Arches
Canyonlands
Hovenweep
Natural Bridges
NPS SOUTHEAST UTAH GROUP

RESEARCH 2002 - LIST OF PROJECTS

RESOURCE MANAGEMENT DIVISION
Charles Schelz / Biologist
April 2002

CANYONLANDS NATIONAL PARK

1) Effects of Plant Invasion on an Arid Ecosystem

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

Name of institution represented: U.S. Geological Survey

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

2) Impacts of Biological Soil Crusts on Ecosystem Nitrogen Cycling

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

Name of institution represented: U.S. Geological Survey

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

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

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

Name of institution represented: U.S. Geological Survey

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

U.S. Geological Survey and collaborating scientists are seeking to understand how climate and how land use have influenced surficial geologic processes that modify landscapes and ecosystems. Such understanding is then used to model the landscape's

response to future changes in climate and land use over time scales of seasons, of a few years, and of a few decades, so that information and interpretations can be applied by federal, state, and local agencies, as well as by Native American governments, for their land-use planning and management of resources.

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

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

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

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

4) Carbon and Nitrogen Cycles in Arid Lands: The Role of Biological Soil Crusts as Influenced by Soil Surface Disturbance, Climate Change and Annual Grass Invasion

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

Name of institution represented: U.S. Geological Survey

Purpose of study

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

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

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

This project will establish how alterations in species composition by surface disturbance, invasive grasses, and/or climate change may affect N and C inputs and fluxes, in different soils under different climatic regimes. Because current and expected changes in land use and climate will occur over millions of acres in western rangelands, impacts to soil crusts have the potential for dramatically affecting C cycles, N cycles, and vascular plant

productivity over much of the western United States. In addition, semi-arid and arid ecosystems represent over one-third of the Earth's terrestrial surface, and most are covered by biological soil crusts. As human impacts are escalating both regionally and globally in these drier regions, the research questions posed in this proposal have significant implications for global C budgets as well.

5) Exotic Annual Grasses in Western Rangelands: Predicting Resistance and Resilience of Native Ecosystems to Invasion

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

Name of institution represented: U.S. Geological Survey

Purpose of study

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

It has long been thought that surface disturbance is a necessary prerequisite for annual grass invasions into established perennial plant communities. However, annual grasses have been seen to invade undisturbed ecosystems as well. In addition, annual grass invasions are often patchy, with some soils apparently uninvadable. Agronomists have long known that one of the most important soil characteristics affecting plants is the availability of soil nutrients. The relative levels of specific soil nutrients, rather than disturbance, successfully explained site-specific patterns of Bromus invasion in SE Utah grasslands. This project will determine if invasion susceptibility of other ecosystems in other geographic regions can be similarly predicted by variations in soil characteristics attributable to geomorphic and pedogenic processes within a given watershed.

Experiments will be be conducted to determine if managers can alter soil chemistry in a way to favor native grass establishment. In addition, Bromus may alter many ecosystem components that prevent native plant re-establishment. This project will monitor soils in a newly-invaded area, and document what alterations in soil chemistry and biology occur. Results from this project will be used to develop management strategies to avoid new Bromus invasions, and for already-invaded areas, to develop techniques to enhance native plant re-establishment.

With many millions of acres currently dominated by non-indigenous annual grasses, and 62 million acres of rangeland habitat highly susceptible to conversion, annual grasses are emerging as a major factor to be considered as we contemplate the future of rangeland ecosystems. It is critical that we understand whether managers can stop or buffer these invasions, and/or restore habitats after conversion. Determining factors that precipitate or

facilitate invasion may provide management tools for preventing dominance of aliens in areas where the population viability of species is of concern, and facilitate re-establishment of lost habitat. In addition, understanding how annual grass invasion changes natural ecosystem processes, such as nutrient availability, water availability, and soil microbial systems and how these changes affect re-establishment of native perennial plants, will enhance efforts to restore lost habitat

