CANYONLANDS NATIONAL PARK
2004 Research Results

Permit#: CANY-2004-SCI-0001

Principal Investigator: Mr David Sucec, BCS Project, 832 Sego Avenue, Salt Lake City, UT 84102

Additional investigator(s):
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Project Title:
BCS PROJECT / BARRIER CANYON STYLE ROCK ART DOCUMENTATION.

Objectives:
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.

Findings and Status:
The BCS PROJECT worked in the Needles District during spring of 2004 (March 5 - 13). Work was hampered by inaccurate Park map locations and lack of assistance from Park staff to correct inaccurate locations. Much time, of the limited available field time, was expended looking for identified sites. Four sites with BCS images were recorded, two of which were not indicated in Park records or maps. Two additional sites that appear to have BCS figures were seen but we were unable to access the sites because of inaccessible walls. Two of the sites contained mixed-style figures (images with BCS and other styles elements, Faces Motif figures found are mixed style). Two other sites, not in Park records, were found to have mixed style figures (one with Faces Motif and BCS elements).

Work was undertaken in the Maze District in the autumn of 2004 (September 23 - 26). Two sites with BCS images were photographed.

Permit#: CANY-2004-SCI-0002

Principal Investigator: Dr EDGAR KLEINER, 4055 PLATEAU ROAD, RENO,, NV 89509-2956

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Project Title:

CONTINUING GRASSLAND INVESTIGATION IN DEVIL'S LANE AND CHESLER-VIRGINIA CANYONS

Objectives:
This project would be a follow-up investigation of grasslands of Canyonlands National Park (focussed in Virginia and Chesler Parks).Initial research for this project was conducted in 1967 and continued subsequently in many follow-up research trips.

Findings and Status:
Follow-up work on recent years visits has been to relocate research sites placed in 1967 and 1970 in Chesler Park, Virginia Park, Devil's Lane and Chesler Canyon.GPS coordinates as desired by the NPS have now been obtained for the majority of sites. Seven more were successfully added in 2004.

Permit#: CANY-2004-SCI-0005

Principal Investigator: Dr Phil Wannamaker, University of Utah/EGI, 423 Wakara Way, Suite 300, Salt Lake City, UT 84108

Project Title:

DEEP THERMAL STATE OF THE COLORADO PLATEAU TECTONIC PROVINCE, UTAH

Objectives:
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. This is to be attempted by acquiring magnetotelluric (MT) geophysical data within the western portion of Canyonlands as part of an overall detailed transect starting in eastern Nevada.

Findings and Status:
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.

Permit#: CANY-2004-SCI-0004

Principal Investigator: Dr Robert Webb, U.S. Geological Survey, 520 N. Park Ave., Tucson, AZ 85719

Additional investigator(s):
Name: Cassandra Fenton Phone: 520-670-6671 ext 267 Email: cfenton@usgs.gov

Project Title:

GEOLOGIC EVOLUTION OF CATARACT CANYON, CANYONLANDS NATIONAL PARK, UTAH

Objectives:
The purpose of this study is to determine the age and geologic evolution of Cataract Canyon, which was created by flow of the Colorado River through Canyonlands.

Findings and Status:
We conducted geophysical work at Spanish Bottom at the head of Cataract Canyon in March 2004. We used ground-penetrating radar, TEM, and seismic refraction techniques to determine the depth to bedrock at this critical position in the longitudinal profile for the Colorado River. The ground-penetrating radar work failed to detect any subsurface stratigraphy and did not penetrate a significant distance into the fine-grained alluvium at Spanish Bottom. The TEM mostly responded to salinity gradients in the subsurface and may have revealed detail concerning the location of the Paradox formation beneath Spanish Bottom. The seismic refraction is completely successful, detecting not only the depth to ground water (about 5 m) but also depth to bedrock (about 70 m) and a gently sloping bedrock floor that is deepest closest to the Colorado River.

