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[GSENM SRP Info 2017 - zipped.zip](#)

Greetings GSENM SRP holders and applicants,
 As many of you know, the Grand Staircase-Escalante National Monument (GSENM) was unfortunately unable to hold its annual Outfitters and Guides Workshop this past spring. However, we do want to provide you with new information about ongoing activities, projects and events that may be of interest to you, your employees, and your clients. Attached to this email is a zipped folder containing the following.

- **2017 GSENM SRPs:** listing of currently authorized operators, as of May 2, 2017
- **2016 Manager's Report:** overall summary of GSENM activities in 2016
- **Paleontology Review:** a recent article from GSENM paleontologist Alan Titus
- **Archaeology Review:** a quick update from GSENM archaeologist Matt Zweifel
- **Recreation Study:** a recent report regarding recreational experiences in the Grand Staircase region
- **Facilities Notes:** a quick overview of recent upgrades to several recreation sites
- **SRP Stipulations:** the standard terms and conditions for all SRP holders
- **Leave No Trace:** brochure on LNT principles in desert ecosystems

Additionally, you may have noted the BLM has transitioned to a new website design and service. Although it's still going through some growing pains, I would encourage you to check out the [new GSENM website](#).

BLM Utah has also developed a number of [georeferenced PDF maps](#), including several for high-use GSENM destinations, corridors, and a full [Monument Travel Map](#) that documents the full network of roads open for vehicle travel.

I hope you find these resources valuable as you continue on into your busy spring and summer seasons, and thank you for your ongoing safe and responsible recreation on your public lands. Please feel free to reach out with any questions, concerns and issues.

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Brian Amstutz
 Park Ranger & Special Recreation Permit Administrator

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Recreation Experience Baseline Study Report
Grand Staircase-Escalante National Monument
Phase 2: Grand Staircase Area



Complete Report

The Natural Resource Center at Colorado Mesa University
2015

Principal Investigator: Dr. Tim Casey, Professor, CMU

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Executive Summary

In the fall of 2012, Grand Staircase-Escalante National Monument (GSENM) entered into a five-year assistance agreement with the Natural Resource Center (NRC) at Colorado Mesa University (CMU) in Grand Junction, Colorado to conduct a recreational experience baseline study of the Monument. A recreational baseline study is designed to develop an understanding of the recreational use and demands of a particular location at a particular time to establish a baseline for future planning or projects. This baseline will also serve as a starting point for conversations between the BLM and their partners in the surrounding communities and beyond regarding recreation on GSENM. The study was planned to be conducted in five phases across the approximately 1.9-million-acre monument, beginning in 2013 with the areas accessed by Hole in the Rock Road. The Grand Staircase study area is located on the western third of GSENM and is accessed primarily by Johnson Canyon, Cottonwood and Skutumpah Roads as well as Highway 89 on the southern edge. This area connects the gateway communities of Bryce Valley (Cannonville, Tropic, Henrieville) with Kanab. Features include slot canyons, unique geographic features such as Grosvenor's Arch, and historic sites such as the Paria River settlements.

A mixed methodology focus group, using audience polling in addition to engaging participants in open dialogue, was determined to be the appropriate approach to establish the recreation experience baseline. In this case, a focus group is a structured conversation with a limited number of participants (less than 25) regarding recreation in GSENM. The small nature of the setting and open-ended nature of the questions allows for a good deal of interaction between the participants and the facilitator, and between the participants themselves. This methodology allows participants to express the subtleties and nuances of what really matters to them about recreating in the area. This mixed methodology approach provides a data set that captures both a complete set of responses from each participant using audience polling technology as well as documents a rich set of notes from the group dialogue that gives context and depth to the polling data. Dr. Tim Casey, a Professor of Political Science at CMU and director of the NRC, was named as the principal investigator to conduct the focus groups and prepare the analytical reports.

A total of 17 focus groups were conducted between March and September 2014 for this second phase of the study. Thirteen of those focus groups were conducted in person in the towns of Kanab, Cannonville and Orderville, Utah, in three separate visits during March, May and September. The remaining four focus groups were conducted digitally via the internet and conference call (these will be referred to throughout this document as "digital focus groups"). There were a total of 77 participants in the 17 focus groups. Of the 77 participants in the study, 41 attended a focus group in Kanab, 13 in Cannonville, two in Orderville, and 16 participated digitally via the internet. The participants were allowed to remain anonymous, although their responses were tracked and collated by the use of audience polling technology. Some basic demographic information was collected at the beginning of each session. Participants were asked to provide home zip codes in order to identify how representative this study was of the overall population. The majority of participants came from zip codes in Utah (63%). Most of those came from Kanab (38%) or the Bryce Valley communities of Cannonville and

Tropic (12.6%), the gateway communities to the Grand Staircase area, as well as other communities near GSENM including Escalante and Boulder (3.5%) and the nearby Arizona communities of Page and Fredonia (7%). Other participants represented a total of eight other states and a Canadian province. There were participants from 31 unique zip codes. Participants were also asked to select one affiliation (role) they have in relation to the landscape. Those selections included: visitor, local resident, community leader, outfitter/guide, business owner, other. The majority of the participants selected affiliations associated with the local area: local resident (39%), business owner (8%), and community leader (11.5%). Visitors represented (20.7%) of the total and outfitters/guides made up 8%. 7% of respondents did not select an affiliation, and 5.75% chose "other".

The design of the focus group for data collection entailed a series of discussion questions designed to engage participants in open dialogue about their preferences, interests and expectations regarding recreation so responses could be captured in their own words, followed by a list of choices that represented a spectrum of possible answers to the discussion questions. They could respond to this list of possible responses by selecting them via anonymous audience polling using hand held remote response devices (clickers). The focus group script covered all the major elements needed in planning for recreation on public lands: preferences for outcomes and experiences, interests and expectations, setting characteristics, activities, and the services needed to support the recreation experience.

After analysis of the responses from 77 participants in 17 focus groups over seven months of data collection in 2014, the following observations and suggestions began to emerge regarding the Grand Staircase area of GSENM accessed by Johnson Canyon, Cottonwood and Skutumpah Roads. Although in a baseline study, the principal focus is on observations of the setting and context, inevitably some participants expressed their ideas concerning the area as suggestions for future action. These were not solicited in the study, but are recorded as part of the response given.

Observations:

- The Grand Staircase is a special place because of its:
 - Uniqueness of Geology (large and small scale).
 - Scenic beauty and view-sheds.
 - Opportunities for learning – scientific study, discovery, public education about diversity of landscape.
 - Variety of recreational opportunities – from iconic to the unknown.
 - Time's effect on dynamic landscape.
 - Seasonal variation and light variation throughout the day.
 - Archeological resources.
 - Abundant and important sites, but some threatened in the area.
 - Robust commitment of site stewards program.
 - Quietness, remoteness, naturalness.
 - Water in the desert – riparian areas.
- It is a land of contrasts among several important dimensions of human interaction with the landscape such as:

- Sense of place
 - Deep sense of place among locals, yet concern that increasing numbers of visitors have little connection to or understanding of the place.
- Accessibility and remoteness
 - Primary roads allow accessibility, but scale of landscape maintains remoteness and space between those recreating, thus solitude is maintained.
- Tourism blessings and curses
 - Beneficial to local economies and some participants expressed the joy of sharing wonders of landscape, yet increased numbers and crowding is becoming a concern in the area.
- Participants expressed mixed feelings about the roads that provide transit through and across this landscape.
 - On the positive side, participants indicated that:
 - Many people are using Cottonwood, Skutumpah, and Johnson Canyon Roads as primary access in and through landscape.
 - These primary roads in GSENM often are used to connect communities on the periphery of the Monument.
 - Some developed roads also allow those with reduced mobility to enjoy the landscape and features.
 - On the negative side, participants indicated that:
 - Weather can make the roads dangerous or impassable due to poor road conditions, wash outs, mud, etc.
 - Visitors can get lost. There is a lack of signs and GPS is not accurate.
 - Late night transit through GSENM might be connected to illegal activity such as smuggling/trafficking.
 - People can move too fast across the landscape to appreciate it with road development.
 - Back country aviation is on the increase; participants have strong but mixed feelings on this development. Some passionately advocate for this recreation opportunity while others suggest that the noise and visual image diminish the specialness of the place and their experience of the Monument.
- Several of the themes emerging from participant's comments centered around displaced tourism as well as recreational tourism in a diverse landscape, for example:
 - On the southern end of the Grand Staircase area there is significant increase in use through the spill over from those who didn't get selected in "The Wave" lottery. This provides an opportunity for those displaced tourists, but also increases pressure on the area resources.
 - Diversity of landscapes in Grand Staircase region is highly valued among participants. (Colors, canyons, wilderness and road variety)
- The Grand Staircase area has a strong connection to Western Heritage both real and imagined.

- Connections to ancestors and pioneers on landscape are very important to many participants, especially Paria Town Site and Cannonville Visitor Center.
- The mythic west is celebrated in festivals around the area. Tourism to old western movie sites in area is an important contributor to recreation and local tourism economies.

Suggestions:

Numerous suggestions were offered by participants to address concerns:

- Development of recreational resources in the southern end of the Grand Staircase area might provide an alternative to restrictions and/or development in surrounding public lands that are more fragile to impacts such as the Paria Canyon and Paria Canyon-Vermilion Cliffs Wilderness Area (includes “The Wave”).
- A diversity of experiences is possible in the region; managers should consider recreational planning at a landscape scale to determine the best niches for GSENM.
- Several efforts should be made to educate public about GSENM
 - Including: maps, signs, visitor information, websites
 - Programs about how to properly respect the land
- Partnerships with local communities and organizations are successful and should be expanded to manage pressures on landscape.
- Maintain views and
- Provide unique recreation opportunities for a variety of travel modes.
- Natural landscapes, tranquil escapes and scientific learning are unique combination of qualities to be maintained in Grand Staircase area of GSENM.

Full Report

Introduction

The Grand Staircase region of Grand Staircase Escalante National Monument (GSENM) embodies such a geologic sweep of time that it is truly humbling to humans standing in the midst of it today. Using the metaphor of a “staircase,” one can both describe the physical geology moving chronologically and physically up through millions of years of change and thousands of feet of elevation from the south to the north in this part of the Monument in some sort of techno-color geologic atlas; but it can also be used as a metaphor to consider the layers of habitation and interaction between the land itself and the creatures and peoples that are connected to this place. Each physical layer of the “Staircase” took eons to form and holds within it not only unique geologic treasures, but remains of dinosaurs and other prehistoric life forms that have called this part of Utah home long before humans ever encountered this landscape. As humans began to move in and settle among the cliffs of the Grand Staircase, they too, left their mark in the form of petroglyphs and pictographs as well as the remains of their small villages and the tools of their daily challenges to live in this remote and unforgiving landscape. The ancestors of those first human inhabitants of the area still live near these ancient ruins practicing some of the same techniques that rise out of the human connection to a place. Drawn by religion and/or a sense of adventure, more humans came to settle in this region along the banks of the Paria River which starts in the highlands at the northern edge of the area and cuts through the middle of the Grand Staircase all the way down to the Colorado River. The remains of the nineteenth century town of Pahrreah along the Paria River in GSENM reminds one of yet another layer of interaction between humans and the landscape. Ancestors of those early settlers also remain living in the area carrying on the traditions that tie them to the landscape so central to the lives of those who have gone before.

Today, the Grand Staircase area remains a living landscape connecting a variety of communities, local residents and an increasing number of visitors from far and wide to a unique and dynamic place that seems at once timeless and familiar, yet ever new and full of surprise and discovery. This report is an attempt to understand the many senses of place that people have with this dynamic landscape known as the Grand Staircase as they recreate in and around this western portion of GSENM and surrounding areas. It is a report on the data collected through a series of focus groups (conversations) in 2014 about the area and people’s connection to it.

In the fall of 2012, GSENM entered into a five-year assistance agreement with the Natural Resource Center (NRC) at Colorado Mesa University (CMU) in Grand Junction, Colorado to conduct a recreational experience baseline study of the Monument. A recreational baseline study is designed to develop an understanding of the recreational use and demands of a particular location at a particular time to establish a baseline for future planning or projects. This baseline will also serve as a starting point for conversations between the BLM and their partners in the surrounding communities and beyond regarding recreation in Grand Staircase Escalante National Monument. The study was planned to be conducted in five phases across the almost two-million-acre monument, beginning in 2013 with the areas accessed by Hole in the Rock Road. Phase 2 of the study began in 2014 focused on the Grand

Staircase region, and Phase 3 will focus on the landscapes within the Highway 89 corridor and on the Paria Plateau in 2015. Finally, the areas accessed by Highway 12 and the Burr Trail will be studied in 2016. The fifth year of the study will be dedicated to compiling a Monument-wide recreation experience baseline by combining and analyzing each of the earlier phases.

Although the principle focus of the study is on lands within GSENM, it is neither possible nor desirable to exclude the surrounding federal and state public lands from the dialogues. Lands adjacent to GSENM that are managed by federal or state agencies include Glen Canyon National Recreation Area, Bryce Canyon and Capitol Reef National Parks, Dixie National Forest, Vermillion Cliffs National Monument, Kodachrome Basin and Escalante Petrified Forest State Parks, Utah State and Institutional Trust Lands, and lands managed by the BLM Kanab and Arizona Strip Field Offices.

A mixed methodology focus group, using audience polling in addition to engaging participants in open dialogue, was used to establish the recreation experience baseline. In this case, a focus group is a structured conversation with a limited number of participants (less than 25) regarding recreation in the Hole in the Rock area. The nature of the small-group setting and open-ended nature of the questions allows for interaction between the participants and the facilitator, and between the participants themselves. This methodology allows participants to express the subtleties and nuances of what really matters to them about recreating in the area. This mixed methodology approach provides a data set that captures both a complete set of responses from each participant using audience polling technology as well as documents a rich set of notes from the group dialogue that gives context and depth to the polling data. Dr. Tim Casey, a Professor of Political Science at CMU and director of the NRC, was named as the principal investigator to conduct the focus groups and prepare the analytical reports.

When the five-year study is complete, each phase will collectively contribute to a rich understanding of the public's recreational preferences, their connections to GSENM and surrounding public lands, as well as the impact of recreational use of those lands on gateway communities.

Methodology

The mixed methodology focus group¹, using audience polling in addition to engaging participants in open dialogue, was determined to be the appropriate approach to establish the recreation experience baseline. This methodology captures both a complete set of responses from each participant using audience polling technology as well as documents a rich set of notes from the group dialog that gives context and depth to the polling data. Either approach used alone would leave an incomplete picture of the broad and deep relationships people have with this landscape.

The design of the focus group for data collection entailed a series of discussion questions intended to engage participants in open dialogue about their preferences, interests, and expectations so responses could be captured in their own words, followed by a list of choices that represented a spectrum of

¹ The methodology discussion here is the same as that found in the Phase 1 report from the Hole in the Rock study area because the methodology for all 4 data gathering phases will be the same. This discussion is repeated here for those who only read this phase 2 report.

possible responses to the discussion questions that could be responded to via anonymous audience polling. The audience polling was captured by each participant using a handheld clicker linked to Turning Technologies software. The open dialogue comments were documented with audio recording equipment as well as by CMU researchers taking notes.

The focus group script covered all the major elements needed in planning for recreation on public lands: preferences for outcomes and experiences, interests and expectations, setting characteristics, activities, and the services needed to support the recreation experience. It included 20 questions, eight were open-ended, nine had prepared responses for audience polling, and three allowed for both polling and open-ended responses. All questions with prepared responses included an “other” option so participants weren’t constrained by the prepared responses. Of the open-ended questions, one included a mapping exercise where participants noted special places on a map of the study area, and another included a series of black and white images that focused dialogue on perceptions of crowding and levels of development. The number of questions included in the script was tailored to allow for a 90-minute focus group. See Appendix 1 for a copy of the focus group handout.

A total of 17 focus groups were conducted between March and September 2014 for this second phase of the study. Thirteen of those focus groups were conducted in person in the towns of Kanab, Cannonville and Orderville, Utah, in three separate visits in March, May and September. The remaining four focus groups were conducted digitally via the internet and conference call (these will be referred to throughout this document as “digital focus groups”). The digital focus groups were facilitated through Adobe Connect software and utilized the same discussion prompts and polls that were used during the in-person focus groups.

There were a total of 77 participants in the 17 focus groups for this phase of the research. Of the 77 participants in the study, 41 attended a focus group in Kanab, 13 in Cannonville, 2 in Orderville and 16 participated digitally via the internet. The participants were allowed to remain anonymous, although their responses were tracked and collated by the use of audience polling technology. Some basic demographic information was collected at the beginning of each session. Participants were asked to provide home zip codes in order to identify how representative this study was of the overall population. The table in Figure 1 indicates the dates, locations, and number of participants for each focus group.

Figure 1 – Table of Focus Groups, Dates and Locations

Focus Group #	Date	Location/Name	Number of Participants
1	3/7/14	Kanab #1 - Outfitters	11
2	3/8/14	Kanab #2	11
3	3/7/14	Kanab #3	1
4	3/8/14	Cannonville #1	6
5	5/14/14	Cannonville #2	4

6	5/15/14	Kanab #4	7
7	5/15/14	Kanab #5	5
8	5/16/14	Kanab #6	3
9	5/17/14	Orderville #1	2
10	7/17/14	Digital Focus Group #1	5
11	7/17/14	Digital Focus Group #2	5
12	7/29/14	Digital Focus Group #3	2
13	7/29/14	Digital Focus Group #4	4
14	9/19/14	Kanab # 7	2
15	9/19/14	Kanab #8	4
16	9/20/14	Kanab #9	2
17	9/20/14	Cannonville #3	3

Outreach to populate the focus groups included:

- Invitations shared with area board and committees (i.e. Monument Advisory Committee, Scenic Byway 12 Committee, etc.),
- Direct outreach to partners and key stakeholders (Grand Staircase-Escalante Partners, Glen Canyon Natural History Association, GSENM Outfitters and Guides, including wilderness therapy and other special use permit holders, etc.),
- Press releases in local newspapers,
- Flyers posted at Visitor Centers, local post offices, and in local businesses,
- Postcards distributed in visitor centers,
- Information packets with business cards in trailhead register boxes,
- Group email notices,
- Word of mouth, and
- Direct e-mail or phone contact with any who expressed interest in participating.

