

To: WWP - Wyoming Office[wyoming@westernwatersheds.org]
Cc: Matthew Betenson[mbetenso@blm.gov]
From: Backer, Dana
Sent: 2017-07-18T13:59:01-04:00
Importance: Normal
Subject: examples of research permit application request and resulting permit
Received: 2017-07-18T14:06:18-04:00
[UT-2017-030-01-B permit SUU Heyborne.pdf](#)
[UT-16-033-05-S permit WSU 2016.pdf](#)
[WSU Request permit GSENM.pdf](#)
[2016 SUU Herpetology Study Proposal permit request support.pdf](#)

Hi Jonathon,

Matt asked me to provide you with examples of requests the Monument receives for research permit applications and the resultant permit approve. I have included two examples: (1) one for herpetology research from SUU and (2) night sky baseline inventory and monitoring from Weber State University.

If you have any questions on the request process and supporting documentation, please feel free to call Matt or me.

Dana

Dana Backer
Science Program Administrator
Grand Staircase Escalante National Monument
Kanab, UT 84741
435-644-1257

**Scientific Research and Collection Permit
Grand Staircase-Escalante National Monument**

Applicant: Dr. Bill Heyborne
Address: Department of Biology
Southern Utah University
351 W. University Blvd.
Cedar City, UT 84720

Application Date: 8/18/2016
Issue Date: 2/27/2017
Expiration Date: 2/27/2021

GSENM Number: UT-2017-030-01-B

State Permit Number (if applicable): PENDING

Federal Permit Number (if applicable): NA

1. Is the research covered by an assistance agreement with this office and/or other BLM offices? Provide the number. Yes, L16AS00171

2. Description of your proposed research:

The scientific objectives include the following: 1) conducting a baseline inventory for reptiles and amphibians within the GSENM, with a focus on species which are rare, threatened or of special concern (such as chuckwalla and night lizards), 2) gathering data related to the use and movement of different habitats within the GSENM, 3) gathering data which will better enable us to understand the basic needs of reptiles and amphibians in the GSENM, including hibernacula, refugia, habitat preferences, etc., 4) collecting baseline data regarding habitat use and preference among reptiles and amphibians with regards to vegetation treatments especially pinyon/juniper removal. Our second category of objectives is specific to student research assistants. We hope to provide the following for our students: 1) experience conducting a field based project with real world application, 2) an opportunity to better understand the diverse habitats and fauna of southern Utah, and 3) an increased understanding of the multidisciplinary nature of land/resource management.

Support of the mission through these objectives is manifold. The scientific objectives will allow us to better understand the reptile and amphibian community of the GSENM. These data will then be used in support of the BLM's mission of managing multiple use of public lands. While the data to be collected will focus on reptiles and amphibians, these species serve as sensitive indicators of ecosystem health and disturbance, and will consequently be useful in mitigating risk associated with climate change, habitat alteration, fire, invasive species, and vegetation treatment. The student learning objectives will hopefully serve to help recruit the next generation of land/resource managers, while providing these students with a rich experience engaged in field based biology.

3. Where may we contact you?

Phone: 435-865-8443

Cell:

Fax:

E-mail: williamheyborne@suu.edu

For GSENM office use only below this line

4. Specialist review complete?	<input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	8. Curation agreement?	<input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> No
Name: T. Tolbert			Attach		
5. Complies w/ MMP?	<input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	9. Permit granted?	<input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> No
6. In WSA status?	<input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	10. Permit extension?	<input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> No
7. Special Requirements?	<input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> No			

Cultural survey and clearance must occur prior to installment of pitfall traps.

11. Area of activity: Skutumpah Terrace emphasis

12. If collecting is authorized. Materials to be collected include: Repository Name, Address, and Contact information

Authorization. Permission is hereby given to the above named individual to collect material(s) specified in the approved research proposal, within the guidelines of stipulations outlined below.

Cynthia Staszak
Monument Manager

Date

I have read and agree to the stipulations of this permit.

Science Permittee Name

Date

STANDARD RESEARCH PERMIT REQUIREMENTS

We ask that you follow all **Leave No Trace Principles** (<https://lnt.org>) and the following.

1. This permit may not be assigned to any other institution, group, or individual. Any modifications to the permit must be requested in writing to the Science Program Administrator.
2. This permit is valid only for the period specified. The permit may be suspended or modified at the discretion of the Monument Manager. Field work under this permit may be halted temporarily by either verbal or written notice from the Monument Manager or other Authorized Officer for violations of permit terms and conditions or for administrative purposes of the BLM.
3. All terms and conditions of this permit shall remain in effect, including reporting requirements, until all permit terms and conditions have been met, regardless of permit expiration date.
4. A copy of this permit must be carried by the individual in direct charge of field work during the course of all work conducted under permit.
5. This permit shall not be exclusive in character, and the Bureau of Land Management reserves the right to authorize other uses of the land during the tenure of this permit. Field work shall be carried out in such a manner as to not impede other legitimate uses of the Monument, except when a provision has been made by the Monument Manager or delegated representative.
6. The Department of Interior, including its bureaus and employees, shall be held blameless for any and all events, deeds, or mishaps, regardless of whether or not they arise from operations under this permit.
7. Field schedule must be coordinated with the Science Program Administrator or a designated representative in advance of field work.
8. The Monument Manager, and /or designated representatives shall have access to the study area during or after performance of field work, and shall have the right to inspect all materials removed.
9. Any stakes, flagging, or other temporary materials used to identify localities in the field shall be removed upon completion of field activity. No permanent survey monuments or markers shall be disturbed or removed during the course of field work.
10. Unless otherwise agreed, all costs shall be borne by the permittee, including costs of curation.
11. Interpreting and sharing the science conducted on GSENM with staff, volunteers and the public, is critical. There shall be a public outreach component for each research project. Recommendations or opportunities for public presentations, a field trip, or the something similar shall be coordinated with the Science Program Administrator.
12. Collections, if authorized, of materials acquired from public lands under the provisions of this permit remain the property of the United States Government and may be recalled at any time for use by the BLM. A designated repository for this project is not necessary. Any recall or transfer of material will be coordinated by BLM with the designated repository. Public display of material collected under this permit shall cite Grand Staircase-Escalante National Monument, Bureau of Land Management, Utah.
13. Grand Staircase-Escalante National Monument, and the BLM, Utah shall be cited in any report, publication, paper, news article, film, television program or other media, resulting from field work under this permit. Copies of such documents shall be provided to the Grand Staircase-Escalante National Monument Headquarters. To assist in producing the best possible science, you are encouraged to forward manuscripts for review to the Science Program Administrator prior to submitting them for publication.

14. Access to research site(s) is authorized only across BLM administered lands. Use of private lands or lands administered by another agency must be secured separately.

15. A report of all activities conducted under this permit shall be prepared by December 31 of each year during the tenure of the permit. This report will be submitted to the Monument Headquarters, in care of the Science Program Administrator. The report shall include a catalog of all specimens collected, if authorized, a description of work accomplished, results, copies of datasets (with FGDC compliant metadata for final reports) and any recommendations for future research or management activities.

16. Collections of materials acquired from public lands, if authorized under the provisions of this permit, remain the property of the United States Government and may be recalled at any time for use by the BLM. In the case of this permit, a designated repository will not be required. It is understood that some samples will be used and destroyed in the analysis process.

17. For any collections that will be curated, a list of all specimens collected must be provided in the annual report to the Science Program Administrator. Each specimen must contain the following information: scientific name, description, collection location (latitude / longitude or UTM Zone 12, NAD83), collection number, and facility's accession number. Provide the curation facility, address, and a point of contact at the facility.

18. Pursuant to the Native American Graves Protection and Repatriation Regulations at 43 CFR 10.4, the permittee shall notify the Science Program Administrator or Monument Manager immediately upon the inadvertent discovery of human remains, funerary objects, sacred objects, or objects of cultural patrimony, with written confirmation. All work in the vicinity must and reasonable efforts shall be made to protect the remains pending BLM action. Activities may resume within 30 days of receipt of the written confirmation of notification unless the situation is resolved sooner.

19. Commercially provided services such as transportation, cooking and packing must be sought from outfitters authorized by the Monument. For a current list of outfitters, please contact Science Program Administrator at 435-644-1257 or dbacker@blm.gov.

Camping

1. Overnight camping in the Monument requires a permit. Currently, permits are free of charge and may be obtained at Visitor Centers or at designated trailheads. Camping restrictions described in the GSENM Management Plan, p. 35, must be followed. The GSENM Management Plan is available on line https://www.blm.gov/nlcs_web/sites/style/medialib/blm/ut/grand_staircase-escalante/planning/monument_management.Par.83655.File.dat/GSENM%20Management%20Plan.pdf

2. No camping within 300 feet of an isolated water source (i.e., seep, spring, pond, rock pool, water pocket).

3. Permittee will maintain all premises to standards of repair, orderliness, neatness, and sanitation acceptable to the Monument. Camp areas will be regularly cleaned and no trash or litter will be allowed to accumulate.

Fire

1. Campfires are not allowed in the Escalante and Paria/Hackberry Canyons, No Mans Mesa, nor in archaeological sites, rock shelters and alcoves throughout the Monument.

2. In the Front country and Passage Zones, campfires are allowed only in designated fire grates, designated fire pits, or mandatory fire pans. Wood collection for campfires is not allowed. Burn all wood

and coals to ash, put out campfires completely; leave cool ashes.

3. In the Outback and Primitive Zones campfires are allowed. Use an existing fire ring instead of building a new one. The use of fire pans is encouraged. Only dead and down wood can be collected. Burn all wood and coals to ash, put out campfires completely, scatter cool ashes, and restore the area to a natural condition before leaving.

Group Size Limits

1. Group size is limited to 25 people in the Passage and Outback Zones including guides.
2. Group size within the Primitive Zone is limited to 12 people and 12 pack animals including guides, however within the Paria River corridor in the Primitive Zone group size is limited to 25 people including guides.
3. Group size limits cannot be achieved by staggering individual groups along a single route by time or distance. Instead, individual groups must comply with group size limits by utilizing separate and unique routes, or by traveling from opposite ends of a single route. If traveling from opposite ends of a single route, groups may pass each other, however they cannot gather at a single location.

Wilderness Study Areas

1. Permittee is responsible for knowing the location of wilderness and wilderness study areas (WSA) comply with the restrictions that apply to such areas. Maps and information concerning restrictions are available at the Monument website

Transportation and Access

1. All machinery (street legal motorized vehicles, non-street legal all-terrain vehicles, dirt bikes etc.) that has been used outside the Monument must be cleaned prior to use in the Monument, to prevent the possible introduction and spread of noxious weeds.
2. Motorized or mechanized vehicles may pull off designated routes no more than 50 feet for direct access to dispersed camping areas in the Outback Zone, except in Wilderness Study Areas, endangered plant areas, relict plant areas and riparian areas.
3. Access onto the Monument will be along defined roads listed on the transportation map in the Grand Staircase- Escalante National Monument Management Plan.
4. Cross-country motorized travel on the Monument is prohibited. All motorized and mechanized (bicycles, deer carts) vehicles must stay on designated roads while traveling in the Monument.
5. Permittee shall not construct new trails, or maintain existing trails without written authorization from the Monument.
6. The permittee shall not use paint or flagging, or construct cairns to mark trails, unless specifically allowed by this permit.

Sanitation and Aesthetics

1. Burning and burying food waste are prohibited.
2. Utilize a portable self-contained toilet system when less than 300 feet from water sources, campsites, and trails. All human waste must be packed out and disposed of at a certified disposal site.

3. If a small portable toilet cannot be used, deposit solid human waste in catholes dug 4 to 6 inches deep at least 300 feet from water sources, camp, and trails. Cover and disguise the cathole when finished. Never dig a cathole under an overhang or shelter.
4. If camping in one location for multiple days, a trench may be dug to dispose of human waste. To dig a trench, start with a cathole dug 4 to 6 inches deep and expand it in one direction as additional people use it; soil dug from the trench should be used to cover the feces.
5. To wash yourself or your dishes, carry water 300 feet away from water sources and use small amounts of biodegradable soap. Scatter strained dishwater and pack out remaining food particles.

Supplemental Stipulations for Permittees using Riding or Pack Animals

1. Horses or other pack animals are not allowed in relict plant communities, archaeological sites, rock shelters, or alcoves. Sheep species will not be allowed for pack use.
2. Weed free hay, straw and non-germinable grains may be used to feed and bed livestock, or be placed in the bottom of stock carrying vehicles.

BUREAU OF LAND MANAGEMENT
Financial Assistance (Cooperative Agreements)



PROJECT PROPOSAL

(Suggested Format)

Instructions: A Project Proposal must be submitted with the Standard Form (SF) 424 Application for Federal Assistance for all BLM Assistance Agreements. Complete each section below. Use additional sheets as needed.

Person Submitting Proposal: William Heyborne, PhD

Date: 8/8/2016

Organization Name: Southern Utah University

Agreement or Announcement No.: L16AS00171

Agreement or Announcement Title: **BLM Utah Reptile and Amphibian Inventory and Monitoring**

Estimated Period of Performance: 9/1/2016 – 8/30/2021

Proposed Project Location: Grand Staircase Escalante National Monument/ Southwestern Utah

This work will occur on: ☒ Public Lands ☐ Private Lands ☐ Both Public & Private Lands

YOUR MISSION:

(Describe your mission. Describe why this support is being requested.)

To begin to assemble baseline data regarding reptile and amphibian diversity, abundance and distribution within the Grand Staircase Escalante National Monument (GSENM) of southwestern Utah. Additionally, in alignment with Southern Utah University's mission, provide an experiential learning opportunity for two undergraduate research assistants.

OBJECTIVE:

(Describe your objectives and how these objectives support your mission.)

Our objectives fall into two categories. First, are the scientific objectives which are based on those stated in the project funding announcement and include the following: 1) conducting a baseline inventory for reptiles and amphibians within the GSENM, with a focus on species which are rare, threatened or of special concern (such as chuckwalla and night lizards), 2) gathering data related to the use and movement of different habitats within the GSENM, 3) gathering data which will better enable us to understand the basic needs of reptiles and amphibians in the GSENM, including hibernacula, refugia, habitat preferences, etc., 4) collecting baseline data regarding habitat use and preference among reptiles and amphibians with regards to vegetation treatments – especially pinyon/juniper removal. Our second category of objectives is specific to student research assistants. We hope to provide the following for our students: 1) experience conducting a field-based project with real world application, 2) an opportunity to better understand the diverse habitats and fauna of southern Utah, and 3) an increased understanding of the multidisciplinary nature of land/resource management.

Support of the mission through these objective is manifold. The scientific objectives will allow us to better understand the reptile and amphibian community of the GSENM. These data will then be used in support of the BLM's mission of managing multiple use of public lands. While

the data to be collected will focus on reptiles and amphibians, these species serve as sensitive indicators of ecosystem health and disturbance, and will consequently be useful in mitigating risk associated with climate change, habitat alteration, fire, invasive species, and vegetation treatment. The student learning objectives will hopefully serve to help recruit the next generation of land/resource managers, while providing these students with a rich experience engaged in field-based biology.

TECHNICAL APPROACH:

(Describe the details of the project, the procedures to be used, how data will be collected, analyzed, and interpreted, etc. Discuss expected goals and outcomes and how project effectiveness will be measured and evaluated. Include a detailed project work plan narrative and a table such as below to summarize the project schedule.)

There will be three main components to the proposed project; 1) a museum/literature survey of documented reptile and amphibian species from the GSENM, 2) general reptile and amphibian surveys, and 3) intensive surveys of three habitat types – pinyon/juniper woodland, sagebrush community, pinyon/juniper removal. Each component will be discussed below.

Museum/literature survey of documented reptile and amphibian species – this would be undertaken in the months between grant award and beginning of the subsequent field season. We would begin with whatever list is already possessed by biologists working in the GSENM. We would then add to this by focusing our efforts on electronically accessible reptile/amphibian collections, the Monte L. Bean Life Science Museum (as the state sanctioned repository), and herp record databases such as HerpMapper and HerpNET. This list would provide a baseline list to which records could be added or subtracted as “ground truthing” occurred over the course of the project.

General reptile and amphibian surveys – In order to confirm the museum/literature search list, we would methodically survey as many locations and subhabitats within the GSENM as possible over the course of the field season. These surveys would not be quantitative, but would instead be used to simply establish a list of known species within the GSENM, paired with associated habitat, weather, and vegetation data. We would focus our efforts on habitats particularly suited to reptiles and amphibians such as aquatic/riparian habitats, rocky outcrops, and cover objects. A variety of techniques would be used, including: visual encounter surveys, nocturnal call surveys, cover boards, and roadkill and basking surveys. Any roadkilled specimens would be collected (under W. Heyborne’s DOR for salvage) and deposited in the Monte L. Bean Life Science Museum.

Intensive habitat surveys – In order to begin to understand the impact of vegetation management, particularly that used for sagebrush restoration, we propose to conduct more intensive, quantitative surveys within three habitat types: 1) established pinyon/juniper woodland, 2) established sagebrush community, and 3) a site which has recently undergone pinyon/juniper removal to promote sagebrush establishment. We would locate these sites as close to one another as possible and do our best to match them in terms of size, topography, elevation etc. Within each of these three sites, we propose to establish a drift-fence/pitfall array and 10 4’x4’ coverboards. Drift-fences and pitfalls are particularly suited for capturing lizards, while cover boards tend to favor snakes. This monitoring would allow us to begin to understand differences which may exist within these distinct plant communities and the potential effect of this vegetation treatment on this animal community.

Milestone/Task/Activity	Start Date	Completion Date
Museum/literature survey	1 September 2016	1 March 2017
Set up of drift fences/cover boards	1 March 2017	31 March 2017
Checking drift fences/cover boards	1 May 2017	31 August 2017
General reptile/amphibian surveys	1 May 2017	31 August 2017
Compilation of final data and report preparation	1 September 2017	31 December 2017
Publication of any notable natural history/distribution data	1 January 2018	31 April 2018

PUBLIC BENEFIT:

(Describe how this project benefits the general public.)

The benefit of the proposed project would be a greater understanding of the herpetofauna of the GSENM. This in turn will lead to more informed management decisions regarding resource use on the monument. Additionally, at a time when natural history studies are on the decline, projects such as the one proposed present an opportunity to make notable observations regarding the natural history of these poorly understood and studied creatures.

QUALIFICATIONS & PAST PERFORMANCE:

(List key personnel and their responsibilities. Describe similar successful projects completed in the past and any unique qualifications your organization may possess.)

The PI for this project, Dr. William Heyborne, worked as a graduate student on a reptile and amphibian inventory and monitoring project in Colorado, under the tutelage of Dr. Stephen Mackessy at the University of Northern Colorado. Dr. Heyborne was also contracted by the Iowa Department of Natural Resources to conduct a reptile/amphibian inventory of the Sylvan Runkel Wildlife Management Area, which was completed in 2011. He is currently collaborating on a project with Dr. Laurie Mauger studying the invasive turtle species of the Virgin River Drainage. Other relevant projects have included studies on lizard paternity using sagebrush lizards, the effect of urbanization on garter snakes, and work with the Utah Division of Wildlife conducting reptile clearances prior to development in Washington County.

Because of Southern Utah University's proximity to the study area, the PI's research expertise and long history living and working in southern Utah, and SUU's track record of work with the BLM and other land management agencies, we are particularly well poised to tackle this project in a timely, meaningful and cost-effective manner.



Scientific Research and Collection Permit
Grand Staircase Escalante National Monument

Applicant: Jeremy Bryson/John Barentine/Janet Muir

Date: April 15, 2016

Address: Department of Geography
Weber State University
1299 Edvalson St.
Ogden, UT 84408 1210

GSENM Number: UT 16 033 05 S

State Permit Number (if applicable): N/A

Federal Permit Number (if applicable): N/A

1. Is the research covered by an assistance agreement with this office and/or other BLM offices? No

2. Please attach a description of your proposed research and provisions for curation of collections.

Some of the darkest skies in the world are found on the Colorado Plateau. Baseline night sky measurements, compliant with IDA standards, have never been taken at GSENM. With rapidly growing changes in night sky quality from expanding populations, increased tourist visits and extractive industry activity, baseline readings are necessary to track changes at the measurement locations and for possible use in other studies by other institutions (such as those focused on habitat changes, wildlife populations, etc.).

Teams from Weber State University, under the direction of Jeremy Bryson, Associate Professor Department of Geography plus personnel from the IDA would take readings with SQMs (Uniuhedron Sky Quality Meters supplied by Weber State University) the evenings of May 6, 7 and, possibly, 8 (new moon). Work plan includes four teams, four people each, one car per team.

3. Where may we contact you?

Phone: (801) 626 6242 Cell: (801) 626 6252 Fax: (801) 626 7130 E mail: jeremybryson@weber.edu

For GSENM office use only below this line.

4. Specialist review complete?	Yes	No	8. Permit granted?	Yes	No
5. Complies w/ plan?	Yes	No	9. Special stipulations?	Yes	No
6. WSA status?	Yes	No	10. Curation agreement?	Yes	No
7. Science review complete	Yes	No	11. Permit extension?	Yes	No

12. Date issued: April 20, 2016

13. Expiration: December 21, 2020

14. Area of activity: Monument Wide

15. Tracking/Agreement Number: N/A

16. Collecting is authorized. Materials to be collected: No collections or ground disturbing activities will occur.

Authorization. Permission is hereby given to the above named individual to collect material(s) specified in the approved research proposal, within the guidelines of stipulations outlined below.

GSENM Science Permit 01-01-2008

By:

Matthew Betenson
Acting Associate Monument Manager
Grand Staircase Escalante National Monument

Date

I have read and accept the stipulations in this permit

By:

Date

STANDARD STIPULATIONS

1. This permit may not be assigned to any other institution, group, or individual. Any modifications to the permit must be requested in writing to the Science Program Administrator.
2. This permit is valid only for the period specified. The permit may be suspended or modified at the discretion of the Monument Manager. Field work under this permit may be halted temporarily by either verbal or written notice from the Monument Manager or other Authorized Officer for violations of permit terms and conditions or for administrative purposes of the BLM.
3. All terms and conditions of this permit shall remain in effect, including reporting requirements, until all permit terms and conditions have been met, regardless of permit expiration date.
4. A copy of this permit must be carried by the individual in direct charge of field work during the course of all work conducted under permit.
5. This permit shall not be exclusive in character, and the BLM reserves the right to authorize other uses of the land during the tenure of this permit. Field work shall be carried out in such a manner as not to impede other legitimate uses of the Monument, except when a provision has been made by the Monument Manager or delegated representative.
6. The Monument Manager, and /or designated representatives shall have access to the study area during or after performance of field work, and shall have the right to inspect all materials removed.
7. Any stakes, flagging, or other temporary materials used to identify localities in the field shall be removed upon completion of field work. No permanent survey monuments or markers shall be disturbed or removed during the course of field work.
8. Access to research site(s) is authorized only across BLM administered lands. Use of private lands or lands administered by another agency must be secured separately.
9. Field schedule shall be coordinated with the Science Program Administrator or a designated representative in advance of field work.
10. Researchers are required to provide an educational outreach component, sharing the research work they have done with the public. This should be coordinated with the Science Program Administrator.
11. A report of all activities conducted under this permit shall be prepared by December 31 of each year during the tenure of the permit. This report shall be submitted to the Science Program Administrator. The report shall include a catalog of all specimens collected, if authorized, a description of work conducted, copies of datasets (with FGDC compliant metadata for final reports) and any recommendations for future research or management activities.
12. The Grand Staircase Escalante National Monument, and the BLM, Utah shall be cited in any report, publication, paper, news article, film, television program or other media, resulting from field work under this permit. Copies of such documents shall be provided to the Science Program Administrator. You are encouraged to submit manuscripts for review to the Science Program Administrator prior to submitting them for publication.
13. Commercially provided services such as transportation, cooking and packing must be sought from outfitters authorized by the Monument. A current list can be found on the Monument's web page at: http://www.blm.gov/ut/st/en/fo/grand_staircase_escalante/Recreation/outfitters_guides.html
14. Pursuant to the Native American Graves Protection and Repatriation Regulations at 43 CFR 10.4, the permittee shall notify the Science Program Administrator or Monument Manager immediately upon the inadvertent discovery of human remains, funerary objects, sacred objects, or objects of cultural patrimony, with written confirmation. All work in the vicinity of the inadvertent discovery shall cease upon discovery and reasonable efforts shall be made to protect the remains pending BLM action. Activities may resume 30 days after certification by the BLM of receipt of the written confirmation of notification of inadvertent discovery unless the situation is resolved sooner.

15. Collections of materials acquired from public lands, if authorized under the provisions of this permit, remain the property of the United States Government and may be recalled at any time for use by the BLM. In the case of this permit, a designated repository will not be required. It is understood that some samples will be used and destroyed in the analysis process.