Permit#: CANY-2004-SCI-0006

Principal Investigator: Dr Jayne Belnap, Canyonlands USGS, 2290 SW Resource Blvd., Moab, UT 84532

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Project Title:

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

Objectives:
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.

Findings and Status:
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. Effect of invasion on active and total bacteria and fungi biomass were variable, although populations generally increased after 50+ years of invasion. The invasion of Bromus resulted in a decrease in richness of 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 nutrient availability to vascular plants. 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 was not affected. In contrast, aboveground Hilaria biomass was significantly greater in recently invaded soils than 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 1) either the presence of a few critical soil food web species can keep ecosystem function high, 2) nutrient loss is very slow in this ecosystem, and/or 3) these processes are microbially-driven. However, as the presence of Bromus reduces key soil nutrients over time, native plant success may be eventually suppressed.

Permit#: CANY-2004-SCI-0007

Principal Investigator: Dr Jayne Belnap, Canyonlands USGS, 2290 SW Resource Blvd., Moab, UT 84532

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Project Title:

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

Objectives:
(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.

Findings and Status:
All aspects of this project that involve soil and plant studies have been completed and the data is being analyzed. We hope to have final results by summer 2005. The only part of this study that will continue is the climate monitoring. The weather stations in Virginia Park, Squaw Flat, Corral Pocket and Dugout Ranch will be maintained and data collection continued. This data is available to all at the newly-revised website, http://climchange.cr.usgs.gov/info/sw/clim-met/ and we hope will provide an excellent resource to NPS and others. Several of the NPS I&M projects are currently using this data.

Permit#: CANY-2004-SCI-0008

Principal Investigator: Dr Tim Graham, USGS, 2290 West Resource Blvd., Moab, UT 84532

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

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

Findings and Status:
We collected invertebrate samples and data on amphibians from seven sites during May to September, with four to seven sites sampled in a given month. Approximately 3600 invertebrate samples were collected from three kinds of traps over the year, and about 1000 samples were sorted to order. All ants from 2000 to 2003 have been identified to genus and assigned to functional groups as established in Andersen (J. Biogeography 24:433-460,1997). Beetles collected in 2000 and some collected in 2001 have been identified to family, with some subfamily, genus and morphospecies assignments made as well. General results of differences between sites and years in community structure at the order level, and results of analysis of beetle data from 2000 were presented at the 7th Biennial Conference of Research on the Colorado Plateau, Flagstaff, AZ, in November 2003, and the beetle data have been submitted to the Proceedings volume for the conference. Additional results will be presented in March 2005 at the Biennial Conference of the George Wright Society, Philadelphia, PA.

Permit#: CANY-2004-SCI-0009

Principal Investigator: Mr Michael J. Wilson, USDA Forest Service, Interior West Forest Inventory, Rocky Mtn. Research Station, 507 25th Street, Ogden, UT 84401

Additional investigator(s):
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Project Title:

ANNUAL FOREST LAND INVENTORY OF UTAH

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

Findings and Status:
State..... Utah
County..... San Juan
Location Number..... 35
Date of Inventory..... 4/29/2004
Current Location Status..... At least one accessible forest land condition classpresent on one or more of the subplots
Elevation..... 6045
Condition Class Number..... 1
Condition Class Status..... Accessible forest land (includes nonstocked forest - e.g. burned area or clearcut)
Forest Type..... Pinyon juniper woodland
Stand-size Class..... 9.0 - 19.9 in (softwoods)/11.0 - 19.9 in(hardwoods)
Physiographic Class..... Dry Slopes - Slopes with thin rock outcrops and considerable exposure to sun and wind. Includes most steep slopes with a southern or western exposure.
Condition Habitat Type..... Pied Series

State..... Utah
County..... San Juan
Location Number..... 129
Date of Inventory..... 4/28/2004
Current Location Status..... Entire location is nonforest
Elevation..... 4973
Condition Class Number..... 1
Condition Class Status..... Nonforest land
Forest Type..... None
Condition Habitat Type..... None

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.