6) The BCS PROJECT / Barrier Canyon Style Documentation

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

Name of institution represented: BCS Project

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

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

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

Name of institution represented: Colorado State University

Purpose of study
To understand the effects of current and past Green River regulation by Flaming Gorge Dam on riparian vegetation along the Green River. My initial work will focus on the Fort Bottom area as a significant hydrologic data set has been developed by the National Park Service Water Resources Division. I will establish homogenous plots to represent the main vegetation types in the area. Each plot will be identified with a GPS location, and can then be analyzed within the hydrologic framework established by NPS hydrologist Brian Cluer. This data set will allow me to analyze the composition of vegetation along hydrogeological gradients. This vegetation composition will be compared with the vegetation from other Green River locations in Lodore Canyon, Whirlpool Canyon, Split Mountain Canyon, Ouray National Wildlife Refuge, Island Park, and Gray Canyon, as well as Deerlodge Park and Yampa Canyon along the unregulated Yampa River in Dinosaur National Monument. The overall goal is to develop an analysis of the riparian vegetation for the entire middle and lower Green River. We will investigate patterns of

vegetation that reflect adjustment to Flaming Gorge Dam regulation. I will also excavate tamarisk and young cottonwood to accurately determine the year each plant established. The goal of this investigation is to understand whether Flaming Gorge Dam has created more suitable conditions for tamarisk invasion, and the role of tamarisk in sediment accumulation and channel narrowing.

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

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

Name of institution represented: USGS--Canyonlands Field Station

Purpose of study

1. To develop effective monitoring protocols that will provide the proportion of habitat units that host breeding populations of amphibians within selected survey areas, in a design that allows broad inference to all of Canyonlands National Park.
2. To develop methods to effectively estimate population density and abundance in sentinel sites that will be worked intensively over each season.
3. Work with Southeast Utah Group NPS staff to enhance and expand existing water monitoring program to ensure amphibian habitats are being monitored, and to add any parameters of importance to amphibians that may not be included in current park monitoring program (e.g., dissolved organic matter, and community attributes such as plankton composition).
4. Monitor the incidence of disease in Canyonlands amphibians.
5. Integrate findings in Canyonlands National Park with a national amphibian monitoring program.
6. Make latest monitoring data available to the NPS via web accessible database within 3 months of data collection.
7. Compile and interpret trend information on amphibians that we collect at regular intervals and place findings into local, regional, and national contexts.

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

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

Name of institution represented: USGS--Canyonlands Field Station

Purpose of study

The objectives of this study are to: 1) establish riparian and aquatic invertebrate and

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

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

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

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

Purpose of study

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

11) Annual Forestland Inventory of Utah

Name of principal investigator: Michael Wilson **Email**: mjwilson@fs.fed.us

Name of institution represented: USDA FOREST SERVICE

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

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

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

Name of institution represented: USGS--Canyonlands Field Station

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

13) Colorado Pikeminnow Monitoring

Name of prin. investigator: Michael Hudson **Email:** mhudson.nrdwr@state.ut.us

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

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

14) Population Estimates of Humpback Chub in Cataract Canyon.

Name of prin. investigator: Michael Hudson **Email:** mhudson.nrdwr@state.ut.us

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

Purpose of study:
To obtain a reasonable estimate of adult Humpback chub abundance in the Cataract Canyon.

15) Fault Growth and Drainage Development in the Canyonlands Grabens

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

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

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

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

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

Name of institution represented: Keele University, United Kingdom

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

17) Biology and Distribution of the Butterflies of Canyonlands National Park

Name: Clyde Gillette **Email:**

Name of institution represented: Utah Lepidopteran Society

Purpose of study
To create an Expanded Checklist of the Butterflies of Canyonlands National Park which will include distribution in space and time, documented larval food plants, limited developmental histories, and some behavioral traits.

18) A study of the distribution of Catocala benjamini and related Catocala in northeastern Arizona and southeastern Utah.

Name: John Peacock **Email:** lepnut@worldnet.att.net

Name of institution represented: Ohio State University

Purpose of study
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.

19) Night Sky Monitoring of Parks of the Southeast Utah Group

Name: Charles Schelz **Email:** charlie_schelz@nps.gov

Name of institution represented: National Park Service

Purpose of study
To develop protocols and gather baseline data on night sky light levels at the four units of the Southeast Utah Group. This project will result in the development of a Night Sky Long-Term Monitoring Plan and a report that will be a template for future reports. This report will detail all protocols, fieldwork required, and test site locations, it will also provide baseline data and analysis for comparison with future monitoring.

Objective 1:
A "Night Sky Long-Term Monitoring Plan" that outlines, in detail and with examples, all protocols, database management, and analysis to be performed at each test site. It will also clearly specify night sky monitoring needs and objectives. And will provide a clear

understanding of how the monitoring program will support management information needs.