16. If collection is authorized by this permit, a complete annotated list of all specimens collected shall be provided to the Science Program Administrator within 180 days of collection. Minimal information required for each specimen includes: what was collected, collection number, collection location (legal, to nearest ¼ section; latitude / longitude; or UTM Zone 12), and final curation location. If GPS units are used for generating location information, the datum should be NAD 83.

17. Unless otherwise agreed, all costs shall be borne by the permittee, including costs of curation.

18. The Department of Interior, including its bureaus and employees, shall be held blameless for any and all events, deeds, or mishaps, regardless of whether or not they arise from operations under this permit.

Camping

C1. Overnight camping in the Monument requires a permit. Currently, permits are free of charge and may be obtained at Visitor Centers or at designated trailheads. Camping restrictions described in the GSENM Management Plan, pp. 35-36, must be followed (the GSENM Management Plan is available online at http://www.blm.gov/ut/st/en/fo/grand_staircase_escalante/planning0/monument_management.html).

C2. Camping within 200 feet of an existing water source (i.e., stream, seep, spring, pond, tinaja/rock pool or water pocket) is prohibited.

C3. Permittee will maintain all premises to standards of repair, orderliness, neatness, and sanitation acceptable to the Monument. Camp areas will be regularly cleaned and no trash or litter will be allowed to accumulate.

Fire

F1. Campfires are not allowed in the Escalante and Paria/Hackberry Canyons, No Mans Mesa, or other identified relict plant areas, nor in archaeological sites, rock shelters and alcoves throughout the Monument.

F2. In the Frontcountry and Passage Zones, campfires are allowed only in designated fire grates, designated fire pits, or mandatory fire pans. Wood collection for campfires is not allowed. Burn all wood and coals to ash, put out campfires completely, then leave cool ashes.

F3. In the Outback and Primitive Zones campfires are allowed. Use an existing fire ring instead of building a new one. The use of fire pans is encouraged. Only dead and down wood can be collected. Burn all wood and coals to ash, put out campfires completely, scatter cool ashes, and restore the area to a natural condition before leaving.

Group Size Limits

G1. Group size is limited to 25 people (including guides) in the Passage and Outback Zones.

G2. Group size within the Primitive Zone is limited to 12 people (including guides) and 12 pack animals, however within the Paria River corridor in the Primitive Zone group size is limited to 25 people (including guides).

G3. Group size limits cannot be achieved by staggering individual groups along a single route by time or distance. Instead, individual groups must comply with group size limits by utilizing separate and unique routes, or by traveling from opposite ends of a single route. If traveling from opposite ends of a single route, groups may pass each other, however they cannot gather at a single location.

Wilderness Study Areas

W1. Permittee is responsible for knowing the location of wilderness study areas (WSA) and other special management areas (i.e., Special Recreation Management Areas, Visual Resource Management areas, Wild and Scenic Rivers, Outstanding Natural Areas and No Mans Mesa Research Natural Area), and complying with use restrictions that apply to such areas. Maps and information concerning restrictions are available at the Monument.

Transportation and Access

T1. All machinery (street legal motorized vehicles, non street legal all terrain vehicles, dirt bikes etc.) that has been used outside the Monument must be cleaned prior to use in the Monument, to prevent the possible introduction and spread of noxious weeds.

T2. Motorized or mechanized vehicles may pull off designated routes no more than 50 feet for direct access to dispersed camping areas in the Outback Zone, except in Wilderness Study Areas, threatened and endangered plant areas, relict plant areas, riparian areas or other areas identified.

T3. Access onto the Monument will be along defined roads listed on the transportation map in the Grand Staircase Escalante National Monument Management Plan.

T4. Cross country motorized travel on the Monument is prohibited. All motorized and mechanized (bicycles, deer carts) vehicles must stay on designated roads while traveling in the Monument.

T5. Permittee shall not construct new trails, or maintain existing trails without written authorization from the Monument.

T6. The permittee shall not use paint or flagging, or construct cairns to mark trails, unless specifically allowed by this permit.

Sanitation and Aesthetics

S1. Burning and burying food waste are prohibited.

S2. Permittees working in an area less than 200 feet (about 85 adult steps) from water sources, campsites, and trails must use a portable self contained toilet system. All human waste must be packed out and disposed of at a certified disposal site.

S3. If a small portable toilet cannot be used, deposit solid human waste in catholes dug 4 to 6 inches deep at least 200 feet (about 85 adult steps) from water sources, camp, and trails. Cover and disguise the cathole when finished. Never dig a cathole under an overhang or shelter.

S4. If necessary, i.e., when camping in one location for multiple days, a trench may be dug to dispose of human waste. To dig a trench, start with a cathole dug 4 to 6 inches deep and expand it in one direction as additional people use it; soil dug from the trench should be used to cover the feces.

S5. To wash yourself or your dishes, carry water 200 feet away from water sources and use small amounts of biodegradable soap. Scatter strained dishwater and pack out remaining food particles.

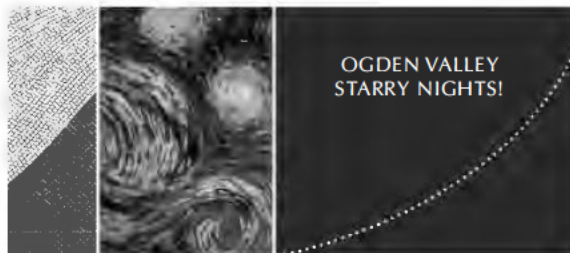
Supplemental Stipulations for Permittees using Riding or Pack Animals

A1. Horses or other pack animals are not allowed in relict plant communities, archaeological sites, rock shelters, or alcoves. Sheep species will not be allowed for pack use.

A2. Only weed free hay, straw and non germinable grains may be used to feed and bed livestock, or be placed in the bottom of stock carrying vehicles.



WEBER STATE UNIVERSITY



REQUEST FOR PERMIT

Bureau of Land Management, US Department of Interior

Scientific Research Project: **Baseline Night Sky Quality Measurements**

Grand Staircase-Escalante National Monument

[April 15, 2016]

Weber State University

Weber State University is located in Ogden, Utah and has deep experience in dark sky education. WSU teams, headed by Jeremy Bryson (applicant), maintain accreditation of North Fork Park (21st International Dark Sky Park, preceding Capitol Reef and Canyonlands National Parks) through annual monitoring.

Weber County enacted the first dark sky ordinances in the State of Utah covering Ogden Valley.

Weber State University is a founding member of The Committee for Dark Sky Studies, the members of which are:

- Brigham Young University
- University of Utah
- Utah State University
- Utah Valley University
- Weber State University

Affiliate Members

Rensselaer Polytechnic Institute (Lighting Research Center) [Mark Rea, Director]

University of Wyoming (Berry Biodiversity Conservation Center) [Carlos Martinez del Rio, Director]

The International Dark-Sky Association (Tucson, AZ)

IDA's work includes initiatives to protect the night skies and fragile ecosystems in parks and protected areas worldwide. See www.darksky.org

The IDA is a founding member of The Committee for Dark Sky Studies

IDA, Ogden Valley Chapter (Eden, UT)

The Ogden Valley Chapter spearheaded the accreditation of North Fork Park as the 21st International Dark Sky Park and will be a nominator for Antelope Island SP. It is a Reviewing Department of Weber County for all exterior lighting and illuminated signage in Ogden Valley and Ogden Canyon. It manages all dark sky public outreach activities for North Fork Park and maintains education liaisons with Utah Division of Wildlife Resources, Ogden Nature Center, Ogden Astronomical Society, Tracy Aviary, Wasatch Audubon Society, Ott Planetarium, HawkWatch International and Ogden Nordic.

The Ogden Valley Chapter is a founding member of The Committee for Dark Sky Studies.

Description of Project

Some of the darkest skies in the world are found on the Colorado Plateau. Existing International Dark Sky Parks include: Canyonlands NP, Capitol Reef NP, Hovenweep NM, Natural Bridges NM with pending designations including Grand Canyon NP, Dead Horse Point SP and Goblin Valley SP.

Baseline night sky measurements, compliant with IDA standards, have never been taken at GSENM. With rapidly growing changes in night sky quality from expanding populations, increased tourist visits and extractive industry activity, baseline readings are necessary to track changes at the measurement locations and for possible use in other studies by other institutions (such as those focused on habitat changes, wildlife populations, etc.).

Work Plan

On-Ground Measurements. Teams from Weber State University, under the direction of Jeremy Bryson, Associate Professor Department of Geography plus personnel from the IDA (headquarters and Ogden Valley Chapter) would take readings with SQMs (Unihedron Sky Quality Meters supplied by Weber State University) the evenings of May 6, 7 and, possibly, 8 (new moon).

Work plan includes four teams, four people each, one car per team.

Measurement template developed by Weber State University for designation of North Fork Park (Weber County) and adapted for GSENM will be utilized (see Supporting Information).

On-ground field measurement locations have been determined in collaboration with BLM (see Supporting Information).

Satellite Images for Interior: Additional information will be pulled from satellite imagery from <http://blue-marble.de/nightlights> and <http://www.lightpollutionmap.info> and analyzed for the vast interior region.

Dissemination of Results

Project results would be open to the public and filed with Weber State University, University of Utah, Southern Utah University, IDA, GSE Partners, and The Committee for Dark Sky Studies.

###

Submission and Affirmations

Affirming the foregoing application and that we have read, understand, and will comply with the Standard Stipulations:

Jeremy Bryson, Associate Professor, Geography, Weber State University (PhD, Syracuse University)

jeremybryson@weber.edu

801.626.6242 (o)

(b) (6)

John Barentine, International Dark-Sky Association (PhD, University of Texas, Austin)

John Barentine, Dark Sky Places manager for the International Dark Sky Association. He was on the staff of Apache Point observatory in New Mexico, serving first as an observing specialist on the Astrophysical Research Consortium 3.5 meter telescope and then as an observer for the Sloan Digital Sky Survey. He is author of the books *The Lost Constellations* and *Uncharted Constellations*, both recently published by Springer International.

john@darksky.org

520.294.3198 (o)

(b) (6)

Janet Muir, International Dark-Sky Association, Ogden Valley Chapter

Janet Muir, member International Dark Sky Park designation teams Grand Teton NP and North Fork Park; nominator Antelope Island State Park, Reviewing Department member for Weber County exterior lighting and illuminated signage for Ogden Valley and Ogden Canyon (Stanford University, UCLA School of Law, Yale School of Management).

(b) (6) @gmail.com

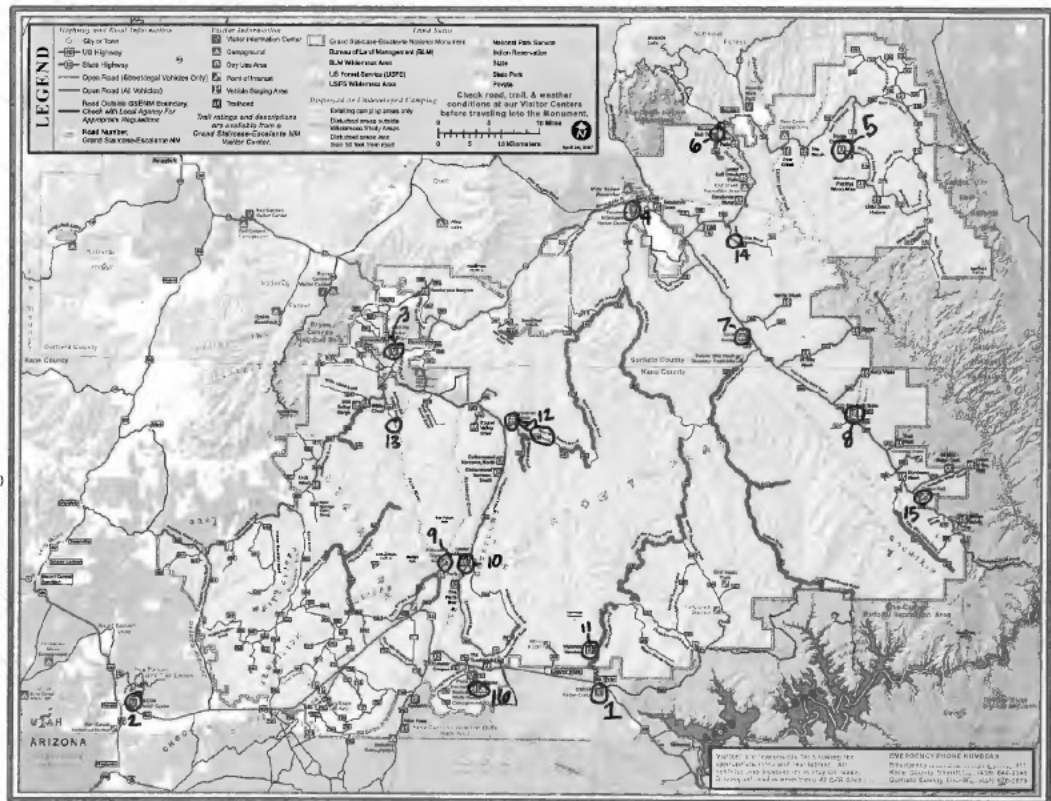
(b) (6)

Supporting Information

Locations for Night Sky Measurements

- 1 GSENM Visitor Center in Big Water
- 2 GSENM Visitor Center in Kanab
- 3 GSENM Visitor Center in Cannonville
- 4 GSENM Visitor Center in Escalante
- 5 Wolverine Trailhead or Circle Cliffs/Lampstand
- 6 Boulder Mail Trail/McGath Rd - Boulder Airstrip
- 7 Devil's Garden
- 8 Dry Fork Trailhead
- 9 Pahreah Townsite/Cemetery
- 10 Lower Hackberry Trailhead
- 11 Wahweap Hoodoos (request access via admin. road)
- 12 Grosvenor Arch/Four Mile Bench Road
- 13 End of Between the Creeks Rd (near Willis Ck)
- 14 Spencer Flat Road (approx. 3 miles off Hwy 12)
- 15 Dance Hall Rock parking area
- 16 Whitehouse Campground

Map: Locations for Night Sky Measurements



Locations for dark sky monitoring:

- 1 GSENM Visitor Center in Big Water
- 2 GSENM Visitor Center in Kanab
- 3 GSENM Visitor Center in Cannonville
- 4 GSENM Visitor Center in Escalante
- 5 Wolverine Trailhead or Circle Cliffs/Lampstand
- 6 Boulder Mail Trail/McGraft Rd - Boulder Airstrip
- 7 Devil's Garden
- 8 Dry Fork Trailhead
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- 10 Lower Hackberry Trailhead
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- 15 Dance Hall Rock parking area
- 16 Whitehouse Campground



The Committee for Dark Sky StudiesSM
 Trans-disciplinary multidisciplinary and in affiliation with
 the International Dark-Sky Association

.....

Mission

The Committee for Dark Sky Studies (CDSSt) is dedicated to the discovery, development, communication, and application of knowledge across a wide range of disciplines and professional fields pertaining to the quality of night skies, growing light pollution and the varied human and animal responses to the "disappearing dark."

Location

Utah, the highly strategic location of CDSSt, possesses night skies among America's darkest (with its steadily growing number of International Dark Sky Parks)¹ and brightest (with light pollution levels of the Wasatch Front reaching those of the Los Angeles Basin)²; its annual astro-tourism dollars likely exceed those of any other state.³

Members

Brigham Young University
 University of Utah
 Utah State University
 Utah Valley University
 Weber State University

Affiliate Members

Rensselaer Polytechnic Institute (Lighting Research Center) [Mark Rea, Director]
 University of Wyoming (Berry Biodiversity Conservation Center) [Carlos Martinez de Rio, Director]

.....

¹ Canyon and the Capitol Reef NP, Naam, Bridges NM, Hovenweep NM, North Fork Park (Weber County), Kaibab Plateau Dark Sky Nation. Pending: Gobin Valley State Park and Dead Horse Point State Park.

² Cass 8.0 Bortle Scale

³ Note that at Bryce Canyon (2012), astronomy-related attendance accounted for over 50,000 visits and \$2 million contributed to the local economy (National Park Service: Protecting Night Sky Resources).

Training Partner

Salt Lake Community College⁴

Steve Crossland, Chair, Environmental Science and Sustainability
Adam Dastrup, Assoc. Professor, Environmental Science and Sustainability

Steering Group

Brigham Young University

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J. Ward Moody: Professor, Department of Physics and Astronomy

Denise Stephens: Associate Professor, Department of Physics and Astronomy

University of Utah

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Kevin Perry: Chair, Department of Atmospheric Sciences

Glenn Prestwich: Professor, Medicinal Chemistry

Myron Willson: Deputy Chief, Sustainability Office

⁴ Dark sky lighting certification: Electrical Engineering, Energy Management, Environmental Services

⁵ Founding member

⁶ Founding member

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Utah Valley University

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John Cavitt: Professor, Department of Zoology

Rick Ford: Chair, Department of Geosciences

David Matty: Dean, College of Science

Brad Mortensen: Vice-President, Institutional Advancement [Honorary]

Stacy Palen: Professor, Department of Physics⁸

Charles Wight: President, Weber State University [Honorary]

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Patrick Barickman: Manager, Technical Analysis, Utah Division of Environmental Quality

Justina Parkson-Bernstein, Heritage and Interpretation Manager, Utah State Parks

Tracy Aviary

Tim Brown, Executive Director

Natural History Museum of Utah

Sarah George, Executive Director

Becky Menlove, Associate Director

⁷ Founding member

⁸ Founding member

International Dark-Sky Association

John Barentine, IDA (Tucson, AZ)⁹

Jess Dwyer (Ogden Valley Starry Nights Chapter)

Richard Menzies (Ogden Valley Starry Nights Chapter)

Janet Muir (Ogden Valley Starry Nights Chapter)¹⁰

Advisors/Supporters

Jay Kinghorn, Director Digital Strategy, Utah Office of Tourism

Douglas Larsen: Director, Economic Development Partnership (Weber County)

Sara Toliver: President/CEO, Ogden/Weber Convention & Visitor Bureau

David Williams, Associate Managing Director, Utah Office of Tourism

⁹ Founding member

¹⁰ Founding member

N O R T H F O R K P A R K

Ogden Valley, Utah

Application for IDA Designation



Ben Lomond Peak Overlooking North Fork Park and the Wasatch Front
[photograph: Casey Grimley]



N O R T H F O R K P A R K

Ogden Valley, Utah

Template for SQM Readings

North Fork Park

Unihedron Sky Quality Measurements

October 5, 2013 / September 24, 2014

Sample Name / Year	GPS Coordinates	SQM _{AVG}	SQM ₁	SQM ₂	SQM ₃	SQM ₄	SQM ₅
Ben Lomond Trailhead / 2013	41.38312, -111.92058	20.93	21.12	20.87	20.91	20.88	
Bicentennial Bowery / 2014	41.38480, -111.92308	20.83	20.77	20.87	20.83	20.84	20.82
Cold Water Intersection / 2014	41.37250, -111.91388	20.91	20.90	20.88	20.91	20.91	20.96
Cold Water Rd / 2013	41.37138, -111.91642	20.94	20.95	20.92	20.97	20.90	
Corrals West / 2014	41.36945, -111.90935	20.92	20.90	20.94	20.90	20.95	20.92
Cutler East / 2014	41.38610, -111.91113	20.91	20.98	20.93	20.86	20.89	20.88
Cutler West / 2014	41.38587, -111.92090	20.96	20.95	20.99	20.89	20.97	21.00
Dark Sky Viewing Entrance / 2014	41.37529, -111.91298	20.84	20.84	20.89	20.84	20.83	20.82
Dark Sky Viewing Area / 2014	41.37447, -111.91503	21.06	20.94	21.39	21.00	20.94	21.05
East Bowery / 2014	41.38512, -111.91278	20.95	21.00	20.98	20.97	20.89	20.89
Middle Gate / 2013	41.37488, -111.89703	20.98	20.91	21.01	21.08	20.92	20.98
Middle Gate / 2014	41.37467, -111.89707	20.93	20.89	20.89	20.93	20.95	20.97
Middle Gate Intersection / 2014	41.37194, -111.90947	20.85	20.80	20.83	20.87	20.89	20.88
Mule Ear Trail North / 2013	41.38073, -111.91955	20.93	21.01	20.93	20.91	20.88	
Mule Ear Trail South / 2013	41.37348, -111.91377	21.23	21.50	21.27	21.17	20.97	
Mule Ear Trailhead South / 2014	41.37366, -111.91310	20.90	20.88	20.89	20.88	20.98	20.86
Mule Shoe Trailhead South / 2013	41.37378, -111.91280	20.94	21.05	20.85	20.93	20.93	
Mustang Flats / 2013	41.37282, -111.89965	20.98	21.00	21.03	20.96	20.92	20.99
Mustang Flats / 2014	41.37313, -111.89988	20.91	21.06	20.88	20.86	20.89	20.87
New Trail Central 1 / 2014	41.37462, -111.91625	20.96	20.92	20.93	20.91	21.03	21.01
New Trail Central 2 / 2014	41.37580, -111.91625	21.00	21.01	21.01	21.03	21.02	20.92
New Trail South 1 / 2014	41.37423, -111.91464	20.92	20.97	20.97	20.87	20.89	20.90
New Trail South 2 / 2014	41.37423, -111.91462	20.85	20.61	20.93	20.88	20.88	20.93
New Trail South 3 / 2014	41.37384, -111.91438	20.90	20.88	20.83	21.00	20.88	20.90
North Fork Park Rd / 2014	41.37827, -111.91722	20.91	20.89	20.91	20.91	20.91	20.93
North Fork Rd / 2014	41.37725, -111.90096	21.04	21.47	20.99	20.95	20.87	20.90
North Gate / 2013	41.38313, -111.90527	20.97	20.94	21.01	20.98	20.95	20.97
North Gate Rd East / 2014	41.38233, -111.90715	20.91	20.92	20.93	20.87	20.93	20.92
North Gate Rd West / 2014	41.38177, -111.91216	20.91	20.87	20.88	20.91	20.92	20.98
River Trail / 2014	41.38915, -111.91440	20.92	20.95	20.82	20.99	21.00	20.86
South Gate / 2013	41.37103, -111.90230	20.97	21.10	20.84	20.77	21.16	
South Gate / 2014	41.37117, -111.90222	20.93	20.89	20.90	20.91	20.96	20.98
Trailhead Parking / 2013	41.38105, -111.91822	20.90	20.82	20.80	20.89	21.10	
Trailhead Parking / 2014	41.38072, -111.91859	20.95	20.94	20.98	20.89	20.89	21.05
View Bowery / 2013	41.38358, -111.91307	20.80	20.92	20.93	20.93	20.40	
View Bowery / 2014	41.38355, -111.91255	20.82	20.88	20.83	20.83	20.82	20.76
Waterfall Trailhead / 2013	41.37157, -111.92165	21.19	21.60	21.04	21.17	20.95	
Waterfall Trailhead / 2014	41.37138, -111.92113	21.04	20.88	21.04	20.94	21.39	20.96
West Bowery / 2013	41.38492, -111.91710	20.75	21.00	20.97	20.86	20.01	20.92
West Bowery / 2014	41.38580, -111.91837	21.11	21.13	21.12	21.14	21.08	21.08

North Fork Park (40 Samples) SQM_{AVG}

20.94



SCIENCE PLAN

FOR

MCINNIS CANYONS NATIONAL CONSERVATION AREA

JUNE 2012



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SECTION 1 – INTRODUCTION AND SCIENTIFIC MISSION

PURPOSE OF NLCS SCIENCE PLANS

The National Landscape Conservation System (NLCS) was administratively established in 2000 and legislatively codified in the Omnibus Public Land Management Act of 2009 (PL 111-11). This system encompasses nearly 900 units spread across approximately 27 million acres of public lands managed by the Bureau of Land Management (BLM). The BLM is mandated to conserve, protect and restore the outstanding cultural, ecological, and scientific values of NLCS units. Scientific investigation can aid in the conservation, protection, and restoration of these lands, and therefore, science is strategically planned and organized within NLCS units.

The objectives of NLCS units' science plans are to:

- Identify the scientific mission of the unit;
- Summarize past scientific efforts in the unit, i.e. the scientific background of the unit;
- Identify the priority needs and management issues within the unit that can be addressed by scientific inquiry;
- Define a strategy for accomplishing the scientific goals of the unit;
- Develop science protocols to, for example, ensure that scientific inquiry does not negatively impact the long term sustainability of the unit and its resources;
- Create a system to organize scientific reports; and,
- Help and promote the integration of science into management.

The science plans of NLCS units are considered 'living' documents and should be revised and updated frequently (e.g. 3-5 years). Scientific needs that emerge during the course of implementing a science plan may be added to the plan on an as-needed basis to meet the unit's scientific mission.