Permit#: CANY-2004-SCI-0012

Principal Investigator: Dr Jayne Belnap, Canyonlands USGS, 2290 SW Resource Blvd., Moab, UT 84532

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Project Title:

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

Objectives:

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.

Findings and Status:

Due to a delay in funding, no activity was conducted this report year. We plan to begin this work in May 2005.

Permit#: CANY-2004-SCI-0013

Principal Investigator: Mr James Von Loh, e2M, 9563 South Kingston Court, Suite 200, Englewood, CO 80112

Project Title:

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

Objectives:
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).

Findings and Status:
The majority of vegetation data for CANY were collected during the 2004 field season, which began in April and lasted through September 2004. After a week-long training session in April, the 8 member crew began sampling vegetation throughout CANY using a gradsect approach. The sampling effort focused on sampling biophysical units (BPUs) that were selected prior to the collection, but other distinct and homogenous vegetation communities were also sampled. In total, 914 vegetation plots and 368 observation points were collected throughout CANY and represented diverse vegetation types. Vegetation plots entailed collecting plant species abundance, environmental data including slope, aspect, and elevation, soils texture data, and spatial location using UTMs. Detailed comments describing the vegetation and environment were also recorded. Observation points were less rigorous and included species cover data, location, and less intense environmental measures. The classification of the data is currently underway and a final classification is expected by mid-January 2005.

Permit#: CANY-2004-SCI-0014

Principal Investigator: Dr John Peacock, 185 Benzler Lust Road, Marion, OH 43302-8369

Project Title:

A STUDY OF THE DISTRIBUTION OF CATOCALA BENJAMINI AND RELATED CATOCALA IN NORTHEASTERN ARIZONA AND SOUTHEASTERN UTAH.

Objectives:
The purpose of this study is to delineate the distribution of *Catocala benjamini* and related Catocala in northeastern Arizona and southeastern Utah, areas that are poorly, if at all, collected, and where little is known of Catocala distribution. A secondary objective is to determine the larval host plant (*Quercus*) associations where Catocala are collected.

Findings and Status:
No activity was conducted in Canyonlands National Park this report year.

Permit#: CANY-2004-SCI-0015

Principal Investigator: Mr Lawrence Rudd, 8532 E. Third St., Tucson, AZ 85710

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Project Title:

THE USE OF AVIRIS IMAGERY TO ASSESS CLAY MINERALOGY AND DEBRIS-FLOW POTENTIAL IN CATARACT CANYON, UTAH.

Objectives:
We propose to demonstrate that the hazard of debris-flow flooding can be assessed from a combination of remotely sensed data, topography, and geologic maps.

Findings and Status:
No activity was conducted this report year in Canyonlands National Park. Research activity in 2004 was conducted adjacent to the park in the Orange Cliffs section of the Glen Canyon National Recreation area. An Investigators Annual Report on the findings of this study has been filed for the Glen Canyon NRA. Future work on this study will involve AVIRIS images taken of Canyonlands National Park.

Permit#: CANY-2004-SCI-0016

Principal Investigator: Mr Douglas Osmundson, U.S. Fish and Wildlife Service, 764 Horizon Dr., Bldg. B, Grand Junction, CO 81506

Project Title:
Monitoring the Colorado pikeminnow population in the mainstem Colorado River via periodic population estimates

Objectives:
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.

Findings and Status:
Three complete sampling passes were made through the 185-mile reach (excluding 12-mile-long Westwater Canyon) using electrofishing. This schedule was completed during a 10-week period from early April to early June. The field effort went well, but the low runoff prevented backwater trammel-netting and the early spawning season precluded a fourth sampling pass. Total number of captures (all pikeminnow > 250 mm) was lower than in 2003 (149 versus 168) as expected with fewer passes; however, mean number of captures per pass was somewhat higher (50 in 2004 versus 42 in 2003). There was again a low number of recaptures (7) in the