This plan will identify site-specific current resource impacts. It will also attempt to address future concerns and problem areas. It will set monitorinig management standards for resource conditions and will identify and assign priorities to areas of greatest concern.

Objective 2:
An initial report of the first completed round of Night Sky monitoring based on the new system recommended in the Night Sky Long-Term Monitoring Plan (Objective 1). This will include all test sites at all four units of the Southeast Utah Group..

20) HISTORIC VEGETATION ANALYSIS THROUGH THE USE OF REPEAT PHOTOGRAPHY AT THE SOUTHEAST UTAH GROUP.

Name: Charles Schelz **Email:** charlie_schelz@nps.gov

Name of institution represented: National Park Service

Purpose of study
Little is known of the historic vegetative cover of any of the habitats of the Southeast Utah Group. The pre-grazing condition of the vegetation has been described anecdotally, but any scientific measurement or quantitative description does not exist. The use of photography to gather this information has become our last chance to determine the pre-grazing conditions. Domestic livestock grazing was introduced into the area of the Southeast Utah Group during the late 1870's. This gives us little latitude for locating historic photographs considering photography was a new invention in the 1840's. Powell's second Colorado River expedition of 1872 had a photographer (E.O Beaman) on board and many of the original glass plates survive. Many of these photos are along the Green and Colorado Rivers but some are also in the uplands above the river. The river environment is presently being studied by Belnap and Webb (personal comm. 1998) from the confluence of the Colorado and Green Rivers south through Cataract Canyon. The Belnap and Webb study, which is utilizing historic photos, is concentrating on the river environment without much analysis of the upland vegetation communities. I propose to search out all existing historic photos that are available and piece together a picture of our upland communities as they existed before the advent of domestic livestock grazing. I also propose setting up permanent long-term monitoring photo stations at the historic photo sites that have a clear and identifiable vegetative element.

This characterization of the ecosystem vegetative change and, in particular, the condition of pristine conditions of the varied habitats of the SEUG is rated as a **Top Priority Critical Research Need** by the 1993 Southeast Utah Group Research Plan. This work

may also facilitate the understanding of the history of the invasion of exotic species into the area and the impacts of visitor use.

OBJECTIVES: Gather baseline historic photographic data and develop a long-term photographic monitoring program on vegetation change in Arches and Canyonlands National Parks, and Natural Bridges and Hovenweep National Monuments (The Southeast Utah Group).

1) Locate all existing historic photographs and in particular pre-1880 photos of the area that encompasses the Southeast Utah Group.

2) Determine the location of each photo with vegetative analysis possibilities and establish a permanently marked and documented photo-station for past, present, and future analysis of vegetation change.

3) Analyze historic and repeat photos for species composition and cover change. Also, to look at visitor use impacts.

4) Produce a final report, and lay the foundation for subsequent reports and monitoring that will assist National Park Service managers in developing resource management plans that could protect habitats of the Southeast Utah Group. This information will help in assessing impacts of internal and external operations, and visitor impacts.

21) Mexican Spotted Owl Inventory at Canyonlands National Park

Name: Charles Schelz **Email:** charlie_schelz@nps.gov

Name of institution represented: National Park Service

Purpose of study

The Mexican spotted owl (*Strix occidentalis lucida*) was listed as Threatened species in 1993 by the U.S. Fish and Wildlife (USDI 1993). Lands in Canyonlands National Park have been established as critical habitat by the U. S. Fish and Wildlife Service (2001). Canyonlands National Park is considered one of the major population centers of Mexican spotted owls on the Colorado Plateau. Surveys have been performed in Canyonlands in the past (Wiley 1995, 1997, 1998) but no monitoring of known territories or searches for new sites have been conducted since 1997. There are some areas in the park where we have reports of Spotted Owls but no official records of them.

Canyonlands NP has 20 historic sites throughout the three districts of the Park (Willey 1998). Most of the sites are in the Needles and Maze Districts. Despite intensive surveys, only 70-80% of potential habitat was checked for spotted owls (Willey 1998).

Most territories are centered around the core nest site which is located in rugged and steep canyon topography with vertical cliffs and numerous caves. Often with small patches of woodland vegetation, pinyon-juniper being the most common type. Canyonlands National Park is the center of this habitat type in southeastern Utah. This strong association between the owls and steep canyon topography suggests that this environment should be thoroughly surveyed and monitored.