Science has been defined within the BLM several times (e.g. BLM 2007, BLM 2008a), but is essentially the study of natural and social phenomena using repeatable observations or experiments. In the context of land management, scientific data are collected, analyzed, or synthesized to increase knowledge and support decision-making. Within NLCS units there is an expectation for 'identifying science needed to address management issues, communicating those needs to science providers, and incorporating the results into the decision making process' (BLM 2007).

UNIT AND GEOGRAPHIC AREA DESCRIPTION

In 2000, McInnis Canyons National Conservation Area (MCNCA)¹, including the Black Ridge Canyons Wilderness, was created to conserve, protect, and restore 'the areas making up the Black Ridge and Ruby Canyons of the Grand Valley and Rabbit Valley, which contain unique and valuable scenic,

¹ The original legislation (P.L. 106-353) named the unit the Colorado Canyons National Conservation Area. Effective January 1, 2005, the Colorado Canyons National Conservation Area's name was changed to McInnis Canyons National Conservation Area (MCNCA) in honor of former U.S. Representative Scott McInnis (Legislation P.L. 108-400).

recreational, multiple use opportunities (including grazing), paleontological, natural, and wildlife components enhanced by the rural western setting of the area, provide extensive opportunities for recreational activities, and are publicly used for hiking, camping, and grazing, and are worthy of additional protection as a national conservation area' (Section 10). Specifically, the legislation mandated the BLM to 'conserve, protect, and enhance for the benefit and enjoyment of present and future generations the unique and nationally important values of the public lands...including geological, cultural, paleontological, natural, scientific, recreational, environmental, biological, wilderness, wildlife education, and scenic resources of such public lands' (Colorado Canyons National Conservation Area and Black Ridge Canyons Wilderness Act of 2000, Public Law 106-353; Section 10).

MCNCA is part of the Colorado Plateau eco-region as defined by the Environmental Protection Agency (Gallant et al 1989). There are numerous other conservation areas in the nearby vicinity (including NLCS units, National Park Service's monuments and national parks, and the US Forest Service's national forests).

The unit encompasses 123,430 surface acres of land and includes a 24 mile stretch of the Colorado River and 75,500 acres of the Black Ridge Canyons Wilderness (Figure 1). MCNCA is located west of Grand Junction, Colorado (Mesa County) within the BLM Grand Junction Field Office (GJFO) in Colorado's North West District, and continues just over the Utah border. It is comprised of four main areas: Mack Ridge, Rabbit Valley, Black Ridge Canyons Wilderness Area, and the Colorado River corridor, which are managed for multiple-use according to the Resource Management Plan (RMP) for the area (Table 1; BLM 2004). Recreation sites within MCNCA include developed areas, picnic areas, and camping sites.

Table 1. MCNCA planning zones and primary activities as set by the RMP (BLM 2004).

Planning zone	Primary activities
Mack Ridge	Mountain bike riding and horseback riding
Rabbit Valley	Off-highway vehicle (OHV) riding, hiking, Native American rock art viewing, camping, wildlife watching, mountain bike riding, horseback riding, and grazing
Wilderness	Hiking, backpacking, horseback riding, grazing and hunting
River corridor	Boating, hiking, and camping

MCNCA supports a diverse plant and animal community, and has significant cultural and paleontological resources. There are considerable challenges facing these resources. As BLM managers strive to determine the best management practices for these areas, scientific study can and should serve as an important and integral tool.

Figure 1 – Map of McInnis Canyons National Conservation Area and surrounding area.



SCIENTIFIC MISSION

This science plan will be used as the basis for conducting science in the MCNCA.

Scientific efforts within MCNCA should support the conservation, protection, and restoration of the values identified in the designating language. Since MCNCA is managed for multiple-use, some level of resource disturbance is inevitable. However, resource conditions should be such that predictable disturbance, for example from grazing and recreational use, is maintained at levels that allow sustained function of natural resources and preservation of socio-cultural and paleontological resources.

Specifically, it is the scientific mission of MCNCA to:

- 1) Allow and encourage pertinent science that can:
 - a. inform management decisions and evaluate management methods within MCNCA;
 - b. improve and maintain ecosystem resiliency and function;
 - c. improve and maintain land health;
 - d. maintain diversity and viability of plant and animal populations; and,
 - e. preserve and understand socio-cultural and paleontological sites.
- 2) Allow and encourage long term and short term investigations.
- 3) Allow scientific inquiry across diverse disciplines, as appropriate within MCNCA.
- 4) Serve as a model system for surrounding areas, so that scientific findings can be exported to other federal and non-federal lands.

SECTION 2 – SCIENTIFIC BACKGROUND

BACKGROUND INFORMATION AND SCIENTIFIC INVESTIGATIONS

Scientific investigations in MCNCA have covered a diverse array of topics, including studies on vegetation, wildlife, paleontology, and the impacts of recreation. The following is a brief summary of the past scientific research that has occurred with the unit; this summary is not meant to be exhaustive or static.

VEGETATION AND SOILS

McInnis Canyons National Conservation Area is located within the Colorado Plateau surface management area, as defined by the U.S. Environmental Protection Agency (Gallant et al. 1989). Diverse vegetation communities are found within MCNCA borders including salt-desert in lower elevations, piñon-juniper communities in canyons and on mesa tops, and sagebrush communities. MCNCA also encompasses a 24 mile corridor along the Colorado River and riparian vegetation along this corridor includes cottonwood galleries, and willow and tamarisk dominated stream banks (BLM 2003). These vegetation communities are influenced by historic and present day disturbances and management efforts including: fire, livestock grazing, re-seeding efforts, and recreation. Drought, use by wildlife, and climate change also influence these vegetation communities.

Soils in the MCNCA are generally derived from sandstone and shale, as well as from mixed alluvium. Soil textures are somewhat variable and include sandy loam, loam, silty clay, and silty loam (BLM 2003). As in many arid ecosystems soils may be rapidly eroded by wind or water, especially where vegetative cover is lacking. Another component of the soils which deserves special note is cryptobiotic crusts. Cryptobiotic soil crusts are an important component of soils in cold deserts and may increase soil stability, enhance moisture, and nutrient retention (Belnap and Gardner 1993). These soil crusts may be easily damaged by trampling and physical disturbance (Belnap and Gardner 1993). Some rare plants are known to occur within MCNCA including the Dolores river skeleton plant (*Lygodesmia doloresensis*, also referred to as Dolores desert pink), Osterhout's cryptantha (*Oreocarya osterhoutii*), and Jones' bluestar (*Amsonia jonesii*) (BLM GJFO, unpublished data).

In 2004, the Colorado Natural Heritage Program provided MCNCA with a biological inventory of the imperiled and vulnerable plants, animals, and natural communities in the Rabbit Valley and Mack Ridge areas (Stevens 2004).

Many invasive and noxious weeds are found within MCNCA. Several of these are actively managed. The following list provides some details on the weeds present, and actions that have/are occurring to manage these species:

- Russian knapweed (*Acroptilon repens*) is an aggressive weed which competes with native vegetation in several ways, including the production of allelopathic substances and ability to grow from seed or hearty root masses (Maddox et al. 1985). Control of this weed can be difficult and biological agents may increase chances of longer term suppression.

- The invasive species cheatgrass (*Bromus tectorum*) is an aggressive invader present throughout much of the arid west (Pellant 1996). Cheatgrass has changed historic fire regimes and increased the likelihood of more frequent fires (Pellant 1996). Traditionally, managers have used techniques to try to mitigate the spread of cheatgrass such as reseeding after fires. However, there is uncertainty as to the effectiveness of this technique at limiting cheatgrass recovery and spread (Getz and Baker 2008), and recovery depends on several variables and is not well understood.
 - In 2004, a study was performed by Mesa State scientists to study how different soil amendments (C addition as sugar, C addition as sawdust, NaCl addition, ammonium fertilizer, one time herbicide application prior to reseeding, and no treatment) would affect the establishment of native species from seed within sites dominated by invasive cheatgrass (*Bromus tectorum*), tumble mustard (*Sysymbrium altissimum*), and Russian thistle (*Salsola iberica*). The study was conducted in an area of acquired lands within MCNCA. Before becoming BLM property, these lands were the site of a proposed golf course where initial work was not completed. Initial findings showed that essentially no native plants established under any of the treatments, therefore, follow up monitoring efforts was not continued (Dr. Tamera Minnick, personal communication).
- Hoary cress, also known as whitetop (*Cardaria draba*), is a rhizomatous perennial plant that invades rangelands and can be abundant on alkali soils (Jacobs 2007). This species spreads by rhizomes, which can be extensive, as well as seed and produces allelopathic chemicals that may inhibit the growth of other plant species (Jacobs 2007).
- Russian olive trees (*Elaeagnus angustifolia*) were introduced to western North America from Europe and Asia around 1900. This species is found in riparian areas, often with tamarisk (Katz and Shafroth 2003). An extensive effort to eliminate this weed has been undertaken by the GJFO and approximately 95% of the species has been removed from MCNCA river corridor (BLM Staff, personal communication).
- Perennial pepperweed (*Lepidium latifolium*) is an invasive species that appears to be increasing in density within MCNCA. This species can be problematic to remove as it spreads primarily through sprouts from roots, which can be very hardy, and treating aboveground plant parts may only temporarily reduce population size (Young et al. 1998). It is often found in riparian or wet areas. This plant can alter soil properties, inhibiting native plant restoration after the plant has been removed, and treating young infestations may drastically reduce the effort needed for restoration once this weed is removed (Renz and Blank 2004). Native plants may be able to exclude this invasive species (Young et al. 1998); therefore, if perennial pepperweed is removed, restoration is a priority.
- Purple loosestrife (*Lythrum salicaria*) is an invasive species found in riparian areas and wetlands that can reproduce and regenerate by seed, buds on roots, and stems (Jacobs 2008). In addition, seed viability is high, seed banks of this seed can outnumber native seed, and seed germination and seedling growth are often faster for this species than for native species (Jacobs 2008). These characteristics give this plant a distinct advantage over native riparian species (Jacobs 2008). When this species invades, it can reduce native plant diversity, reduce pollination and seed

production of some species, and reduce habitat suitability for some bird species (Blossey, Skinner et al. 2001). Along with Mesa County, Colorado and Grand County, Utah, the Grand Junction BLM has an ongoing eradication program along the Colorado River (which goes through MCNCA). This weed has been actively managed for almost a decade and it now exists as isolated plants within MCNCA (BLM GJFO unpublished data).

- Tamarisk (*Tamarix spp.*) is an invasive shrub that can exclude native riparian vegetation and alter native systems through changes to water flow, wildlife habitat, and soil properties (Di Tomasso 1998). Due to the widespread nature and difficulty in effectively removing this species, a biological control agent (the tamarisk beetle, *Diorhabda carinulata*) was released in the Horsethief Canyon area in the River corridor planning area in 2005. However, the tamarisk beetle was not very effective in tamarisk control until a population of beetles from a release in Utah moved into the canyon in 2008 (Dr. Dan Bean, Pallisade Insectory, personal communication). Scientists from Pallisade Insectory and Colorado State University are collecting data (from 2005 to present) in Horsethief Canyon, as well as other release sites of tamarisk beetle, to determine the effects of the beetle on target (tamarisk) and non-target vegetation (Dr. Dan Bean, personal communication”).

Other invasive species in MCNCA include: Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), yellow toadflax (*Linaria vulgaris*), Siberian elms (*Ulmus pumila*), halogeton (*Halogeton glomeratus*), and annual wheatgrass (*Eremopyrum triticeum*).

The BLM GJFO ecologist, in collaboration with Mesa State scientists, began a study in 2003 to determine appropriate methods of transplanting the threatened Colorado hookless cactus (*Sclerocactus glaucus*), using fishhook cactus (*Sclerocactus parviflorus*) as a proxy. Transplants have occurred in Rabbit Valley within MCNCA. This project is ongoing with high survival rates to date (Ballard et al. in prep).

WILDLIFE

MCNCA is home to a diversity of wildlife which serves as an attraction to visitors to the area. The fauna of MCNCA is typical of piñon-juniper dominated woodlands, red rock canyons, cold deserts, sagebrush parks, and river habitats. Additionally, fauna associated with irrigated agriculture and metropolitan areas (found around the conservation area) are found within the boundaries of MCNCA.

MCNCA is home to four listed threatened or endangered species: bonytail entire chub (*Gila elegans*), humpback entire chub (*Gila cypha*), Pikeminnow (squawfish) (*Ptychocheilus lucius*), and greenback cutthroat trout (*Oncorhynchus clarki stomias*). Other species of concern include: western snowy plover (*Charadrius alexandrinus nivosus*), western burrowing owl (*Athene cunicularia hypogaea*), gray vireo (*Vireo vicinior*), long-billed curlew (*Numenius americanus*), wilson’s phalarope (*Phalaropus tricolor*), canyon treefrog (*Hyla arenicolor*), long-nosed leopard lizard (*Gambelia wislizenii*), and river otter (*Lutra canadensis*) (Colorado sensitive species, http://www.blm.gov/co/st/en/BLM_Programs/botany/Sensitive_Species_List_.html). Breeding pairs of burrowing owls have been documented within GJFO and are likely within MCNCA (klute et al. 2003, BLM GJFO unpublished data). Long-nosed leopard lizards have also been documented within the MCNCA area

(McCoy 1967). Additionally, in MCNCA there are two known nests of the recently de-listed bald eagle (*Haliaeetus leucocephalus*) (BLM GJFO, unpublished data).

Another species of concern in MCNCA is the Gunnison sage grouse (*Centrocercus minimus*) which is found only in sagebrush rangelands in western North America. Population declines of Gunnison sage grouse have been attributed to decreasing overall habitat and increasing fragmentation of remaining habitat (Oyler-McCance et al. 2001). The Gunnison sage grouse is currently a candidate under review for listing as threatened or endangered by the U.S. Fish and Wildlife Service. In 2000, the Gunnison sage grouse working group authored a conservation plan for the Piñon Mesa, Colorado population (BLM 2004, Appendix 4). This population of Gunnison's sage grouse has habitat along the south-eastern edge of MCNCA. Stemming from this plan, there have been several habitat treatments aimed at improving habitat in this area, by the BLM and other agencies and private land owners. For example, three areas near to the southern edge of Black Ridge Wilderness were seeded with native grasses and forbs in 2009 and 2010, and are currently being monitored determine the effectiveness of these treatments (Grant-Hoffman, unpublished data). In addition, GJFO is currently determining the extent of Gunnison sage grouse habitat in MNCNA and surrounding areas.

Desert bighorn sheep (*Ovis canadensis*) were extirpated from the Black Ridge Canyon Wilderness area prior to European settlement, but were reintroduced in the 1970's, 80's, and 90's. The Black Ridge desert bighorn sheep herd initially grew, but experienced population declines in the 1990's (BLM 2004, Appendix 4). In order to monitor this herd and get accurate estimates of populations and habitat use, 25 ewes and 6 rams were collared by the Colorado Department of Wildlife in 2008 and 2009. This study is being expanded in collaboration with Colorado State University.

Historically, kit foxes (*Vulpes macrotis*; listed as endangered by the State of Colorado) have been present within MCNCA (Grand Junction Field Office BLM Wildlife Biologist, personal communication). However, populations have declined and the current status of this species in western Colorado is uncertain. There is an ongoing study by the University of Colorado, Boulder together with the BLM and the Colorado Department of Wildlife to determine the status of this species as well as its habitat in Western Colorado. Kit Fox artificial dens and 'quick escapes' were installed by the BLM wildlife biologist in August 2004 and June 2005 to increase habitat suitability for kit foxes. Research is on-going as to the success of these efforts (Reed-Eckert 2010).

White-tailed prairie dogs (*Cynomys leucurus*) are found in many areas within MCNCA. Prairie dogs have been termed keystone species because of the influence they have on their surrounding environment and other animals (Kotliar et al. 1999). There are numerous threats to prairie dog populations including decreasing habitat and sylvatic plague (*Yersinia pestis*). Sylvatic plague can reduce prairie dog populations and extirpate prairie dog towns (e.g. Collinge et al 2005).

MCNCA is likely home to several bat species (Fitzgerald et al. 1994). Confirmed bat species are: Brazilian free-tailed bat, California myotis, Western small-footed myotis, long-eared myotis, little brown myotis, fringed myotis, long-legged myotis, Yuma myotis, spotted bat, pallid bat, big brown bat, silver-haired

bat, and Canyon bat (Dan Neubaum personal communication). Unconfirmed but species likely found within the NCA include: big free-tailed bat, Townsend's big-eared bat, and hoary bat, and possible Allen's big-eared bat (Dan Neubaum personal communication). Since 2006 a fungal infection, white-nosed syndrome, has been linked with high mortality rates of bats in the northeastern U.S. (Buchnen 2010). While this disease has not yet been reported in Colorado, it has been moving west (<http://www.fws.gov/whitenosesyndrome/#map>).

The Audubon Society named an Important Bird Area in 1999 within the Rabbit Valley Recreation Area. Data collected to support this nomination include: bird counts and bird ranges, the BLM Bald Eagle Survey (1978-1980), Mesa County Spring Bird Count (1979-1999), and personal observations by BLM staff (http://co.audubon.org/birdcon_iba.html).

Pollinators, including honeybees, are important members of the MCNCA wildlife community. However, both feral and managed honeybee populations have significantly dropped in recent years, 25% since 1990 (Allen-Wardell et al 1998). Declines may be due to several factors but likely include: introduced mites, pesticides, weather, and competing introduced bees (Allen-Wardell et al 1998). Information about other pollinators is lacking and many of these populations may also be in decline (Buchmann and Nabhan 1996). Decreases in pollinators can cause decreases in crop yields and native plant seed production. Within Mesa County agriculture, including fruit production and wineries are important industries. According to the Colorado State University extension office, there are over 1700 farms (over 370,000 acres of land) in Mesa county and over \$61,000,000 in agricultural products are sold from this county (Colorado State University Extension Office, <http://www.extension.colostate.edu/TR/>). Thus, maintaining healthy populations of pollinators is important for the local economies.

SOCIO-CULTURAL HERITAGE

MCNCA is home to significant cultural heritage. For example, McDonald Creek Cultural Resource Management Area is an area where rock art from Native American Fremont people who inhabited the area 1000 years ago can still be seen (BLM GJFO, unpublished data). Pack rat middens can also be found in MCNCA, but have not yet been closely cataloged or studied (BLM GJFO, unpublished data).

While many prehistoric and historic cultural sites have been identified within MCNCA (Hauck 2003), few have been extensively studied. These sites represent significant and irreplaceable components of our national heritage. In addition, some of these sites may be eligible for the National Register of Historic Places (Martin 2007). Due to increased recreation within the area, some of these sites may be experiencing increased impacts (Connor et al. 2007) and further research on these sites is needed.

PALEONTOLOGY AND GEOLOGY

MCNCA is rich in paleontological and geological resources, especially with fossils from the Jurassic period. One area in the unit, the Trail through Time, includes an active dinosaur quarry which is currently being excavated with many new discoveries (e.g. Foster and Hunt-Foster 2011). The Fruita Paleontological Area is another area rich in paleontological resources and has been described by Kirkland (2006) as "an excellent natural laboratory for the study of late Jurassic faunas, floras,

sedimentology, taphonomy, ecology, and climatology". The Split Rock Trail is also abundant in paleontological resources and has been cited in several articles for discoveries made there (Bray and Hirsch 1998, Hasiotis et al. 1998, Turner and Peterson 1999).

An example of geological research in MCNCA is a 2003-2004 collaborative study between several universities (Mesa State University, State University of New York – Geneseo, Mount Holyoke College, Bucknell University, College of William and Mary, Kansas State University), which considered the past climatic conditions of MCNCA's Sieber Canyon area. The researchers examined how these past climatic conditions may have influenced arroyo cutting in the Little Dolores River valley (Aslan 2004).

RECREATION

MCNCA supports a wide variety of recreational activities, including hiking, mountain biking, horseback-riding, river running, use of ATVs, etc. Within the four planning zones found within MCNCA are ten outcome-focused management zones², which vary based on physical, social, and administrative classes, and aim to provide different recreation experiences (e.g. more versus less primitive; BLM 2004). These outcome-focused management zones were studied in 1992-1993 and again in 2001-2002 by a group of researchers from Northern Arizona University to determine the recreation and community benefits of this approach to recreation. Both reports addressed recreation topics, such as visitor demographics, expectations, and satisfaction with their experience within MCNCA (Lee 2003).

Visitor-related research has also been conducted by Colorado Mesa University to better understand recreationists' desired setting and outcomes in MCNCA. These researchers helped to begin to identify recreation 'niche bundles' based on setting character and desired participant outcomes, versus the classic activity based groupings, which may not be as robust or accurate. This research aimed to better understand the public's expectations and impressions of the NLCS unit (Tim Casey unpublished data).

RECENT FIRE HISTORY

Three recent fires have occurred in MCNCA, all of which affect the MCNCA landscape. The restoration efforts that followed each fire, in addition to follow-up monitoring, allow researchers and BLM specialists to analyze the effectiveness of re-seeding techniques (BLM GJFO unpublished data).

- The 1999 Black Ridge / Wrigley fire burned over 3500 acres within the Black Ridge Wilderness as part of a larger complex of fires.
- The 2005 Mee Canyon Fire burned 58 acres near the Colorado River.
- The 2007 Knowles Canyon (human-caused) fire burned 91 acres burned, including approximately 300 cottonwood trees.

GLOBAL CLIMATE CHANGE

Global climate change is an underlying factor in any research or management decisions pertaining to MCNCA. The Colorado Plateau may be particularly susceptible to climate change as it sits at the ends of two moisture trajectories coming from opposite directions (systems arising from the Gulf of Alaska and

² These areas were formerly referred to as benefits-based management zones.

those from the Gulf of Mexico), as such this area can give important information about climate change (Schwinning et al. 2008).

ON-GOING MONITORING OF RESOURCES

In addition to the scientific investigations identified above, ongoing monitoring of resources is a large portion of the science conducted in MCNCA. Monitoring can be useful for determining: areas of resource decline, background information for scientific inquiries, early indicators of invasive weeds, stability of cultural and paleontological resources, effectiveness of management activities, and the identification of new concerns and needs for scientific research. Ongoing monitoring in MCNCA includes:

1. ECOLOGICAL SITE INVENTORIES

Ecological site inventories serve as baseline data for natural resource management and planning (BLM 2001). These inventories involve 'the use of soils information to map ecological sites and plant communities and the collection of natural resource and vegetation attributes (BLM 2001)'.

Ecological site inventories were completed in Ruby Canyon in 1993. The West Salt grazing allotment, located within Rabbit Valley in MCNCA was re-surveyed in summer 2010.

2. LAND HEALTH ASSESSMENTS

Land health assessments are completed periodically to determine if a particular area is 'meeting land health standards' or 'not meeting land health standards' based on vegetation, soil, wildlife and riparian characteristics. In addition, many BLM offices, including the Grand Junction field office, include a 'meeting with problems' category to identify areas that, while not severely degraded, have ecological issues that need to be addressed. Specific sampling methods vary by BLM office, areas identified as 'meeting with problems' or 'not meeting' land health standards are revisited more often than healthy landscapes. Within MCNCA, Land Health Assessments were completed in 2003 (BLM 2003). Several areas within MCNCA have been identified as areas not meeting land health standards. Many of these areas overlap with areas of high use, thus they are visible to the public and potentially have impacts from recreation use.

3. RANGELAND HEALTH MONITORING

In order to determine rangeland health and carrying capacity of grazing allotments, managers collect vegetation data, photo points, and measures of livestock utilization. Nested frequency plots are used to detect significant changes in dominant vegetation. Measurements are taken at time intervals dependent on the category of allotment, but time intervals range between 4 and 10 years.

4. PROPER FUNCTION CONDITION (PFC) ASSESSMENTS

Proper functioning condition assessments are used to determine the overall health of riparian and wetland areas. An interdisciplinary team samples lotic areas approximately every 5 years according to set guidelines (Prichard 1998) to determine if a riparian area is in 'proper functioning condition'. PFC sampling has not historically been linked to land health, but GJFO and MCNCA are moving towards linking the two monitoring approaches.

5. CAMPSITE DISTURBANCE MONITORING

The BLM began sampling campsites according a standard protocol in Fall 2008 (BLM 2008b). This protocol incorporates four areas of sampling: campsite monitoring, visitor satisfaction, visitor contacts, and camping signup.

6. MONITORING CONDUCTED BY VOLUNTEER STEWARDS

Volunteer stewards do yearly visits to several sites, including paleontological sites and areas of critical environmental concern. They complete a form with field observations which includes observations of wildlife, vegetation, human impacts, natural impacts, and management concerns. Relevant photographs are also taken. This information is then provided to the BLM.

7. SUPPLEMENTARY AND SPECIFIC MONITORING

Supplementary monitoring efforts to address specific concerns and management activities are conducted as needed. Due to limited funding, these types of studies must be concentrated on efforts that directly benefit the management goals of MCNCA, and where the information needed cannot be gleaned from other ongoing efforts.