later passes (5 in 2003). Fortuitously, there were additional capture data made available to us from another field effort (smallmouth bass removal). These data were added to those of our third pass resulting in a sizable increase in our number of recaptures (from 7 to 13 for fish > 450 mm). Preliminary abundance estimates were produced using Program CAPTURE (White et al. 1982). The additional fish added to pass 3 made the probability of capture vary by time (pass); hence, Model Mt might be the appropriate model. However, Model Mt was not selected by CAPTURE's model selection algorithm. Model Mo (the null model) and Mt produced similar point estimates of abundance: about 775 individuals >250 mm; about 475 individuals > 450 mm; about 370 individuals > 500 mm (Table 1). The 95% confidence interval for pikeminnow > 450 mm was 317-789 (Model Mo). The probability of capture (p) improved greatly from the previous year: p-hat = 0.10 (2004); p-hat = 0.03 (2003) for individuals >450 mm. Precision of the estimate was also higher than in 2003. A 'rule of thumb' for acceptable precision is to achieve a coefficient of variation (CV) of 20% or less (Pollock et al. 1990). The CV for our whole-river estimate of Colorado pikeminnow was 47% in 2003 and 24% in 2004.
There was a large cohort that showed up in 2003. These fish appear to be from one year-class, and based on their size, probably were hatched in 1998. In 2003, about half fell into the size range that qualified them as subadults about to recruit, according to Recovery Goal criteria, or those 400-449 mm long. By 2004, some of these had become larger than 450 mm and therefore classed as adults, while most of the remainder had moved up into the subadult size range.

Data were too sparse to partition out the subadult-sized fish and develop a separate mark-recapture estimate of their abundance. Therefore, we used length frequency 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, recruitment (as measured by the number of subadults about to recruit) exceeded expected adult mortality, theoretically resulting in a net gain to the adult population. Year classes just prior to and after this strong 1998-produced cohort were evidently very weak.

Permit#: CANY-2004-SCI-0017

Principal Investigator: Dr Nigel Mountney, School of Earth Sciences and Geography, Keele University, Staffordshire, ST5 5BG, UK

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Project Title:

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

Objectives:
This field-based research project aims to examine and document the sedimentology and paleoenvironment of a succession of Permian-age, arid-climate continental successions exposed within the Paradox Basin of the Canyonlands District, SE Utah.

Findings and Status:
Field-based research in 2004 concentrated on developing an improved understanding of the detailed stratigraphic architecture of the Permian Lower Cutler Beds in the Canyonlands region

of Utah. Detailed, high resolution sedimentary logs were constructed from four separate regions: the Grabens District and the Needles District within Canyonlands National Park and the Lockhart Basin and the Shafer Basin from just outside the confines of the park. Key stratigraphic horizons were traced laterally between individual logs with the aim of providing criteria for correlation within and between the non-marine aeolian and fluvial, marginal marine and shallow marine sub-environments that comprise the suite of facies types within the study section. In particular, emphasis has been placed on tracing thin tongues of marine strata in order to document the nature of their pinch-out into non-marine strata.

Rapid lateral facies changes indicate that the shoreline system that developed during Permian times exhibited a complex morphology and no one single generic facies model is applicable across the region. To this end several models have been devised for the marginal marine realm. These include sandy tidal flat, wave influenced sandy foreshore and upper shoreface, lower energy enclosed marine embayment (probably with back flooded incised valley systems) and a system characterised by an abrupt transition from a shoreface marine realm to an aeolian dune-dominated non-marine realm. Additional complexity is present within the study area because the sedimentary system was subject to repeated transgressive and regressive cycles in response to high frequency relative sea level fluctuations. Consequently, the morphology of the shoreline area underwent significant yet predictable temporal changes relating to cyclical changes in sea level. The final phase of this project will be to develop a sequence stratigraphic model for the Lower Cutler Beds that accounts for both the complex spatial facies architecture and the temporal evolution on the system in response to changes in external controls including sea level, climate and sediment supply.