The methodology of audience polling allows each participant the opportunity to weigh in on every area of the research. This is important to avoid a wide variety of social setting dynamics that arise in traditional focus group settings, such as only hearing from extroverted participants who dominate a conversation. The polling also minimizes the undue influence of peer settings in small communities. If an individual is worried about the repercussions of their responses mentioned aloud in a focus group within their community, they are not likely to respond, or not as accurately. However, if they can anonymously record their preferences, they may feel more liberated to express their true opinion. The audience polling using electronic recording devices preserves participants' anonymity while being able

to link all of their answers together for the purposes of analysis. In traditional focus groups, one might be able to link comments and preferences back to a particular focus group, but unless the group was small and homogenous, it would be difficult to determine preferences for groups, or how those preferences might interact with other preferences (i.e. if a person is seeking solitude, do they choose particular activities or settings to achieve that outcome?). Traditionally, a survey was needed to link these variables; however, a survey often misses the nuance of the dialogue. The advantage of using audience polling and open-ended questions in a focus group setting is that participants are allowed to clarify what they mean when they select certain responses.

It is important to note the limitations of using this data. Because the sampling of participants was not random, it would be difficult to suggest this analysis is generalizable to the preferences of the entire population that might be interested in the area, and no attempt to do so is done here. However, effort was made to hear from a broad sample of groups who have a connection to the landscape including both locals and visitors that were willing to spend 90 minutes participating in the conversation. Participants did self-select to join the study, but given the diversity of participants and the depth of data gathered, this study is certainly defensible as a solid baseline for recreational experiences in the Grand Staircase area of GSENM.

Demographics

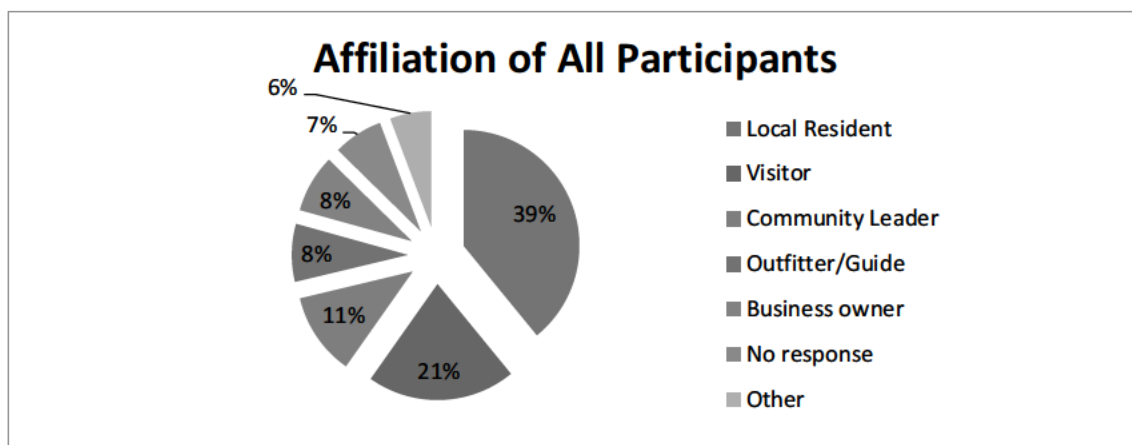
Participation in the study was anonymous and voluntary and no personal information was gathered or retained from the participants other than the two demographic questions of zip code and affiliation. Although participants were allowed to remain anonymous, their responses were tracked and collated by the use of audience polling technology. Participants were asked to provide home zip codes in order to identify how representative this study was of the overall population. There were 77 participants in this phase of the study. The majority of participants came from zip codes in Utah (63%). Most of those came from Kanab (38%) or the Bryce Valley communities of Cannonville and Tropic (12.6%). Escalante and Boulder residents (3.5%) as well as those from the Arizona communities of Page and Fredonia (7%) participated. Other participants represented a total of eight other states and a Canadian province. There were participants from 31 unique zip codes.

Demographic distinctions are important to understand visitor experiences on public lands compare to local resident expectations and experiences on landscapes they have a very strong sense of attachment to through years, often generations, of interaction. Understanding these similarities and differences is absolutely essential for agencies to effectively manage public lands in partnership with local communities, while balancing local demands with visitor expectations constitutive of a broader national mandate to manage those lands.

Participants were also asked to select one affiliation (role) they played in relation to the landscape. Those selections included: visitor, local resident, community leader, outfitter/guide, business owner, or other. Often individuals had more than one affiliation (for example a business owner might also be a local resident, or an outfitter might also be a visitor), but they were asked to choose their primary

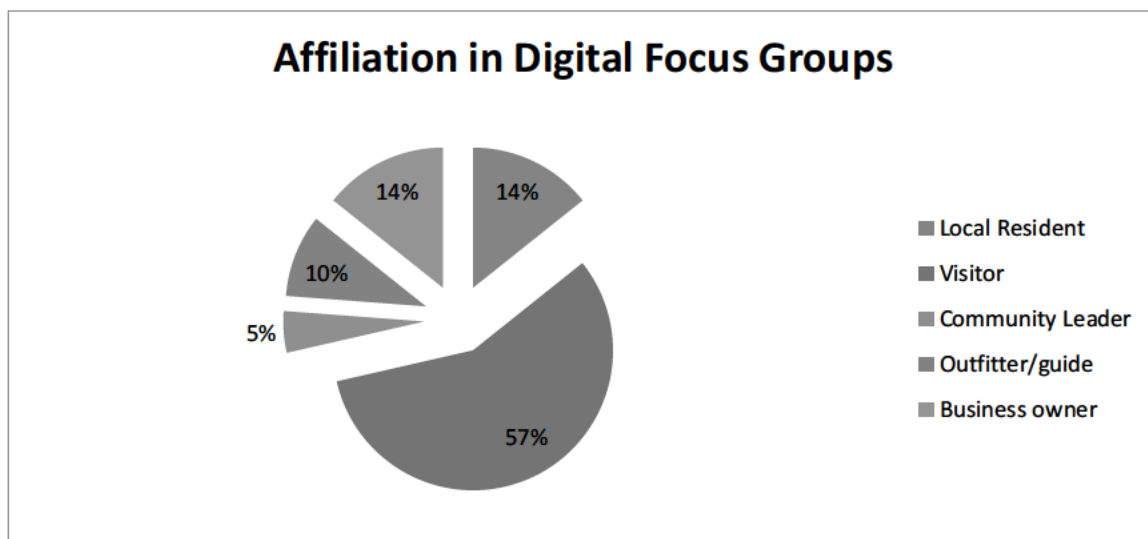
affiliation and respond to all questions "wearing that hat." The majority of the participants selected affiliations associated with the local area: local resident (39%), business owner (8%), and community leader (11.5%). Visitors represented 20.7% of the total and outfitters/guides made up 8%. 7% of respondents did not select an affiliation, and 5.75% chose "other". Those that selected "other" as a category often indicated that they were part time residents or former federal employees who had settled in the area but might have a different perspective than any of the affiliations offered. Figure 2 shows the composition of the focus group participants in terms of their affiliation with the Grand Staircase region of GSENM.

Figure 2 –Affiliation of All Participants in Study



In order to better capture the recreational experience of non-residents we continued to offer digital focus groups for this phase as well. Figure 3 below shows how different the make-up of the digital focus groups is from traditional focus groups in terms of who they can reach.

Figure 3 – Affiliation in Digital Focus Groups



Data Analysis

The data analysis that follows combines the polling data from each question with the spoken comments from the meetings as those particular questions were discussed. The result is a comprehensive and nuanced collection of participant preferences that will serve as a recreational experience baseline for future planning in the Grand Staircase area and across GSENM as these results are compared with other phases of the research on other regions of the Monument and surrounding public lands. For recreation planning, land managers need to know the desirable outcomes people are seeking for when recreating on public lands. They also need to know the activities that people engage in, as well as the landscape setting characteristics that support those interests and expectations. Finally, they need to understand the essential services provided by the agency or surrounding communities that support recreation on the public lands. The data analysis section is divided into these essential elements needed for planning and management of the Grand Staircase area. This recreational experience baseline data will not only be useful for planning, but it will serve as a background for conversations that BLM can have with its local public and private partners and service providers.

Desirable and Undesirable Experiences and Outcomes:

What are the qualities of the Grand Staircase area that make it special?

Initially, focus group participants were asked to share the qualities of the Grand Staircase area that make it special. A wide variety of responses were given during the open-ended dialogue prior to the prepared list of responses was shared for polling. To allow for analysis, the dialogue responses were grouped with the choices selected through the polling. Comments were coded in terms of what response or responses they related to in the polling selections. There were several comments in each section that didn't neatly fit into the choices offered in the preset audience polling. These responses were coded and grouped according to their concern. Only a representative sample of all the comments is located in this report, but the total comments as well as the audio recordings for all focus groups were given to the BLM as part of the administrative record of the research. The responses are discussed in the order of their popularity as measured by the percentage of participants in the entire study (all focus groups) that selected them. Figure 4 (below) shows the overall distribution of responses by all participants.

Figure 4 – Special Qualities of the Grand Staircase Area



- **Scenic Quality**

It should not be surprising given the incredible vistas and visual features that abound in the Grand Staircase area of GSENM that the most popular special quality of the area is scenic beauty (74%). Several participants commented on how this particular landscape is particularly special in the way the scenery inspires their art as well. The following comments expressed during the focus groups identify the importance of scenery (often combined with other qualities) in the overall recreational experience in the Grand Staircase area.

"The outstanding scenic beauty, strikes me"

"The relatively undeveloped, rugged scenery, access to hiking, opportunities for solitude, and I can visit with my dogs too!"

"History, vistas, the natural environment, along with the size and terrain all make it a special place."

"Landscape—for visual artists this is the most spectacular place on the earth; I like the Staircase, people on the north end like the slot canyons. The colors are unmatched in their beauty and inspiration for art."

"I paint western landscapes and I've been all over the West. There is nothing like the Vermillion Cliffs, the way the light contributes to the changing landscapes. It can be a very different place depending on time of day or the time of year the way the light interacts with the land."

- **Wild, Unspoiled and Natural/Remote and Rugged/Sense of Solitude and Privacy**

The relatively isolated location also contributes to the strong preference for the values of wild, unspoiled, and natural (66%) and remote and rugged (49%) as well as the opportunity for solitude and privacy (42%). This was beautifully expressed in several of the comments offered by the participants.

"I agree with the sentiments expressed about the value of unspoiled, wild country. Wild country is such a valuable, fragile resource that will cease to exist in the absence of adequate protection. "

"Even when on a paved road, you can look out and for miles, and I feel like I'm seeing nothing but nature (of which humans are a part, but like metal or concrete modern construction is not)."

"I feel like I am encountering Nature one on one."

"I prefer the quiet, and ability to have solitude and encounter a relatively pristine landscape, especially the relatively untouched places, away from the road."

"You can be alone in a truly wild remote beautiful landscape. A place for discovery, beauty, inspiration and adventure."

"The feel of it, I like the way I feel when I am out there. When I see the power lines it puts me back, and seems so disruptive."

"Remoteness and the accessibility—close to remote places."

- **Lack of Development and Improvements/Natural Quietness/Dark Night Skies/Spiritual Qualities**

The lack of development and improvements on the landscape (31%) contributes to a setting that is conducive to a tranquil escape from the hustle and bustle of modern life including a sense of natural quietness (29%) as well as the opportunity to experience dark night skies (23%) identified as a special value by nearly 1 out of every 4 participants. From comments offered regarding these qualities, it is clear that the quietness and solitude also contribute to a spiritual quality (14%) to the landscape in the Grand Staircase area.

"More undeveloped, not like a national park. You might see a few people but you don't feel like you're being herded."

"It is a special place because of the dark skies, open spaces, archaeology, canyon exploring, diversity of landforms, views, plants, and lack of development/too many constraints."

"The uniqueness, very remote, untouched for the most part by humans."

"Terry Tempest Williams says the desert is important because it exposes; makes you naked; spiritual aspects."

"There is a spirituality out there that could be positive or negative depending on the area and the history."

- **Sense of Discovery and Learning Opportunities/Natural and Cultural Resources**

Many participants also identified the Grand Staircase area as a place of learning as evidenced by their emphasis on the physical (43%), biological (23%), historic (23%) and cultural (31%) resources as well as the opportunity the landscape provides for a sense of discovery and learning opportunities (42%). Some of the many comments made by the participants give a better understanding of the value of these learning opportunities on the landscape.

"Amazing history, in the sense of dinosaur bones, Native American trails; it's buried in the rest of the US under pavement."

"I emphasize the opportunity for discovery."

"Contains resources that can't be found anywhere else (geological)"

"The archeology, piles of old trash, etc. and connection to the past it important for me."

"I am a volunteer site person for BLM and am very interested in the previous Indians who lived here. I like to Jeep and hike all over the landscape to discover the geology, paleontology, archeology of this place."

"I like it because of the hiking, vegetation, wildlife (e.g., birds, insects), geology, and beauty."

- **My Backyard/Quality Time with Family and Friends**

One important theme that emerged out of the conversations about why this is a special place is how much the local populations utilize this landscape for recreational opportunities because it is in their back yard (32%) and it is a great place to share with family and friends (26%). They articulated this local sense of place in many comments offered.

"It's my home and it has been for some time and my children would be fourth generation. My grandfather first homesteaded in the area in the 1930's."

"I grew up here, it is home."

"I have a sense of home here—it is my backyard—and I am familiar with it."

"Nice to provide people with natural landscapes—spiritual escapes out my back door."

"I love talking to people about the area, it's like sharing my home. To share it with other people is wonderful."

- **Diversity**

Another important theme to emerge out of participants comments on the specialness of the place (but not captured in the list of options all could select) was the diversity of the landscape and resources available. The setting seems to match the diversity of recreational opportunities available in the Grand Staircase area. A selection of those comments will illustrate the point.

"I like that there are some dirt roads with varying levels of maintenance that allow us to get a little further out there than we might on bike, foot, etc. But I like that when I'm out on one of those roads I don't feel crowded. I don't see and hear evidence of other visitors."

"The Grand Staircase area is a unique progression from higher elevation to here (Kanab). There are many different layers of distinct cliffs all the way down to the bottom of the Grand Canyon."

"The Monument as a whole is a special place because of its diversity—its scarlet plateau—its paleontology—Escalante Canyon completely different from the Grand Staircase side of the Monument."

"Vastness. Can lose yourself out there. A lot of surprises out there. Extensive resources for landscape scenes."

- **Public Lands Context**

Finally, several participants commented on the value of GSENM as part of a network of public lands in the area. They suggested GSENM should be viewed in the context of these surrounding lands for the unique contributions it makes to the diversity of recreational settings in the area.

"The Grand Staircase area of GSENM is special because of where it's located between Bryce Canyon National Park and Escalante, which gets a whole lot of visitation. In the area by the Paria you know won't really run into anybody. The Grand Staircase area has spectacular places where you can't see anyone."

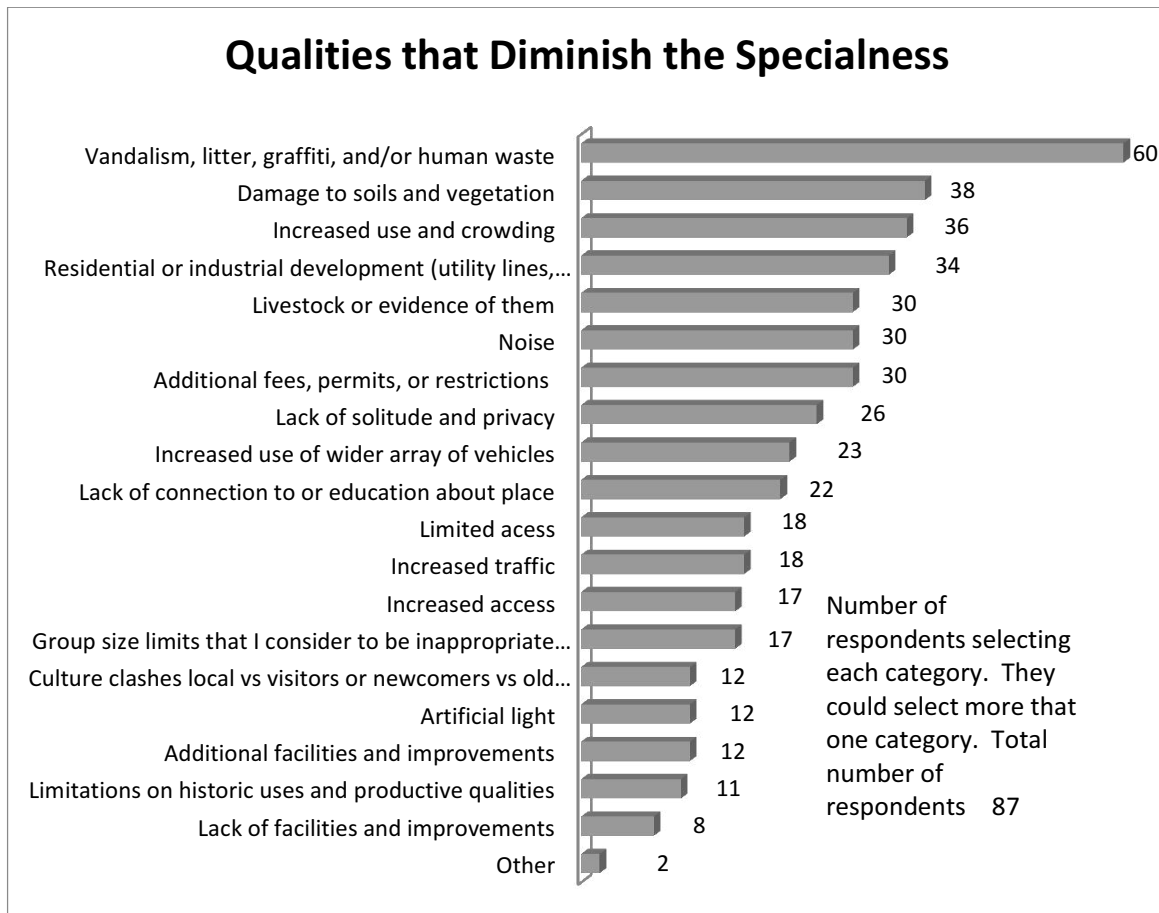
"I grew up in the east in New York and Maine—access to public land is an extraordinary gift to the American people. The reason I moved from Maine is because of the Monument (GSENM) as a new addition to public lands."