8. MONITORING BY OTHER AGENICES

Wildlife and wildlife habitat within MCNCA is monitored by the Colorado Department of Parks and Wildlife, or the U.S. Fish and Wildlife service.

The BLM's assessment, inventory and monitoring (AIM) strategy for integrated renewable resources management seeks to provide more standardized monitoring across all BLM lands through the use of standardized protocols that concentrate on three key ecosystem attributes; soil/site stability, hydrologic function, and biotic integrity (BLM 2011). Data collected via the AIM Strategy protocols are statistically-sound and usable at multiple scales for multiple purposes. Pilot studies of this initiative are underway, but not within MCNCA. As BLM's AIM Strategy develops, every effort will be made to adopt MCNCA's data collection protocols.

SECTION 3 – IDENTIFICATION AND PRIORITIZATION OF MANAGEMENT QUESTIONS AND SCIENCE NEEDS

SCIENTIFIC NEEDS

The scientific needs of MCNCA are based on pressing management questions and continually change as management decisions are made and new concerns arise. Thus, the scientific needs will remain fluid and opportunities for research should remain open and inclusive. MCNCA's current science needs are listed in Table 2.

PRIORITIZATION

Science needs are prioritized to reflect the needs identified in the Resource Management Plan, needs identified by resource specialists, needs that reflect management and leadership concerns, as well as public concerns. These prioritizations can change based on changing conditions and are not meant to be steadfast or static.

Science needs are categorized as high, medium, or low priorities within topic areas (Table 2). These are pragmatic decisions: even low priority science needs are important.

TABLE 2. Prioritized science needs, by topic area

TOPIC AREA	PRIORITY	FOCUS AREA	QUESTIONS
Cross-cutting	High	Fauna and Flora	What is the full list of flora and fauna found within MCNCA?
		Land Health	There are several areas within MCNCA that do not meet Land Health Standards. What are the best treatments and/or restoration practices to move these lands toward meeting Land Health Standards?
		Climate Change	What are the predicted/realized effects of climate change on the resources of MCNCA? What are strategies to cope with climate change?
		Restoration	As restoration in dry climates can be difficult (Allen 1996), what are best management practices for restoring degraded dry lands in MCNCA and throughout the American West, and potentially globally?
Vegetation and invasive/Noxious Weeds	High	Tamarisk	How effective are biological controls at long term reduction and suppression of tamarisk?
			Are native species able to increase in cover in areas where biological controls have suppressed tamarisk?
			Does mechanical removal of tamarisk provide a significant increase in native species cover and survival?
			Can native plant species, and under what circumstances, recover from tamarisk invasion without active restoration?
			Does percent cover of other invasive or non-native species increase with tamarisk suppression?
			How are ecosystem processes effected by tamarisk suppression including: food webs (for example migratory bird diversity and abundance, insect diversity and abundance, native fish abundance and reproduction), evapotranspiration and water use, and nutrient cycling?
	Medium	Cheatgrass	What native species can compete with cheatgrass and under what circumstances (precipitation, time of seeding, mix of species, etc.)?
			Can inter-seeding native species with cheatgrass increase diversity and cover of native plants?
			Can removal of cheatgrass followed by seeding with native species increase native plant species diversity and cover?
			What seeded species, and under what circumstances (precipitation, time of fire and seeding, etc.), can prevent cheatgrass domination after fire?
			How are ecosystem process affected by cheatgrass invasion including; fire regimes, insect and animal diversity and abundance, soil nutrient cycling, soil crust

TOPIC AREA	PRIORITY	FOCUS AREA	QUESTIONS
Wildlife	Low	Russian knapweed	abundance, and soil microbial communities?
			What impacts do different soil amendments and different levels of soil disturbance have on cheatgrass/ native plant success?
			Do management activities, for example chemical or mechanical removal, significantly decrease the cover of Russian knapweed in the presence of the biological agent?
			What is the recovery, in terms of cover and diversity, of native plant species when Russian knapweed is suppressed or removed? What variables influence native plant recovery?
			Does active restoration of former Russian knapweed habitat significantly increase native plant diversity or density?
		Hoary cress	How well do native plant species recover after hoary cress removal?
			Is active restoration of hoary cress habitat necessary to increase native plant cover and diversity?
		Perennial pepperweed	What pepperweed removal methods are most effective in terms of long term removal, cost, and time?
			How well do native plant species recover after pepperweed removal?
			Is active restoration of pepperweed habitat necessary to increase native plant cover and diversity?
	High	Desert bighorn sheep	Are populations of desert bighorn sheep increasing, decreasing, or stable within MCNCA?
			What are the patterns of movement and habitat use exhibited by this herd?
			What are the main causes of mortality within this herd?
			Is habitat within MCNCA sufficient to sustain this herd?
		Gunnison sage grouse	Are Gunnison sage grouse present (and what numbers of sage grouse are present) within MCNCA?
			Have habitat treatments aimed at improving sage grouse habitat improved habitat by increasing native plant species diversity and abundance, and are Gunnison sage grouse utilizing these areas in increased numbers?
		Kit fox	What sage grouse life history stages are supported by habitat within MCNCA (for example breeding, nesting, brood rearing)?
			Are kit foxes still present within MCNCA?
		Kit fox	What are the main causes for mortality of kit foxes in MCNCA and western Colorado?
			What are the reproductive success rates for kit foxes within MCNCA and western Colorado?
			Is habitat sufficient to sustain kit fox populations within MCNCA and western Colorado?

TOPIC AREA	PRIORITY	FOCUS AREA	QUESTIONS
	Medium	Bats	Where are bat hibernacula in and around MCNCA?
			What are appropriate monitoring protocols for early detection of white-nosed syndrome?
			What are other stressors and trends in these bat populations?
		Audubon BA	Is the diversity of birds stable in this area?
			What migrant species are present?
			What year round residents are present?
			What species use the area for breeding and brood rearing?
			Can MNCA birds serve as an indicator of the general health of MCNCA habitats (Carignan and Villard 2002)?
		Pollinators	How important are wild pollinators to agriculture in MCNCA, especially considering the close proximity of agriculture to this protected area?
			Are populations of pollinators increasing or decreasing in MCNCA?
			What factors are contributing to pollinator population fluctuations in MCNCA, for example parasites, disease, pesticide use, etc.?
	Low	Burrowing owl	What common plants are 'pollinator friendly' and are they included in common seed mixes?
			What are appropriate long term monitoring strategies for pollinators within MCNCA?
			How many burrowing owls are present within MCNCA and where are they present?
		Canyon tree frogs	What are nestling survival rates? What factors limit nestling survival?
			Due to the use of active prairie dog burrows for breeding, burrowing owl populations decline with declining prairie dog populations (Desmond, Savidge et al. 2000). How able are burrowing owls to locate active prairie dog towns? How burrowing owl populations react to fluctuating prairie dog populations?
			What is the density of canyon tree frogs within MCNCA and where are they present?
		Long nosed leopard lizard	What is the life history/population dynamics of canyon tree frogs? E.g. What are the reproductive and death rates, and what limits these rates?
			What are habitat requirements for canyon tree frogs?
			What is the density of long nosed leopard lizards within MCNCA?
		White tailed prairie dog	What is the life history/population dynamics of long nosed leopard lizards? E.g. What are the reproductive and death rates, and what limits these rates?
			What are habitat requirements for long nosed leopard lizards?
			Where within MCNCA where are active and in-active prairie dog towns found?
			Are towns being impacted by plague?
			What are the death and re-colonization rates of prairie dog towns in MCNCA and what drives these rates?
			What other factors drive prairie dog population fluctuations in this area?
			What are the dynamics of plague and the population fluctuations of prairie dogs in the presence of plague?

TOPIC AREA	PRIORITY	FOCUS AREA	QUESTIONS
Socio-Cultural Heritage	Medium	Socio-cultural, general	What is the full list of MCNCA socio-cultural heritage sites? Where are important areas for archeological excavation?
			What can MCNCA's socio-cultural heritage sites tell us about past climatic and cultural changes, and movement of historical peoples? This type of information can be invaluable as we are facing potentially rapid climate changes.
			What are the locations of past Ute trails?
			What is ethno-history of the MCNCA area including but not limited to Native Americans and early settlers/homesteaders?
Paleontology	Medium	Paleontology, general	What can pack rat middens in MCNCA tell us about historical vegetation and ecosystem conditions (Cole 1986)?
			What is the full list of fossil fauna and flora found within MCNCA?
			What can fossil biota tell us about paleo-environments at MCNCA? Can information about these paleo-environments and their changes help predict effects of local and global climate change and thus inform modern management of BLM lands?
			What are potential gains, and how can these gains be quantified, from further prospecting and excavation at certain areas including: Mygatt-Moore quarry, Fruita Paleontological Area, and cliffs and fall blocks in canyon areas?
Recreation	Medium	Recreation, general	How can paleontology research efforts over potentially large geographic areas be prioritized to concentrate limited resources in areas most likely to produce scientifically significant results?
			How are the targeted beneficial outcomes for users, households/communities, the economy, and the environment, which are identified in the MCNCA plan, realized and how do we measure our success in meeting these outcomes?
			What are the negative outcomes of recreational use of MCNCA and how can we analyze, both qualitatively and quantitatively, these outcomes to be avoided?
			How do we engage essential services providers and other non-participants in a way that informs management of desired outcomes of affected communities? Key service providers and non-participants have been identified.
			What relationships underpin recreation 'niche bundles'?

SECTION 4 – MEETING SCIENCE NEEDS

INTERNAL ORGANIZATION

Internal organization is necessary to strategically identify and address science in MCNCA. A science coordinator has been established in MCNCA to coordinate all scientific efforts in the unit. The NCA ecologist will serve as the science coordinator, and will coordinate with appropriate specialists as needed to address science within MCNCA³.

The role of the coordination team is to:

- 1) Coordinate and collaborate to identify and prioritize MCNCA's science needs;
- 2) Ensure that partners and collaborators are familiar and engaged with MCNCA's documented science needs;
- 3) Coordinate with staff to approve science proposals;
- 4) Engage and remain engaged with partners and collaborators working within MCNCA;
- 5) Ensure that results of scientific inquiries are available to BLM staff, in appropriate formats, including progress and final reports;
- 6) Communicate results of scientific inquiries to researchers, staff, and managers both within and outside of the BLM, and to the general public when appropriate; and,
- 7) As necessary, coordinate and collaborate to update and revise the MCNCA science plan.

Additionally, the science coordinator will:

- 8) Conduct needed monitoring and scientific inquiries, as time permits, within MCNCA;
- 9) Interpret long term data and periodically publish results; and,
- 10) Serve as the contact person for scientific inquiries within MNCNA.

COLLABORATION AND PARTNERS

It is imperative that MCNCA have good working relationships with a variety of partners that can assist in the diverse scientific needs of MCNCA. As scientific study is often not part of the work that BLM field staff performs, partnering with numerous outside entities can greatly increase the BLM's ability to use science to improve management decisions and actions.

Furthermore, collaboration between BLM offices and with other government agencies, universities, and science partners can ensure that all parties have a clear and common understanding of management needs. This type of collaboration can aid in the sharing of information, which can help to save time and resources by reducing duplicative effort, and can help to improve outcomes on broad scales by addressing common problems with common solutions.

As management questions and needs are not bound by jurisdictional boundaries, the success of management efforts in one geographical area will often be dependent on management efforts in

³ Internal organization will be different for each unit. The duties of the science coordinator may be assigned to a single person as a collateral duty, several people may serve on a 'coordination team', or an interdisciplinary team may be assigned.

another area. Regular conversations, inter-agency work groups, and attendance at regional and national meetings (e.g. the Colorado Plateau Cooperative Ecosystem Studies Unit (CPCESU) meetings, and the Colorado Plateau Biennial Science Conference) can help foster these relationships and collaborative opportunities.

There are numerous potential partners for scientific study within MCNCA, some current partners include: Colorado Canyons Association, Audubon Society, Tamarisk Coalition, Colorado Mesa University, Colorado State University, Museum of Western Colorado, and Chicago Botanic Garden.

When appropriate, MCNCA will coordinate research needs through the Cooperative Ecosystem Study Unit (CESU) network (<http://cesu.org>).

SECTION 5 – SCIENCE PROTOCOLS

SCIENCE GUIDELINES

It is anticipated that three main types of science are likely to occur within MCNCA:

- 1) Assessment, inventory, and monitoring;
- 2) Solicited science addressing management questions/science needs; and,
- 3) Unsolicited contributed scientific studies.

There are numerous topics of research that may be addressed by these three types of inquiries including but not limited to: botany, ecology, wildlife studies, anthropology (including archaeology), paleontology, and recreation studies.

General guidelines that apply to all of types of science in MCNCA include:

- 1) All scientific investigation must comply with relevant laws and regulations.
- 2) All non-permitted external scientific investigations must be authorized, according to the procedures described below.
 - a. The final decision for granting authorization will be the MCNCA manager.
- 3) Science should not impact the long term health or sustainability of the resources of MCNCA, especially the values for which MCNCA was designated.
 - a. If impacts are anticipated, appropriate government protocols should be followed and the potential gains should be carefully considered and weighed against potential impacts.
- 4) A balance must be maintained between research and education, and preservation and protection of MCNCA resources.
- 5) Scientists initiating research projects within MCNCA should be aware of existing data within the BLM and should incorporate these data into projects whenever possible.
- 6) Proposed research within the Black Ridge Wilderness Area should comply with appropriate laws and regulations including the Wilderness Act of 1964 and BLM wilderness policy (Manual 6340)
 - a. Proposals must be carefully evaluated for legal and policy compliance, scientific merit, and impacts and benefits (Landres 2000). A set of worksheets may be used to ensure that scientific proposals are evaluated in a consistent way and should be completed for each scientific proposal considered within the wilderness area (found here: http://www.wilderness.net/index.cfm?fuse_toolboxes&sec_resSciAct).
- 7) MCNCA staff should use all available monitoring protocols to achieve adequate monitoring of the resources of MCNCA (e.g. land health assessments), especially with consideration to the national Assessment, Inventory, and Monitoring Strategy (AIM; BLM 2011).
 - a. For example, sampling techniques and consideration of the three identified key ecosystem attributes; soil/site stability, hydrologic function, and biological integrity (BLM 2011).

SCIENCE AUTHORIZATIONS

Currently, there is no formal process for scientific authorizations with MCNCA outside of the state-wide process for permitting paleontological and archaeological research. The process described below is not meant to replace or duplicate these processes. When a prior process is already in place, it will take precedence and researchers will only need to complete one permitting process. The process outlined below will only take affect when no other permitting process applies. However, permits and authorizations will be shared between appropriate state and field office staff for research taking place within MCNCA.

All requests should be carefully considered, weighing potential benefits and costs. The following process has been adapted from other NLCS units.

1. Scientist submits proposal to MCNCA science coordinator.
 - a. Proposals must include:
 - i. Contact information for the principal investigator
 - ii. Summary of proposed research (not to exceed 3 pages) including
 1. A brief explanation of background information;
 2. Rationale for research;
 3. Research methods;
 4. Timeline for field work; and,
 5. Outline of public outreach effort, if appropriate.
2. The proposal will be considered by the MCNCA science coordinator for completeness. The coordinator will consult with staff specialists, as appropriate ,to determine if the proposal is:
 - a. Complete;
 - b. Conforms to the MCNCA Science Guidelines (including all relevant laws and regulations);
 - c. Conforms to the MCNCA Resource Management Plan;
 - d. Meets the MCNCA scientific mission.
3. The science coordinator will brief the MCNCA manager on the review of the science proposal. Subsequently, the MCNCA manager (or the manager's designee) will grant or deny authorization to conduct the scientific investigation.
4. If a proposal is denied authorization:
 - a. A letter of denial will be provided to the scientist, and will include justification for the denial.
5. If a proposal is granted authorization:
 - a. A determination will be made as to what, if any, NEPA analysis is necessary.
 - b. A letter of authorization will be provided to the scientist, signed by the MCNCA manager (or the manager's designee). The authorization may include stipulations such as NEPA analysis requirements, time limits, geographic limits, reporting requirements, and public outreach requirements.
 - c. The proposal will be added to an internal tracking document of on-going scientific investigations in MCNCA, accessible by all MCNCA staff.
 - d. Reporting requirements for all scientific investigations will require:

- i. Progress reports (at least annually), filed with the science coordinator;
 - 1. Progress reports should include status of the investigation and preliminary findings when possible.
 - ii. Final reports, filed with the science coordinator;
 - 1. Final report should include:
 - a. Research background and results;
 - b. Discussion of the results including how the results are relevant to the NLCS unit and potential management decisions;
 - c. A summary of the public outreach effort if appropriate;
 - d. Raw data where appropriate; and,
 - e. Electronic copies of any published papers resulting from the scientific investigation.
 - iii. Manager's summary report
 - 1. Manager's summary reports are brief presentations (in any appropriate format) of research results to BLM managers, which ensure that:
 - a. Management questions are answered;
 - b. Managers have a full understanding of scientific findings; and,
 - c. Managers can incorporate these findings into their management decisions.
 - iv. If results of research are not sensitive material (for example some cultural and paleontological studies), a public outreach component.
- 6. The authorization is routed to MCNCA and GJFO staff.
 - a. Copies of the authorization will be made available to BLM staff, for example on the shared drive.
 - b. Short descriptions of ongoing research will be made available to the general public, for example on the MCNCA webpage.
 - i. Sensitive topics, for example location of specific cultural or paleontological sites, should be excluded from public information for protection of resources.
- 7. Research is initiated.
 - a. Research must be conducted according to the stipulations outlined in the authorization.
- 8. Research is completed, and final report is filed with the science coordinator.

SECTION 6 – ORGANIZATION AND COMMUNICATION OF COMPLETED SCIENCE

INTERNAL ORGANIZATION OF COMPLETED SCIENCE

Section 2 of this report provides a brief summary of the scientific background of the unit, and provides citations to the relevant reports in the bibliography (Section 9) of this science plan. At every revision of the science plan, these sections will be updated.

All reports, as described in Section 5, submitted to the MCNCA science coordinator will be stored and organized on a shared drive, or via a similar medium (e.g. a Sharepoint site), accessible by all MCNCA staff. The science coordinator should aim to organize periodic presentations of scientific results to MCNCA staff.

CONTRIBUTIONS TO BROADER BLM ORGANIZATIONS OF COMPLETED SCIENCE

The MCNCA science coordinator will comply, in a timely manner, with all requests for completed scientific investigations' information/reports from BLM Field Offices, District Offices, State Offices, and Washington D.C. Office.

COMMUNICATING SCIENTIFIC RESULTS TO THE PUBLIC

The science coordinator will strive to make information on science projects within MCNCA accessible to the general public, and the MCNCA webpage is a logical place for dissemination of this type of information. The format to present material may include but is not limited to: links to short informational videos or written descriptions of scientific inquiries occurring within MCNCA, public presentations, and citations of published research papers.

One innovative avenue for communicating science to the public is to show interested individuals the scientific process, first-hand. MCNCA manages the hiking trail, Trail through Time, which includes passing through an active dinosaur research quarry. This type of first-hand view of active research is sometimes the most effective means to share information, and should be encouraged throughout the unit.

The general public has a vested interest in MCNCA which is heavily utilized by varied outdoor enthusiasts. Thus, sharing what research is occurring (or has occurred) within MCNCA and why it is occurring (or has occurred) should be a priority, and can help avoid confusion and discontent that can stem from misunderstandings about the nature of scientific inquiries. However, while communication with the public is important, sensitive information about certain scientific projects may need to be kept confidential to ensure the protection of these resources.

SECTION 7 – INTEGRATING SCIENCE INTO MANAGEMENT

INTEGRATING SCIENTIFIC FINDINGS INTO MANAGEMENT DECISIONS

It is the responsibility of the science coordinator to ensure that scientific findings are communicated to managers. Managers can then use scientific information as they deem appropriate.

Written progress reports, final reports, published papers, and manager’s summary will all be available to decision-makers, as described in Section 6, to help inform decisions. Furthermore, direct dialogue between scientists and managers will be encouraged.

SECTION 8 – SCIENCE PLAN REVIEW AND APPROVAL

SIGNATURE PAGE

I approve the McInnis Canyons National Conservation Area Science Plan.

This plan will be used as the basis for conducting science in the McInnis Canyons NCA and Black Ridge Canyons Wilderness. “Science” is defined in Section 1 of this plan.

As a living and working document, this plan will be updated no less than every five years, preferably more frequently. Scientific needs that emerge during the course of implementing this plan may be added to the plan on an as-needed basis to meet the unit’s scientific mission.

Madeline N. Grant-Hoffman, Science Coordinator McInnis Canyons National Conservation Area	Date
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Katie A. Stevens, NCA Manager McInnis Canyons National Conservation Area	Date
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Marcia H. deChadenedes, Colorado NLCS Lead Colorado State Office	Date
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Matthew Preston NLCS Science Coordinator Washington, D.C.	Date
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SECTION 9 – BIBLIOGRAPHY

RESEARCH IN MCNCA

- Aslan A (2004) Alluvial history and geoarchaeology of Sieber Canyon, McInnis Canyons National Conservation Area, Mesa County, Colorado. BLM report.
- Ballard R, R Ott, T Novotny, A Lincoln, E Rechel (In prep) Examining different procedures for transplanting the cactus *Sclerocactus parviflorus* (Benson) (fishhook cactus)
- BLM (2003) Land Health Assessment for the Colorado Canyons National Conservation Area. U.S. Department of the Interior, BLM, Grand Junction field office, CO.
- BLM (2004) Resource management plan and record of decision for the Colorado Canyons National conservation Area and Black Ridge Canyons Wilderness. U.S. Department of the Interior, Bureau of Land Management, Grand Junction Field Office, CO.
- Bray E and K Hirsch (1998) 6.Tetrapods, trackways and history-eggshell from the Upper Jurassic Morrison Formation. *Modern Geology* 23(1): 219-240.
- Conner CL, N Darnell, R Ott, B Davenport (2007) Report of an archaeological assessment of the twenty-five prehistoric sites within McInnis Canyons National Conservation Area in Mesa County, Colorado, BLM Project No. 15807-01, Dominguez Archaeological Research Group, Inc.
- Distel S, Sebring D, Veety C (2008) Opal Hill trail and disturbance restoration. Department of Environmental Science, Mesa State College, 26 p.
- Foster JR, RK Foster (2011) New occurrences of dinosaur skin of two types (Sauropoda? and Dinosauria indet.) from the Late Jurassic of North America (Mygatt-Moore Quarry, Morrison Formation). *Journal of Vertebrate Paleontology*. 31: 717-721.
- Hasiotis S, J Kirkland, G Callison (1998) Crayfish fossils and burrows from the Upper Jurassic Morrison Formation of western Colorado. *Modern Geology* 22: 481–491.
- Hauck FR (2003) GIS analysis of cultural resources in the Colorado Canyons National Conservation Area and Colorado National Monument in Mesa County, Western Colorado; A class 1 overview. Archeological Research Institute, Bountiful, Utah. General Studies series No. 7, Federal ID. No. 1422 C950A70016(M06).
- Kirkland J (2006) Fruita Paleontological Area (Upper Jurassic, Morrison Formation), western Colorado: an example of terrestrial taphofacies analysis. In: JR Foter and SG Lucas (Eds) *Paleontology and Geology of the Upper Jurassic Morrison Formation*, New Mexico Museum of Natural History & Science, Bulletin 36: 67–95.
- Klute D, LW Ayers, MT Green, WH Howe, SL Jones, JA Shaffer, SR Sheffield, TS Zimmerman (2003) Status assessment and conservation plan for the Western Burrowing Owl in the United States. Bio Tech Pub FWS/BTP-R6001-2003, Washington: US Fish and Wildlife Service (<http://mountain-prairie.fws.gov/birds>).
- Kotliar NB, BW Baker, AD Whicker, G Plumb (1999) A critical review of assumptions about prairie dogs as a keystone species. *Environmental Management* 24: 177-192.
- Lee M, A Stephens, K Fuller (2003) Colorado Canyons National Conservation Area user study, Final Report. Prepared for the Bureau of Land Management by School of Forestry, Northern Arizona University, Flagstaff AZ.

- Martin C (2007) A class II aboriginal wooden reasure inventory of two parcels in the Black Ridge area of McInnis Canyons National Conservation Area in mesa County, Colorado. Dominquez Archaeological Research Group, Grand Junction, CO. DARG Project No. D2704.
- McCoy C (1967) Natural history notes on *Crotaphytus wislizeni* (Reptilia: Iguanidae) in Colorado. American Midland Naturalist 77: 138-146.
- Reed-Eckert ML (2010) Teetering on the edge of suitable climate: Kit fox (*Vulpes macrotis*) range limit dynamics in east-central Utah and west-central Colorado, 1983-2009. Masters Thesis, University of Colorado, Boulder.
- Stevens J (2004) Biological Inventory of the Colorado Canyons National Conservation Area. Colorado Natural Heritage Program Report, Colorado State University.
- Turner C and F Peterson (1999) Biostratigraphy of dinosaurs in the Upper Jurassic Morrison Formation of the western interior, USA. Vertebrate paleontology in Utah: 77–114.