Permit#: CANY-2004-SCI-0019

Principal Investigator: Dr Michael Bogan, Fort Collins Science Center, US Geological Survey, Dept. of Biology, University of New Mexico, Albuquerque, NM 87131

Project Title:

INVENTORY FOR BATS AT CANYONLANDS NATIONAL PARK

Objectives:

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.

Findings and Status:

Our efforts in 2004 resulted in capturing 1053 individuals of 14 (82%) of the 17 species that might occur at CANY. Additionally, we heard and identified the audible cries of another species, the spotted bat. Thus, we have been able to document the occurrence of 15 (88%) of 17 species. Our average catch per night was almost 28 individuals of over 4 species; the maximum catch on a single night was 103 individuals of 9 species (at the junction of Salt and Horse creeks in the Needles District in June). Only once did we not capture any bats (Granary Spring, BLM, in June). Digital photographs of netting sites and selected individuals of all but one captured species were taken. These images will be provided with later project reports.

The most abundant species was the western pipistrelle (550 individual captures, followed by the pallid bat (198) and California myotis (129). All three are arid-adapted species and would be expected to be common at CANY. There were six species for which we netted from 11 to 49 individuals and five species for which we netted fewer than 10 individuals. These least abundant species are hoary bat (3 captures), silver-haired bat (9), long-eared myotis (6), big

free-tailed bat (2), and Mexican free-tailed bat (1). All but the long-eared myotis are suspected to be migratory in Utah and this may account for some variation in capture numbers but the more likely reason probably involves habitat preferences of the bats. Male hoary and silver-haired bats tend to be resident at higher elevations in the mountains in the summer. Maternity colonies of big free-tailed bats are known from sites near CANY (e.g., Arches National Park and Natural Bridges National Monument, Bogan et al., unpublished report to NPS). The status of the Mexican free-tailed bat in Utah is poorly known (Oliver 2000).

The most prevalent species across sites and netting episodes was the California myotis (86.8% of all netting episodes), followed by the western pipistrelle (76.3%) and pallid bat (71.1%). Seven species were present from 15 to 47% of episodes, including Allen's big-eared bat (37%), a species often regarded as uncommon. We captured this species every month and at most sites. The least prevalent species included the hoary bat, silver-haired bat, and both species of free-tailed bats. It is possible that some of these species find it difficult to maneuver at many of the relatively small pools of water where we netted and seek water and insects elsewhere.

Permit#: CANY-2004-SCI-0020

Principal Investigator: Ms ANGIE MOLINE, COLORADO STATE UNIVERSITY, DEPARTMENT OF BIOLOGY, E330 ANATOMY-ZOOLOGY BLDG., FORT COLLINS, CO 80523

Project Title:

DETERMINING THE EFFECT OF TAMARISK INVASION ON STREAM INVERTEBRATE COMMUNITIES ON THE COLORADO PLATEAU

Objectives:
To develop an understanding of how stream invertebrate communities are altered by invasive riparian vegetation and to determine the mechanisms behind these changes.

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

Permit#: CANY-2004-SCI-0021

Principal Investigator: Dr Glenn Kroeger, Department of Geosciences, Trinity University, One Trinity Place, San Antonio, TX 78232

Additional investigator(s):

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Project Title:

GEOPHYSICAL SURVEYS OF CYCLONE GRABEN AND DEVILS LANE GRABEN, NEEDLES DISTRICT, CANYONLANDS NATIONAL PARK, UTAH.

Objectives:
The actively deforming system of geologically young grabens and associated normal faults in the Needles District of Canyonlands National Park has become an important model in such diverse fields as petroleum exploration and planetary geology. Although the faults are well

exposed above the surface, sediments obscure the bedrock floor of the grabens complicating the measurement of fault displacement. Our geophysical surveys in 1996, 1999 and 2000 were the first direct measurements of the thickness and geometry of those sediments. Our results show that previous estimates of sediment depth are in error by factors of at least 4 to 10, and corresponding estimates of fault offsets are in error by factors of from 1.5 to 2.

