often outdated or incorrect; for example, museums may mistakenly list a particular species as collected from a Utah park, leaving the verification process in question. Once all sources have been reviewed, there are often gaps remaining in the species verification process which need to be filled.

The NPS and UDWR agree to work cooperatively toward obtaining voucher, photographic or observational data for the herpetofauna, mammalian, and avian species currently lacking complete information, and to standardize the taxonomic nomenclature for all species in the Utah units of the NCPN.

2005 Findings and Status:

Preliminary work focused on amphibians and reptiles. Three species of amphibians and ten species of reptiles were documented with precise geographic locations, and ecological data for these were obtained.

5) Permit #: NABR-2005-SCI-0005

Study Title:

Sound Levels in Natural Bridges National Monument

Primary investigator contact information:

Name: Skip Ambrose,

Address: HC 64 Box 2205 Castle Valley, UT 84532

Phone: 435-259-0401 or 970.227.8154

Email: skipambrose@frontiernet.net

Project Summary:

To determine natural ambient sound levels in the primary vegetation types in NABR, and the relative influence of human-caused sounds on natural sound levels.

The only collections will be the collection of recorded sound data.

The National Park Service (NPS) is concerned with degradation of natural soundscapes in units of the National Park system. NPS Management Policies (4:9; 2001) states: "The National Park Service will preserve, to the greatest extent possible, the natural soundscapes of parks. Natural soundscapes exist in the absence of human-caused sound. The natural soundscape is the aggregate of all natural sounds that occur in parks, together with the physical capacity for transmitting natural sounds. Natural sounds occur within and beyond the range of sounds that humans can perceive, and can be transmitted through air, water, or solid materials."

"Using appropriate management planning, superintendents will identify what levels of human-caused sound can be accepted within the management purposes of the parks. The frequencies, magnitudes, and durations of human-caused sound considered acceptable will vary throughout the park, being generally greater in developed areas and generally lesser in undeveloped areas. In and adjacent to parks, the Service will monitor human activities that generate noise that adversely affects park soundscapes, including noise caused by mechanical or electronic devices. The Service will take action to prevent or minimize all noise that, through frequency, magnitude, or duration, adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified as being acceptable to, or appropriate for, visitor uses at the sites being monitored" (NPS 2001).

OBJECTIVES

1. Determine natural ambient sound levels in the primary habitats/acoustic zones in Natural Bridges National Monument, during the summer and winter seasons; and
2. Assess the influence of man-made noise on natural ambient sound levels.

The primary objective of this project is to provide basic acoustic data necessary for preparation of a Soundscape Management Plan for Natural Bridges National Monument. A secondary objective is to collect acoustic data which will be useful in assessing the influence of man-made noise on natural sounds.

HOVENWEEP NATIONAL MONUMENT

2005 Research Permits

1) Permit #: HOVE-2005-SCI-0001

Study Title:

**NORTHERN AND SOUTHERN COLORADO PLATEAU NPS SPRINGS ECOSYSTEMS
INVENTORY**

Primary investigator contact information:

Name: Dr. Abraham Springer, Northern Arizona University

Address: P.O. Box 4099, Flagstaff, AZ 86011

Phone: 928.523.7198

Email: abe.springer@NAU.EDU

Project Summary:

As part of the joint Northern and Southern Colorado Plateau Parks Networks collaboration on springs ecosystems, we are conducting a comprehensive physical and biological inventory of springs ecosystems on NPS units on the Colorado Plateau. This project will be conducted by staff from Northern Arizona University, Flagstaff, Arizona with funds from the National Park Service (Cooperative Agreement Number: CA 1200-99-009, attached below). We would like to conduct an inventory of several springs on your NPS unit to test our methods and provide you with information on the ecological condition of your springs.

This inventory will be conducted by Abraham Springer and Lawrence Stevens of the Geology Department at Northern Arizona University, and their assistants. These two researchers recently produced a springs ecosystem conceptual model, a comprehensive springs classification system, and a suite of springs inventory protocols that we are testing for further use in assessing the health of springs ecosystems. Their curriculum vitae are available upon request.

These inventories will require approximately one half day / site, and will involve mapping the site and its vegetation, and collecting water, soil, and biological specimens (especially plants and invertebrates). We have extensive experience inventorying springs ecosystems on National Park lands in Grand Canyon, Lake Mead National Recreation Area, Glen Canyon National Recreation Area, and other NPS lands. Through this experience, we have learned how to minimize researcher impacts on these delicate ecosystems, and we will use that knowledge to make sure we minimize our impacts to the sites visited.

The study sites will include those that best represent the variety of springs habitats on your NPS land unit. Selection criteria include diverse settings, elevations, and water chemistries, and the sites inventories will hopefully include both pristine and human altered sites. Your staff may have recently provided a list of candidate springs for this analysis, and we will follow up on that site selection by personally contacting the appropriate staff to better understand the timing and access to the sites. We are providing a comprehensive list of study sites in this permit application, which will be refined once we discuss priority and access with appropriate NPS staff

and confirm the collection dates. The data collected will be incorporated into a newly created comprehensive NPS database and the researcher's classification system. Data will be provided back to your NPS unit for your information and use.

The draft protocols to be used during the springs inventories are attached. The Northern and Southern Colorado Plateau networks are jointly developing a database into which the data will be compiled. Specimens collected through this project will be sacrificed for analysis (e.g., water quality samples), or prepared and housed at the Museum of Northern Arizona in Flagstaff, an approved NPS repository.