GENERAL BIBLIOGRAPHY

- Allen EB (1996) Restoration ecology: limits in arid and semiarid lands. In: Roundy BA, ED McArthur, JS Hayley, DK Mann. Proceedings: Wildland shrub and arid land restoration symposium, Las Vegas, NV, October 1993. Intermountain Research Station, Forest Service, U.S. Department of Agriculture, pgs. 7-15.
- Allen-Wardell G, P Bernhardt, R Bitner, A Burquez, S Buchmann, J Cane, P Allen, V Dalton, P Feinsinger, M Ingram, D Inouye, CE Jones, K Kennedy, P Kevan, H Koopowitz, R Medellin, S Medellin-Morales, GP Nabhan, B Pavlik, V Tepedino, P Torchio, S Walker (1999) The potential consequences of pollinator declines on the conservation of biodiversity and stability of food crop yields. Conservation Biology 12: 8-17.
- Armstrong DM, JP Fitzgerald, CA Meaney, (2011) Mammals of Colorado, 2nd Edition. Denver Museum of Nature and Science and University Press of Colorado, Boulder, CO.
- Belnap J, JS Gardner (1993) Soil microstructure in soils of the Colorado Plateau: The role of the cyanobacterium *Microcoleus vaginatus*. Great Basin Naturalist 53: 40-47.
- Belnap J, SL Phillips (2001) Soil Biota in an ungrazed grassland: response to annual grass (*Bromus, Tectorum*) invasion. Ecological Applications 11; 1261-1275.
- BLM (2001) Inventory and Monitoring Technical Reference 1734-7 – Ecological Site Inventory. U.S. Department of the Interior, Bureau of Land Management.
- BLM (2007) Bureau of Land Management National Landscape Conservation System Science Strategy. U.S. Department of the Interior, Bureau of Land Management, National Landscape Conservation System office, Washington D.C.
- BLM (2008a) Bureau of Land Management Science Strategy. U.S. Department of the Interior, Bureau of Land Management, Printed Materials Services, Denver, CO.
- BLM (2008b) McInnis Canyons National Conservation Area: River Monitoring Plan, Version 1: November 2008.
- BLM (2011) Assessment, Inventory, and Monitoring Strategy for integrated and renewable resources management. U.S. Department of the Interior, Bureau of Land Management. Washington, D.C.
- Blossey B, L Skinner, J Taylor (2001) Impact and management of purple loosestrife (*Lythrum salicaria*) in North America. Biodiversity and Conservation 10: 1787-1807.

- Bray, E. and K. Hirsch (1998) 6. Continued. Tetrapods, trackways and history-eggshell from the upper jurassic morrison formation. *Modern Geology* 23(1): 219-240.
- Buchmann SL, GP Nabhan (1996) *The forgotten pollinators*. Island Press, Washington D.C.
- Carignan V, MA Villard (2002) Selecting indicator species to monitor ecological integrity: a review. *Environmental monitoring and assessment* 78: 45-61.
- Chambers JC, BA Roundy, RR Blank, SE Meyer, A Whittaker (2007) What makes Great Basin sagebrush ecosystems invisable by *Broums tectorum*? *Ecological Monographs* 77: 117-145.
- Cole K (1986) The lower Colorado River Valley: A Pleistocene desert. *Quaternary Research* 25(3): 392-400.
- Collinge SK, WC Johnson, C Ray, R Matchett, J Grensten, JF Cully Jr, KL Gage, MY Kosoy, JE Loye, AP Martin (2005) Landscape structure and plague occurrence in black-tailed prairie dogs on grasslands of the Western USA. *Landscape Ecology* 201: 941-955.
- Desmond, M., J. Savidge, et al. (2000). "Correlations between burrowing owl and black-tailed prairie dog declines: a 7-year analysis." *The Journal of Wildlife Management* 64(4): 1067-1075.
- Di Tomaso JM (1998) Impact, Biology, and Ecology of Saltcedar (*Tamarix* spp.) in the Southwestern United States. *Weed Science* 12: 326-336.
- Gallant, A.L., T.R. Whittier, D.P. Larsen, J.M. Omernik, and R.M. Hughes. 1989. Regionalization as a tool for managing environmental resources. EPA/600/3-89/060. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR. 152 p.
- Getz HL, WL Baker (2008) Initial invasion of cheatgrass (*Bromus tectorum*) into burned pinon-juniper woodlands in western Colorado. *American Midland Naturalist* 159: 489-497.
- Jacobs J (2007) Ecology and management of Whitetop (*Cardaria draba* (L.) Desv.). United States Department of Agriculture Natural Resources Conservation Service: Invasive Species Technical Note, No. MT 12.
- Jacobs J (2008) Ecology and management of Purple Loosestrife (*Lythrum salicaria* L.) United States Department of Agriculture Natural Resources Conservation Service: Invasive Species Technical Note, No. MT-21: 1-9.
- Katz G and P Shafroth (2003) Biology, ecology and management of *Elaeagnus angustifolia* L.(Russian olive) in western North America. *Wetlands* 23(4): 763-777.
- Landres P, Editor (2010) A framework to evaluate proposals for scientific activities in wilderness. Gen. Tech. Rep. RMRS-GTR-234WWW. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 74 p.
- Maddox DM, A Mayfield, NH Poritz (1985) Distribution of Yellow Starthistle (*Centaurea solstitialis*) and Russian Knapweed (*Acroptilon repens*) *Weed Science* 33: 315-327.
- Oyler-McCance SJ, KP Burnam, CE Braun (2001) Influence of changes in sagebrush on Gunnison sage grouse in Southwestern Colorado. *The Southwestern Naturalist* 46: 323-331.
- Pellant M (1996) Cheatgrass: The Invader that won the west. Interior Columbian Basin Ecosystem Management Project. Bureau of Land Management, Idaho.
- Prichard D (1998) Riparian area management: A user guide to assessing proper functioning condition and the supporting science for lotic areas. US Department of the Interior, Bureau of Land Management. Technical Reference 1737-15.

- Renz MJ, RR Blank (2004) Influence of perennial pepperweed (*Lepidium latifolium*) biology and plant-soil relationships on management and restoration. *Weed Technology* 18: 1359-1363.
- Schwinning S, J Belnap, DR Bownling, JR Ehleringer (2008) Sensitivity of the Colorado plateau ot chane: climate, ecosystems and society. *Ecology and Society*
(<http://www.ecologyandsociety.org/volXX/issYY/artZZ>).
- Walters CJ, CS Holling (1990) Large-scale management experiments and learning by doing. *Ecology* 71: 2060-2068.
- Young JA, DE Palmquist, RR Blank (1998) The ecology and control of perennial pepperweed (*Lepidium latifolium* L.). *Weed Technology* 12:402-405.

SECTION 10 - UNIT'S LEGISLATION: COLORADO CANYONS NATIONAL CONSERVATION AREA AND BLACK RIDGE CANYONS WILDERNESS ACT OF 2000

POUR EN SAVOIR PLUS, CONTACTEZ-NOUS

[illegible]

1. The Commission has the honor to acknowledge the receipt of your letter of the 11th of June 1901, in which you inform us that you have been appointed to the position of Vice-President of the American Society of International Law, and that you have been elected to the position of President of the American Society of International Law for the year 1902.

Following are the different views of oil companies regarding the subject:

[illegible]

1993-1994, 1995-1996, 1997-1998, 1999-2000, 2001-2002, 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2012, 2013-2014, 2015-2016, 2017-2018, 2019-2020, 2021-2022, 2023-2024, 2025-2026, 2027-2028, 2029-2030, 2031-2032, 2033-2034, 2035-2036, 2037-2038, 2039-2040, 2041-2042, 2043-2044, 2045-2046, 2047-2048, 2049-2050, 2051-2052, 2053-2054, 2055-2056, 2057-2058, 2059-2060, 2061-2062, 2063-2064, 2065-2066, 2067-2068, 2069-2070, 2071-2072, 2073-2074, 2075-2076, 2077-2078, 2079-2080, 2081-2082, 2083-2084, 2085-2086, 2087-2088, 2089-2090, 2091-2092, 2093-2094, 2095-2096, 2097-2098, 2099-2100, 2101-2102, 2103-2104, 2105-2106, 2107-2108, 2109-2110, 2111-2112, 2113-2114, 2115-2116, 2117-2118, 2119-2120, 2121-2122, 2123-2124, 2125-2126, 2127-2128, 2129-2130, 2131-2132, 2133-2134, 2135-2136, 2137-2138, 2139-2140, 2141-2142, 2143-2144, 2145-2146, 2147-2148, 2149-2150, 2151-2152, 2153-2154, 2155-2156, 2157-2158, 2159-2160, 2161-2162, 2163-2164, 2165-2166, 2167-2168, 2169-2170, 2171-2172, 2173-2174, 2175-2176, 2177-2178, 2179-2180, 2181-2182, 2183-2184, 2185-2186, 2187-2188, 2189-2190, 2191-2192, 2193-2194, 2195-2196, 2197-2198, 2199-2200, 2201-2202, 2203-2204, 2205-2206, 2207-2208, 2209-2210, 2211-2212, 2213-2214, 2215-2216, 2217-2218, 2219-2220, 2221-2222, 2223-2224, 2225-2226, 2227-2228, 2229-2230, 2231-2232, 2233-2234, 2235-2236, 2237-2238, 2239-2240, 2241-2242, 2243-2244, 2245-2246, 2247-2248, 2249-2250, 2251-2252, 2253-2254, 2255-2256, 2257-2258, 2259-2260, 2261-2262, 2263-2264, 2265-2266, 2267-2268, 2269-2270, 2271-2272, 2273-2274, 2275-2276, 2277-2278, 2279-2280, 2281-2282, 2283-2284, 2285-2286, 2287-2288, 2289-2290, 2291-2292, 2293-2294, 2295-2296, 2297-2298, 2299-2300, 2301-2302, 2303-2304, 2305-2306, 2307-2308, 2309-2310, 2311-2312, 2313-2314, 2315-2316, 2317-2318, 2319-2320, 2321-2322, 2323-2324, 2325-2326, 2327-2328, 2329-2330, 2331-2332, 2333-2334, 2335-2336, 2337-2338, 2339-2340, 2341-2342, 2343-2344, 2345-2346, 2347-2348, 2349-2350, 2351-2352, 2353-2354, 2355-2356, 2357-2358, 2359-2360, 2361-2362, 2363-2364, 2365-2366, 2367-2368, 2369-2370, 2371-2372, 2373-2374, 2375-2376, 2377-2378, 2379-2380, 2381-2382, 2383-2384, 2385-2386, 2387-2388, 2389-2390, 2391-2392, 2393-2394, 2395-2396, 2397-2398, 2399-2400, 2401-2402, 2403-2404, 2405-2406, 2407-2408, 2409-2410, 2411-2412, 2413-2414, 2415-2416, 2417-2418, 2419-2420, 2421-2422, 2423-2424, 2425-2426, 2427-2428, 2429-2430, 2431-2432, 2433-2434, 2435-2436, 2437-2438, 2439-2440, 2441-2442, 2443-2444, 2445-2446, 2447-2448, 2449-2450, 2451-2452, 2453-2454, 2455-2456, 2457-2458, 2459-2460, 2461-2462, 2463-2464, 2465-2466, 2467-2468, 2469-2470, 2471-2472, 2473-2474, 2475-2476, 2477-2478, 2479-2480, 2481-2482, 2483-2484, 2485-2486, 2487-2488, 2489-2490, 2491-2492, 2493-2494, 2495-2496, 2497-2498, 2499-2500, 2501-2502, 2503-2504, 2505-2506, 2507-2508, 2509-2510, 2511-2512, 2513-2514, 2515-2516, 2517-2518, 2519-2520, 2521-2522, 2523-2524, 2525-2526, 2527-2528, 2529-2530, 2531-2532, 2533-2534, 2535-2536, 2537-2538, 2539-2540, 2541-2542, 2543-2544, 2545-2546, 2547-2548, 2549-2550, 2551-2552, 2553-2554, 2555-2556, 2557-2558, 2559-2560, 2561-2562, 2563-2564, 2565-2566, 2567-2568, 2569-2570, 2571-2572, 2573-2574, 2575-2576, 2577-2578, 2579-2580, 2581-2582, 2583-2584, 2585-2586, 2587-2588, 2589-2590, 2591-2592, 2593-2594, 2595-2596, 2597-2598, 2599-2600, 2601-2602, 2603-2604, 2605-2606, 2607-2608, 2609-2610, 2611-2612, 2613-2614, 2615-2616, 2617-2618, 2619-2620, 2621-2622, 2623-2624, 2625-2626, 2627-2628, 2629-2630, 2631-2632, 2633-2634, 2635-2636, 2637-2638, 2639-2640, 2641-2642, 2643-2644, 2645-2646, 2647-2648, 2649-2650, 2651-2652, 2653-2654, 2655-2656, 2657-2658, 2659-2660, 2661-2662, 2663-2664, 2665-2666, 2667-2668, 2669-2670, 2671-2672, 2673-2674, 2675-2676, 2677-2678, 2679-2680, 2681-2682, 2683-2684, 2685-2686, 2687-2688, 2689-2690, 2691-2692, 2693-2694, 2695-2696, 2697-2698, 2699-2700, 2701-2702, 2703-2704, 2705-2706, 2707-2708, 2709-2710, 2711-2712, 2713-2714, 2715-2716, 2717-2718, 2719-2720, 2721-2722, 2723-2724, 2725-2726, 2727-2728, 2729-2730, 2731-2732, 2733-2734, 2735-2736, 27

[illegible]

1) *Prove that $\forall x \in \mathbb{N}$ there exists $y \in \mathbb{N}$ such that $x + y = 1$. (Total 11 marks)*
 2) *Prove that $\forall x \in \mathbb{N}$ there exists $y \in \mathbb{N}$ such that $x + y = 1$. (Total 11 marks)*
 3) *Prove that $\forall x \in \mathbb{N}$ there exists $y \in \mathbb{N}$ such that $x + y = 1$. (Total 11 marks)*
 4) *Prove that $\forall x \in \mathbb{N}$ there exists $y \in \mathbb{N}$ such that $x + y = 1$. (Total 11 marks)*
 5) *Prove that $\forall x \in \mathbb{N}$ there exists $y \in \mathbb{N}$ such that $x + y = 1$. (Total 11 marks)*
 6) *Prove that $\forall x \in \mathbb{N}$ there exists $y \in \mathbb{N}$ such that $x + y = 1$. (Total 11 marks)*
 7) *Prove that $\forall x \in \mathbb{N}$ there exists $y \in \mathbb{N}$ such that $x + y = 1$. (Total 11 marks)*
 8) *Prove that $\forall x \in \mathbb{N}$ there exists $y \in \mathbb{N}$ such that $x + y = 1$. (Total 11 marks)*
 9) *Prove that $\forall x \in \mathbb{N}$ there exists $y \in \mathbb{N}$ such that $x + y = 1$. (Total 11 marks)*
 10) *Prove that $\forall x \in \mathbb{N}$ there exists $y \in \mathbb{N}$ such that $x + y = 1$. (Total 11 marks)*

(U) This information does not contain information that is exempt from public release under E.O. 13526, therefore, it is being released to the public without redaction.

1. The following information is provided for the year ended 31 December 2014 in the
 2. Which is the only one of the following that is not a valid reason for the company to
 3. The following information is provided for the year ended 31 December 2014 in the
 4. The following information is provided for the year ended 31 December 2014 in the
 5. The following information is provided for the year ended 31 December 2014 in the
 6. The following information is provided for the year ended 31 December 2014 in the
 7. The following information is provided for the year ended 31 December 2014 in the
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15. _____

DISCUSSION

Received 15 November 2005; accepted 15 November 2005
Published online 12 December 2005 in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/anie.200525901

(2) **Personnel.**—The rules governing personnel shall:

[illegible][illegible][illegible]

(U) The Secretary shall provide the following information to the President:

[illegible][illegible][illegible]

Wiederholungsfragen sind in der Regel mit einem Sternchen (*) gekennzeichnet. Diese Fragen sind in der Regel wichtiger als die anderen Fragen und sollten daher besonders beachtet werden.

of the *Leptocarpus* spores was not detected. The *Leptocarpus* spores, many of which did not kill the germinating *S. aureus* spores, were recognized as such by the rapid color change in culture and the necessary co-culture approach. Any *Leptocarpus* spores that did not germinate in co-culture should be removed from the co-culture.

WATERBURY, (Source: *Waterbury*)

[illegible]

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(B) the lands designated as wilderness by this Act generally are not suitable for use for development of new water resource facilities, or for the expansion of existing facilities;

(C) it is possible to provide for proper management and protection of the wilderness and other values of such lands in ways different from those utilized in other legislation designating as wilderness lands not sharing the attributes of the lands designated as wilderness by this Act.

(2) STATUTORY CONSTRUCTION.—

(A) Nothing in this Act shall constitute or be construed to constitute either an express or implied reservation of any water or water rights with respect to the lands designated as a national conservation area or as wilderness by this Act.

(B) Nothing in this Act shall affect any conditional or absolute water rights in the State of Colorado existing on the date of the enactment of this Act.

(C) Nothing in this subsection shall be construed as establishing a precedent with regard to any future national conservation area or wilderness designations.

(D) Nothing in this Act shall be construed as limiting, altering, modifying, or amending any of the interstate compacts or equitable apportionment decrees that apportion water among and between the State of Colorado and other States.

(3) COLORADO WATER LAW.—The Secretary shall follow the procedural and substantive requirements of the law of the State of Colorado in order to obtain and hold any new water rights with respect to the Conservation Area and the Wilderness.

(4) NEW PROJECTS.—

(A) As used in this paragraph, the term “water resource facility” means irrigation and pumping facilities, reservoirs, water conservation works, aqueducts, canals, ditches, pipelines, wells, hydropower projects, and transmission and other ancillary facilities, and other water diversion, storage, and carriage structures. Such term does not include any such facilities related to or used for the purpose of livestock grazing.

(B) Except as otherwise provided by section 6(g) or other provisions of this Act, on and after the date of the enactment of this Act, neither the President nor any other officer, employee, or agent of the United States shall fund, assist, authorize, or issue a license or permit for the development of any new water resource facility within the wilderness area designated by this Act.

(C) Except as provided in this paragraph, nothing in this Act shall be construed to affect or limit the use, operation, maintenance, repair, modification, or replacement of water resource facilities in existence on the date of the enactment of this Act within the boundaries of the Wilderness.

(5) BOUNDARIES ALONG COLORADO RIVER.—(A) Neither the Conservation Area nor the Wilderness shall include any part of the Colorado River to the 100-year high water mark.

PUBLIC LAW 106-353—OCT. 24, 2000

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(B) Nothing in this Act shall affect the authority that the Secretary may or may not have to manage recreational uses on the Colorado River, except as such authority may be affected by compliance with paragraph (3). Nothing in this Act shall be construed to affect the authority of the Secretary to manage the public lands between the boundary of the Conservation Area and the edge of the Colorado River.

(C) Subject to valid existing rights, all lands owned by the Federal Government between the 100-year high water mark on each shore of the Colorado River, as designated on the Map from the line labeled “Line A” on the east to the boundary between the States of Colorado and Utah on the west, are hereby withdrawn from—

- (i) all forms of entry, appropriation, or disposal under the public land laws;
- (ii) location, entry, and patent under the mining laws; and
- (iii) the operation of the mineral leasing, mineral materials, and geothermal leasing laws.

SEC. 7. MAPS AND LEGAL DESCRIPTIONS.

(a) IN GENERAL.—As soon as practicable after the date of the enactment of this Act, the Secretary shall submit to Congress a copy of the Map and a legal description of the Conservation Area and of the Wilderness.

(b) FORCE AND EFFECT.—The Map and legal descriptions shall have the same force and effect as if included in this Act, except that the Secretary may correct clerical and typographical errors in the Map and the legal descriptions.

(c) PUBLIC AVAILABILITY.—Copies of the Map and the legal descriptions shall be on file and available for public inspection in—

- (1) the Office of the Director of the Bureau of Land Management;
 - (2) the Grand Junction District Office of the Bureau of Land Management in Colorado;
 - (3) the appropriate office of the Bureau of Land Management in Colorado, if the Grand Junction District Office is not deemed the appropriate office; and
 - (4) the appropriate office of the Bureau of Land Management in Utah.
- (d) MAP CONTROLLING.—Subject to section 6(1)(3), in the case of a discrepancy between the Map and the descriptions, the Map shall control.

SEC. 8. ADVISORY COUNCIL.

(a) ESTABLISHMENT.—Not later than 6 months after the date of the enactment of this Act, the Secretary shall establish an advisory council to be known as the “Colorado Canyons National Conservation Area Advisory Council”.

(b) DUTY.—The Council shall advise the Secretary with respect to preparation and implementation of the management plan, including budgetary matters, for the Conservation Area and the Wilderness.

(c) APPLICABLE LAW.—The Council shall be subject to—

- (1) the Federal Advisory Committee Act (5 U.S.C. App.); and

16 USC
460mm–6.

16 USC
460mm–6.
Deadline.

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SCIENCE PLAN
FOR
GUNNISON GORGE NATIONAL CONSERVATION
AREA
JULY 2013



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SECTION 1– INTRODUCTION AND SCIENTIFIC MISSION

PURPOSE OF NLCS SCIENCE PLANS

The National Landscape Conservation System (NLCS) was administratively established in 2000 and legislatively codified in the Omnibus Public Land Management Act of 2009 (PL 111-11). This system encompasses nearly 900 units spread across approximately 27 million acres of public lands managed by the Bureau of Land Management (BLM). The BLM is mandated to conserve, protect and restore the outstanding cultural, ecological, and scientific values of NLCS units.

Scientific investigation can aid in the conservation, protection, and restoration of these lands, and therefore, science is strategically planned and organized within NLCS units. Within NLCS units there is an expectation for ‘identifying science needed to address management issues, communicating those needs to science providers, and incorporating the results into the decision making process’ (BLM 2007).

The objectives of NLCS units’ science plans are to:

- Identify the scientific mission of the unit;
- Summarize past scientific efforts in the unit, i.e. the scientific background of the unit;
- Identify the priority needs and management issues within the unit that can be addressed by scientific inquiry;
- Define a strategy for accomplishing the scientific goals of the unit;
- Develop science protocols to, for example, ensure that scientific inquiry does not negatively impact the long term sustainability of the unit and its resources;
- Create a system to organize scientific reports; and,
- Help and promote the integration of science into management.

The science plans of NLCS units are considered ‘living’ documents and should be revised and updated frequently (e.g. 3-5 years). Scientific needs that emerge during the course of implementing a science plan may be added to the plan on an as-needed basis to meet the unit’s scientific mission.

UNIT DESCRIPTION

Gunnison Gorge National Conservation Area and Wilderness (GGNCA) was designated by Congress in 1999 in recognition of its outstanding geologic, scenic, wilderness, recreational, and scientific resources. GGNCA is located approximately 10 miles northeast of Montrose, Colorado within the boundaries of the BLM Uncompahgre Field Office (UFO). GGNCA is bordered by the Black Canyon of the Gunnison National Park and originally encompassed 57,725 acres of public land as designated in the Black Canyon of the Gunnison National Park and Gunnison Gorge National Conservation Area Act of 1999 (Public Law 106-76). However, GGNCA expanded to 62,844 acres with the Black Canyon of the Gunnison Boundary Revision Act of 2003 (PL 108-78). GGNCA includes the Gunnison Gorge Wilderness (17,784 acres) and 22 river miles of the Gunnison River. Fourteen of these river miles pass through the wilderness (Figure 1).

GGNCA is composed of adobe badlands formations, sagebrush flats, oakbrush parks, piñon-juniper slopes, river canyons, and mesas, along with the plants and animals found in these habitats. Elevations

range from 5,000ft to 9,000ft and are part of the Gunnison uplift, cut by the Gunnison and Uncompahgre Rivers (BLM 2001). The climate is semi-arid to arid with variable precipitation, ranging from approximately 9 to 14 inches annually (Colorado Climate Center 2010). Temperatures also vary but range from near 0°F in January to approaching 90°F in July (Colorado Climate Center 2010). GGNCA has significant cultural resources and recreational value.