Although we have shown that sediment thickness in both Devils Lane and Cyclone grabens approaches 100 m, we have not yet observed the maximum sediment thickness in either of these grabens due to equipment limitations. We have not yet been able to determine the geometry of the bedrock floor of either graben with sufficient accuracy to answer fundamental questions about relative motion on the faults bounding the grabens, or faults which may cut across the grabens. We have not yet been able to image the internal structure of the sediments to shed light on their depositional history.

We propose to conduct detailed seismic refraction, seismic reflection and gravity surveys of Cyclone graben to answer these outstanding questions. Road geometry and traffic make Cyclone graben the ideal place to conduct this study with a minimum impact to the Park and its visitors. In addition, the floor of Cyclone has features that may indicate the presence of cross-cutting faults in its bedrock floor. If time and weather permit, we will also acquire a small amount of seismic reflection data in Devils Lane graben to complete our characterization of its sediment geometry.

Findings and Status:
Our field work was conducted in Cyclone graben during the last week of July and first two weeks of August 2004. Participants included the PIs and six undergraduate students supported by the Keck Geology Consortium. Seven seismic refraction lines were shot along the main road using an accelerated weight drop source. Geophone (10 hz) spacing was 10 m and individual lines ranged from 350 m to 470 m in length. A shear wave survey was conducted along one of the lines at the southern end of the graben. Two short reflection lines with 40 hz geophones at 2 m spacing were acquired across the graben at major drainages. Gravity was measured with a Lacoste & Romberg Model G Aliod 100 gravity meter at 49 stations located approximately every 100 m along the axis of the graben. The relative horizontal and vertical locations of these stations were surveyed using an optical total station and the survey was georeferenced with WAAS corrected GPS data.

Preliminary processing of our seismic refraction data shows sediment depths in Cyclone are similar to (but perhaps slightly shallower than) those we measured previously in Devils Lane. Sediment fill appears generally deeper in the southern half of the graben with typical depths of about 50 m increasing to a maximum depth of approximately 80 m near the center of the graben. Sediment fill in the northern half of the graben is generally less than 50 m and shallows to approximately 30 m at the northernmost end. Our seismic results suggest that the bedrock floor of Cyclone graben may be offset by faults running both along and perpendicular to the axis of the graben. We are continuing to refine our seismic models with more advanced analysis methods including seismic refraction tomography.

Our gravity data is both unexpected and exciting. Analyzing this data is particularly difficult because of the large terrain corrections necessitated by the shear vertical walls of the graben. We have calculated terrain corrections with both the traditional Hammer chart method and with a computer algorithm using a combination of 1 arc-second (~30 m) and 1/3 arc-second (~ 10 m) digital elevation data from the USGS National Elevation Dataset. Although the details of the two sets of corrections differ, their overall effects on the gravity data are remarkably similar. Both approaches yield an anomaly with a maximum amplitude of approximately -3.5 mgal just south of the middle of the graben. This is over 3 times the amplitude of the anomaly we measured previously in Devils Lane. Modeling this gravity anomaly with sediment fill alone requires sediment depths of approximately 250 m with plausible values of density contrast between the bedrock and sediment. Such depths are incompatible with our seismic refraction

results and reasonable estimates of fault displacements. This large gravity anomaly may be the result of upwelling of salt beneath the floor of Cyclone graben which has been postulated in previous structural models of the grabens. We are continuing to model this data to estimate the location and amplitude of salt upwelling required to produce this gravity anomaly.

Permit#: CANY-2004-SCI-0022

Principal Investigator: Ms Alicyn Gitlin, 2135 S. Ash Lane, Flagstaff, AZ 86004

Project Title:

FACTORS INFLUENCING DISTRIBUTION & MORTALITY OF A DOMINANT RIPARIAN TREE

Objectives:
Sites in Canyonlands National Park did not meet the requirements necessary to be included in this study. A separate IAR submitted to Arches National Park contains study details.