There are lots of things {in the Grand Staircase area} in close proximity to national parks. It is the last mapped region in lower US."

What could or does diminish the specialness of the place?

While it is important to understand why people think a place special, it is equally important to understand what might diminish that specialness and affect their connection to place. After discussing why the Grand Staircase area is special, participants were asked to identify, *"What could or does diminish the specialness of the place?"* After the open-ended dialogue about the threats to specialness, the participants were given prepared list of qualities from which to choose using the audience polling clickers. Figure 5 (below) shows the percentage of responses selected by all participants. Details about the most commonly selected responses are then discussed in more depth.

Figure 5: Qualities that Diminish Specialness



- **Human Impacts**

From the selections of those things that would diminish the specialness of the Grand Staircase area, it is clear that human impacts on the resources are considered the most significant threat to the area. The vast majority of participants across the study identified the presence of vandalism, litter, graffiti and/or human waste (78%) as a significant issue to be addressed. Additionally, damage to soils and vegetation (49%) and increased use and crowding (47%) are human-caused impacts that are particularly salient as negative outcomes for recreation in the area. This increased use is accompanied by concerns for increased traffic (23%), a wider use and array of vehicles (30%) and other crowding issues. The following comments offer more detail on how these elements impact recreational visitation to the area.

"I am concerned about the abuse of the land by anyone regardless of what group they represent of our cross section of people who use or visit the monument."

"Where I'm at, I often have to clean up human waste and trash, and I really see the impact."

"Many of my concerns about additional use and access relate not only to my personal experience and crowding, but also to the potential for increased damage to the natural world that can accompany greater use and visitation, both intentional and unintentional."

"People don't know rules and regulations and end up damaging the resources."

"Non-compatible activities. Somebody out there tearing it up—in a vehicle or stomping across the landscape not having proper reverence for the place concerns me."

"The presence of illegal OHV tracks to many places is a negative impact I experience regularly when hiking in the Monument."

"Too many roads, paved roads, and too many people would diminish my experience. Paved roads all through the back country would negatively affect the recreational experience of visitors and displace existing values."

- **Working Landscape (Livestock, Hunting, Trapping)**

The Grand Staircase area of GSENM is a working landscape with transit corridors for local communities passing through it, cattle grazing across the landscape and numerous signs of development such as utility lines, and residential structures on private in-holdings, especially in the northern and western edges of the study area. For many participants, the consequences of cattle grazing (39%) and residential or industrial development (44%) diminish the special qualities of the landscape. The lack of additional recreational facilities and improvements (10%), and limitations on historic uses and productive qualities of the landscape such as grazing (14%) seems to be a concern for only a few of the participants, which is consistent with the concerns expressed about grazing and development. This

would support the claim that most participants want a minimal amount of additional development in the area. Participant comments indicate that cattle grazing poses a threat to riparian areas and the general aesthetic experience of the area, and some government actions to support that grazing also compromise the recreational and natural resource. While most participants did not advocate removal of cattle altogether from the landscape, they identified it as a potentially significant problem if not addressed. Similar comments were also expressed about residential and industrial development. There were also a number of concerned comments regarding trapping in this area. Below are a few of the comments to better understand how the working nature of this landscape can negatively interact with recreational expectations in the area.

"Popular hiking areas like hackberry get trampled by cattle in the winter. Come spring it's torn up and looks bad. Visitors think it isn't that great."

"The damage from livestock grazing and BLM management for "forage". Disgusting and devastating to the landscape."

"Pollution of backpacking drinking water in key hiking places by cattle feces."

"Destruction of the landscape by failed vegetation treatments that were done to support cattle raising... but have failed to do so."

"The result of cattle grazing diminishes my experience throughout the Monument. Cow pies, flies, destroyed vegetation, erosion, and seeing skinny and suffering cows."

"Dust blowing around from roads and trampled soil crusts. Some grazing is okay, but it should be scientifically determined as to its validity."

"Number of cattle for a grazing area is not too much, but I noticed over the years there is a recovery factor particularly when we get monsoons—too many cattle damage soil and vegetation; then we get dust from the soil erosion; The BLM should look at the allotments carefully so that they can be a little more long-term sustaining."

"I know the Monument is multiple use, but I hate seeing traps out for coyotes, and grazing going on. They diminish my experience."

"I'm a little scared to go out; been shot at or close to. Hunting trapping thing going on. The difficulty is an increase in hikers, and we have done a little study. People have been traumatized by being shot at or close to. Year-round-hunting and separating hikers from hunters/trappers."

- **Infrastructure Development**

"Driving across the landscape and the power lines by the side of the road diminishes the experience for me. They disrupt the photography."

"I really don't want any development I like the isolation up there. I like it to be as isolated as it so people can enjoy it. Think of how many national parks are crowded and you can't get in. You can feel like you are alone and enjoy nature. You can experience real wilderness. If there are developments, I will be there with a protestor sign."

"Inadequate signage and management of designated route system. Hard for users to determine what is OK and what is not thus abuse occurs. The damage from vehicles going across the land is terrible."

- **Noise**

Given the value placed on naturalness and remoteness discussed above, one would expect that participants might express concerns about anything that would disrupt their expectations of tranquility and natural settings such as the presence of noise (39%), or a lack of solitude and privacy (34%), and even the presence of artificial light at night (16%) which impacts the dark night skies discussed in the previous section of this report.

"I've been here for over 20 years and I find myself looking forward to winter for the quietness. Motorcycles and helicopter tours and definitely changing the character of the place."

"People are too loud. The sound of kids screaming destroys the mood of place for me."

"Aviation over-flights can be a real problem. It is not compatible with quiet recreation (witness the overwhelming noise on the flight corridor in the Grand Canyon). Aviation is certainly not a big problem now in GSENM, but it could be in the future."

- **Administrative Controls**

While many participants acknowledge the need for some regulations of recreational activity on public lands in GSENM, concerns were raised by nearly 2 out of every 5 participants about the possibility of additional fees, regulations and restrictions (39%) in the area. These concerns were also associated with limitations on access, especially motorized access (although others expressed the need to limit just such access to avoid diminishing the resource). Recreational users with livestock and dogs seek out places with fewer restrictions than the parks regarding their animal companions. The following comments give a sense of what restrictions or fees are most troubling to the participants.

"Too much development and management control would make it lose its specialness and sense of discovery. Permits to manage resource impacts and keep use dispersed are fine but fees and difficult to obtain permits are a real downer. People need to be educated. Enforcement of regulations needs to happen for all...grazing permittees and recreational users."

"I agree with supporting the lack of fees for backcountry/trailhead uses. It is appropriate for campgrounds or other similar developed areas."

"Size limits are usually set too small to accommodate a hiking club or similar themed group."

"I think it's very difficult to restrict people from a place from you love. The more people that learn to love an area that's good for the resource."

"Restrictions to accessibility—can't take my ATV back into those remote areas to hike."

"Leave it the way it is. Don't close things off so that only special people or a small group can get into places and things. Access is important—ATVs, Jeep, bikes, and hiking."

"Restrictions of responsible access—excessive restrictions—no more than 12 heartbeats—no competitive events—footraces or mountain biking—historic roads to get to places to hike—seems to be a conflict—remove problems by restricting access or by education about responsible use two choices—finding the cross-over between responsible use and restricted access. "

"If they didn't allow dogs or horses it would diminish the specialness of the place for me. I love that there's a place to go hiking with your dog. You can't take a dog to the National Parks."

- **Increasing number and diversity of visitors**

Another real concern is how to manage the increasing tourism coming into the area, particularly from people who lack a sense of connection to the place (29%) which likely includes accommodating a growing number of international visitors (through additional and multi-lingual signage for safety in the backcountry when those visitors don't "know" the place). Visitors without a connection to place can often lead to culture clashes (16%) between locals and the visitors their tourism economy partially depends on. Although the iconic feature of "The Wave" in Coyote Buttes is to be discussed in Phase 3 of this study, the displacement of visitors who are unsuccessful gaining access to "The Wave" by the lottery system is putting pressure on the landscape and the recreational experience of the Grand Staircase region where many o after the disappointment of not getting a permit. The comments below show that the impact of The Wave displacement and tourists unfamiliar with the area is affecting the resources all around the area.

"We have to deal with lots of visitors. GSENM gets international visitors who take their rental car off the pavement but still get stuck in the middle of nowhere, and they don't understand weather and other concerns."

"Sometimes, people don't understand what they are doing or understand what this landscape is. They were rolling rocks {vandalism} because they couldn't get into the Wave."

They have wrong ideas about wilderness, like it's a park with animals. People are disappointed because they have incorrect perceptions."

"Visitation restrictions can diminish the specialness of this place as people want to go to a particular area but not necessarily the area they end up going to. I don't want to go to The Wave; I study Coyote Buttes area, but it is enclosed in The Wave lottery so I can't get there."

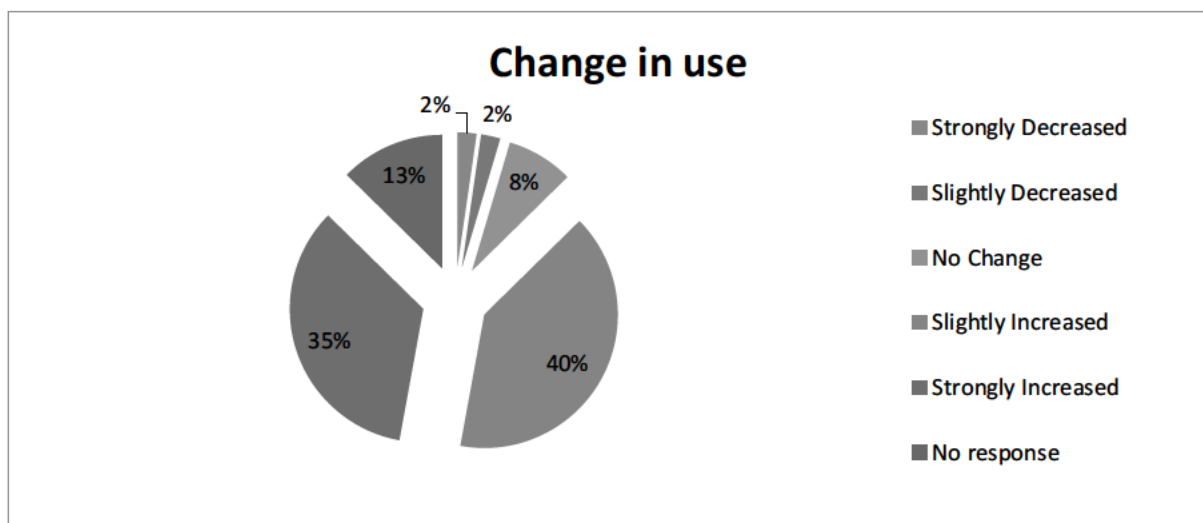
"I have concerns of lack of connection to land or understanding of the land from people who have not been in the area. They are not aware of what, "leave no trace" really is.

"People want to hike the Wave but get shuttled over to the Toadstools Trail when they can't get into The Wave. There are social trails going everywhere out there."

How has the use of the area changed in the last five years? Has it been for the better or worse? The next question revolved around the nature of change the participants had noticed and their perception of whether those changes in use were for the better or worse. These questions are related, and when discussing their answers, participants were encouraged to speak both of how much change they had noticed, as well as whether it had made things better or worse, and why. All participants were asked to record their selections on a series of two Likert scales using the audience polling clickers. The first scale recorded how much change in use they noticed in the area over the last five years from strongly decreased to strongly increase with a neutral value of no change in the middle of a 5-point scale. The second scale recorded whether they felt that the change they had indicated had made things much better to much worse with a neutral no change in the middle of a 5-point scale.

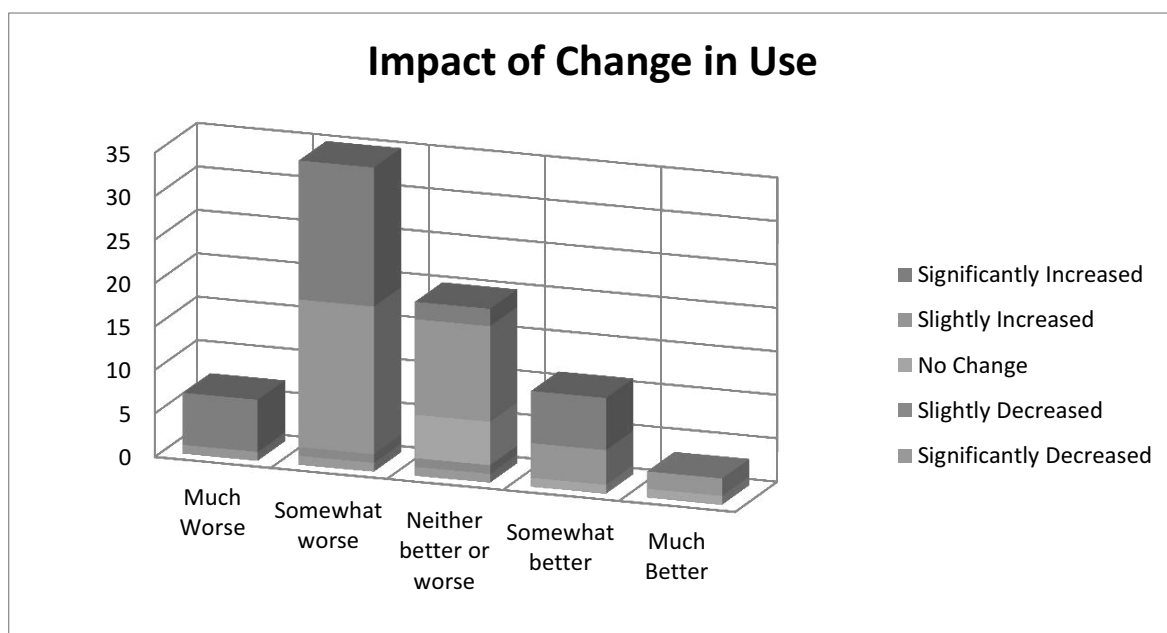
Figure 6 (below) shows the response to the question on the nature of change in use over the last five years.

Figure 6: Nature of Change in Use



It is clear from Figure 6 that use in the Grand Staircase area has increased in the last five years according to the participants in this phase of the study. Three out of every four participants indicated use had increased either slightly or strongly (roughly evenly split between the two). Only 4% of the participants indicated use had decreased in any way from their perspective. Twice that many (8%) indicated they had not seen any change either way. In their clarifying comments several participants indicated that there was a difference in the change between the front country/prominent locations and the backcountry locations. Each of these indicated that while use might be increasing in the front country, they have noticed little change or even a slight decrease in backcountry use.

Figure 7: Value of Change in Use over the Last 5 Years



When considering how the change impacted the landscape and their connection to it; few identified the change in use as making the conditions better. Large numbers of participants who indicated use had increased, also noted that change had made conditions somewhat worse. Seven participants indicated that the change made conditions in the area much worse. This is less than the number of participants that indicated that the increased use had actually made conditions somewhat better. Figure 6 depicts not only the nature of change in use over the last five years in the Grand Staircase region, but the perceived value of that change in use.

The following comments illustrate some of the ways conditions were perceived to be better or worse as a result of the general trend of increased use in the area over the last five years. It appears that determining whether conditions have worsened or not could depend on an individual's affiliation with (and expectations of) the landscape, and the management response to the increased use.

"I would answer this differently depending on the visit. When there is more crowding or evidence of resource damage I feel it is worse, when I luck out and find solitude I feel the quality is still pretty high."

"[It is worse because of] lack of solitude, unconfined recreation. Seeing more campsites, more litter, more human waste, increased impacts from vehicles both on and off roads."

"Old timers say there used to be artifacts out there, now there is nothing. We are leaving future generations with less and less of the cultural connections."

"It is worse for those that live here, but for tourists, they are seeing a part of the world they would never see. It is totally selfish to want it to myself. It is public land and the public has a right to be a part of it. Management is key."

"More people have been able to enjoy the Monument and the beauty out there."

"Increased for the worse; resources are strained because of reduced federal budgets and lack of resources to make sure places are protected. Fewer rangers are available."

What are your interests and expectations when going out into the Grand Staircase area?