UNIT'S RESOURCE MANAGEMENT PLAN (RMP)

The GGNCA RMP was completed in 2004 and included the NCA as well as additional public, private, and state lands totaling 196,000 acres of land (BLM 2004, Appendix A). The following mission statement from the RMP provides an underlying vision for managing GGNCA and the associated planning area:

“The BLM will manage the NCA to protect the resources in accordance with the designating legislation, FLPMA, the Wilderness Act of 1964, as amended, and other applicable provisions of the law. The BLM will incorporate multiple uses to the extent that important resources are protected and the combination of uses takes into account the long-term needs of future generations for renewable and nonrenewable resources. The purpose of the planning effort is to establish an integrated guiding plan for future site-specific analysis and decisions that maintains or improves existing conditions to meet or exceed Colorado BLM Land Health Standards (BLM 2004).”

The RMP focuses management on ecosystem management; that is management based on the ecological system instead of a single species or resource. Morrissey et al. (1994) defines ecosystem-based management as “the integration of ecological, economic, and social principles to manage biological and physical systems in a manner safeguarding the long-term ecological sustainability, natural diversity, and productivity of the landscape.” The goal of BLM ecosystem management is “to develop and implement management that conserves, restores, and maintains the ecological integrity, productivity, and biological diversity of public lands” (Morrissey et al. 1994). One mechanism to achieve integrated, ecosystem-based management is to utilize an adaptive approach to management (defined by, for example, Noss and Cooperider 1994, Reever Morghan et al. 2006, Williams et al. 2007), where management actions are treated as scientific experiments. In doing so, assumptions are tested, actions and outcomes are monitored, and future management actions are refined based on the results.

The Gunnison Gorge RMP was the first BLM plan to incorporate the Benefits-Based Management (BBM) approach for recreation management in a RMP-level document. The BLM partnered with Arizona State University on the development of BBM visitor surveys that were used to gather information on visitor profiles prior to the start of the planning process. In general, this approach requires managers, to consider the benefits to users in balance with resource protection.

The RMP designated six management zones based on ‘a particular geographic area’s public land resources, uses, and values relative to the goals and objectives of the RMP’ (BLM 2004, Table 1). The plan designated three Areas of Critical Environmental Concern (ACEC): the Native Plant Community

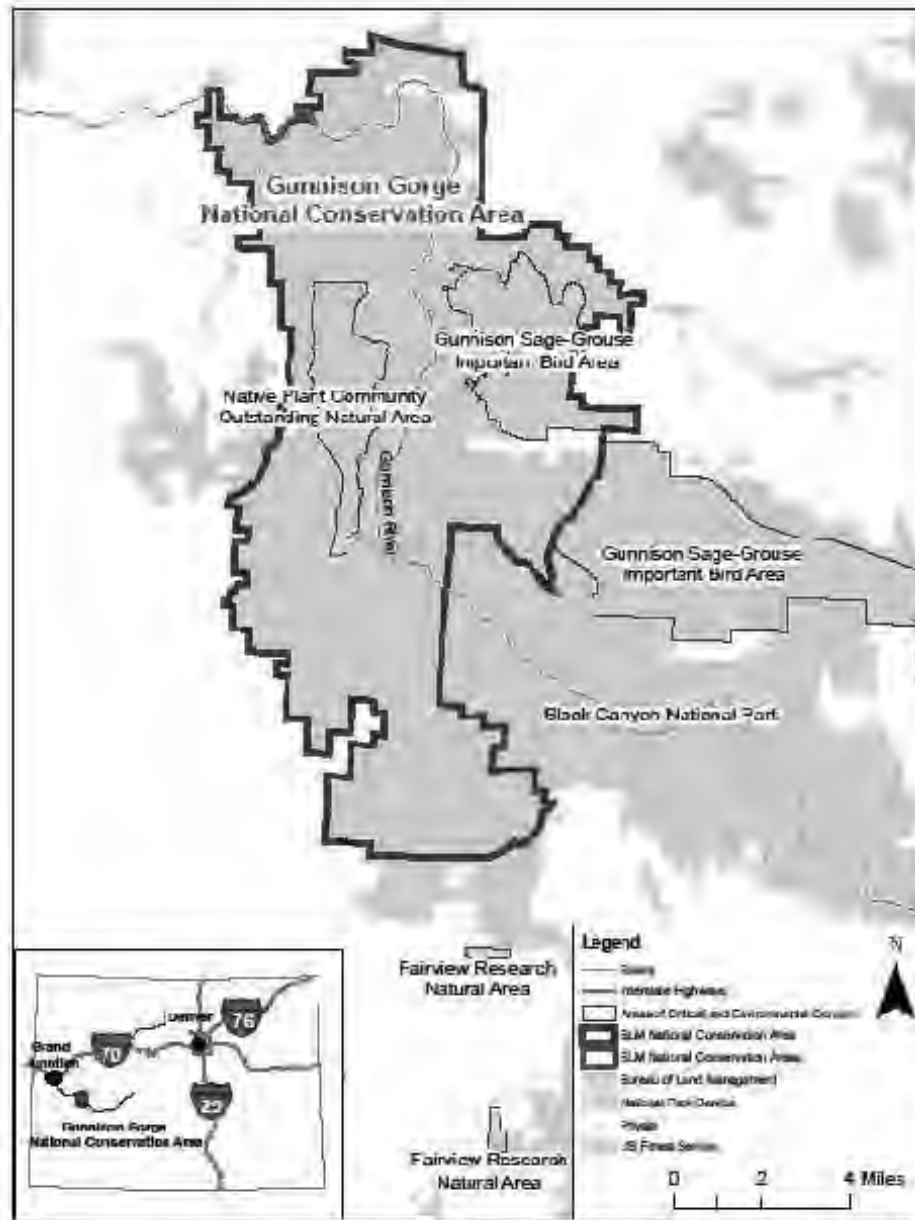
ACEC and Outstanding Natural Area (3,800 acres), the Gunnison Sage Grouse ACEC/Important Bird Area (22,200 acres), which also has a portion outside of GGNCA, and the Fairview Native Plant ACEC (160 acres) (Figure 1). The RMP also identified three Special Recreation Management Areas (SRMA's): the Gunnison Gorge Wilderness SRMA (17,784 acres), the Flat Top-Peach Valley OHV SRMA (9,754 acres), and the Gunnison and North Fork River SMRA (13,502 acres) which was designated to enhance riparian and recreation resources.

GGNCA receives approximately 90,000 visitors a year, 17,700 of which visit the Wilderness. There are four major vehicle entrances to GGNCA and four major wilderness trailheads. There are over 60 dispersed campsites, trailheads, overlooks, and other high-use areas. GGNCA has over 65 miles of designated roads and over 126 miles of designated trails. In 2005, an assessment of use allocation was conducted in the Wilderness area, including feedback from Gunnison Gorge commercial outfitters, in order to begin development of the RMP's Wilderness Recreation Strategy (BLM 2005).

Table 1 – GGNCA management zones identified in the RMP (BLM 2004).

Management Unit	Acres of Public Land	Percentage of Planning Area	Important Values, Resources, or Land Uses
1	17,784	19	Protect Wilderness (Gunnison Gorge Wilderness)
2	9,754	10	Enhance natural, scenic, and recreational values (Flat Top-Peach Valley OHV Recreation Area)
3	13,502	14	Protect and enhance riparian and recreation resources (Gunnison and North Fork Rivers Special Recreation Management Area (SRMA))
4	22,200	23	Protect Gunnison sage grouse (<i>Centrocercus minimus</i>), elk (<i>Cervus elaphus</i>), and mule deer (<i>Odocoileus hemionus</i>) winter concentration (Gunnison Sage-Grouse Area of Critical Environmental Concern (ACEC)/ Important Bird Area (IBA))
5	3,785	4	Protect native plants (Native Plant Community ACEC/Outstanding Natural Area (ONA))
6	28,755	30	Provide for multiple use under common management

Figure 1 – Map of Gunnison Gorge National Conservation Area and surrounding area.



This map was produced by the Grand Junction Field Office September 2012

SCIENTIFIC MISSION

Science in National Landscape Conservation System (NLCS) units is defined broadly as ‘including basic and applied research in natural and social science, as well as inventory and monitoring initiatives’ (BLM 2007). In addition, within NLCS units there is an expectation for ‘identifying science needed to address management issues, communicating those needs to science providers, and incorporating the results into the decision making process’ (BLM 2007).

Science has been defined within the BLM several times (e.g. BLM 2007, BLM 2008); it is essentially the study of natural and social phenomena using repeatable observations or experiments. In the context of land management, scientific data are collected, analyzed, or synthesized to increase knowledge and support decision-making.

This science plan will be used as the basis for conducting science in GGNCA. Scientific efforts within GGNCA should support the conservation, protection, and restoration values identified in the designating language, such as ecosystem resiliency and function, land health, diversity and viability of plant and animal populations, and cultural and paleontological sites. Since GGNCA is managed for multiple-use, some level of resource disturbance is inevitable (e.g. from grazing and recreational use). Scientific knowledge can provide information to ensure the authorized uses do not negatively impact GGNCA’s conservation mission.

Specifically, it is the scientific mission of GGNCA to:

- 1) Allow and encourage pertinent science that can directly or indirectly:
 - a. inform management decisions and evaluate management methods;
 - b. improve and maintain GGNCA’s resources, objects, and values;
 - c. improve and maintain ecosystem resiliency and function;
 - d. improve and maintain land health, and address land health concerns;
 - e. maintain diversity and viability of plant and animal populations;
 - f. preserve and understand socio-cultural and paleontological sites;
 - g. improve understanding of the impacts of authorized uses; and,
 - h. improve understanding, development, and implementation of best management practices.
- 2) Allow and encourage:
 - a. long term and short term investigations;
 - b. internal and external scientific investigations; and,
 - c. scientific inquiry across diverse disciplines, as appropriate.
- 3) Serve as a model system for surrounding areas, so that scientific findings can be exported to other federal and non-federal lands.

SECTION 2 – SCIENTIFIC BACKGROUND

Past and present research in GGNCA is abundant and has covered a diverse array of topics, including studies on vegetation, wildlife, paleontology, archaeology, and the impacts of recreation (Section 9 - Bibliography of published studies related to GGNCA). The following is a brief review of subjects, topics, and areas of research that have been published about GGNCA, or that are directly relevant to GGNCA. Some of the research is also linked with the bordering Black Canyon of the Gunnison National Park.

In addition to the scientific research above, ongoing monitoring of resources is a large portion of the science conducted in GGNCA. Monitoring in GGNCA is used to 'assess resource conditions, identify resource conflicts, and determine if resource objectives are being met, and periodically refine and update desired conditions and management strategies' (BLM 2004). Monitoring can be useful for determining: areas of resource decline, background information for scientific inquiries, early indicators of invasive weeds, stability of cultural and paleontological resources, effectiveness of management activities, and the identification of new concerns and needs for scientific research.

VEGETATION

GGNCA is home to several distinct vegetation communities including salt-desert shrublands, semi-desert grasslands on sandstone derived soils, piñon-juniper woodlands on shallow soils, big sagebrush flats on deeper soils, and oakbrush dominated sites at higher elevations (BLM 2001). In addition, pockets of aspen can be found at the highest elevations and riparian vegetation along river corridors (BLM 2001). Numerous sensitive plant species and communities exist in GGNCA (BLM 2013).

Vegetation research efforts in GGNCA include:

The Colorado Natural Heritage Program's (CNHP; www.cnhp.colostate.edu) studies in GGNCA on sensitive and rare species (Decker 2005, Panjabi and Anderson 2004, Lyon and Denslow 2001, Lyon et al. 1999). CNHP projects included:

- establishing permanent monitoring plots for endangered clay-loving wild buckwheat (*Eriogonum pelinophilum*);
- designing rapid, cost efficient monitoring programs for four additional rare species: Uinta Basin hookless cactus (*Sclerocactus wetlandicus*), Delta lomatium (*Lomatium concinnum*), Rocky Mountain thistle (*Cirsium perplexans*), and good neighbor bladderpod (*Lesquerella vicina*);
- mapping the extent of sensitive native plant communities in the Native Plant ACEC; and,
- conducting inventories for endangered and rare plants on 5,700 acres of the conservation area (report available upon request, Uncompahgre Field Office, UFO).

Internal BLM research has examined the effectiveness of planting cottonwood poles and willow cuttings at eleven sites in GGNCA (BLM 2008).

Pinyon woodland stand structure-historic range of variation research was conducted by the University of Colorado, Boulder (Eisenhart 2004).

USGS research examined the tie between plant community condition, rare plants, and Mancos shale-derived soils (USGS unpublished report).

General vegetation monitoring efforts within GGNCA include:

- The BLM monitors land health at 33 sites (evaluated every 10 years) in GGNCA, beginning in 2001. As one aspect of land health monitoring, the status and trend of vegetation is measured and analyzed to determine if established land health standards are being met. This information is then used to rate landscapes as 'meeting', 'meeting with problems', or 'not meeting' land health standards. These ratings are used to inform management actions.
- The effects of vegetation treatments (e.g. burned area rehabilitation projects, tree or shrub removal plus seeding, typically implemented to improve habitat for deer, elk or sage grouse, or reduce fuels) are monitored at 2, 5, and 10 year intervals following the treatment.

Invasive plants are present throughout GGNCA and are actively managed. Annual inventories of invasive plants and noxious weeds, via photo points and field inspections, are conducted in partnership with Delta and Montrose counties. The following list provides some details on the non-native plants present and management responses:

- Tamarisk (*Tamarix spp.*) is an invasive shrub that can exclude native riparian vegetation and alter native systems through changes to water flow, wildlife habitat, and soil properties (Di Tomasso 1998). A biological control agent, the tamarisk beetle (*Diorhabda carinulata*) was released in Colorado in 2005 to control this species. Research is on-going to test its efficacy (Palisade Insectory; Colorado State University). In GGNCA, numerous projects and partner groups have worked on Tamarisk control, including: Delta County's tamarisk/noxious weed eradication program, the Tamarisk Coalition, and the Denver Botanic Gardens.
- Russian knapweed (*Acroptilon repens*) is an aggressive weed which competes with native vegetation in several ways, including the production of allelopathic substances and an ability to grow from seed or hearty root masses (Maddox et al. 1985). Control of this weed can be difficult and biological agents may increase chances of longer term suppression.
- Hoary cress, also known as whitetop (*Cardaria draba*), is a rhizomatous perennial plant that invades rangelands and can be abundant on alkali soils (Jacobs 2007). This species spreads by rhizomes, which can be extensive, as well as seed, and produces allelopathic chemicals that may inhibit the growth of other plant species (Jacobs 2007).
- The invasive species cheatgrass (*Bromus tectorum*) is an aggressive invader present throughout much of the arid west (Pellant 1996). Cheatgrass has changed historic fire regimes and increased the likelihood of more frequent fires (Pellant 1996). Managers have often tried to mitigate the spread of cheatgrass by reseeding after fires; however, there is uncertainty as to this method's effectiveness (Getz and Baker 2008).

- Halogeton (*Halogeton glomeratus*) is a native of China that was introduced to the United States in the early 1900s and rapidly spread throughout the west (Davis et al. 2009). Halogeton usually invades previously disturbed communities, but once established may out-compete native vegetation. Halogeton can rapidly use summer rainfall for growth and seed production, produces seeds that can germinate anytime and seeds that can survive for long periods, which make it well adapted to the erratic desert weather (Davis et al 2009). It does well on alkaline soils and can be toxic to livestock (Whitson et al. 2009).
- To control yellow toadflax (*Lunaria vulgaris*) and dalmation toadflax (*Linaria genistifloia spp. dalmatica*), a noctuid moth (*Calophasia lunula*) has been released, with limited success. A new agent (*Mecinus janthinus*) may be released for control of yellow toadflax (Colorado Department of Agriculture 2011).
- Invasive thistles in and around GGNCA include: musk thistle (*Carduus nutans*), Canada thistle (*Cirsium arvense*), Scotch thistle (*Onopordum acanthium*), and bull thistle (*Cirsium vulgare*). The thistle seed weevil (*Rhinocyllus conicus*) was released to control Musk thistle (*Carduus nutans*) in the late 1960's. While this biological agent provides some control of this species it also feeds on native thistles and is no longer released. This weevil is established throughout Colorado and likely offers some control of non-native thistles in GGNCA. This weevil may also be found on Canada thistle, but is not as effective in controlling this species (Wiggins et al 2010).
- Field bindweed (*Convolvulus arvensis*) is typically found in croplands. A small eriophyid mite (*Aceria malherbae*) was released in 1987 in the west to control this invasive species and is established in Colorado and GGNCA (Colorado Department of Agriculture Insectory 2011, Boydston and Williams 2004). Another biological control agent, the bindweed moth (*Tyta luctuosa*) is also being released in Colorado and has been found to overwinter in Mesa county, this first place of documented establishment in the US (Colorado Department of Agriculture Insectory 2011).
- Additionally, several 'early detection, rapid response' invasive plants exist in small populations in GGNCA and surroundings areas. These species are not yet a substantial problem, but should be treated whenever they are found and include: spotted knapweed (*Centaurea stoebe*), diffuse knapweed (*Centaurea diffusa*), leafy spurge (*Euphorbia esula*), and yellow starthistle (*Centaurea solstitialis*).

WILDLIFE

GGNCA houses a variety of upland, riparian, and aquatic species, as well as year-round and migrant bird species, and listed and threatened species. Wildlife serves as one of the main attractions of GGNCA (e.g. parts of the Gunnison River are considered 'gold medal trout waters' by Colorado Parks and Wildlife).

Birds

Gunnison sage grouse (*Centrocercus minimus*; USFWS candidate species for endangered status) are dependent on sagebrush and their population declines have been attributed to decreasing overall habitat and increasing fragmentation of remaining habitat (Oyler-McCance et al. 2001). Within GGNCA the Gunnison Sage Grouse Important Bird Area/ Area of Critical Environmental Concern encompasses

approximately 22,000 acres of sage grouse habitat. This area is home to the Crawford population of Gunnison sage grouse, which occupies both Montrose and Delta Counties. Conservation plans have been published for the Crawford population (BLM 2004, Appendix H; Crawford Area Gunnison sage-grouse conservation plan, 2011; available upon request, UFO).

An ongoing project with the USGS has fitted Gunnison sage grouse and elk (*Cervus elaphus*) with GPS transmitters to determine traffic effects on Gunnison sage grouse, habitat use and population dynamics, and elk migration routes (Ouren and Watts 2005a, b). A climate monitoring station was installed on the east side of GGNCA to track weather conditions, which is used to monitor Gunnison sage grouse habitat.

Between 2011 and 2013, 60 sage grouse were captured in the Gunnison Basin and translocated into the Crawford area population in and adjacent to GGNCA. Some birds were fitted with radio collars or GPS transmitters by Colorado Parks and Wildlife (Crawford Area Gunnison Sage-grouse Conservation Plan, 2011). Yearly Gunnison sage grouse lek counts are performed by Colorado Parks and Wildlife and Crawford Working Group in GGNCA.

Vegetation surveys are completed within the ACEC every 10 years by the BLM, results of these are incorporated into BLM land health reports.

An inventory of bird species, relative abundance, and breeding status was conducted within GGNCA in 2011. Prominent habitat types were surveyed. A total of 91 native bird species and 5 non-native bird species were found (Dunne 2011, report available upon request). More broadly, the Colorado Breeding Bird Atlas gives habitat, breeding, and distribution information on bird species found in Colorado, including in GGNCA (Kingery 1998). Information is currently being collected for an updated version.

Raptors, including bald eagles (*Haliaeetus leucocephalus*; USFWS delisted species), peregrine falcons (*Falco peregrines anatum*; USFWS delisted species), and golden eagles (*Aquila chrysaetos*; USFWS species of concern) inhabit GGNCA and locations of some nesting pairs is known.

Burrowing owls (*Athene cunicularia hypugea*; State of Colorado species of concern) are found within GGNCA. Burrowing owls are closely linked to active prairie dog towns and use prairie dog burrows for breeding. Burrowing owl populations decline with declining prairie dog populations (Desmond, Savidge et al. 2000).

The yellow-billed cuckoo (*Coccyzus americanus*; USFWS candidate species for endangered status; Federal Register 2012)). This species may breed in riparian areas in Western Colorado (Laymon 1998), and while it has not been documented within GGNCA, breeding pairs have been documented near the town of Paonia (about 15 miles of GGNCA; Rocky Mountain Bird Observatory, Black Canyon Audubon unpublished data).

Mammals

White-tailed prairie dogs (*Cynomys leucurus*), a keystone species (Kotliar et al. 1999), are found in many areas within GGNCA. Prairie dog towns were mapped by BLM in Peach Valley in 1978-1979 (BLM 2001).

There are numerous threats to prairie dog populations in GGNCA including decreasing habitat and sylvatic plague (*Yersinia pestis*); however it is unknown how these factors affect long term prairie dog populations (Federal Register 2010).

Recent inventory has used both mist netting and acoustic surveys to determine the presence of bats in GGNCA and throughout the Uncompahgre Field Office (Hayes et al. 2009, as well as reports available on request, UFO). Five of the 17 bat species found in western Colorado are considered sensitive wildlife species by the BLM UFO in GGNCA: Townsend's big-eared bat (*Corynorhinus townsendii*), spotted bat (*Euderma maculatum*), Allen's big-eared bat (*Idionycteris phyllotis*), fringed myotis (*Myotis thysanodes*), and Yuma myotis (*Myotis yumanensis*). For over two decades, Colorado Parks and Wildlife has conducted bat surveys at abandoned mines. While white-nosed syndrome has not been found in GGNCA or in Colorado, its spread westward is of concern. Research is ongoing.

Kit fox status in GGNCA is uncertain (*Vulpes macrotis*; State of Colorado endangered species), but their populations may have declined from historic levels. A recent study modeled kit fox habitat in Western Colorado (Reed-Eckert 2010). Ongoing research by Colorado Parks and Wildlife in GGNCA and elsewhere utilizes trapping and hair snares.

Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) are an iconic animal in Colorado and in GGNCA. Between 1947 and 2007 bighorns were released in Colorado to establish new populations or supplement existing populations (George et al. 2009). Concerns with bighorns include disease, overgrazing, plant community succession and forestation of native ranges, human development, and competition with livestock (George et al. 2009).

Elk (*Cervus elaphis*) and mule deer (*Odocoileus hemionus*) use habitat within GGNCA, especially in winter, and may impact other species (e.g. sage grouse) and habitat (e.g. shrub use). Research by USGS scientists had addressed elk migration routes (Ouren and Watts 2005a, b).

Fish, reptiles, and amphibians

The midget faded rattlesnake (*Crotalus viridis concolor*; BLM sensitive species) is a subspecies of western rattlesnake that ranges from eastern Utah to the Four Corners area, within a range of dry habitats (Stevens 2004). A few individuals have been detected within GGNCA as part of an ongoing research project (Parker and Spear 2013, unpublished data), but accurate population estimates have not been determined, this species may be decreasing with decreasing prairie dog populations (Stevens 2004).

Amphibian species are present within GGNCA, but a baseline has not been scientifically established. Amphibian species have been in decline throughout the world, with poorly understood causal factors (Stuart et al. 2004).

The introduction of whirling disease in the 1990's caused declines in the rainbow trout population of the Gunnison River and stocking of these fish has occurred since 2004 in an attempt to increase populations (Hebein et al. 1998, Schiesler and Fetherman 2010). Research with Colorado Parks and Wildlife is

ongoing and these species may be found within GGNCA. In 2009, BLM researchers surveyed the fish population at the Smith Fork, a perennial tributary to the Gunnison River in the Gunnison Gorge Wilderness. The survey found limited fish, likely attributed to a steep stream gradient and high water temperatures (Fresques unpublished data, report available upon request, UFO).

The bluehead sucker (*Catostomus discobolus*), flannelmouth sucker (*Catostomus latipinnis*), and roundtail chub (*Gila robusta*) are listed as BLM sensitive fish species. These species may be present within GGNCA. Threats to these fish include water diversion and changes to flow regimes and competition with non-native fish (e.g. Rees et al 2005, Bezzerides and Bestgen 2002).

HYDROLOGY AND WATER FLOW

Hydrologic resources include the Gunnison River, North Fork of the Gunnison, and Smith Fork of the Gunnison, as well as other intermittent streams and springs.

Research has addressed sediment distribution and movement within the Gunnison River, especially as it pertains to regulated flows (Dubinski and Wohl 2006, Elliott and Parker 1997). Related research has addressed flows and uses of the Dolores River (Vandas et al 1990), which is a nearby western river.

Baseline surveys of macro-invertebrates have been completed in some perennial streams within GGNCA (information available on request from UFO). Currently surveys follow protocols outlined by the Utah State University National Aquatic Monitoring Center.

Riparian monitoring includes:

- BLM's Proper Functioning Condition (PFC) monitoring (a qualitative assessment) and,
- ground water monitoring wells to track changing water levels and salinity levels (installed in 2009 and 2012).

SOILS

Soils within GGNCA are variable, generally have low potential for plant production, and are susceptible to erosion (BLM 2001).

Research has addressed basic information about the stability of Mancos Shale soils (one of the soil types found within GGNCA, and links between biological soil crusts and soil stability (Carpenter and Chong 2010, Carpenter 2008).