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

Permit#: CANY-2004-SCI-0023

Principal Investigator: Mr Brian Jacobs, Bandelier National Monument, Los Alamos, NM 87544

Additional investigator(s):
Name: Dr. Bill Romme Phone: 9704912870 Email: romme@cnr.colostate.edu

Project Title:

CHARACTERIZE SOUTHWESTERN U.S. WOODLAND SYSTEMS: SOILS AND ASSOCIATED SITE FACTORS AS INDICATORS OF STAND AGE-STRUCTURE

Objectives:
Delineation of Southwestern woodlands using soil parameters and associated understory community and fire history attributes.

Findings and Status:
No activity was conducted this report year

Permit#: CANY-2004-SCI-0025

Principal Investigator: Dr David Gillette, Museum of Northern Arizona, 3101 N. Fort Valley, Road #65534, Flagstaff, AZ 86001

Project Title:

PALEONTOLOGICAL RESOURCE MANAGEMENT FIELD INVESTIGATIONS

Objectives:
Reconnaissance for assessment of paleontological resources in CANY. The results of the assessment will be used for preparation of a Resource Management Plan for Canyonlands National Park in keeping with National Park Service policies and regulations. The plan will seek to achieve uniform administration of activities that affect paleontological and related geological resources, including research, education, recreation and other functions.

Findings and Status:
In 2004 we established the beginnings of a base-line assessment of paleontological resources with approximately one week of field survey in back country and a one-week river trip led by a Canyonlands River Ranger on the Colorado. The river trip passed through deep canyons cut into Pennsylvanian and Permian formations with locally abundant invertebrates and several unique geological features related to ancient reefs in a shallow sea. The work also recognized an important exposure that contains petrified logs of Permian Age. These activities represent the beginning of the project, which will be conducted in earnest in 2005.

Permit#: CANY-2004-SCI-0026

Principal Investigator: Mr Michael Firnhaber, Post Box 2046, Estes Park, CO 80517

Project Title:

RECORDING BARRIER CANYON STYLE ROCK ART.

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

Findings and Status:
Due to funding shortfalls, no activity took place during this calendar year. The project is scheduled to take place during the first half of 2005.

Permit#: CANY-2004-SCI-0027

Principal Investigator: Dr Juliet Crider, Department of Geology, MS 9080, Western Washington Univ., 519 High Street, Bellingham, WA 98225

Additional investigator(s):
Name: Dr. Susan Owen Phone: 213-740-6308 Email: owen@terra.usc.edu

Project Title:

ACTIVE GEOLOGIC EXTENSION AT THE GRABENS OF CANYONLANDS NATIONAL PARK

Objectives:
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 are evaluating the rate and spatial variation in vertical deformation using interferometric synthetic aperture radar (satellite images); 2) determining the rate and direction of horizontal extension along two orthogonal traverses across the Canyonlands using Global Positioning System measurements on the ground; and 3) monitoring the contribution of individual faults directly detailed ground measurements. 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.

Findings and Status:
2005 was the fifth year of the project. We revisited all 6 of the 6 GPS sites established in 2001 and 2002, collecting precise locations using high-precision GPS receivers. The rates of deformation across the Grabens are low, with most sites showing millimeters of motion each year. The signal is near the limit of our ability to resolve, and this fifth year of observations will be crucial to the project . (Data are not yet processed to give rates.) The first three years of observations have been used to constrain interpretation of satellite-based deformation measurements (InSAR). These show, in general, increasing rates of motion toward the river. Interesting patterns are seen within individual grabens: InSAR suggests that in Devils Lane and nearby, motion is slightly higher near the fault tips than in the center of the faults. An enigmatic signal in the satellite data in the vicinity of Beef Basin suggests that there is salt motion in the subsurface there.