The most important threat to the owl in Canyonlands National Park is increased human activities in the remote backcountry (Swarthout 1999). Swarthout concludes that high levels of recreational activity in nesting habitat maybe detrimental to Mexican spotted owls. This is why it is imperative that we know the location of the nesting habitat. To avoid a detrimental scenario.

OBJECTIVES: The goals of this project are to identify the distribution, abundance, and breeding status of Mexican spotted owls in Canyonlands National Park as part of the monitoring requirements of listing by the U.S. Fish and Wildlife Service. We will use the standard Mexican spotted owl survey manuals (Rinkevich 1991, Forseman 1983, Ganey 1988) as the main protocol guide.

Objective 1:

To inventory all known and potential Mexican spotted owl habitat in Canyonlands National Park.

Objective 2:
To document distribution, abundance, and breeding status of Mexican spotted owls in Canyonlands National Park.

Objective 3:
To map all survey routes and found Mexican spotted owl territories using GPS and GIS. To enter all survey results into the database management framework currently being developed by the Northern Colorado Plateau Inventory and Monitoring Network. This will help ensure the long-term security, compatibility, and accessibility of the data. And to create a final report summarizing all historic data and current inventory and monitoring results.

ARCHES NATIONAL PARK

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

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

Name of institution represented: National Park Service

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

2) Carbon and Nitrogen Cycles in Arid Lands: The Role of Biological Soil Crusts as Influenced by Soil Surface Disturbance, Climate Change and Annual Grass Invasion

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

Name of institution represented: U.S. Geological Survey

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

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

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

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

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

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

Name of institution represented: USDA FOREST SERVICE

Purpose of study

The models and decision support tools that will be developed from this project will facilitate the most efficacious gypsy moth control/eradication programs within the Intermountain west with the least possible impacts on non-target organisms. The project has 3 major objectives:

1. Validate improved egg hatch and larval phenology models.
2. Produce validated decision support tools for field application within western regional climates.
3. Evaluate probability of gypsy moth establishment in Utah which includes the production of probability of establishment maps. The probability of establishment maps

will produce categories of risk for all vegetative types associated with various elevations within the state of Utah.

4) A study of the distribution of Catocala benjamini and related Catocala in northeastern Arizona and southeastern Utah.

Name: John Peacock **Email:** lepnut@worldnet.att.net

Name of institution represented: Ohio State University

Purpose of study
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.

5) Acoustic Monitoring in Arches National Park, 2002

Name: Skip Ambrose **Email:** Skip_Ambrose@nps.gov

Name of institution represented: National Park Service

Purpose of study
The primary objective of this project is to provide basic acoustic data necessary for preparation of air tour management plans for ARCH. A secondary objective is to collect acoustic data that will be useful in preparing a soundscape management plan. Specifically, these data include:

1. Natural sound levels in the primary habitats/acoustic zones in ARCH during all seasons of the year; and

2. The influence of aircraft and other man-made noise on natural sound levels.

6) Night Sky Monitoring of Parks of the Southeast Utah Group

Name: Charles Schelz **Email:** charlie_schelz@nps.gov

Name of institution represented: National Park Service

Purpose of study
To develop protocols and gather baseline data on night sky light levels at the four units of the Southeast Utah Group. This project will result in the development of a Night Sky Long-Term Monitoring Plan and a report that will be a template for future reports. This report will detail all protocols, fieldwork required, and test site locations, it will also provide baseline data and analysis for comparison with future monitoring.

Objective 1:
A "Night Sky Long-Term Monitoring Plan" that outlines, in detail and with examples, all protocols, database management, and analysis to be performed at each test site. It will also clearly specify night sky monitoring needs and objectives. And will provide a clear understanding of how the monitoring program will support management information needs.

This plan will identify site-specific current resource impacts. It will also attempt to address future concerns and problem areas. It will set monitorinig management standards for resource conditions and will identify and assign priorities to areas of greatest concern.

Objective 2:
An initial report of the first completed round of Night Sky monitoring based on the new system recommended in the Night Sky Long-Term Monitoring Plan (Objective 1). This will include all test sites at all four units of the Southeast Utah Group..

7) Biology and Distribution of the Butterflies of Arches National Park

Name: Clyde Gillette **Email:**

Name of institution represented: Utah Lepidopteran Society

Purpose of study
To create an Expanded Checklist of the Butterflies of Arches National Park which will include distribution in space and time, documented larval food plants, limited developmental histories, and some behavioral traits.