Some research has been done on the composition of Mancos Shale soils especially as it pertains to potential salt run-off into the Colorado River (Whittig et al 1982). Internal research details a study of salinity of the Elephant Skin Wash area of GGNCA (Murphy 1990, Available upon request, UFO).

From 2003 to 2008 the BLM participated in the 'Mancos Shale Landscape Project'. This project involved studies in regional geochemistry, geologic and soil mapping, digital elevation and GIS modeling, soil and rock mineralogy, remote sensing, landscape classifications, erosion processes, and inventories of

Mancos vegetation communities. The U. S. Geological Survey (USGS) website provides information on this project including data, research updates, summaries, maps, Landsat and LIDAR imagery, and scientist contact information (USGS 2013).

In 2006, the BLM tested the feasibility of using close-range photogrammetry to collect three-dimensional data to detect and monitor hill slope erosion processes and the effects of surface disturbance in Mancos Shale soils (report available on request from UFO).

From 2007 to 2011, the USGS used ground-based LIDAR imagery to measure disturbed and undisturbed Mancos Shale hill slopes in the GGNCA and to detect and quantify changes in surface soil elevations (information available on request, UFO).

In 2008 and 2009, seasonal GeoCorps interns inventoried, mapped, and documented erosion and invasive weed areas on over 1,200 salinity control check dam structures in GGNCA's Mancos Shale areas (data available on request from UFO).

In 2010, BLM, USGS, and NPS hydrologists conducted preliminary hydrologic function assessments and water testing on the network of irrigation canals and natural arroyos in a newly acquired GGNCA inholding. Water in these channels cuts through highly erosive Mancos Shale soils picking up increasingly higher loads of salinity and selenium, which can cause water quality and fish toxicity problems in the lower Gunnison and Colorado River systems (Grand Basin and Grand Valley selenium task forces 2013).

GEOLOGY AND PALEONTOLOGY

The geologic history of western Colorado (Kirkham et al 2002, O'Sullivan 1992) in general, and Gunnison Gorge in particular (Kellog 2004, Aslan et al. 2008) have been extensively studied including: how rock layers were formed, uplifted, and eroded, as well as information on fault-lines in the area and the geologic history of the Gunnison River.

In 2002, a BLM report provided an overview and analysis of the paleontological resources and known fossil localities of the GGNCA (Armstrong 2002, report available on request from UFO). A subsequent study documented the Molluscan fossils in GGNCA (Merewether et al. 2006).

Jurassic and Cretaceous paleontological localities have been identified by BLM seasonal GeoCorps interns. Cretaceous age dinosaur trackways (including dinosaur skin imprints), particularly the Suncliff Canyon trackway, have been studied in GGNCA, information available upon request UFO.

CULTURAL RESOURCES AND ARCHAEOLOGY

The archaeological record of the GGNCA spans the known pre-history of North America.

Ongoing research at the Eagle Rock shelter in the northern extent of the gorge has discovered human occupational deposits dating back as far as 12,880 years ago, making the site one of the oldest known Clovis occupation sites in the nation (more information available, UFO). Since 2006, Western Wyoming

College has worked closely with the BLM on excavations of prehistoric deposits and documentation of rock art at the site (research is ongoing, more information available from UFO). Analysis and reporting of this project is in progress.

Other known cultural sites in GGNCA include: archaic period rock art, campsites and hunting stands, formative era occupations and evidence of corn horticulture, late prehistoric and historic period Ute occupations and rock art, historic European homesteading, mining and ranching operations, including Howell Village and the “Stemwinder” cattle trail (unpublished data, UFO).

Ongoing research in the GGNCA has been focusing on a discovery of Ute map rocks in the gorge. Sometime between ca. 1600 AD and 1800 AD, Ute people left detailed maps of trails, wildlife and hunting areas inscribed on rock panels in the area. The rock art maps have recently been interpreted with the help of elders from the Ute tribes, and a series of archaeological surveys have been implemented. The trails depicted on these “map rocks” can still be found, and in many cases can provide information valuable to other research. For example, the Smith Canyon map rock shows detailed renderings of a trail system leading through more inaccessible areas of the canyon to areas on the upland benches where figures of sage grouse are depicted. These mapped renderings on the rock panel coincide quite closely with areas that wildlife researchers are examining for their historic and current sage grouse populations. Likewise, the mapped trails with figures of elk closely match locales currently identified by wildlife professionals as elk migration and wintering ranges (unpublished data, UFO). Archaeological survey of these trails and hunting areas is ongoing and may serve to inform current research.

Cultural site inventory and monitoring are performed with volunteers as part of the GGNCA Volunteer Site Steward program.

- Stewards are trained by the BLM archaeologist during an annual training course emphasizing regional cultural history, archaeological ethics, impact assessment, photo-documentation, and record keeping. Site stewards visit their assigned sites on at least a quarterly basis, photograph the site from pre-established points, and keep a regular site assessment log. These logs and photos are kept at the GGNCA cultural resources office and are tracked on the GGNCA site monitor log. In addition to site monitoring, protection and management, volunteers also assist in inventory, site stabilization, and data recovery projects. As of 2012, there were four monitoring teams (eight people) responsible for monitoring six cultural sites eligible for the National Register of Historic Places.

RECREATION

As part of GGNCA’s RMP development, researchers at the BLM partnered with Arizona State University at Tempe on a study of GGNCA visitors to determine their attitudes and preferences in order to help implement benefits-based management (BBM). The study identified baseline visitor profiles and increased understanding of desired user activities, experiences, and benefits derived from recreating in GGNCA. These results informed the development of GGNCA’s fifteen recreation management zones, including identification of the zones’ management objectives and prescriptions (BLM 2004). BLM

managers use this information to inform decisions and balance benefits to users with resource protection.

In 2008, researchers from the University of Idaho examined visitor satisfaction at GGNCA's Chukar Trailhead, following protocols used throughout several western states, and found overall visitor satisfaction to be good (University of Idaho 2008, available on request, UFO).

In 2008, Northern Arizona University developed a human-impact monitoring program that used several impact indicators to rapidly assess recreation areas and recreational impacts. The method was designed to analyze trends in site conditions, determine landscape-level problems versus site-specific problems, and identify key sites for further monitoring. This method involves inventory of riparian and upland recreation sites and cultural sites. These monitoring data can be used to inform the management of designated campsites and implementation of the Gunnison Gorge Wilderness use allocation plan (information available upon request, UFO).

The effects of OHV's (off-highway vehicles, where they are used) on natural resources and socioeconomics were examined by USGS scientists. The project identified mitigation and restoration techniques, in addition to further research and monitoring needs (Ouren et al. 2007).

Ongoing recreation monitoring in GGNCA includes:

- Wilderness and riparian campsite monitoring is performed based on monitoring protocols developed by Northern Arizona University faculty, including the 2008 project described above (protocol available on request, UFO). Data are used to determine visitor use trends, carrying capacities, and resource protection and regulatory needs.
- Visitor use data is collected annually using the Wilderness self-issuing permit program, trailhead registration forms, law enforcement and seasonal river ranger patrol logs, photos and videos, outfitter trip logs, trail counters, and visitor contacts.
- Motorized and mechanized use on trails, roads, and in designated open areas is tracked via trail counters, law enforcement patrols, and contacts by BLM staff and the public. Helmet cams record trail and riding conditions, safety hazards, and maintenance needs.

MANAGEMENT PROJECTS

While land management actions are not typically scientific experiments, their implementation and the monitoring of their outcomes can be used for adaptive management purposes and can identify science needs. A list of management projects can be found in the Manager's reports, beginning in 2006 and published annually (reports available upon request, UFO). Management projects can include habitat treatments, cottonwood plantings, rehabilitation of closed routes, etc. Many times these projects are done with uncertainty in a difficult, arid environment with limited resources. Therefore research, especially in an adaptive management framework, is needed to improve the success of these projects.

Historic grazing and fire, or lack thereof, may have dramatically altered vegetation conditions within GGNCA. Therefore, it is difficult to accurately determine historic conditions. With that in mind reference conditions are not always available, and managers and specialists may need to define what 'restoration' should look like in GGNCA and what will constitute restoration success to have measurable targets.

SECTION 3 – IDENTIFICATION AND PRIORITIZATION OF MANAGEMENT QUESTIONS AND SCIENCE NEEDS

The following is a list of scientific needs, questions, and opportunities within GGNCA. However, this list is not meant to be exhaustive or static. The scientific needs of GGNCA are based on pressing management questions and continually change as management decisions are made and new concerns arise. Thus, the scientific needs will remain fluid and opportunities for research should remain open and inclusive. GGNCA's current science needs are listed in Table 2.

Science needs are prioritized to reflect the needs identified in the Resource Management Plan, needs identified by resource specialists, needs that reflect management and leadership concerns, as well as public concerns. These prioritizations can change based on changing conditions and are not meant to be steadfast or static. Science needs are categorized as high, medium, or low priorities within topic areas (Table 2). These are pragmatic decisions: even low priority science needs are important.

Table 2 – Prioritized science needs by topic area.

TOPIC	PRIORITY	FOCUS AREA	QUESTIONS
Vegetation and Soils	High	Sensitive plants	<p>Genetic studies of Clay-loving wild buckwheat (<i>Eriogonum pelinophilum</i>) to determine species, and the feasibility of population augmentation. What are the habitat requirements of this plant and what are minimum viable populations? What are the effects of human activities, including grazing, on this plant?</p> <p>How do sensitive native plants, from the BLM sensitive species list, respond to disturbance and other stressors (recreation, off highway vehicles, livestock use, etc.)?</p> <p>What are population trends of sensitive native plant species (upward or downward) and what are the driving factors for these trends?</p> <p>What management decisions can influence trends in sensitive native plant populations?</p> <p>Where are populations of sensitive plants?</p> <p>What are the effects of human activities on hookless cacti populations?</p>
		Riparian communities Salt Desert shrub community	<p>What are effective means of restoring and managing degraded riparian communities in altered river systems?</p> <p>What are the relationships between river flows, riparian vegetation and riparian weeds?</p> <p>What methods can be used to successfully restore and manage degraded salt desert shrub sites?</p> <p>What restoration techniques are effective in restoring native diversity of grasses (both warm and cool season) and forbs?</p> <p>If biological agents are used, what is their effectiveness in terms of suppression and removal of the target species?</p>
		Russian knapweed (non native)	<p>Do management activities (e.g. chemical or mechanical) significantly decrease the cover of this non-native in the presence of the biological agent?</p> <p>What is the recovery, in terms of cover and diversity of native plants, when this species is suppressed or removed? What variables influence native plant recovery?</p> <p>Does active restoration significantly increase native plant diversity or cover, when Russian knapweed is removed?</p> <p>How likely is reinvasion after removal of this species, and what factors influence whether a site is re-invaded or not?</p> <p>What native species can compete with this species and under what circumstances (seeding time or method, pre-treatments, mix of species, etc.)?</p>
		Soils/ Hydrology	<p>What are the impacts from multiple uses, for example OHV use, livestock grazing, mountain biking, and other surface-disturbing uses, on Mancos shale soils? Specifically what are impacts to sediment, selenium, and salinity production? How can these be mitigated?</p> <p>What are the contributions to soil erosion, salt and selenium loading, sedimentation and dust from OHV use, livestock grazing, mountain biking, and other surface-disturbing uses? How can these be mitigated?</p>
	Medium	Tamarisk (non-native)	<p>How effective are biological controls at long term reduction and suppression this species?</p> <p>Are native species able to increase in cover in areas where biological controls have suppressed this species?</p> <p>Does mechanical removal of this species provide a significant increase in native species cover and survival?</p>

TOPIC	PRIORITY	FOCUS AREA	QUESTIONS
		Cheat grass (non-native)	When tamarisk is removed, can native plant species recover without active restoration, if so under what circumstances?
			Does percent cover of other invasive or non-native species increase with this species' suppression or removal, under what conditions?
			How are ecosystem processes effected by this species' suppression and removal including: food webs (for example migratory bird diversity and abundance, insect diversity and abundance, native fish abundance and reproduction, etc.), evapotranspiration and water use, nutrient cycling?
			Can inter-seeding native species with this species increase diversity and cover of native plants?
			What seeded species, and under what circumstances, can prevent this species' domination after fire?
		Halogeton (non-native)	How are ecosystem processes affected by this species' invasion including: fire regimes, insect and animal diversity and abundance, soil nutrient cycling, soil crust abundance, and soil microbial communities?
	Low		How can establishment and cover of desirable native plant species be increased in areas currently dominated by halogeton (interseeding, transplants, etc.)?
			After disturbance, how can domination by halogeton be prevented (appropriate seed mixes, measures to help establishment of native species)?
		Ecosystem function	When is piñon-juniper expansion 'encroachment' and when is it a more natural process?
			What role does fire play in piñon-juniper expansion?
			What are appropriate dynamics for native shrub communities (age class structure)?
			What is the likely local fire history?
		Biocontrol agents	How effective are bio-control agents at controlling the target plant (yellow toadflax, Canada and musk thistle, field bindweed)?
			How are the bio-control agents for the species mentioned above affecting native systems and non-target species?
		Whitetop	How well do native species recover after this species' removal?
			Is active restoration necessary to increase native plant cover and diversity?

TOPIC	PRIORITY	FOCUS AREA	QUESTIONS
Wildlife		(non-native)	How likely is reinvasion after removal of this species and what factors influence whether a site is reinvaded or not?
	High	Gunnison sage grouse	How does traffic effect migration patterns and habitat use by sage grouse? How are sage grouse using habitat in GGNCA and the surrounding areas? How is collecting of antler sheds effecting sage grouse habitat use and at what time of year might this be an issue? How effective have habitat treatments been at improving sage grouse habitat? Are sage grouse using treated areas?
		Bats	What are the locations and uses (e.g. roosting, reproduction) of bat inhabited caves and roosts, and which species of bats are present? How to gain early detection of the presence of white-nosed syndrome?
		Midget faded rattlesnake	What are the occupied or otherwise important habitats for midget faded rattlesnake populations? What is the relationship, if any, between midget faded rattlesnakes and prairie dog towns?
		Reintroduction	What are the population dynamics of midget faded rattlesnakes within GGNCA and what factors contribute to population fluctuations? What is the feasibility of reintroduction of native wildlife species, such as kitfox, pronghorn, bighorn sheep? What are the implications for habitat?
	Medium	Raptors	Where are breeding pairs of bald eagles, peregrine falcons, and golden eagles, how many are there, and what are the habitat types where they are found? What is the status and trend of habitat used by bald eagles, peregrine falcons, and golden eagles in GGNCA?
		Burrowing Owls	How many burrowing owls are present within GGNCA, including where they are present and in what habitat types? What are the population dynamics of burrowing owls within GGNCA and what factors, especially as related to habitat, contribute to population fluctuations? How do population dynamics of prairie dogs influence population dynamics of burrowing owls?
		Amphibians	What are the effects of OHV recreation on nest site selection? What species of amphibians are present within GGNCA? Where are important habitats and what are the characteristics of important habitats? Are populations of amphibians growing, in decline, or stable?
		Recreation	What are the effects of the open use areas on land health, noise, dust, user conflicts, and safety?
	Medium		

TOPIC	PRIORITY	FOCUS AREA	QUESTIONS
Paleontology	Medium	Paleontology	Identification and interpretation, when appropriate, of known and unknown paleontological sites.

SECTION 4 – MEETING SCIENCE NEEDS

INTERNAL ORGANIZATION

Internal organization is necessary to strategically identify and address science in GGNCA. An NLCS science coordinator has been established for the Dominguez-Escalante, McInnis Canyons, and Gunnison Gorge NCAs to assist in coordination of scientific efforts in these units. The UFO ecologist serves as the GGNCA unit science coordinator, and works with appropriate specialists as needed to address GGNCA science needs. The NLCS and GGNCA science coordinators and the GGNCA manager make up the GGNCA science coordination team.

The role of the coordination team is to:

- 1) Coordinate and collaborate to identify and prioritize GGNCA's science needs;
- 2) Ensure that partners and collaborators are familiar and engaged with GGNCA's documented science needs;
- 3) Coordinate with staff to approve science proposals;
- 4) Engage and remain engaged with partners and collaborators working within GGNCA;
- 5) Ensure that results of scientific inquiries are available to BLM staff, in appropriate formats, including progress and final reports;
- 6) Communicate results of scientific inquiries to researchers, staff, and managers both within and outside of the BLM, and to the general public when appropriate; and,
- 7) As necessary, coordinate and collaborate to update and revise the GGNCA science plan.

Additionally, the GGNCA science coordinator will:

- 8) Conduct needed monitoring and scientific inquiries, as time permits, within GGNCA;
- 9) Interpret long term data and periodically publish results; and,
- 10) Serve as the contact person for scientific inquiries within GGCNA.

COLLABORATION AND PARTNERS

It is imperative that GGNCA have good working relationships with a variety of partners that can assist in the diverse scientific needs of GGNCA. Scientific study is generally not part of the work that BLM field staff performs. However, this type of study can greatly improve the ability of managers to effectively manage these special areas. By partnering with numerous outside entities, the BLM can greatly increase its ability to use science to improve management decisions and actions.

Collaboration between BLM offices, other government agencies, and local universities can help scientists and managers better understand the needs of the area and ongoing science, and can provide opportunities to share information. Management issues are not defined by office boundaries and by sharing knowledge, management outcomes can be improved on larger and larger scales. Also, the success of management efforts in one geographical area will often be dependent on management efforts in another area. Regular conversations between local scientists and managers can help foster these relationships and collaborative opportunities.

GGNCA is part of the Southern Rockies eco-region as defined by the Environmental Protection Agency, and GGNCA will coordinate research needs through Rocky Mountain Cooperative Ecosystem Studies Unit, Uncompahgre Plateau Partnership, North Rim Landscape Strategy, and others as appropriate.

GGNCA has a history of partnering with varied organizations for scientific research and outreach, for example universities, private organizations, community groups, and local, state and other federal agencies. For a more complete list of past and present partners see the GGNCA Manager's reports (reports available upon request, UFO).

SECTION 5 – SCIENCE PROTOCOLS

GUIDELINES FOR SCIENTIFIC RESEARCH

It is anticipated that three main types of research are most likely to occur within GGNCA:

- 1) Assessment, inventory, and monitoring;
- 2) Solicited research addressing management questions and science needs;
- 3) Unsolicited contributed scientific studies.

There are numerous topics of research that may be addressed by these three types of inquiries including but not limited to: botany, ecology, hydrology, geology, wildlife studies, paleontology, recreation, and archaeology.

There are some general guidelines that apply to all of these types of research.

- 1) All scientific investigation must comply with relevant laws, regulations, and policies, including any permit needs.
- 2) All non-permitted external scientific investigations must be authorized by the GGNCA manager (or the manager's designee), according to the procedures described below.
- 3) Science should not impact the long term health or sustainability of the resources of GGNCA, especially the resources, objects, and values for which GGNCA was designated.
 - a. If impacts are anticipated, appropriate protocols should be followed and the potential gains should be carefully considered and weighed against potential impacts.
- 4) A balance must be maintained between research and education, and preservation and protection of GGNCA resources, objects, and values.
- 5) Scientists initiating research projects within GGNCA should be aware of existing data within the BLM and should incorporate these data into projects whenever possible.
- 6) Proposed research within the Gunnison Gorge Wilderness Area should comply with appropriate laws and regulations including the Wilderness Act of 1964 and BLM wilderness policy (Manual 6340).
 - a. Proposals must be carefully evaluated for legal and policy compliance, scientific merit, and impacts and benefits (Landres 2000). A set of worksheets may be used by GGNCA to ensure that scientific proposals in Wilderness are evaluated in a consistent way (found here: http://www.wilderness.net/index.cfm?fuse_toolboxes&sec_resSciAct).
- 7) GGNCA staff should use all available monitoring protocols to achieve adequate monitoring of the resources of GGNCA (e.g. land health assessments), especially with consideration to the national Assessment, Inventory, and Monitoring Strategy (AIM; BLM 2011).
 - a. For example, staff should use the AIM Strategy's sampling techniques and key ecosystem attributes, as feasible (BLM 2011).

SCIENCE AUTHORIZATIONS

Currently, there is no formal process for scientific authorizations within GGNCA outside of the state-wide process for permitting paleontological and archaeological research. The process described below is not meant to replace or duplicate these processes. When a prior process is already in place, it will take

precedence and researchers will only need to complete one permitting process. The process outlined below will only take effect when no other permitting process applies (e.g. non-paleontological or archeological projects). Permits and authorization projects will be shared between appropriate state and field office staff for research taking place within GGNCA.

All requests should be carefully considered, weighing potential benefits and costs. The following process has been adapted from other NLCS units.

1. Scientist submits proposal to GGNCA science coordinator.
 - a. Proposals must include:
 - i. Contact information for the principal investigator
 - ii. Summary of proposed research (not to exceed 3 pages) including
 1. A brief explanation of background information;
 2. Rationale for research;
 3. Research methods;
 4. Timeline for field work; and,
 5. Outline of public outreach effort, if appropriate.
2. The proposal will be considered by the GGNCA science coordinator for completeness. The coordinator will consult with the Colorado State Science Coordinator and staff specialists, as appropriate ,to determine if the proposal is:
 - a. Complete;
 - b. Conforms to the GGNCA Science Guidelines (including all relevant laws and regulations);
 - c. Conforms to the GGNCA Resource Management Plan;
 - d. Meets the GGNCA scientific mission.
3. The science coordinator will brief the GGNCA manager on the review of the science proposal. Subsequently, the GGNCA manager (or the manager's designee) will grant or deny authorization to conduct the scientific investigation.
4. If a proposal is denied authorization:
 - a. A letter of denial will be provided to the scientist, and will include justification for the denial.
5. If a proposal is granted authorization:
 - a. A determination will be made as to what, if any, NEPA analysis is necessary.
 - b. A letter of authorization will be provided to the scientist, signed by the GGNCA manager (or the manager's designee). The authorization may include stipulations such as NEPA analysis requirements, time limits, geographic limits, reporting requirements, and public outreach requirements.
 - c. The proposal will be added to an internal tracking document of on-going scientific investigations in GGNCA, accessible by all GGNCA staff.
 - d. Minimum reporting requirements for all scientific investigations will include:
 - i. Progress reports (at least annually), filed with the science coordinator.

1. Progress reports should include status of the investigation, areas studied, approximate dates of fieldwork, partners involved, and preliminary findings when possible.
- ii. Final reports, filed with the science coordinator.
 1. Final reports should include:
 - a. Research background and results;
 - b. Discussion of the results including how the results are relevant to the NLCS unit and potential management decisions;
 - c. A summary of the public outreach effort if appropriate;
 - d. Raw data where appropriate; and,
 - e. Electronic copies of any published papers resulting from the scientific investigation.
 - iii. Manager's summary report
 1. Manager's summary reports are brief presentations (in any appropriate format) of research results to BLM managers, which ensure that:
 - a. Management questions are answered;
 - b. Managers have a full understanding of scientific findings; and,
 - c. Managers can incorporate these findings into their management decisions.
 - iv. If results of research are not sensitive material (for example some cultural and paleontological studies), a public outreach component.
6. The authorization is routed to GGNCA and UFO staff.
 - a. Copies of the authorization will be made available to BLM staff, for example on the shared drive.
 - b. Short descriptions of ongoing research will be made available to the general public, for example on the GGNCA webpage.
 - i. Sensitive topics, for example location of specific cultural or paleontological sites, should be excluded from public information for protection of resources.
7. Research is initiated.
 - a. Research must be conducted according to the stipulations outlined in the authorization.
8. Research is completed, and final report is filed with the science coordinator.

SECTION 6 – ORGANIZATION AND COMMUNICATION OF COMPLETED SCIENCE

INTERNAL ORGANIZATION OF COMPLETED SCIENCE

Section 2 of this report provides a brief summary of the scientific background of the unit, and provides citations to the relevant reports and publications in the bibliography (Section 9) of this science plan. At every revision of the science plan, these sections will be updated.

All reports, as described in Section 5, submitted to the GGNCA science coordinator will be stored and organized on a shared drive, or via a similar medium (e.g. a Sharepoint site), accessible by all GGNCA staff. The science coordinator should aim to organize periodic presentations of scientific results to GGNCA staff.

CONTRIBUTIONS TO BROADER BLM ORGANIZATIONS OF COMPLETED SCIENCE

The GGNCA science coordinator will comply, in a timely manner, with all requests for completed scientific investigations' information/reports from BLM Field Offices, District Offices, State Offices, and the Washington D.C. Office.

COMMUNICATING SCIENTIFIC RESULTS TO THE PUBLIC

The science coordinator or coordination team will strive to make information on science projects within GGNCA accessible to the general public, and the GGNCA webpage is a logical place for dissemination of this type of information. GGNCA has a history of communicating with the public about topics of importance to GGNCA through brochures, maps, and other materials. In addition to these types of materials, information may be presented by: links to short informational videos, written descriptions of scientific inquiries occurring within GGNCA, public presentations, and citations of published research papers.