Research has indicated that people visit public lands to achieve a variety of beneficial outcomes and experiences for themselves, their communities, and the environment, while at the same time trying to avoid adverse outcomes and experiences. The list of such outcomes and experiences is extensive, but further research has discovered that people tend to bundle these experiences and expectations into a limited number of profiles of interests and expectations.² Participants were given a list of 12 profiles of interests and expectations they might have when visiting the HTR area. Each profile included a descriptive sentence of what someone choosing that profile might say. The profiles and descriptions included the following:

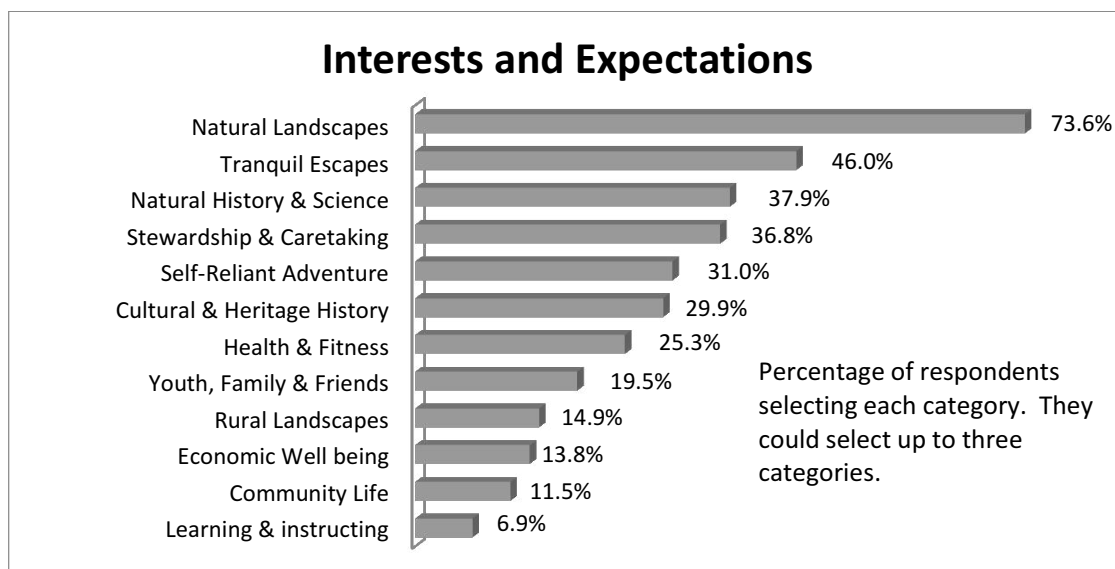
1. **Natural Landscapes** - I like to surround myself with the beauty of open space and the wildness of mountains, forests, rangeland, water and wildlife.
2. **Rural Landscapes** - I want to connect with the visual landscapes, sense of place and pace of rural areas where people make their living from the land.
3. **Cultural & Heritage History** - I am interested in how historic and prehistoric peoples lived in the area, and in exploring the connections I have with those peoples.

² For a good discussion of the experiences and outcomes that people seek when recreating in public lands see the work of Driver, B.L. and D.H. Bruns. 1999. Concepts and Uses of the Benefits Approach to Leisure. P. 349-369 in Leisure Studies: Prospects for the Twenty-First Century E.L. Jackson and T.L. Burton et al. (eds.). Venture Publishing, State College, PA. Venture. To see the research that narrows the list of experiences and outcomes into profiles of interests and expectations see Parry, B., Gollob, J. and Frans, J. 2014. Benefits of public land usage: an analysis of outdoor recreationists. In Managing Leisure 19(4). That study narrowed the profiles down to eight (8). Those eight (8) are used in this study along with an additional four (4) that were added to more comprehensively capture people's expected experiences and outcomes for recreating in these landscapes.

4. **Natural History & Science** - I am interested in knowing about natural processes in this area and the study of the scientific value of the landscape for enhancing our understanding of the world around us.
5. **Health & Fitness** - I like being able to regularly access public lands recreation areas that help me get and stay fit or improve my mental well-being.
6. **Self-Reliant Adventure** - I prefer outdoor adventure on my own that challenges my outdoor skills, improves my abilities, and maybe even involves some risk.
7. **Tranquil Escapes** - I look forward to the quiet serenity of getting away from it all for some mental and physical relaxation, reflection, and renewal.
8. **Youth, Family & Friends** - I am enriched by socializing with others: young people, my family and/or friends and enjoying companionship in the outdoors together.
9. **Community Life** - I like seeing what the discovery and enjoyment of nearby open space recreation does for my community and our visiting guests
10. **Economic Well-being** - I want to see public lands recreation areas contributing in a significant way to our economic livelihood.
11. **Learning & instructing** - I feel comfortable having others equip and enable me to do recreation and tourism outings—or being part of helping others learn how to do that.
12. **Stewardship & Caretaking** - I like giving back to the outdoors from what I've received by helping care for special sites and facilities so others can also enjoy them.

Participants were allowed to select up to three profiles. Figure 8 (below) indicates the percentage of total selections by all participants for particular interest and expectation profile options. Figure 8 (following page) shows the analysis by affiliation preference to see if additional insight could be gained on the motivation for visiting this area and how that might differ depending on who is visiting.

Figure 8: Interest and Expectation Profiles



The most popular sets of interests and expectations for the Grand Staircase area of GSENM are the natural *landscapes* (83%) and *tranquil escapes* (52%). This seems to support the strong interest in the wild, natural, rugged and remote characteristics of much of this landscape where one can find the desired experiences of solitude and renewal of mind and spirit in nature (discussed in earlier sections of this report). There is also a real interest in the learning and discovery characteristics of the *natural history and science* (43%) of this part of the Monument, as well as in *stewardship and caretaking* (42%). This interest in stewardship and caretaking indicates support for programs and management actions to support the unique qualities of the Monument. This affords the BLM staff a great opportunity to work with these potential (and actual) partners to create opportunities to exercise more stewardship and caretaking activities. This might build more support for management decisions and actions as the public takes ownership in those actions through cooperation. Given the small number of participants selecting the Learning and Instructing (8%), one might conclude that much of this discovery and study is self-directed.

Figure 9: Interest and Expectations by Affiliation

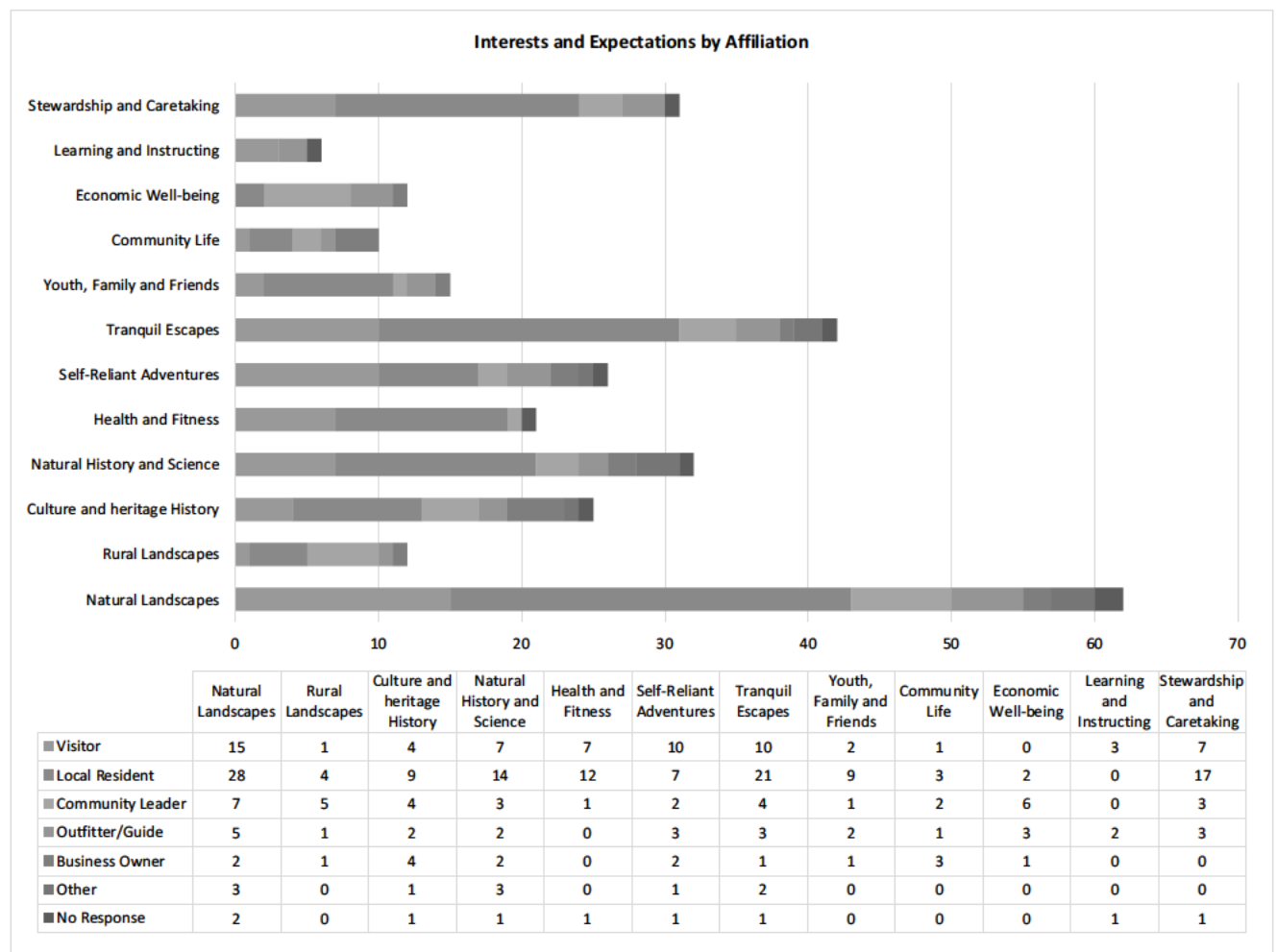


Figure 9 above displays preferences for particular interest and expectations of the landscape by affiliation. Read left to right the colors in sequence in the bar chart correspond to the attributes with color next to them from top to bottom in the table. The bar chart identifies the percentage of each option that was selected by a participant with a particular affiliation. For example, of those that chose local resident as their affiliation, nearly 20% selected natural landscapes as one of their choices, far fewer selected rural landscapes. For clarity, the table below the bar chart shows the number of participants in each affiliation that selected each of the interest and expectation options. It should be noted again, that they could chose up to three options.

Some values such as natural landscapes, tranquil escapes, cultural and heritage history, and self-reliant adventures appear in every affiliation. Other values such as health and fitness and stewardship and caretaking have relevance for some affiliations such as visitors and local residents, but less so for outfitters/guides and business owners. The value with perhaps the greatest divergence between affiliations was Learning and Instructing. This value of learning about the area by having others teach about it was perhaps predictably more important to the visitors and those instructing them (outfitters /guides), but not identified as a top value by those who are more familiar with the landscape such as local residents, community leaders, and business owners.

The following sample of comments illustrates the diversity of opinions about the interests and expectations (value profiles) of the landscape.

"From Kanab to Boulder the Monument covers such an extraordinary spectrum of landscapes that it is hard to narrow it down to single points. I enjoy the entire place. It provides opportunity for vehicular access to beautiful landscapes in a number of areas, while others allow you to get out and hike through wild terrain for weeks on end."

"To immerse in a landscape where I FEEL part of wild nature. Where I FEEL more alive and connected to the Earth than anywhere else on Earth."

"Hiking in GSENM is invigorating, inspirational. It contributes to my physical and mental well-being. I just love the hell out of the place!"

"Nice that it can be economically enhancing so that things don't have to be extractive."

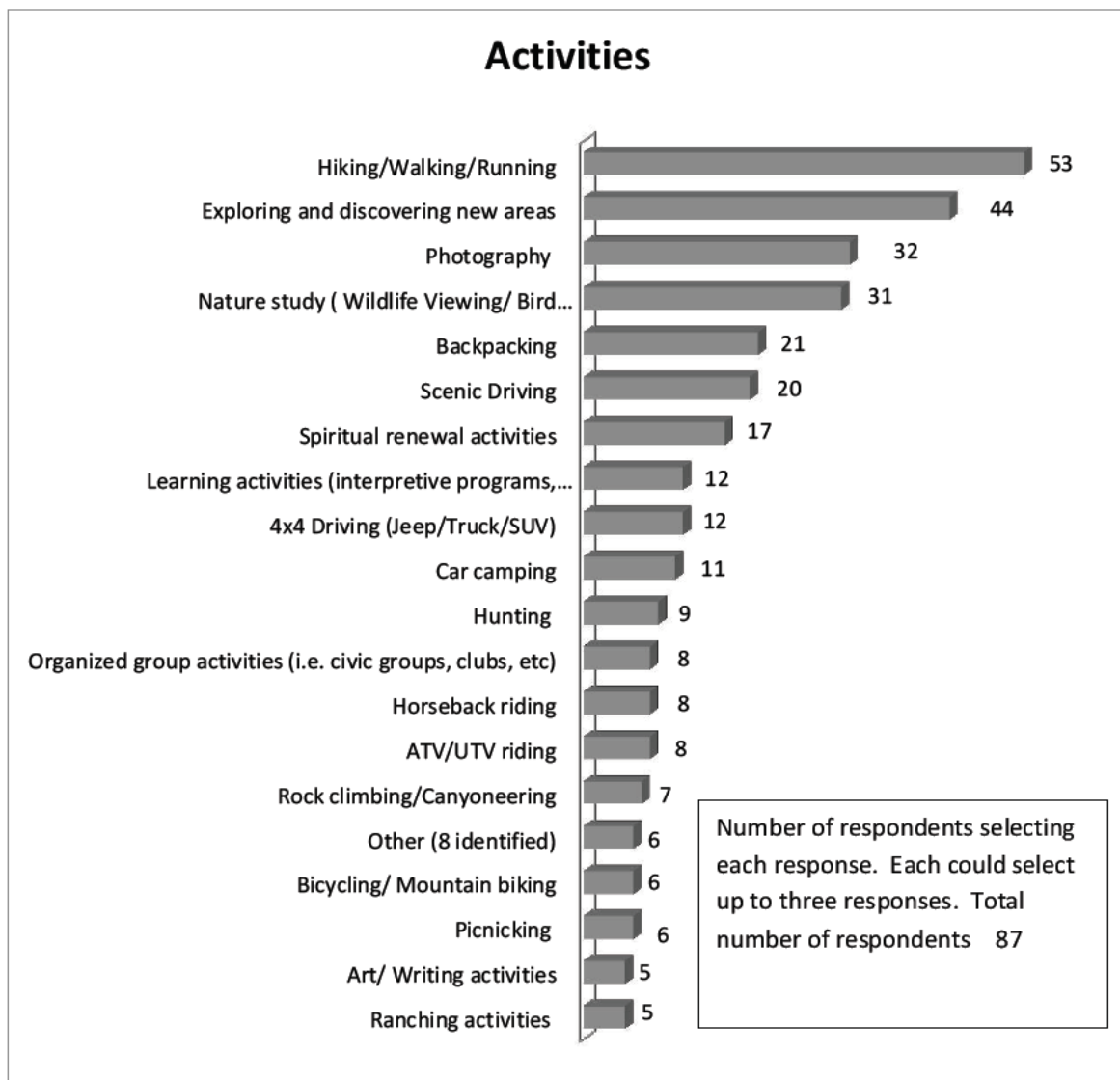
"I like the openness of it; if I lived in Las Vegas or California I'd come here because there are so many places that are restricted there."

Activities

Traditional recreation studies on public lands typically begin by determining which activities people engage in, then determining how and whether those activities could be supported by the land base. More contemporary recreation studies focus instead on the interests, expectations and benefits the public receives from recreating on public lands and the settings necessary to provide them, recognizing

that a variety of activities can provide similar benefits and meet expectations if the settings needed remain intact. Also, discussing preferred activities has a tendency to allow people to form “tribes” and allow stereotypes to cloud interactions. For these reasons, activities were not discussed until midway through each focus group during this study. After discussing the specialness of the place, threats to it, and participants’ interests and expectations, they were asked to select up to three activities they engaged in most often from a prepared list. Participants could select more than one activity and had the option of selecting “other” then were asked to clarify it. Figure 10 shows the number of participants that selected any given activity.

Figure 10: Activities Engaged in Most Often



When asked to choose the activities they engage in most often, a significant majority of participants selected hiking/walking/running (69%) as their top activity. A number of activities highlighted the observation, study and learning objectives outlined in the GSENM Management Plan. Examples include chronicling their visit with photography (42%), and nature study (40%) as well as more formal learning opportunities (16%) and the less formal self-guided discovery and exploration of the area (57%).

Vehicles use plays a role for many participants in the area through activities such as scenic driving (26%), use of 4x4 vehicles (16%), and ATV/UTV riding (10%) as well as car camping (14%) and even back-county aviation which was mentioned several times in the comments. Another activity that is taking place on the landscape, but was not among the options in the list, is wilderness or outdoor therapy activities where participants are on the landscape for extended periods of time under a special recreation permit.

The results of this question indicate that there is significant preference for non-motorized recreation though recreational activities on this landscape are certainly not limited to only those pursuits, and that recreational plans in the area will need to address the diversity of activities that occur. The following comments from the meetings provide a more nuanced understanding of this recreational activity mosaic.

"Explore landscape and make connection between landscapes."

"Camping and four wheeling gives us access to hike and camp."

"I like helping others discover the beauty of the outdoors while reconnecting with who they are by being part of nature and understanding our connection and stewardship with the land that provides us with everything we enjoy. "

"I can't choose only 3: I would say "human powered recreation" (which for me is foot or bike travel because I don't own a horse)."