2005 Findings and Status:

During 2005, 75 springs were inventoried in 26 units of the National Park Service for the Northern and Southern Colorado Plateau Inventory and Monitoring Network. The inventories included site descriptions, environmental and climate conditions, vegetation and invertebrate surveys, wildlife observations, water-quality analyses, geomorphology descriptions, and water-quantity measurements. We inventoried Goodman Point Stream and Square Tower Spring at Hovenweep NM. A final project report to be submitted to the I&M Network in spring 2006 will include a summary of the inventories of these springs.

2) Permit #: HOVE-2005-SCI-0002

Study Title:

SOIL SURVEY OF HOVENWEEP NATIONAL MONUMENT

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 that meets National Cooperative Soil Survey (NCSS) standards and park management and planning needs.

The existing soil surveys were conducted in the 1970's and the early 1980's as part of the Henry Mountains, San Juan County, Central Part, and the San Juan County, Navajo Indian Reservation, Utah soil surveys. These inventories were primarily designed as a tool for use in managing grazing lands and have 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. The parts of the Hovenweep NM in Colorado were mapped in the Cortez Area, Colorado soil survey which is of more recent vintage and more detailed than the older surveys. It is anticipated that less field work will be required in this area than on the Utah side. Ecological site descriptions will be correlated to a common standard crossing the state line.

In 2003, representatives of the National Park Service approached the Natural Resources Conservation Service to update the existing soil surveys within Arches and Canyonlands National Parks, Natural Bridges and Hovenweep National Monuments and the Orange Cliffs portion 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.

2005 Findings and Status:

No activity was conducted this report year.

3) Permit #: HOVE-2005-SCI-0003

Study Title:

VERTEBRATE SPECIES IN UTAH NATIONAL PARKS

Primary investigator contact information:

Name: Mr George Oliver, Utah Natural Heritage Program

Address: Utah Division of Wildlife Resources, 1594 W. North Temple, Salt Lake City,
UT 84116-3154

Phone: 801-538-4820

Email: georgeoliver@utah.gov

Project Summary:

The principal purpose of this research is to increase basic knowledge and understanding of biological inventories with specific vertebrate species verification. This is one component of the biological inventories being conducted within the units of the NCPN as part of a national emphasis on inventory and monitoring within the National Park Service. Species verification will benefit the NPS and UDWR and the entire scientific community through updated information housed in the Automated National Catalog System (ANCS+), the NPS national biodiversity database, NPSpecies, and the UDWR state biodiversity database.

The purpose of the biological inventories is to document 90 percent of the vascular plant and vertebrate animal species in the units of the NCPN. Data collected from these inventories are incorporated into the national bio-diversity database, NPSpecies. In order to verify the existence of a species in a park unit, the NCPN requires a voucher specimen, a photograph, or an authoritative observation for each species listed in the database.

Species verification may be obtained from a number of sources such as NCPN inventories; existing voucher data housed in the ANCS+; from data mining efforts at other museums and herbaria; and from review of technical reports and publications. The taxonomic nomenclature associated with these verification sources is often outdated or incorrect; for example, museums may mistakenly list a particular species as collected from a Utah park, leaving the verification process in question. Once all sources have been reviewed, there are often gaps remaining in the species verification process which need to be filled.

The NPS and UDWR agree to work cooperatively toward obtaining voucher, photographic or observational data for the herpetofauna, mammalian, and avian species currently lacking complete information, and to standardize the taxonomic nomenclature for all species in the Utah units of the NCPN.

2005 Findings and Status:

Preliminary work focused on amphibians and reptiles. One species of amphibian and three species of reptiles were documented with precise geographic locations, and ecological data for these were obtained.

4) Permit #: HOVE-2005-SCI-0004

Study Title:

Sound Levels in Hovenweep National Monument

Primary investigator contact information:

Name: Skip Ambrose,

Address: HC 64 Box 2205 Castle Valley, UT 84532

Phone: 435-259-0401 or 970.227.8154

Email: skipambrose@frontiernet.net

Project Summary:

To determine natural ambient sound levels in the primary vegetation types in HOVE, and the relative influence of human-caused sounds on natural sound levels.

The only collections will be the collection of recorded sound data.

The National Park Service (NPS) is concerned with degradation of natural soundscapes in units of the National Park system. NPS Management Policies (4:9; 2001) states: "The National Park Service will preserve, to the greatest extent possible, the natural soundscapes of parks. Natural soundscapes exist in the absence of human-caused sound. The natural soundscape is the aggregate of all natural sounds that occur in parks, together with the physical capacity for transmitting natural sounds. Natural sounds occur within and beyond the range of sounds that humans can perceive, and can be transmitted through air, water, or solid materials."

"Using appropriate management planning, superintendents will identify what levels of human-caused sound can be accepted within the management purposes of the parks. The frequencies, magnitudes, and durations of human-caused sound considered acceptable will vary throughout the park, being generally greater in developed areas and generally lesser in undeveloped areas. In and adjacent to parks, the Service will monitor human activities that generate noise that adversely affects park soundscapes, including noise caused by mechanical or electronic devices. The Service will take action to prevent or minimize all noise that, through frequency, magnitude, or duration, adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified as being acceptable to, or appropriate for, visitor uses at the sites being monitored" (NPS 2001).

OBJECTIVES:

The objectives of this study are to:

1. Determine natural ambient sound levels in the primary habitats/acoustic zones in Hovenweep National Monument, during the summer and winter seasons; and
2. Assess the influence of man-made noise on natural ambient sound levels.

The primary objective of this project is to provide basic acoustic data necessary for preparation of a Soundscape Management Plan for Hovenweep National Monument. A secondary objective is to collect acoustic data which will be useful in assessing the influence of man-made noise on natural sounds.

2005 Findings and Status:

Acoustic monitors deployed at two locations at HOVE. No data analysis as of 12-31-2005.