The general public has a vested interest in GGNCA which is heavily utilized by varied outdoor enthusiasts. Sharing what research is occurring (or has occurred) within GGNCA and why it is occurring (or has occurred) should be a priority, and can help avoid confusion and discontent that can stem from misunderstandings about the nature of scientific inquiries. However, while communication with the public is important, sensitive information about certain scientific projects may need to be kept confidential to ensure the protection of these resources.

SECTION 7 – INTEGRATING SCIENCE INTO MANAGEMENT

It is the responsibility of the science coordinator or coordinating team to ensure that scientific findings are communicated to managers. Managers can then use scientific information as they deem appropriate.

Written progress reports, final reports, published papers, and manager's summary will all be available to decision-makers, as described in Section 6, to help inform decisions. Furthermore, direct dialogue between scientists and managers will be encouraged.

SECTION 9 – BIBLIOGRAPHY

RESEARCH IN GGNCA

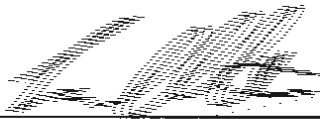
- Armstrong HA. 2002. Fossils in the Gunnison Gorge National Conservation Area: An Analysis of Paleontological Resources. US Department of the Interior, Bureau of Land Management, Gunnison Gorge National Conservation Office.
- Aslan A, K Karlstrom, WC Hood, RD Cole, TW Oesleby, C Betton, MM Sandoval, A Darling, S Kelley, A Hudson, B Kaproth, S Schoepfer, M Benage, R Landman. 2008. River incision histories of the Black Canyon of the Gunnison and Unaweep Canyon: Interplay between late Cenezoic tectonism, climate change, and drainage integration in the western Rocky Mountains. *In*: Reynolds RG, Ed. Roaming the Rocky Mountains and Environs: Geological Field Trips: The Geological Society of America Field Guide 10.
- BLM. 2005. Assessment of Use Allocation Issues in the Gunnison Gorge National Conservation Area Wilderness, available on request, BLM, UFO.
- Brashear AJ. 2006. River recreation management in western states: Results of a recreation management survey. University College University of Denver, CO.
- Carpenter DR. 2008. Thesis: Soil stability of Mancos Shale in the Gunnison Gorge National Conservation Area, Colorado. M.S. Thesis, Colorado State University, Ft. Collins, CO.
- Carpenter DR, GW Chong. 2010. Patterns in the aggregate stability of Mancos Shale derived soils. *Catena* 80: 65-73.
- Chermak JM, J Price. 2010. The economic value of river restoration: The effect of peak-flow restoration on non-market values for the Gunnison River. Final Report, University of New Mexico.
- Decker K. 2005. *Astragalus wetherillii* Jones (Wetherill's milkvetch): A Technical Conservation Assessment. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.
- Dubinski IM, E Wohl. 2007. Assessment of coarse sediment mobility in the Black Canyon of the Gunnison River, Colorado. *Environmental Management* 40: 147-160.
- Dunne BK. 2011. Inventory of breeding birds in the Gunnison Gorge National Conservation Area. Report available upon request.
- Elliot JG, JR Herring, GP Ingersoll, JJ Kosovitch, J Fahy. 2007. Rainfall-runoff and erosion data from the Mancos Shale formation in the Gunnison Gorge National Conservation Area, Southwestern, Colorado. US Department of the Interior, US Geological Survey: Open-File Report 2007-1002G, 68 pgs.
- Elliot JG, RS Parker. 1997. Altered streamflow and sediment entrainment in the Gunnison Gorge. *Journal of the American Water Resources Association* 33(5): 1041-1054.
- Elliott JG, DM Murphy, KS Tucker. 1994. Resource management considerations in a changing physical environment, the Gunnison Gorge. In *Proceedings, American Water Resources Association, Annual Symposium, Jackson Hole, Wyoming, June 26-29*; 619-628.
- Elliot JG, RS Paker. 1992. Potential climate-change effects on bed-material, the Gunnison Gorge, Colorado. In: *Proceedings, American Water Resources Association, 28th Annual Conference and Symposia, Reno, Nevada, November 1-5, 1992*, pgs. 751-759.
- Eisenhart K (2004) Historic range of variability and stand development in pinyon-juniper woodlands in western Colorado. Master's Thesis. University of Colorado, Boulder.

~~SECTION 2 - SIGNATURE PAGE AND APPROVAL~~~~SIGNATURE PAGE~~

I approve the ~~Summit Group National Conservation Area Science Plan~~.

This plan will be used as the basis for conducting science in the ~~Summit Group WCA~~. Science is defined in Section 1 of this plan.


As a living and working document, this plan will be updated or deleted every five years, potentially more frequently. Scientific needs that emerge during the course of implementing this plan may be added to the plan or an addendum as needed. Science not in the plan will be at the discretion of the scientific community.



~~Amanda Clements, Science Coordinator~~
~~Summit Group National Conservation Area~~

~~7/23/13~~

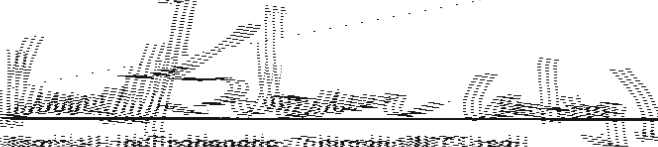
~~Date~~



~~Karen Lister, Manager~~
~~Summit Group National Conservation Area~~

~~7/27/13~~

~~Date~~



~~William H. Hollander, Colorado Wildlife~~
~~Colorado Game Office~~

~~7/26/2013~~

~~Date~~



~~Matt Preston, WCS Science Coordinator~~
~~Washington, D.C.~~

~~7/22/13~~

~~Date~~

- Hansen WR. 1965. The Black Canyon of the Gunnison today and yesterday. US Department of the Interior, US Geological Survey: Bulletin 1191, 76pgs (http://www.nps.gov/history/history/online_books/geology/publications/bul/1191/index.htm).
- Hansen WR, ZE Peterman. 1968. Basement-rock geochronology of the Black Canyon of the Gunnison, Colorado. US Department of the Interior, US Geological Survey: Professional Paper 400.
- Hansen WR. 1987. Black canyon of the Gunnison: In depth. Southwest parks and monuments association, Tuscon, AZ, 58 pgs.
- Hayes MA, KW Navo, LR Bonewell, CJ Mosch, RA Adams. 2009. Allen's big-eared bat (*Idionycteris phyllotis*) documented in Colorado based on recordings of its distinctive echolocation call. The Southwestern Naturalist 54:499-501.
- Hebein S, RB Nehring, KG Thompson. 1998. Impacts of whirling disease on wild trout in the Gunnison River Gorge. In: Proceedings of the 1998 Whirling Disease Symposium.
- Kellog KS. 2004. The geologic story of the Gunnison Gorge National Conservation Area. US Department of the Interior, US Geological Survey: Professional Paper 1699.
- Krikham RM, RB Scott, TW Judkins (eds). 2002. Late Cenozoic evaporate tectonism and volcanism in west-central Colorado. The Geological Society of America, Special Paper 366.
- Kellog KS, WR Hansen, KS Tucker, DP VanSistine. 2004. Geology of Gunnison Gorge National Conservation Area, Delta and Montrose Counties, Colorado. US Department of the Interior, US Geological Survey: Fact sheet 2004-3050.
- Kellog KS, WR Hansen, KS Tucker, DP VanSistine. 2004. Geologic map of Gunnison Gorge National Conservation Area, Delta and Montrose Counties, Colorado. US Department of the Interior, US Geological Survey: Scientific Investigations, Map 2825.
- Kingery HE. 1998. Colorado breeding bird atlas. Colorado bird atlas partnership, Colorado Wildlife Heritage Foundation, Denver, CO.
- Knopf RC, KL Andereck, K Tucker, B Bottomly, RJ Virden. 2004. Building connections among lands, people and communities: A case study of Benefits-based management plan development for the Gunnison Gorge National Conservation Area. In Proceedings: The 4rth Social Aspects and Recreation Research Symposium: February 4-6m, San Francisco, California. Pgs. 169-179.
- Lyon P, T Stephens, J Siemers, D Culver, P Pineda, J Zoerner. 1999. The Uncompahgre River Basin: A natural heritage assessment. Colorado Natural Heritage Program Report. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.
- Lyon P, M Denslow. 2001. Gunnison Gorge National Conservation Area survey of impacts on rare plants. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.
- Merewether EA, DA Sawyer, WA Cobban. 2006. Molluscan fossils and stratigraphic descriptions from the Upper Cretaceous Mancos Shale, West-Central Colorado. US Department of the Interior, US Geological Survey: Open-File Report 2006-1326, 17 pgs.
- Murphy DM. 1990 (unpublished). Variation of surface soil salinity on steep Mancos Shale terrain. US Department of the Interior, Bureau of Land Management, Uncompahgre Field Office
- O'Sullivan RB. 1992. The Jurrasic Wanakah and Morrison Formations in the Telluride4-ouray-Western Black Canyon Area of Southern Colorado. US Department of the Interior, US Geological Survey: Bulletin 1927, 24 pgs.

- Ouren DS, RD Watts. 2005a. Public access management as an adaptive wildlife management tool. US Department of the Interior, US Geological Survey: Open-File Report 2005-1349, 13 pgs.
- Ouren DS, RD Watts. 2005b. Roads and traffic: effects on ecology and wildlife habitat use, applications for cooperative adaptive management. US Department of the Interior, US Geological Survey: Fact Sheet 2005-3102, 2 pgs.
- Ouren DS, C Hass, CP Melcher, SC Stewart, PD ponds, NR Sexton, L Burris, T Fancher, SH Bowen. 2007. Environmental effects of off-highway vehicles on Bureau of Land Management Lands: A literature synthesis, annotated bibliographies, extensive bibliographies, and internet resources. US Department of the Interior, US Geological Survey: Open-File Report 2007-1353, 241 pgs.
- Panjabi SS, DG Anderson. 2004. *Cirsium perplexans* (Rydb.) Petrak (Rocky Mountain thistle: A technical conservation assessment. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.
- Parker JM and SF Spear. 2013. Developing predictive models for the presence and absence of midgert gaded rattlesnakes (*Crotalus oreganus concolor*) across their range in Colorado. Report. Department of Natural Sciences, Clayton State University, Morrow GA.
- Schisler GJ, ER Fetherman. 2010. Salmonid disease studies, Federal Aid Project F-394R-9. Colorado Division of Wildlife, Aquatic Wildlife Research Station, Fort Collins, CO.
- Tuttle MLW, J Fahy, RI Grauch, BA Ball, W Chong, JG Elliot, JJ Kosovich, KE Livo, LL Stillings. 2007. Results of the chemical analyses of soil, shale, and soil shale extract from the Mancos Shale Formation in the Gunnison Gorge National Conservation Area, Southwestern Colorado, and at Hanksville, Utah. US Department of the Interior, US Geological Survey: Open-File Report 2007-1002D, 67 pgs.
- University of Idaho. 2008. GGNCA Chukar Trailhead Visitor Survey. Available on request, UFO
- USGS. 2013. Mancos shale landscapes: Science and management of black shale terrains. Accessed July 2013 (http://minerals.cr.usgs.gov/projects/mancos_shale/index.html)
- Vandas S, D Whittaker, D Murphy, D Prichard, L MacDonnell, B Shelby, D Muller, J Fogg, B Van Haven. 1990. Dolores River instream flow assessment: Project Report. US Department of the Interior, Bureau of Land Management, Denver Federal Center.
- Whittig LD, AE Devo, KK Tanji. 1982. Evaporite mineral species in Mancos shale and salt efflorescence Upper Colorado River Basin. Soil Science Society of America Journal 46: 645-651.

GENERAL BIBLIOGRAPHY

- Bezzerrides N, KR Bestgen 2002. Status review of roundtail chub *Gila robusta*, flannelmouth sucker *Catostomus latipinnis*, and bluehead sucker *Catostomus discobolus* in the Colorado River basin. Colorado State University Larval Fish Laboratory. 118: pgs. 1-139. Colorado State University, Fort Collins, CO.
- BLM (2001) Land Health Assessment: Gunnison Gorge Area. Record of Decision. US Department of the Interior, Bureau of Land Management, Uncompagrh Field Office, Montrose, CO.
- BLM (2004) Gunnison Gorge National Conservation Area: Approved Resource Management Plan and Record of Decision. US Department of the Interior, Bureau of Land Management, Uncompagrh Field Office, Montrose, CO.

- BLM (2007) Bureau of Land Management National Landscape Conservation System Science Strategy. US Department of the Interior, Bureau of Land Management, National Landscape Conservation System Office, Washington DC.
- BLM (2008) Bureau of Land Management Science Strategy. US Department of the Interior, Bureau of Land Management, Washington DC.
- BLM (2011) Assessment, Inventory, and Monitoring Strategy for integrated and renewable resources management. US Department of the Interior, Bureau of Land Management, Washington DC.
- BLM (2013) Bureau of Land Management Colorado Sensitive plant species of the Uncompahgre Field Office. Accessed July 16, 2013
(http://www.blm.gov/co/st/en/fo/ufo/wildlife_and_vegetation/sensitive_plant_species.html)
- Boydston RA, MM Williams (2004) Combined effects of *Aceria malherbae* and herbicides on field bindweed (*Convolvulus arvensis*) growth. Weed Science 52: 297-301.
- Colorado Climate Center (2010) Montrose, CO and Cimarron, CO Stations. <http://www.wrcc.dri.edu/summary/Climsmco.html>, downloaded November 2010.
- Colorado Department of Agriculture Insectory. Biological Pest Control Program (2011) . Downloaded June 2011.
- Crawford Area Gunnison Sage Grouse Working Group. (2011) Crawford Area Gunnison Sage-grouse Conservation Plan. 51pgs. Report available upon request.
- Davis TZ, ST Lee, MH Ralphs, KE Panter (2009) Selected common poisonous plants of the United States rangelands. Rangelands 31: 38-44
- Desmond M, J Savidge, et al. (2000). Correlations between burrowing owl and black-tailed prairie dog declines: a 7-year analysis. The Journal of Wildlife Management 64(4): 1067-1075.
- Federal Register (2010) 12 Month Finding on a Petition to List the White-tailed Prairie Dog as Endangered or Threatened. 75 FR 30238- 30363
- Federal Register (2012) Review of Native species tha are candidates for listing as endangered or threatened: Annual notice of findings on resubmitted petitions: Annual descriptio of progress on listing actions. 77FR 6993 70060
- George JL, R Kahn, MW Miller, B Watkins. 2009. Colorado Bighorn sheep management plan 2009-2019. Special Report #81, Colordo Division of Wildlife, Terrestrial Resources.
- Gunnison Basin and Grand Valley selenium task forces. 2013. Accessed July 2013,
<http://www.seleniumtaskforce.org/>
- Hayes MA, KW Navo, LR Bonewell, CJ Mosch, RA Adams (2009) Allen's Big-eared bat (*Idionycteris phyllotis*) documented in Colorado based on recordings of its distinctive echolocation call. The Southwestern Naturalist 54: 499-501
- Hayes MA (2008) Bats in the Paradox Valley Area and Gunnison Gorge National Conservation Area: Results of mist-netting and acoustic surveys during (2008). BLM Report, University of Northern Colorado, Greeley, CO
- Jacobs J (2007) Ecology and management of Whitetop (*Cardaria draba* (L.) Desv.). Invasive Species Technical Note No. MT 12. US Department of Agriculture, Natural Resources Conservation Service.
- Kotliar NB, BW Baker, AD Whicker, G Plumb (1999) A critical review of assumptions about prairie dogs as a keystone species. Environmental Management 24: 177-192

- Landres P (Ed) (2010) A framework to evaluate proposals for scientific activities in wilderness. Gen. Tech. Rep. RMRS-GTR-234WWW. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station. 74 pgs.
- Laymon SA. 1998. The Riparian Bird Conservation Plan: A strategy for reversing the decline of riparian-associated birds in California. BLM, accessed online June 4, 2013 (http://www.blm.gov/ca/pdfs/cdd_pdfs/Ybcu1.pdf).
- Morrissey WA, JA Zinn, ML Corn (1994) Ecosystem Management: Federal Agency Activities. CRS Report for Congress, Congressional Research Service, Library for Congress
- Noss RF and AY Cooperrider (1994) Saving Nature's Legacy: Protecting and restoring biodiversity. Island press, Washington, D.C.
- NRLS (North Rim Landscape Strategy Workgroup (2010) North Rim Landscape Strategy Document. <http://northrimlandscapestrategy.org/document.htm>, downloaded November 2010
- Oyler-McCance SJ, KP Burnam, CE Braun (2001) Influence of changes in sagebrush on Gunnison sage grouse in Southwestern Colorado. The Southwestern Naturalist 46: 323-331
- Reed-Eckert ML (2010) Teetering on the edge of suitable climate: Kit fox (*Vulpes macrotis*) range limit dynamics in East-central Utah and West-central Colorado, 1983-2009. Thesis, University of Colorado, Boulder, CO
- Rees DE, JA Ptacek, RJ Carr, and WJ Miller. 2005. Flannelmouth sucker (*Catostomus latipinnis*): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain region. Available: <http://www.fs.fed.us/r2/projects/scp/assessments/flannelmouthsucker.pdf> [accessed June 4, 2013]
- Reever Morghan KJ, RL Sheley, TJ Svejcar (2006) Successful adaptive management: The integration of research and management. Rangeland ecology and management 59: 216-219
- Stevens J 2004 Biological Inventory of the Colorado Canyons National Conservation Area. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.
- Stuart SN, JS Chanson, NA Cox, BE Young, ASL Rodrigues, DL Fischman, RW Waller (2004) Status and trends of amphibian declines and extinctions worldwide. Science 306: 1783-1786
- US Fish and Wildlife Service (2011) A national Plan for assisting States, Federal agencies, and Tribes in managing white-nose syndrome in bats. US Fish and Wildlife Service. Hadley, MA (<http://www.fws.gov>, accessed March 2013)
- WhitsonTD, LC Burrill, SA Dewey, DW Cudney, BE Nelson, RD Lee, R Parker (2009) Weeds of the West, 10th Ed. The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities Cooperative Extension Services. Las Cruces, NM
- Wiggins GJ, JF Grant, PL Lambdin, JW Ranney, JB Wilkerson, A Reed, RA Follum (2010) Host utilization of Field-caged native and introduced thistle species by *Rhinocyllus conicus*. Environmental Entomology 39: 1858-1865
- Williams, B. K., R. C. Szaro, et al. (2007). Adaptive management: the US Department of the Interior Technical Guide. US Department of the Interior, Adaptive Management Working Group

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1. The Department of Transportation is authorized to take the following actions:

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Information: <http://www.pennstate.edu/ice/iceinfo.htm>
 Penn State's Office of Information and Communications Technology
 322 Old Main Building, University Park, PA 16802-1500
 814/863-7100

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The following is the full text of the letter, which is a request for a copy of the letter from the author to the editor of the journal. The letter is dated 1998 and is addressed to the editor of the journal. The letter is written in a formal, professional tone and is signed by the author, Dr. [Name].

1. *Chlorophyll a* and *b* contents were determined by the method of Lichtenthaler and Whistler (1973). The total chlorophyll content was determined by the method of Arar and Cook (1980).

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INVESTMENT CONSULTATION ON PROPERTY AND FINANCIAL SECURITY

(S) ALL INFORMATION CONTAINED HEREIN IS UNCLASSIFIED
DATE 09-18-2011 BY 60322 UCBAW/BJS

(1) **RESEARCH ON PRODUCTION**
(2) **RESEARCH ON CONSUMPTION** — *See* **RESEARCH ON CONSUMPTION**

(1) 1990年12月31日以前，在中华人民共和国境内，凡从事生产、经营、建设、服务等活动的单位和个人，均应当依照《中华人民共和国营业税暂行条例》的规定，缴纳营业税。

[illegible]

1. The first step is to identify the problem. In this case, the problem is that the company is not meeting its sales targets. The second step is to analyze the data. The third step is to develop a plan. The fourth step is to implement the plan. The fifth step is to evaluate the results.

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Desmond, M., J. Savidge, et al. (2000). "Correlations between burrowing owl and black tailed prairie dog declines: a 7 year analysis." The Journal of Wildlife Management 64(4): 1067 1075.

Jacobs, J. (2007). "Ecology and management of Whitetop (*Cardaria draba* (L.) Desv.)." United States Department of Agriculture Natural Resources Conservation Service: Invasive Species Technical Note No. MT 12.

This is from the vegetation section for Section 3:

A. Describe the management decisions that the BLM expects to make in the next five-plus years for the unit

1. Develop habitat restoration vegetation treatments in areas where pinyon pine and juniper have encroached into sagebrush communities.
2. Protection and management of T/E/S species. Determine degree of investment into protecting existing objects, surveying for additional populations, and conducting inventories for State and BLM sensitive species.
3. Determine level of engagement (staff, funds, etc.) in the Escalante River watershed invasive plant removal and monitoring. Consider expansion of these efforts into other watersheds.
4. Need a prioritized fuel treatment and resilient landscape program for forest and woody shrub vegetation communities.
6. Grazing permit renewal following the completion of the Livestock Grazing Plan Amendment and EIS.

B. Describe the scientific knowledge needed to support those management decisions

1. Information about the success of recent past and current restoration treatments and seeding project.
2. Status, trends and conditions of the three threatened and endangered plants and the extent of BLM sensitive plants. Understanding the threats, stressors, and degree of impacts.
3. Knowledge of the effectiveness of the woody plant removal treatments, re-infestation rates, and a cost-benefit analysis.
4. Understand the effectiveness of current invasive plant control methods and how success is defined. Evaluate other tools (methods, herbicides, etc.) for effectiveness and economic efficiencies.
5. Work with foresters from Color Country Fire Division and BLM State Office to develop a scientific understanding of the status, trends, and condition of the woodland vegetation communities as well as the threats and stressors.
6. Current conditions and future trajectories of the rangeland health by grazing allotment.

- C. Of the scientific knowledge needed, identify which knowledge is already accessible and which knowledge needs more scientific effort. The latter are the unit's science needs
1. Analyze and summarize existing rangeland health and AIM data. Incorporate new information on harvest efficiencies and livestock distribution across the landscape.
 2. Analyze current vegetation restoration datasets to evaluate pinyon pine, juniper, and sagebrush treatments and seeding projects. Evaluate the short- and long-term ecological effect of non-native seeds used in restoration seed mixes.
 3. Analyze annual monitoring data on the three Threatened and Endangered species to determine status and trend. Evaluate the robustness of the current monitoring plan. Continue monitoring on a frequency appropriate for each species.
 4. Continue collecting and analyzing vegetation data from the ERWP to evaluate long-term vegetation change and effects of woody invasive plant removal on geomorphology. Evaluate the success and costs of treatments.
 5. Utilize Forest Service's Forest Inventory and Analysis (FIA) and Forest Health Monitoring Program (FHM) data for status and trends. Work across agencies to develop landscape scale forestry plans/

I am also considering simplifying it to:

Analysis of current data sets (rangeland health, restoration treatments, T/E/S species, riparian habitat improvements, etc.) and develop status and trends.

Design and implement monitoring sampling designs that have quantifiable objectives and are statistically robust to answer management objectives.

This is from the social science section for Section 3:

A. Describe the management decisions that the BLM expects to make in the next five-plus years for the unit (Need MLT input)

Management will assess the recreational use, visitor infrastructure and visitor impacts to ensure resource protection and compatible multiple uses.

B. Describe the scientific knowledge needed to support those management decisions

Some examples of the information needed to support management decisions for recreation resources and visitor management include visitor use, patterns, and

numbers by location; visitor impacts to resources by type, degree and location; and visitor experiences, expectations and desired outcomes.

C. Of the scientific knowledge needed, identify which knowledge is already accessible and which knowledge needs more scientific effort. The latter are the unit's science needs

Recreational and visitor research studies in conjunction with the Monument's tracking systems and staff expertise, are currently available and can be synthesized to inform recreation allocations, developing Special Recreation Management Area Plans, managing to meet visitor expectation for desired outcomes, identifying visitor infrastructure needs, and evaluate and develop stronger tools for tracking and analyzing recreational numbers and types of use. Much of the work that has been completed to date is synthesized in a report compiled by Dr. David Cole (2015). The focus area of this report is one of the most visited and impacted area in the Monument, the Escalante Canyons. Current visitor use, backcountry monitoring, and recreational experience studies can also help inform management decisions.

Some of the earlier visitor use studies are now outdated, in particular the front country, (Burr et al. 2006 – usu study). Because visitation has almost doubled and visitor demographics have changed, it would be timely to conduct this study again.