Most Important Places Mapping

In order to contextualize comments from the focus groups as about the Grand Staircase area, participants were asked to identify particular areas of importance by writing place names on sticky notes and attaching them to the general location of the place on a large map. They were also asked *"Why is this area particularly special?"* They could either record those responses on the sticky notes or verbalize them in the discussion afterwards. Figure 11 indicates the most commonly articulated places and the discussion that follows captures some of the conversations about the places identified. The table includes the top 34 locations named by frequency, but there were a total of 288 places identified of which there were 114 unique locations named. The table contains all places that were mentioned at least three times by different participants which correlate to 30% of the total number of unique special places identified, and 68% of all special places identified. It is clear from this sample that the area is a diverse complex of special places, few of which are special to everyone, but many of which are particularly important to some people. All sites identified, along with their locations and comments on

why they are special, was recorded and mapped and included in the data provided to GSENM as a result of this study.

Figure 11: Identified Special Places

<u>Location Name</u>	<u>Number of selections</u>	<u>% of total special places named</u>	<u>Management</u>
Hackberry Canyon	16	5.56%	GSENM
Willis Creek	15	5.21%	GSENM
Cottonwood Road	11	3.82%	GSENM
No Man's Mesa	10	3.47%	GSENM
Bull Valley Gorge/Wash	9	3.13%	GSENM
Yellow Rock	9	3.13%	GSENM
Flag Point	8	2.78%	GSENM
Paria River	8	2.78%	GSENM
Cockscomb	7	2.43%	GSENM
Nephi Pasture	7	2.43%	GSENM
Glass Eye	6	2.08%	GSENM
Johnson Canyon Road	6	2.08%	GSENM
Kitchen Corral	6	2.08%	GSENM
Lick Wash	6	2.08%	GSENM
Paria Box Canyon	5	1.74%	GSENM
Skutumpah Road	5	1.74%	GSENM
Between The Creeks	4	1.39%	GSENM
Cottonwood Narrows	4	1.39%	GSENM
Johnson Canyon	4	1.39%	GSENM
Johnson Canyon Lakes	4	1.39%	GSENM
Molly's Nipple	4	1.39%	GSENM
Round Valley/Round Valley Draw	4	1.39%	GSENM

Sheep Creek	4	1.39%	GSENM
Vermilion Cliffs	4	1.39%	VCNM
Deer Creek/Paria	3	1.04%	GSENM
Four Mile Bench	3	1.04%	GSENM
Grosvenor Arch	3	1.04%	GSENM
Inchworm Arch	3	1.04%	GSENM
Kitchen Canyon	3	1.04%	GSENM
Long Canyon	3	1.04%	GSENM
Red Breaks	3	1.04%	GSENM
Seamen's Wash	3	1.04%	GSENM
Starlight Arch	3	1.04%	GSENM
Toadstool	3	1.04%	GSENM

The comments that surfaced as to why these places are special varied from unique qualities of the place to personal connections to the place. Some of the special places identified were highlighted because of concerns for resource damage that is taking place at the location. Many of the comments referred to the scenic qualities of the place, while others identified important features of the landscape such as historic characteristics, geologic formations and the uniqueness of the ecosystems. Access to these special places is an important part of their specialness for many participants. Some access is easy where as some is challenging and both were valued. Some participants expressed the need to understand better the impact of diverse demands on these special places in order to maintain their special characteristics.

A sample of the comments provides greater understanding of why places were identified, such as:

"Hackberry is another fantastic backcountry area. The Cottonwood Wash road, via the Cockscomb also gives backdoor access to the Kaiparowits Plateau region. "

"The Cut has great views, rarely visited. It is a unique area for fossils and geology."

"The Old Parea Township Site is important for its historical and archeological sites."

"The access to canyon hikes from Cottonwood Road and Johnson Canyon Road is unequalled. Easy access to get into these unique ecosystems."

"Between the Creek for the view, the height of the canyon walls - the access can be rocky and a little rough which adds to the remote feeling of the place."

“Each time I visit GSENM I find new areas that are fabulous. They are all important in creating the sense of discovery, diversity of the area, expanse of the area, ability to get out and find incredible areas to explore and enjoy. “

Settings

Is it the place or the activity or both that is most important to you?

There is a good deal of debate among academics and practitioners of recreational management on public lands as to whether the place is most important and people simply chose activities to enjoy the places where they want to be; or whether the activities they engage in are most important and they simply look for ideal places to engage in their chosen activities. The answer to this debate is likely to have a direct impact on the way the area is managed in order to provide desired setting characteristics. To better understand how these debate plays out in the Grand Staircase area, participants were asked whether the place is most important to them, or the activity, or a combination of the two.

This dichotomy turns out to be more of a constructed debate among academics and land managers than in the preferences of the participants involved in this study. Most of the participants (75%) said that both place and activity were important to them. The second most popular selection was that the place itself is inherently special (10%) and activity was only selected by 3% of all participants. Specific comments offered by the participants offer some clarification into the thinking behind their selections:

“I first visited the Monument because of the activity: canyoneering. But now, I'm so in love with this place that I'm happy to just be there; doesn't matter what I'm doing.”

“For me, flying in remote areas is an act of discovery. While doing so, I love to practice the discipline of backcountry aviation, as well as backpack, camp, hike, even hunt and fish, depending upon the characteristics of the area. “

“Place matters because of the lack of people and the uniqueness of place—archeological, geological, biological are all special. I choose activities that don't diminish the specialness of the place, but add to its specialness: birding, hiking, canyoneering, spiritual experience.”

“This is hard to separate. We moved here because of the multitude of slot canyons to explore, so it started as activity. Over time the place has become important. Now I feel ownership of the place.”

“These areas provide a diversity of interest that is hard to find in other places.”

“Each place is special to each person based on the events that occurred or the time of life that we discovered them. The activity is something that adds to or helps others maybe find that connection as well. It's such a hard balance to find between them as a special place is special to each of us. “

"I could recreate the way I do in many places... but the Monument is a special place that is unique. I value this place beyond what I do there. Just being there is the key."

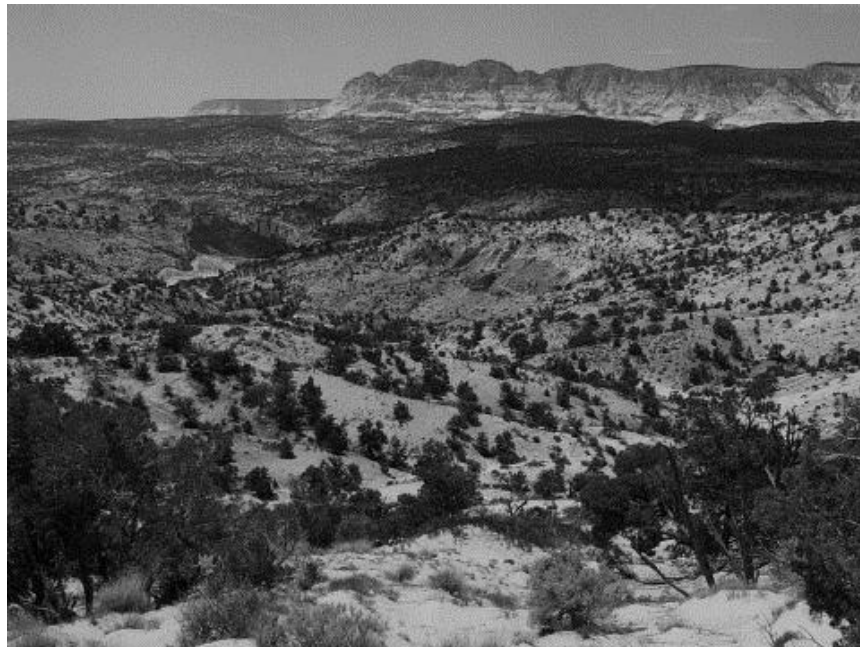
Crowding Analysis Using Series of Black and White Landscape Images

One of the principle considerations for land managers and recreation planners is the setting characteristics for the landscape that should be tied to particular interests and expectations of the public. Unfortunately, the settings matrix used to determine the appropriate setting (primitive to urban) along at least 16 different setting characteristics (see Appendix 2) can be overwhelming to members of the public, so it is difficult to determine what really matters most.

In order to get at what matters most to the participants in terms of setting characteristics related to the issue of crowding, a series of black and white images without any sign of other visitors were offered. The same discussion prompt, *"If you came across other people while visiting the scene in this photo, how many people would be too many people before it would change the character of the place for you?"* was included with each image. Since many public landscapes have prescriptions that limit the number of people in some way, the prompt was good to begin discussion; but more important than the number assigned, was the rationale participants used to make their determinations³. Open-ended discussion was encouraged before participants were asked to record a number with the clickers.

The three images in the series and the comments they generated are shared below.

Image #1 – Representative Large Scale Landscape



³ This is interesting to note, because one of the major management tools to maintain characteristics of the landscape is the ability to assign a number to the total visitor count in an area, and the group size in an area. The fact that every focus group responded to a numeric question by suggesting "it depends on..." might cause one to rethink some of those prescriptions.

The first image was a black and white image of a large scale landscape without people in the scene so that participants would be able to use their imagination to locate people in the scene in order to comment on how many were too many. The scale of this landscape generated a number of comments regarding the larger number of people that could be absorbed without changing the character of the area, what those people were doing, and how close they were to the observer. While participants generally noted the values of solitude and the wildness of the landscape, asking about crowding in such a large scale landscape helped to clarify how the scale of the landscape, as well as the proximity, visibility, group size and activities of other people affect those values of solitude and wildness in the landscape. The following comments are an example of the overall conversations that arose surrounding this particular landscape image.

- *“Depends on how close they are to me. In the foreground 12+ would be too many. In the background and scattered, 200 would be too many. The activity is a key. If they were on an ATV making noise, one would be too many. Horses maybe 12 would be too many. If it were hikers, maybe 15 in one group would be too many.”*
- *“Depends on how close I am to the other people. There could be a lot of people out there. If I have to use my binoculars to see them they don’t bother me.”*
- *“That country holds a lot of people and you wouldn’t be stepping on each other. You could walk across there with 100 people and never notice it.”*
- *“This large of a landscape, it would depend on the visibility. If there were 50 people in blaze orange, compared to 200 people in subdued browns and greens that wouldn’t impact my experience nearly as much.”*
- *“I feel safer in a group. If you are not used to vastness, you might need to get closer to them, even if you don’t know them.”*
- *“What they were doing might affect me—if they’re doing what we are doing I’m more favorable.”*
- *“Smaller parties are different than larger groups which make it seem more cluttered.”*
- *“The landscape is huge and multiple groups could be using various canyons. If there was a huge group all in one spot, that would be negative for my visual experience.”*

Image #2 – Grosvenor Arch



This second image is a smaller scale landscape and includes the iconic feature Grosvenor Arch which has been widely publicized and is perhaps one of the most recognized locations in the Phase 2 study area. As such, many of the comments indicated that because it was such an iconic image, they expected to see more people around the area. Although the scale of the landscape depicted is smaller and participants expressed concerns about more people in close proximity, they also recognized that this area with developed facilities such as a toilet, picnic tables and a paved walkway) is likely to attract many visitors and it was generally acceptable to expect more people in these iconic areas. The following sample of comments underscores these changed expectations.

"It's a small landscape with high volume of traffic, but you're not looking for a wilderness experience."

"You're gonna see people there. You know that before you go. But I know that if you go around it, and there's nobody there."

"If there were a dozen people there I'd drive by. It's a destination. When I go to a place, I prefer solitude. I don't begrudge people access; I want them to come."

"The Grosvenor's Arch is iconic so it attracts a lot of front-country visitors. One would expect to see larger numbers gathered around or walking on the walkways. I would not consider it to be unattractive and it would not ruin my experience. If I did not want to see a lot of people, I would avoid "named" spots like this."

"It's an iconic image. When I go to the Louvre I want to see the Mona Lisa; I expect to see people, just like here. I am mentally prepared to see many people."

"Some areas lend themselves to needing some improvements- rest rooms or parking lots. Not a whole lot different than Bryce Canyon [that has] more people."

"Paved pathway going all the way to the arch. It's more developed and I know that there are picnic tables, a walkway, restrooms."

"Occasionally I have people who have difficulty walking, so for people I take out, I appreciate places like this for that reason."

"Photographers don't want a ton of people, photographic situation, reasonable number, not obscuring landscape or crowd scene."

Image #3 – Willis Creek Canyon



The final image was taken in Willis Creek Canyon. The close nature of the canyon walls had an impact on the participant's responses. Generally, this setting had the fewest number of other people tolerated by participants; however, several did indicate that there is a time dimension to using the area when answering that question. If other people were moving through the canyon, one might need to simply wait a little bit before the crowding issue solves itself as those others move on. The following comments offer a description of the participant's reaction to this image.

"Depends on if there is water there or if it is raining. Depends on the kind of people. This is a very limited place. No more than a few. There is more of spirituality to this place."

"Knowing that it's a popular hike I would expect to see some people, but not 2 dozen and that amount of noise."

"This is a slot canyon area, narrow passage way. I like the isolation and solitude of it."

"A lot depends on if the people are with me or in other groups. I would not mind seeing a number of people recreating with me. But if I ran into multiple groups of lots of people, that would have a negative aspect."

Several comments focused on the impact larger numbers of people would have on the solitude experience, particularly as it relates to noise and visual impacts which are magnified in a slot canyon.

"I would want to be in this canyon alone—like feeling solitude—I wouldn't mind passing a small group of people—not like Zion Narrows—small number of people is best in this image."

"Noise level and how boisterous they are. If there are a lot of them, [and I am] taking a picture and there were people there, it would diminish my experience."

"Slot canyons special because of topography. Channel people, big groups look bigger in a spot like this."

"Behavior, in a place like this commotion and noise is amplified."

When considering this image, several participants raised the issue of displacement of visitors from The Wave which is limited by lottery to 20 visitors per day and their impact on expectations of crowding in this area.

Willis and Lick area are full of yuppie cars of people that don't get into The Wave—but where do you send them when they lose? But then all those folks in the same place not the kind of experience you want them to have.

Large groups of Europeans who don't get permit for The Wave will have an impact on the experience, but I understand the reason they are there and some other places on the Monument.

Other participants indicated that to answer the question of how many would be too many, they would need to consider time - how many people would be in the area at the same time seemed as important as the question of how many people were there.

"It's a matter of timing. You can sit and wait for people to leave. As a photographer one is too many."

"Timing is everything and you can't restrict everyone. If you live close you know when good times to avoid people are."

“Time and space matter. It depends if you are there all day or for an hour.”

Landscape Imagery Analysis

In general, there was reluctance amongst participants to assign a number answering the question, *“How many would be too many?”* to each image, but after extensive discussion several participants did so with the polling clickers. Fewer participants answered these questions related to crowding than any other question in the focus group. While other questions generally had 95% or higher participation with clicker responses, these images had response rates ranging from 71% to 62% response rate. This seemed to match the reluctance to respond with a particular number either because it was too contingent on numerous other factors described above, or fear that a specific number could be used to justify restrictions on the number of people who could visit a particular site. In general, for those who did identify a specific number for each photo image, they were more tolerant of higher numbers of visitors in a setting represented by the Grosvenor Arch image because of its accessibility and iconic nature. To a lesser extent, they were tolerant of higher numbers in the large scale landscape setting. Likewise, they were least likely to offer a number for human encounters in the intimate canyon setting image because of the smaller scale of the place and the desire to be uncrowded. Although there were exceptions to these general trends; taken together, the comments and numbers of acceptable people in the images indicate that some of the key determining factors that impact perceptions of crowding include the scale of the landscape, the activities and proximity of other people, impacts to quiet and visual values of the area, the accessibility and level of development, and the familiarity of the site. The more accessible a setting, the larger the scale of the landscape, and the more known a setting is (iconic), the more one expects to see others. Several comments indicate that these are significant criteria for visitors and locals as they try to determine where they will recreate based on crowding.

Analysis of Road Development Preferences Using Black and White Images

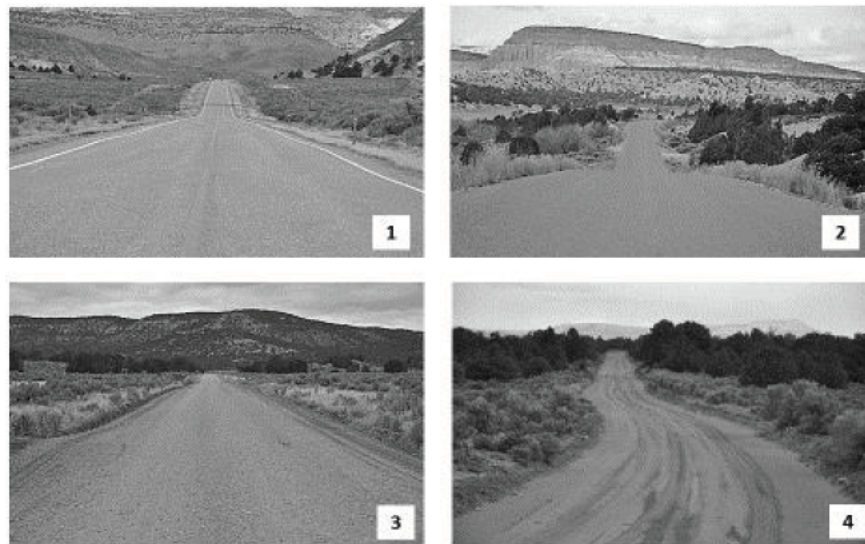
Participants were asked to compare images depicting various levels of road development in the Grand Staircase area to determine their preferences for travelling within the landscape. There were two sets of images. The first set asked participants about primary roads in the area (these were defined as roads such as Cottonwood Road, Skutumpah Road, Glendale Bench Road, etc.). The second set asked participants about secondary roads (defined as those roads spurring off the primary roads accessing specific recreational destinations such as the road through Nephi Pasture Road, Brigham Plains Road, Rock Springs Bench Road, etc.).