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

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

Name of institution represented: USGS--Canyonlands Field Station

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

9) HISTORIC VEGETATION ANALYSIS THROUGH THE USE OF REPEAT PHOTOGRAPHY AT THE SOUTHEAST UTAH GROUP.

Name: Charles Schelz **Email:** charlie_schelz@nps.gov

Name of institution represented: National Park Service

Purpose of study
Little is known of the historic vegetative cover of any of the habitats of the Southeast Utah Group. The pre-grazing condition of the vegetation has been described anecdotally, but any scientific measurement or quantitative description does not exist. The use of photography to gather this information has become our last chance to determine the pre-grazing conditions. Domestic livestock grazing was introduced into the area of the Southeast Utah Group during the late 1870's. This gives us little latitude for locating historic photographs considering photography was a new invention in the 1840's. Powell's second Colorado River expedition of 1872 had a photographer (E.O Beaman) on board and many of the original glass plates survive. Many of these photos are along the Green and Colorado Rivers but some are also in the uplands above the river. The river environment is presently being studied by Belnap and Webb (personal comm. 1998) from the confluence of the Colorado and Green Rivers south through Cataract Canyon. The Belnap and Webb study, which is utilizing historic photos, is concentrating on the river environment without much analysis of the upland vegetation communities. I propose to search out all existing historic photos that are available and piece together a picture of our upland communities as they existed before the advent of domestic livestock grazing. I also propose setting up permanent long-term monitoring photo stations at the historic photo sites that have a clear and identifiable vegetative element.

This characterization of the ecosystem vegetative change and, in particular, the condition of pristine conditions of the varied habitats of the SEUG is rated as a **Top Priority Critical Research Need** by the 1993 Southeast Utah Group Research Plan. This work

may also facilitate the understanding of the history of the invasion of exotic species into the area and the impacts of visitor use.

OBJECTIVES: Gather baseline historic photographic data and develop a long-term photographic monitoring program on vegetation change in Arches and Canyonlands National Parks, and Natural Bridges and Hovenweep National Monuments (The Southeast Utah Group).

1) Locate all existing historic photographs and in particular pre-1880 photos of the area that encompasses the Southeast Utah Group.

2) Determine the location of each photo with vegetative analysis possibilities and establish a permanently marked and documented photo-station for past, present, and future analysis of vegetation change.

3) Analyze historic and repeat photos for species composition and cover change. Also, to look at visitor use impacts.

4) Produce a final report, and lay the foundation for subsequent reports and monitoring that will assist National Park Service managers in developing resource management plans that could protect habitats of the Southeast Utah Group. This information will help in assessing impacts of internal and external operations, and visitor impacts.

NATURAL BRIDGES NATIONAL MONUMENT

1) Night Sky Monitoring of Parks of the Southeast Utah Group

Name: Charles Schelz **Email:** charlie_schelz@nps.gov

Name of institution represented: National Park Service

Purpose of study
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2) HISTORIC VEGETATION ANALYSIS THROUGH THE USE OF REPEAT PHOTOGRAPHY AT THE SOUTHEAST UTAH GROUP.

Name: Charles Schelz **Email:** charlie_schelz@nps.gov

Name of institution represented: National Park Service

Purpose of study

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HOVENWEEP NATIONAL MONUMENT

1) Floristic Study of Hovenweep National Monument.

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

Name of institution represented: National Park Service

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

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

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

Name of institution represented: Northern Arizona University

Purpose of study
Provide biological inventory data on vertebrate animals and vascular plants in parks of the Northern Colorado Plateau Inventory and Monitoring Network. This proposal addresses the inventory of reptiles and amphibians at HOVE.

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

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

Name of institution represented: U.S. Geological Survey

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

4) A study of the distribution of Catocala benjamini and related Catocala in northeastern Arizona and southeastern Utah.

Name: John Peacock **Email:** lepnut@worldnet.att.net

Name of institution represented: Ohio State University

Purpose of study
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.

5) Night Sky Monitoring of Parks of the Southeast Utah Group

Name: Charles Schelz **Email:** charlie_schelz@nps.gov

Name of institution represented: National Park Service

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Name: Charles Schelz **Email:** charlie_schelz@nps.gov

Name of institution represented: National Park Service

Purpose of study

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