Permit#: CANY-2004-SCI-0029

Principal Investigator: Mr Michael Hudson, Utah Division of Wildlife Resources, Moab Field Station, 1165 S. Hwy 191 - Suite 4, Moab, UT 84532

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Project Title:

POPULATION ESTIMATE OF HUMPACK CHUB IN CATARACT CANYON, COLORADO RIVER RECOVERY IMPLEMENTATION PROJECT 22L

Objectives:
This is a three-year, mark-recapture, population estimate of humpback chub in Cataract Canyon on the Colorado River. The study will also examine the relationship between ISMP catch rates and population size.

Findings and Status:
Three sampling trips were conducted in Cataract canyon on October 10–17, October 23–30,and November 7–14. Flows during sampling ranged from approximately 8,000 to 5,500 cfs. Daily mean water temperature ranged from 13 o C to 9 o C. Sampling occurred in three primary sites which were identified as trend sites for long-term monitoring (RM 212-211,RM 210, RM 208-207).

Humpbacks: A total of 43 humpback chub captures were recorded during 1,246 net hours of trammel netting, yielding a total catch rate of 0.035 fish/net hr. No humpback chub were collected during 7.5 hours of electrofishing. Overall, 28 unique individuals were captured with a mean total length of 233.8 mm (range 200-298 mm TL). None of the humpback chub captured were sub-adults (<200 mm TL).

A population estimate was calculated for humpback chub using program CAPTURE within the program MARK. The model selection procedure within CAPTURE was used to select an appropriate estimator. The null model (Mo) was selected by the program, this selection is supported by lack of any significant difference in catch rates between trips. The estimate was calculated using 28 individuals and four recaptures between trips. The provisional population estimate for humpback chub in Cataract Canyon is 72 individuals (p-hat= 0.151, C.V.= 0.37) with a profile of likely hood of 39 - 160 individuals.

Bonytails: Only one bonytail chub was captured in 2004, this is a large reduction from the 20 captures and 16 individuals encountered in 2003. The bonytail captured was hatchery-reared and previously marked with a coded wire tag. The individual was healthy and measured 342 mm (total length).

Overall Catch: a total of 332 fish, consisting of Eleven species were captured in Cataract Canyon. All four main-stem endangered species and three other native species were present and combined represented 28 % of the total catch. Humpback chub were the most common native fish present in our samples. Channel catfish were the most abundant species overall.

Permit#: CANY-2004-SCI-0030

Principal Investigator: Dr Gery Allan, Northern Arizona University, Biological Sciences Dept. Bldg 21, S. Beaver St. Box 5640, Flagstaff, AZ 86011

Additional investigator(s):
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Project Title:

USING BIOTECHNOLOGY TO RESTORE RIPARIAN HABITATS IN THE WEST: GENETIC AND GENOMIC STUDIES OF BIODIVERSITY AND DROUGHT TOLERANCE

Objectives:
This study examines the link between the genetic diversity of a dominant riparian tree and biodiversity in riparian ecosystems.

Findings and Status:
CANYONLANDS -To examine the link between genetic diversity and biodiversity in a dominant riparian tree, we initiated genetic analyses of cottonwood trees in Canyonlands National Park. We sampled leaves for DNA analysis from one site: Horseshoe Canyon. In Horseshoe Canyon we sampled leaves from 30 trees. We have extracted DNA from all 30 trees. DNA from these trees is being processed for genetic analysis. This analysis includes the generation of molecular markers called AFLPs (Amplified Fragment Length Polymorphims). These markers will allow us to genetically fingerprint individual trees and compare their genetic profile with the genetic profile of other cottonwood trees found in other national parks. Our preliminary analyses indicate that cottonwood trees in Canyonlands NP are genetically unique, representing genotypes that are distinct from cottonwood trees in Arches NP. Additional analyses are underway and should be completed by Fall 2005.

Permit#: CANY-2004-SCI-0032

Principal Investigator: Dr Mark Miller, U.S. Geological Survey, Canyonlands Research Station, 2290 S. West Resource Blvd., Moab, UT 84532

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

Objectives:
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).

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