Primary Roads

The four images provided for the primary road question are shown in Figure 15 (below). The explanations associated with each photo included:

- Photo 1 – An asphalt paved road with painted striping
- Photo 2 – An asphalt paved road with no striping
- Photo 3 – A crowned and ditched gravel road – regularly maintained
- Photo 4 – A natural surface road - regularly maintained

Image Set 1: Primary Road Development Preference Images

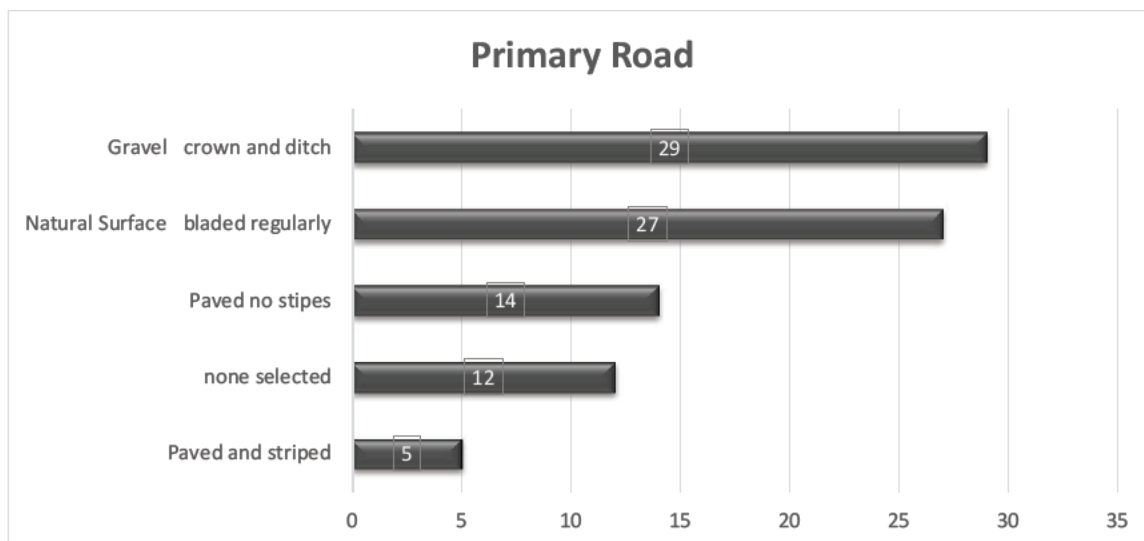


Which of these do you prefer as primary road?

23

Participants were allowed to select only one option when asked, “Which road would you prefer as a primary road when traveling through or going to recreate in the Grand Staircase area?” Figure 12 shows the percentage each choice was selected. The data revealed a preference for non-paved options (#3 and #4) from the majority of the participants. Within the non-paved options there was a pretty even split between the gravel and natural surface roads for the primary routes through the Grand Staircase area.

Figure 12: Primary Road Development Preferences



The most popular selection among the 87 participants that responded to this question was the crowned and ditched road (33%). This was followed closely by the natural surface road (31%). Nearly two of every three participants indicated a preference for non-paved roads. Only 22% of the participants identified one of the paved options as their preference, with 14% not offering any selection. While it is important to remember that these percentages are not generalizable to the larger population, they illustrate trends among those willing to commit the time and effort to participate in one of the focus groups, and thus show an active interest in GSENM management actions related to development of roads and travel corridors.

This set of questions illustrates the value of a mixed methodology in which participants not only select an option, but are able to offer comments about why they made their selection. The additional comments are useful information for managers and local officials responsible for determining the conditions of the roads in and around GSENM. Comments offered in clarification of their choices support leaving roads less developed, although an important minority of participants expressed support for the development of access to various points on the Monument for visitors who might not otherwise be able to access them.

The comments can be grouped along several themes. First, there were numerous comments about how the destination impacts the condition of the route. Clear distinctions were made between transiting through the Monument to get to from one community to another and a journey to undertake recreation activities. Primary roads in the Grand Staircase region of the Monument serve dual purposes as both travel corridors connecting communities and as routes to recreational destinations. The following comments illustrate these distinctions.

Theme #1 - Destination

“Depends on where you’re going—trying to get to town and you have to go through the Monument as opposed to going to see a ruin. ”

“Depending on where you’re headed 2 or 3 would be fine, but if I am headed for a backcountry experience I want 3 or 4.”

“It depends on if I am going to somewhere else or onto the landscape. Page, Arizona would be number 1. If I were traveling to explore a destination, I would prefer 4.”

“What am I doing? Am I going to Cedar City or am I going hiking?”

Theme #2 - Crowding

Some participants commented on the trade-off between developed roads and the solitude experience that might be adversely affected by larger number of visitors. Participants noted this while acknowledging the need to accommodate the increasing number of visitors who are likely to come in the future. This accommodation of future increased use includes protection of the landscape from damage and the safety of the visitors themselves.

"Complicated because it's neat to drive on good roads, but these roads mean more people."

"Primary roads do need to accommodate the general public, but there don't need to be many that are considered primary."

"I chose number 4 because I think less people will travel on this road and this makes me happy. Tougher roads narrow down the users."

"For tourists that (No. 1) is what they expect to see when they come up Skutumpah. They see the spur off of Willis Creek and GPS tells them that it's a short way to get to Bryce Canyon. They don't realize it's a dead end road. I work with search and rescue and ambulance and in the winter when situations are dire and we get calls 5 or 6 times a winter. There have been fatalities because people don't know what to expect."

"Harder question, images 1 and 2 I'm absolutely not going to have my clients {Wilderness Therapy} close to; however, road 3 is definitely helpful for medical access."

"#2 is preferred; visitors are not causing damage to the surrounding landscape because of the roadway."

"The quality of 4 is that people will be driving slowly (hopefully); fewer people. But if the dirt road is in a sensitive area that would be better protected with a higher level of stability, then I would prefer another level."

Theme #3 - Setting

Road conditions also have an impact on the recreational experience people have in the landscape. Several comments indicated that the roads should match the natural, remote and rugged character of the area and contribute to achieving the much desired solitude experience (as documented elsewhere throughout this report).

"Part of the remote adventure: travelling into the Monument. If it got paved, you'd just whiz right through it. I would hate to see it commodified. Speed has a lot to do with my experience. Duration of relationship with the landscape—spiritual renewal and if I go slow then that happens—vs. getting to the place and then I have my experience."

"I am little conflicted on it, I answered 4, I like slow speeds, more engaged with the landscape, but part of me wants to have a gravel road because if it gets wet I don't want to get stuck."

"The setting is so wild you want the road to be compatible with experience."

Theme #4-Type of access

Finally, several comments were made regarding how a particular road type might impact the access to certain vehicles or accessories used to travel through and recreate in the area.

"Depending on what I'm doing - if I'm road biking or trail biking."

"We need better roads for 4X4 and ATV travel."

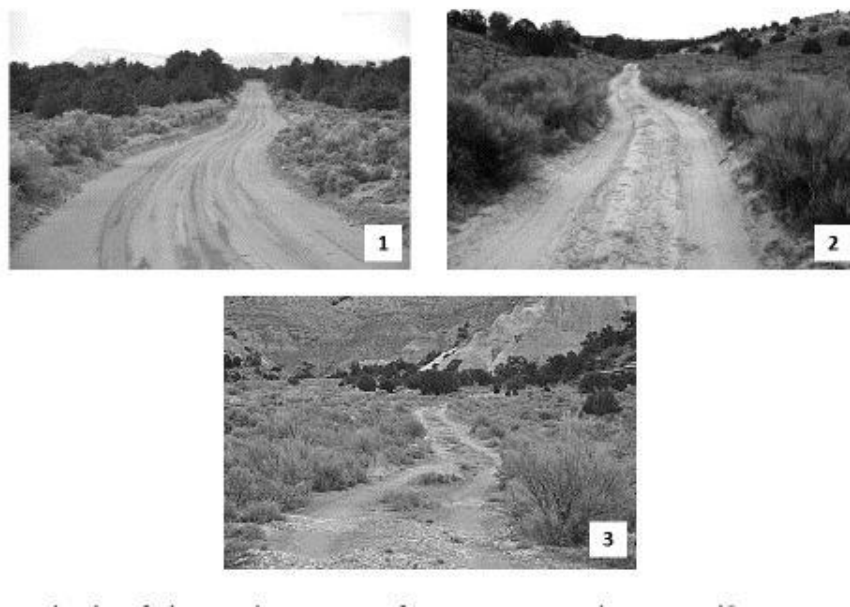
"I picked road 2, since I might want to pull a pop-up camper."

Secondary Roads

After discussing the relative merits of several primary road options, participants were asked to compare a second set of three images depicting various levels of road development for secondary roads. The three images provided for the secondary road question are shown in Image Set 2 and included:

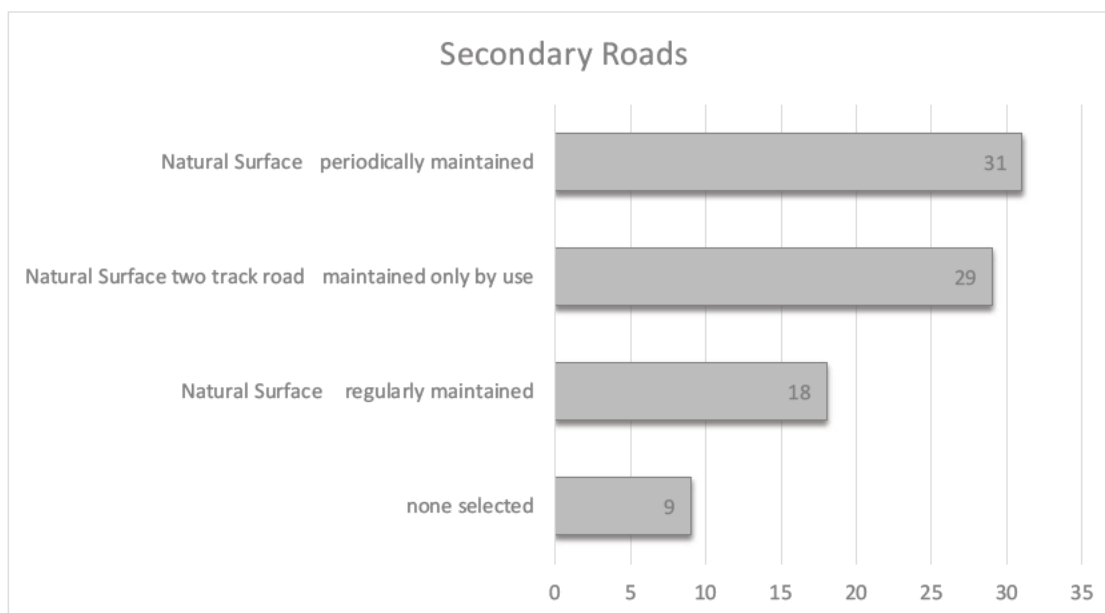
- Photo 1 – A natural surface road – regularly maintained
- Photo 2 – A natural surface road - periodically maintained (every few years)
- Photo 3 – A natural surface two-track road - maintained only by use

Image Set 2: Secondary Road Development Preference Images



Participants were allowed to select only one option when asked, "Which road would you prefer as a secondary road when traveling through or going to recreate in the Grand Staircase area?" Figure 13 shows the number of participants who selected each choice.

Figure 13: Secondary Road Development Preferences



The selections made by the participants do not reveal a clear pattern as they were fairly evenly split between Road 2 - periodically maintained natural surface at 36% and Road 3 - no maintenance, two-track natural surface at 33%. Even Road 1 - regularly maintained natural surface had a significant number of participant preferences at 21%. With such an evenly matched set of preferences it is even more important to try to understand why participants made the selections they did through the comments. Comments offered in clarification of their choices offer a variety of issues that impacted their decision making which, again, might usefully be organized along a set of themes.

Theme #1 – Character of the experience

Similar to the responses for primary roads, participants identified a number of recreational experience characteristics such as ruggedness, wildness, scenic qualities and solitude that would be impacted by the type of secondary roads in the Monument, and generally preferred less developed roads in order to maintain those qualities. For example:

"I chose 3 because I find better places where there aren't a lot of people along those roads. It is more about the experience."

"One of the things when you have an area that is intended to be remote - then roads should be remote and hard roads making it hard to get to."

"#3 because it seems to have the least visual impact."

"#3 least degrading activity. #3 still has some of the actual terrain on it. #3 would have less erosion over time."

"I like the more challenging road. I believe that helps protect the remoteness of the resource that so many of us have commented makes the Monument so special."

"#3 fits with the risk and sense of adventure."

Theme #2 – Wildlife

Several comments were made about the impact of the roads on the local wildlife habitat, for example:

"The purpose of retaining wild places is not about humans. Wildlife doesn't like roads. It's not always about humans."

"Site-by-site determination to protect environment and does not place wildlife at risk. For instance, sometimes a wide road is difficult for small mammals to cross."

Theme #3- Safety

Another major theme of the comments on secondary roads mirrors the primary road discussion's focus on safety as it relates to road conditions in an area that can easily become inaccessible because of weather or other factors.

"I want to be able to take a non-high clearance a little ways in. I want to be able to take a high clearance the whole way but I also want to have a low risk of getting stuck if I'm in the appropriate high clearance 4wd vehicle."

"I picked 2 (again) since I'd like at least the opportunity to be able to get out if it rains!"

Theme #4-Vehicles

Related to these concerns about safety are comments regarding the amount and type of vehicles encountered and how the road conditions enable or inhibit these interactions. Depending on what the participant desires, these can be positive or negative effects.

"I will vote here for #1 because many times I have come across vehicles on the roads who don't want to move over or help others pass. They expect that everyone else should get off the road, and 1 allows an easier passing of 2 vehicles. Whereas in number 2, someone has to drive off into the bushes to allow others to pass etc. including ATVs and tractors."

"I think it is important to be able to distinguish actual "roads" from user created routes that can encourage motorized travel in places it is not appropriate."

"Has to do with where that road is going and may not even be passable unless you have 4-wheel drive."

"When they are maintained, they help keep the roads open for further use."

While these comments offer more insight into the rationale for the split choice on this question of secondary road preferences, the results are far from conclusive other than the need for a diversity of options when traveling to or through this landscape.

Management Boundaries

There are many different administrative boundaries (BLM, USFS, NPS, state land, etc.) in the area and it is often times easy to cross from one jurisdiction to another without being aware of them. In order to better understand the challenges and opportunities this presents participants were asked if they were awareness when crossing boundaries in the area. If they responded yes, they were also asked to explain whether or not crossing a boundary influenced their behavior, expectations or perceptions.

Theme #1 – Management Approaches and Regulations

The following is a sample of some of the comments that were made related to different management approaches and regulations.

“I generally appreciate the level of management provided by BLM, especially on the Monument. Park Service’s emphasis on access and regulation tends to make me feel I am in a museum or an amusement park. This detracts from the power of the landscape for me. I tend to experience a much more powerful feeling in the less structured, more remote sections of the Monument. “

“NPS has typically the highest standards; BLM the lowest.”

“It does matter to me what kind of public land it is. For example, I expect more development and use at Kodachrome Basin State Park than I do hiking off the Cottonwood Road near The Narrows.”

Theme #2– Signs and Maps

Others were concerned that the lack of on the ground signage and adequate maps identifying boundaries might lead to confusion and a diminished recreational experience. For example:

“Very difficult to know when you cross into State land.”

“If you live here, you know where stuff is, but visitors get confused easily, especially foreign visitors.”

“Yes, because I have worked for agencies in the past. However, most people have NO CLUE as to administrative boundaries or how use/expectations change with those boundaries. This is a huge problem. Seamless use and consistent management should be paramount and better coordination between agencies needs to happen. The Monument should have the highest level of protection as the “Science Monument”. ”

“Unless there is something posted, I am not aware of it.”

“Boundaries are not always well marked.”

"The Monument's travel map is so poor both in size and detail that it is almost impossible to tell which roads are legal and illegal to travel on... and where you are on the map."

"Not aware when I am moving from one to another. I take a bioregional approach rather than focus on the differences between agencies."

Theme #3– Private Property

Some private land is located in the Grand Staircase area, particularly along Skutumpah and Johnson Canyon Roads. Most participants were concerned that private lands are sometimes not clearly marked. Many expressed a desire to respect private land as the following comments indicate.

"Private land is an issue. Some people just walk across people's front yards."

"The only thing that matters as to the boundaries is to know if it's private land and they don't want me on the land."

"I am always leery when entering private land due to unknown expectations of the owner."

"Yes, I use a map so I know when I am on private land. I try to be careful when I am on private land."

"I like to stay on federal land. I am really excited because I feel a sense of ownership. If I am on private land I feel like I don't belong."

Theme #4– User Conflicts

Finally, several comments were directed toward the conflict over control of roads and grazing in the area that negatively affects the recreational experience.

"The Monument's administrative boundaries when it comes to grazing are unclear. We've backpacked more than once into a riparian area with cattle polluting the water and have wondered whether these cows were legally allowed to be doing this in the spring when many visitors come to hike in the Monument."

"The recent legal battles over roads are a problem and do cause conflict with roads and use."

Wilderness Study Area Boundaries

Another question was added during this phase that addresses crossing into Wilderness Study Areas (WSA) in the region. Participants were asked if they were aware when they crossed WSA boundaries and if it influenced their expectations, perceptions or actions. The responses to this open-ended question surfaced a wide variety of perspectives on the topic of wilderness, and the management actions associated with WSAs in the area. The following samples of comments identify the key themes to emerge from this conversation.

Theme #1—Awareness of boundaries

Many participants commented on how difficult it was to determine where the boundaries are, or even to be aware of them at all.

“Some people don’t worry about them or are not aware of regulations.”

“I was not aware, and if I were, it would definitely change my expectations and my activities.”

“Most of them are poorly marked if at all and in many cases the maps that exist do not help to know for the average person. “

“I am aware visitors don’t care for boundaries. If they have some expectations, WSA’s make it harder for them and they don’t care either way.”

“When you do see the signs you are more aware of what is going on in the area.”

“I find that the Monument doesn’t adequately inform casual visitors about the importance and the rules associated with WSA’s and Wilderness Areas on the Monument.”

Theme #2— Management expectations in WSAs

Where people are aware of the boundaries or the existence of WSAs, they have an expectation that they are managed for wilderness characteristics.

“I love wilderness study areas—preservation where all creatures can live without being disturbed.”

“I am inspired by these areas; it allows nature to exist without interference. “

“WSA’s are managed as de-facto Wilderness. I seek out and crave these wild landscapes.”

Theme #3- Misunderstanding purpose or activity in WSAs

However, many participants expressed their concern that WSAs “study” period has gone on too long and that officials should make a decision. Several assumed that the reason for the designation had to do with active scientific research in the area, rather than a management prescription using the language of the Wilderness Act.

“It does matter to me too; hopefully someday someone makes a decision.”

“The study never ends. It seems like they put it up to keep ATV’s out. “

“Change sign then—it says “study area,” but not studying it.”

“Influence perceptions. Sign for study area. Way too often because they don’t have the gonads to enforce laws—No tracks, rangers, biologist, geologist, anthropologists, etc. If you’re going to say you’re doing a study, do a study.”

"Even though WSA's have out lived what they were set up to do. I still obey the law concerning them."

"But they provide a good space for educational areas. Some people aren't aware of how to treat these areas."

"Always welcome people doing studies—dinosaur studies, etc."

Theme #4– Restrictions on recreation

For many, the existence of WSA boundaries was interpreted as restricting or enabling certain types of recreational activity. In the words of the participants:

"Primitive use - maybe horseback. If I see something in there like an ATV it disturbs me."

"If I'm on foot I'm not doing anything inconsistent with WSA. On foot or on horseback. If I'm driving, I know pretty well where those are."

"If I want to recreate in the absence of motor vehicles, I will pick a WSA."

"I am very aware of activities within WSAs that are not in compliance, and know that Law Enforcement {personnel} can't enforce these rules as required."

Theme #5 – Land Ethic

Lastly, several participants spoke of the land ethic that treats all areas as if they are wilderness. Thus, the WSA boundary does not matter to them even if they are aware of it.

"I believe I have been aware. It doesn't change my expectations. It is kind of convoluted, but I don't treat areas differently based on the designation. I don't misuse or throw trash out regardless."

"I am aware, but I treat the landscape the same. Just because there's some sort of administration does not change how I treat the land."

"I treat everything the same as wilderness."

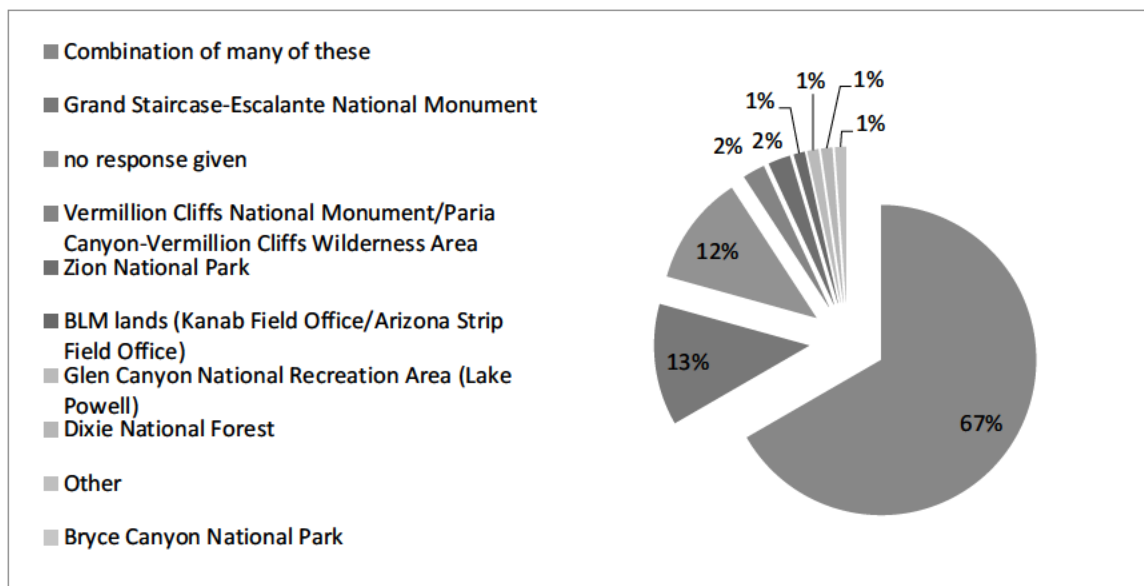
When choosing to recreate in the area, where do you spend the most time?

One of the remarkable aspects of the area studied in this phase is the context of the larger landscape the Grand Staircase is set in. Not only is the Grand Staircase area part of the Monument which includes the rugged and remote Kaiparowits Plateau and the stunning Escalante Canyons to the east, but there are numerous other world-class public lands and recreational opportunities in the surrounding areas. These include the Paria Canyon-Vermilion Cliffs Wilderness Area, Vermilion Cliffs National Monument, and other BLM managed lands. Zion National Park is to the west; Capitol Reef National Park is to the east; Bryce Canyon National Park is to the west; Grand Canyon National Park is to the south; and Glen

Canyon National Recreation Area is to the southeast. To the north is Dixie National Forest including The Box-Death Hollow Wilderness Area. Utah State Parks in the area include Coral Pink, Kodachrome, Anasazi, and Escalante Petrified Forest.

With so many recreational opportunities and amazing landscapes in close proximity to the study area, it is important to understand how the Grand Staircase area fits into the mix. To better understand where visitors spend the most time when recreating in the area, participants were provided a list of options including “other” and “a combination of many of these”. They were only allowed to select one option with the clicker but they could also explain their thinking through comments. Figure 14 shows the two out of every three participants selected the combination option. The Monument (13%) was the single largest destination followed by no given response and other BLM lands (2%) in Vermilion Cliffs National Monument and Kanab Field Office. Generally, the most popular choice was by far a combination of destinations.

Figure 14: Destination(s)



Participants indicated that there were a variety of factors that would influence their decision on what destination they chose to recreate at, including seasons, who they are with, crowding, regulations, and accessibility. The following comments are a sample of individual comments that further understanding of how participants choose locations in which to recreate.

“When I have family and friends come to visit we pick a place that they haven’t been before. I sometimes get a bellyful of Bryce. It’s not a place I recreate. Everything’s different. Mostly I’m interested in accessibility depending on canyon.”

‘Spend time on Kanab Field land – closer. If I have a day to spend I’d go on the Monument, but it depends on road construction.’

“Most of my time is in GSENM, but I do spend significant time in Glen Canyon (Hole in the Rock/Escalante Canyons) and Dixie National Forest.”

“It’s a seasonal issue. In the winter time I don’t go north. Those are the places I avoid in the wintertime. In the springtime as the snows melts I migrate up the Staircase.”

“Depends on time and season—don’t usually go to Zion, unless it’s off-season.”

“I have a great love for all these areas and try to spend time in most of them. Each is unique and needs to be appreciated. There isn’t one area that I do not go to.”

“GSENM, Dixie National Forest, Parks with visitors, ...all are wonderful and call to be experienced at different times.”

“I prefer areas of least human presence, including livestock!”

“The areas are all adjacent to each other so you can cross boundaries very easily. Driving south off of Hwy 89 for instance, you cross NPS, AZ Strip, Vermilion Cliffs.”

What is clear from most of these comments is that those who chose a combination of destinations are appreciative of and utilize the diversity of opportunities, settings and experiences available in the areas surrounding and including the Grand Staircase region.

Services

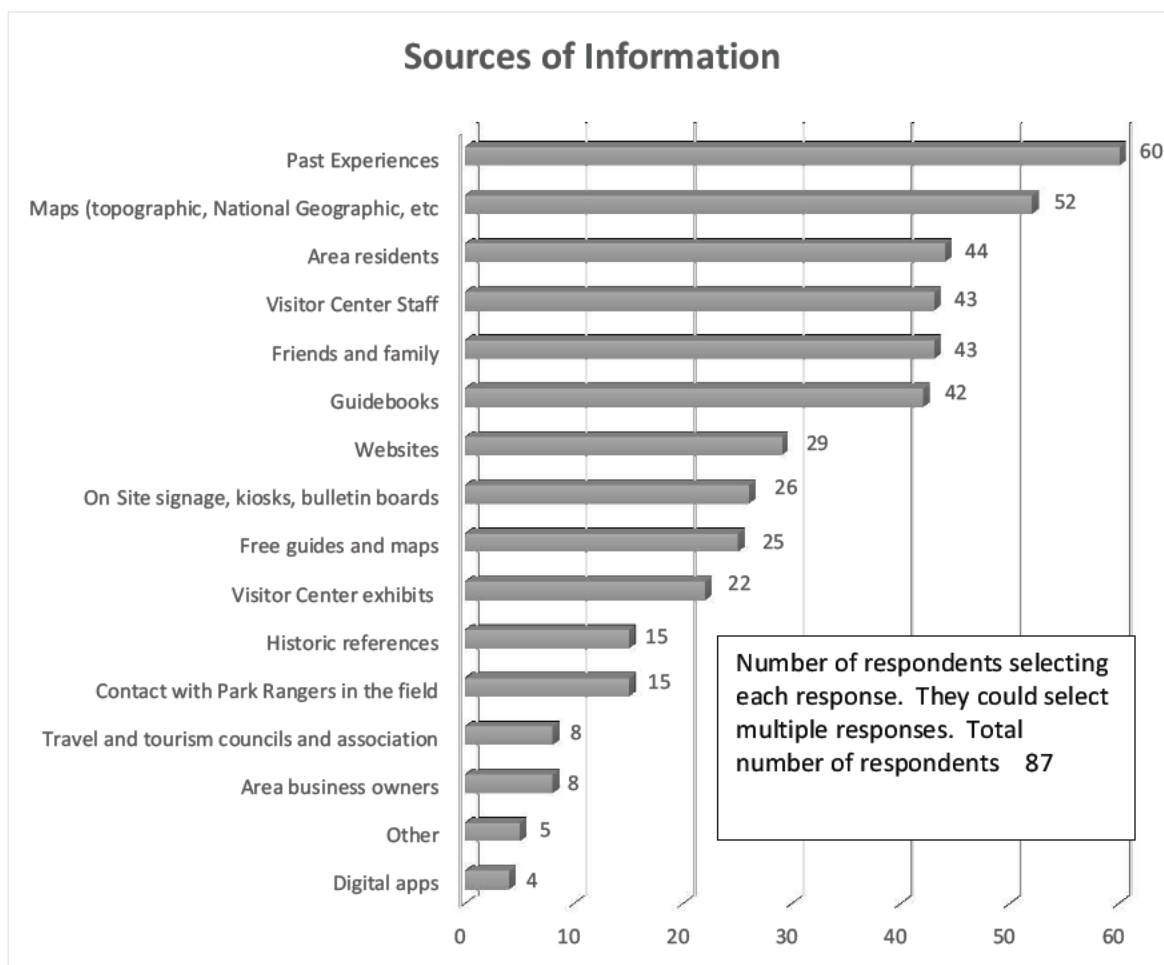
When individuals recreate on public lands they are concerned about the outcomes and experiences that they desire, the activities they want to participate in, and the setting characteristics that make all of those possible, but they are also reliant on the provision of services that make their experiences possible. These services typically range from information to fuel, food to gear, and accommodations to communications. While BLM does not provide many of the services needed by recreationists using the area, the agency does need to understand what services are necessary for visitors and local residents to be successful when recreating in the Monument and on adjacent public lands. The data about services allows BLM staff to engage in dialogue with business owners, community leaders, and residents to develop partnerships that enhance the livelihood and well-being of the local communities and supports visitor needs. The conversations that arise from these "practical partnerships" between the BLM and the service providers are one of the best values of this study. Done well, these will strengthen the ties of local residents, community leaders, business owners, to the landscapes surrounding their gateway communities.

Participants were asked several questions to prompt discussion about the kinds of services that are needed to be successful when they recreate in the Grand Staircase area and where those services are located. Their responses and a selection of clarifying comments follow.

Information Sources for the Grand Staircase area

The first set of services almost every recreationist relies on to be successful is quality information. The participants were asked, "*Which sources of information do you depend upon to plan your recreation in the Hole in the Rock area?*" and were allowed to choose more than one response from the prepared list. Figure 15 contains the percentage of participants that chose particular responses.

Figure 15: Sources of Information about Grand Staircase Area



As one might expect, past experiences (69%), and maps (60%) remain very important sources of information about the area for over half of the participants. These sources of information seem to be complimented by personal interaction with family and friends (49%), area residents (51%) and Monument Visitor Center staff (49%). It is worth noting the important role that the information provided by GSENM plays in the preparation and successful recreation experience in the Grand Staircase area. Not only did roughly half the participants identify the Visitor Center staff as sources of information, they also indicated that on-site kiosks (30%), Visitor Centers exhibits (25%), and even occasional contacts with rangers in the field (17%) all contribute to their successful recreational experience in the area. Digital information seems to have a mixed review in terms of being sources of

information. While a significant number of participants indicate the usefulness of websites (33%) in their preparation, far fewer identified digital apps (5%). Because there was no distinction between government websites and other websites in this phase of the study, it is not possible to say how effective the effort of BLM websites were in supporting recreation in the area. Realizing that this would be useful information to have, starting in the next phase of the study, a distinction will be made between government and non-government sites to get a better understand the role BLM information provision plays in the successful recreational experience on GSENM.

Additional sources of information not listed in options given

The following comments help to identify other important sources of information not listed as options in the clicker responses.

“Waitresses at breakfast who are talking about what’s available.”

“Google Earth is important in my trip planning.”

Role of BLM in providing information

While several important sources of information surfaced in the discussion, most of the comments had to do with the role that BLM efforts play in the preparation and execution of a successful recreational experience in the Grand Staircase area. Here are a few of the comments that offer more nuance than simply identifying GSENM staff as a source.

“Personalized visitor center staff that has the most up to date information is most beneficial.”

“I am always hoping the information person has really been in remote areas and cares about the condition of the Monument”

“Agency websites to check for specific requirements in popular areas and find out if there are restrictions.”

Not all comments on the BLM information provision efforts was positive. It was noted that more positive news regarding GSENM could be shared in Kanab, and that more rangers would be needed in the field for them to be a reliable source of information. Nevertheless, it is clear from this phase of the study that GSENM efforts to provide recreation information is important so that people can be successful.

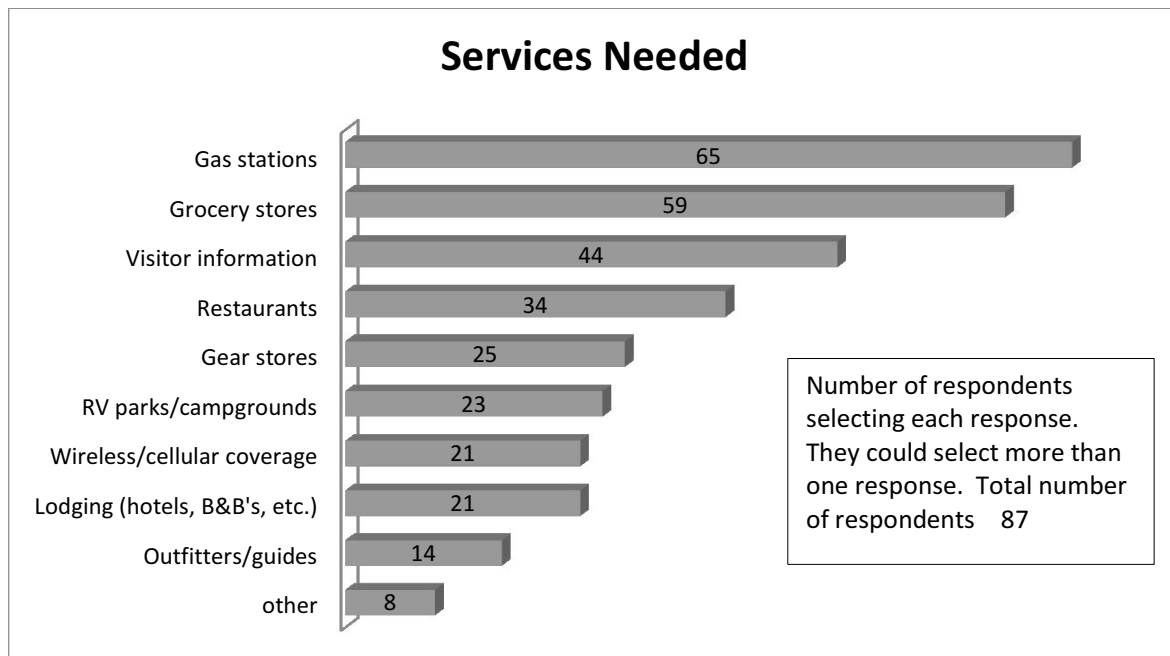
Other services needed for successful recreation experiences

In order to measure the other services that participants depended on, they were asked *“What services do you depend on to have a successful recreational experience?”* and asked to select as many responses from the prepared list as were applicable. These services range from gas to groceries, gear to accommodations. It is important to note that BLM is not planning on offering most or any of these services, but BLM planning efforts require that the agency understand the interactions between recreational users of public lands and the surrounding communities. “Practical partnerships” between

BLM and service providers can result from this understanding and provides support for the provision of quality recreational experiences on public lands. Done right, this will strengthen the ties of local residents, community leaders, business owners and the landscape surrounding their gateway communities.

Figure 16 indicates the percentage of total participants selecting each of the services.

Figure 16: Services Needed

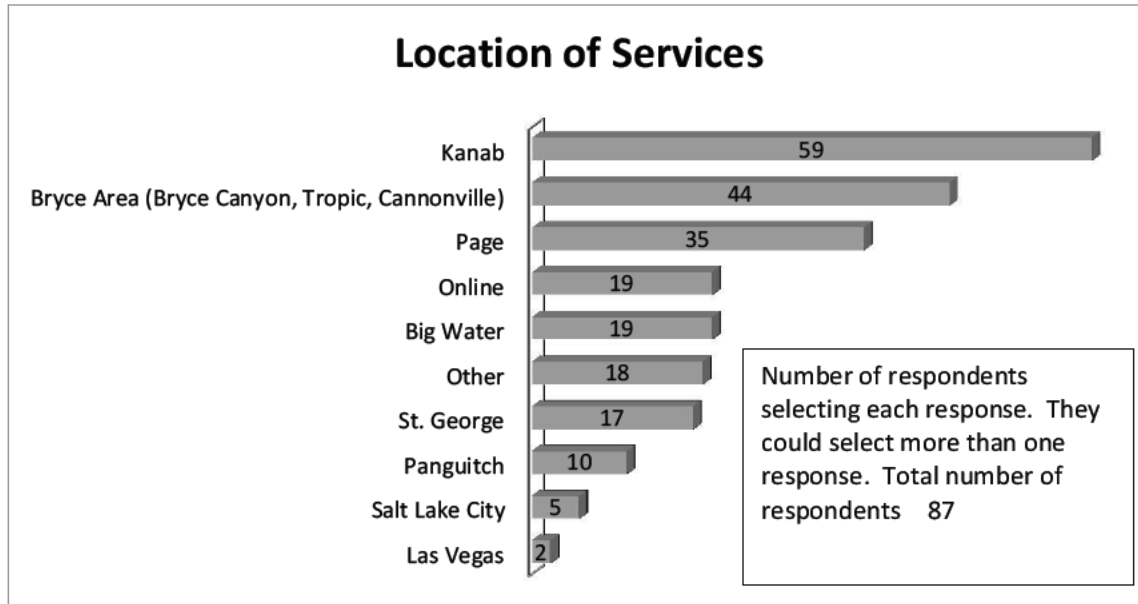


As one might expect, gas stations are the most common selection (84%) followed by grocery stores (77%), visitor information (57%) and restaurants (34%). Wireless/cellular coverage (27%) drew mixed reaction in the comments as a split between those who felt safer with cell coverage, and those who didn't need or want it because of a desire for self-reliance or a "wilderness" setting. Accommodations were split between RV parks / campgrounds at 23% and lodging (hotels, B&Bs, etc.) at 21%. 25% of participants selected gear stores (25%), and 14% selected outfitters and guides (14%).

Where those services are located

The real power of a discussion of services that participants depend on is to combine it with the location of those services so we can better understand that dimension of the relationship between the gateway communities and the public lands surrounding them. Once again participants were encouraged to offer comments as well as consider a list of several of the communities from which they might obtain services. They were allowed to choose as many locations as they thought essential. Figure 17 shows the number of total selections for any particular location to obtain services.

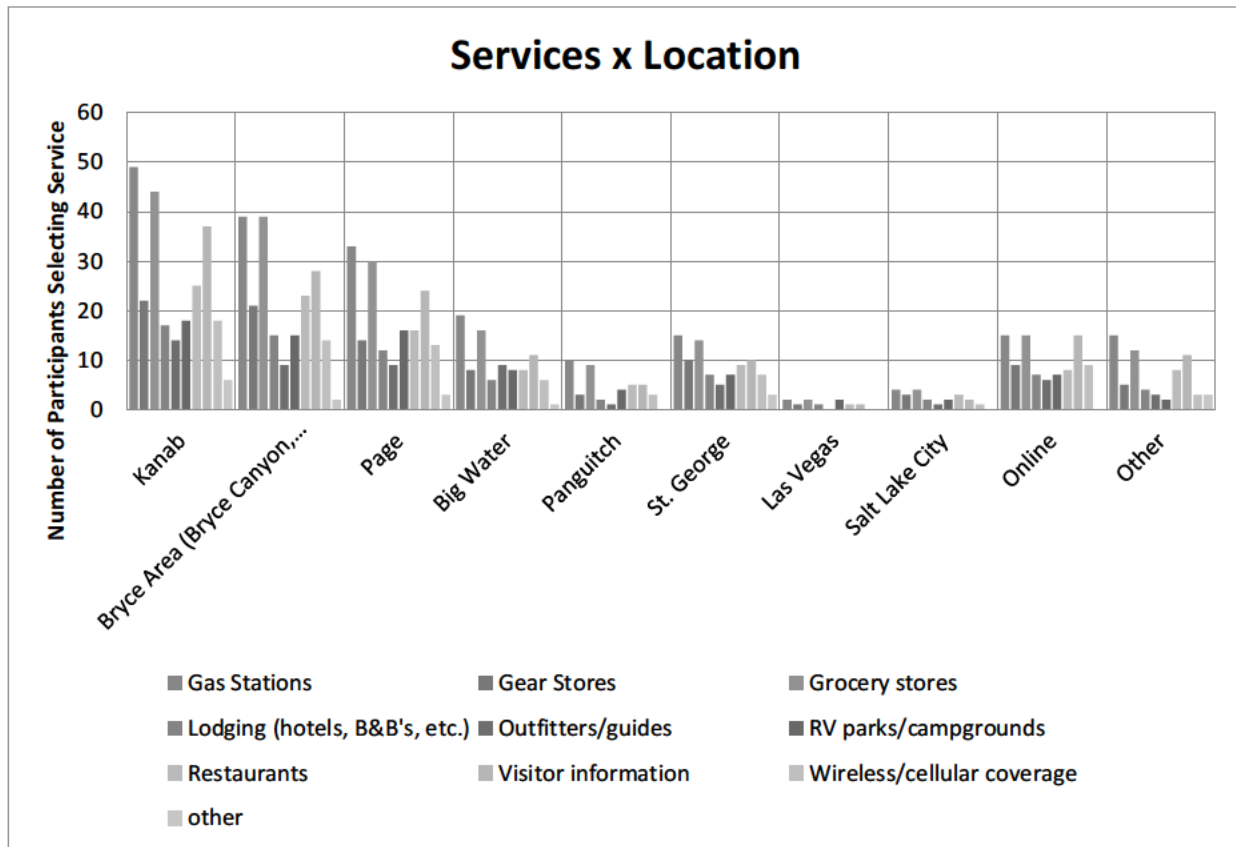
Figure 17– Location of Services



When asked about where the services are located that participants depend on for recreational support in the Grand Staircase area it is apparent the significant role played by the gateway communities of Kanab (76%) to the southwest; Cannonville, Tropic and Bryce Canyon City (57%) to the north; and Page, Arizona (45%) and Big Water (25%) to the southwest. Nearly a quarter of the participants selected other. And when asked to clarify they indicated that they obtained services from Escalante, Boulder and Torey, as well as the communities in Long Valley and Fredonia. Backcountry aviation participants indicated they rely on services often further away in the communities with local airports.

From these responses it appears that recreation in the Grand Staircase area provides an important contribution to the local tourist economy in the gateway communities proximate to the Monument and a spill-over economic effect on other communities in the region. In order to understand more precisely what types of services are utilized in each community, individual services were correlated with the communities selected by each participant and are displayed below in Figure 18 below.

Figure 18 – Services and locations of those services



Missing Services

When asked what services were missing that hinder the participant's ability to have a successful recreational experience in the Grand Staircase area, responses ranged from more social opportunities to increased law enforcement to expanded times services are available.

"Bar/night life. I don't live in a bar, but if I'm vacationing I want to have dinner and a couple of beers and then go home."

"Services adequate but not available on a given day of the week - expanding availability."

"Services missing after the season ends."

"Adventure center. Find out outfitters and make contact with people and book a trip."

"More information on the website - detailed maps on website."

"Signage in multiple languages."

"A little more signage might help. People often rely so heavily on their electronic devices that they get out there and in trouble. More signs."

"Increased monitoring of biological impacts is essential; of human activities, that is."

"Some type of shuttle services would be a great advantage to be able to make it across country to another area."

"It would be great if there were some ways to learn in-depth from certain people who know the nature well. "

Most Recent Visit -Expectations and Surprises

The final discussion in the focus groups centered on the participants' memories of their most recent visit to the Grand Staircase area. They were asked to comment on whether that last visit met their expectations and whether they were surprised by anything. Of course, the most important element of this discussion was their response to the follow up question, "Why?"

Based on their responses, the area is generally meeting or exceeding expectations as evidenced by this comment which is typical of many expressed about the area and its ability to surprise and delight.

"Always meets expectations. Always see something that I don't expect. Try to go someplace new - come around a corner and see something that knocks my socks off!"

In addition to the value of surprise and opportunities for discovery, the Grand Staircase area was praised for its diversity of recreational opportunity as articulated in this comment.

"The Monument always meets my expectations. It is a great place to have diversified activity, including ATV riding, 4x4 riding, cattle-raising and historical sites. Anyone who would shut the Monument down and not allow all people to enjoy it is truly mistaken. "

Because of the outstanding opportunities for a diversity of recreation and other uses of the Grand Staircase area, it is in danger of being loved to death from increasing use according to several participants' comments. Some suggested the important role of management to protect the resources of the area by balancing restrictions and access to recreational opportunities.

"Exceeded my expectations, which is the reason for increased interest and expanded use."

"Still, it is my favorite place in the universe! It needs to be very carefully managed due to increased pressure from ranching, petroleum development, sheer human numbers, and ORV activity."

"Last time I actually recreated, it was during the government shutdown. It was awesome."

"I'm a lifelong southern Utah resident. I expected the Monument to have more restrictions so was a pleasant surprise. I have dealt with park service and national parks especially in the back

country, beyond where it {restrictions} is reasonable, so I was pleasantly surprised {in the Grand Staircase area}.”

Several final comments identified seasonal experiences such as an abundant wildflower blossom in 2014 as another reason that you never know what you might encounter in this dynamic landscape. Others expressed concern in their last visit over seasonal road conditions, vegetative treatments, over-grazing, exotic species, and vandalism or other damage to the resources in particular locations. These locations have been noted in the administrative record for BLM attention on a case by case basis, but overall the impression is that the Grand Staircase area is a resilient landscape and an amazing place for so many successful recreational experiences.

Conclusions:

After analysis of the responses from 87 participants in 17 focus groups over seven (7) months of data collection in 2014, the following conclusions began to emerge regarding the Grand Staircase area of GSENM. They will be separated here into observations and recommendations. Although in a baseline study, the principal focus would be on observations of the setting and context, inevitably as participants expressed their ideas concerning the area of study, some of these ideas came as recommendations for future action. These were not solicited, but are recorded as part of the response given.

Observations

- One of the most important characteristics of the Grand Staircase area for recreational experiences is the land itself, in particular the uniqueness of the geology. The geology is unique at the large and small scale. The large scale of the “steps” of the Grand Staircase from the Vermillion Cliffs in the south near Kanab up north to the Pink Cliffs of Bryce Canyon give the area its distinctive name, but also provide the backdrop for every recreational experience in the area. On a smaller scale, unique geologic features such as Grosvenor’s Arch and the slot canyons of Willis Creek and Bull Gorge become iconic destinations within the broader landscape.
- The overall scenic beauty of the landscape and the unobstructed view-sheds also were mentioned again and again as essential elements of the recreational experience in the area. Threats to the scenic beauty such as power lines or other signs of development were identified as cause for significant concern because of the impact they would have on overall enjoyment of the landscape.
- Fitting of the scientific mandate in the Monument’s enabling legislation, many participants identified opportunities for learning as a critical characteristic of this particular landscape. Not only did they value the scientific inquiry that happens in GSENM, but they valued the opportunity to discover new and different aspects of this vast landscape. They also see this landscape as an opportunity to teach visitors and future generations about the important

connections between people of the past and the Grand Staircase area, as well as educating them about a broad respect for the land, its flora and fauna, and its protection.

- Participants identified the variety of recreational opportunities in the area as a highly desired characteristic of the landscape. Preferred activities often change depending on time available, seasons, company, etc. Additionally, they were supportive of a diversity of activities, as long as those activities are compatible with other valued characteristics of the place.
- Part of what makes recreation in the Grand Staircase region so desirable for many participants is the way time interacts with this dynamic landscape. This includes the variation of experiences one can have depending on the season (wildflowers, solitude, and flash flooding); as well as the way the light changes throughout the day and into the dark night skies of evening. Moving up the Staircase, one can transcend over 100 million years of geologic change, and yet be swept away by the beauty and serenity of a rare flower in bloom for only a day after a rain.
- The history of human settlements is etched into the very rock of the canyons even as the footprints of the most recent visitors disappear in the flow of a stream. Some of the most important resources for many participants in the study were the archeological and historic resources. There are many sites in the area covering the many layers of human occupation in the area from pre-history to the homestead era that people enjoy visiting, but some of these sites are being damaged by thoughtless or malicious visitors. There is a robust commitment to the preservation of these sites through the Monument's site steward program that several participants were proud to participate in.
- Several qualities identified as significant to the recreational experience included the quietness, remoteness, and naturalness of the area. Others identified the creeks and the Paria River as critical corridors for recreation around water in the desert.
- The Grand Staircase area of GSENM is a land of many contrasts. While there is a deep and rich sense of place among the locals, there is a concern that increasing numbers of visitors have little connection or understanding of the place.
- The accessibility and remoteness of the region was noted as having an impact on the quality of the recreational experience in the Grand Staircase area. There are several primary roads in the area that allow for access throughout the landscape, yet the scale (vastness) of the area maintains a sense of remoteness and space between those recreating. This supports the highly desired values of solitude and tranquil escapes. Some areas such as the WSAs are only accessible by foot and hoof which supports both the variety of experiences and recreational settings that most participants valued.
- The local communities and their residents seem to struggle with the contrast of the tourism industry being both a blessing and a curse. The tourism industry is beneficial to the local economies of the gateway communities and many local participants described their joy in sharing the wonders of the landscape that is "right out my back door." However, an increasing number of visitors can lead to crowding and a diminishment of the specialness of the place characterized by solitude, wildness, and other attributes of the area.
- Participants seemed to be torn on the benefit or harm that comes from the many roads and transit corridors that cut across this region. Roads such as Cottonwood, Johnson Canyon and

Skutumpah are used as primary access in and through the landscape. These roads are often used not only to access recreational opportunities, but they serve to connect communities on the periphery of the Monument. Some of these roads also allow those with reduced mobility to enjoy the landscape and its features. However, these roads (with mostly natural surfaces) make travel in the area very weather dependent and force travelers to pay attention to road conditions that may be effected by washouts, mud and other hazards. Some participants indicated that the roads may be used as transit corridors for illegal activity at night. There were also concerns that developed roads would encourage people to move too fast through the area to gain a meaningful connection to the place.

- The internationally-known, iconic geologic formation known as “The Wave” in the Paria Canyon-Vermilion Cliffs Wilderness Area draws visitors from around the world. However, there is a limit of 20 visitors a day to preserve the area’s wilderness characteristics. A daily lottery is held to determine who will receive the ten walk-in permits for the following day, but there are exponentially more attempting to get permits than spaces available, so those not receiving permits are displaced onto surrounding landscapes including the Grand Staircase region of GSENM. Several participants highlighted this displacement as a potential problem, while others suggested that this was more of an opportunity to share other recreational opportunities in GSENM with those who might not have been aware of the incredible recreation, resources and scenery available there.

Suggestions

There were several suggestions offered to address concerns expressed by participants. These suggestions appeared in a variety of comments from various focus groups throughout the study. This report does not necessarily endorse the suggestions; however, because this study is intended to develop a baseline for recreational interests and expectations in the Grand Staircase region of GSENM, they are certainly worth consideration and further conversation between all relevant stakeholders including the GSENM staff. They are summarized here.

- There should be a number of efforts made to educate the public about the unique resources in GSENM as well as how one can recreate without diminishing those resources (e.g. maps, signs, visitor information, websites).
- GSENM should develop existing and future partnerships with local communities and organizations to manage pressures on the landscape.
- With such a heavy value placed on the diversity of experiences offered in this landscape, the GSENM staff and partners should maintain [the] unique recreation opportunities for a variety of travel modes.
- The natural landscapes, tranquil escapes, and scientific learning are unique combination of qualities to be maintained in Grand Staircase area of GSENM.

Future research in this five-year study will include three additional phases. In 2015 Phase 3 will encompass the southern part of GSENM accessed by Highway 89, Vermillion Cliffs National Monument in Arizona, as well as parts of the Kanab BLM Field Office (Paria Canyon/Vermillion Cliffs Wilderness

Area). In 2016 Phase 4 will concentrate on the northern region of the Monument accessed by Highway 12 and Burr Trail Road. The last year of the study will take a comparative look at all four areas of the Monument covered in earlier phases. A final report released in 2018 will identify a recreational baseline of desired outcomes across the entire Monument, with emphasis on unique qualities of one or more regions.

Appendix 1: Meeting Handout phase 2 - Grand Staircase region

Grand Staircase-Escalante National Monument

Grand Staircase Region

Recreation Experience Baseline Study – Phase 2

Tim Casey, PhD

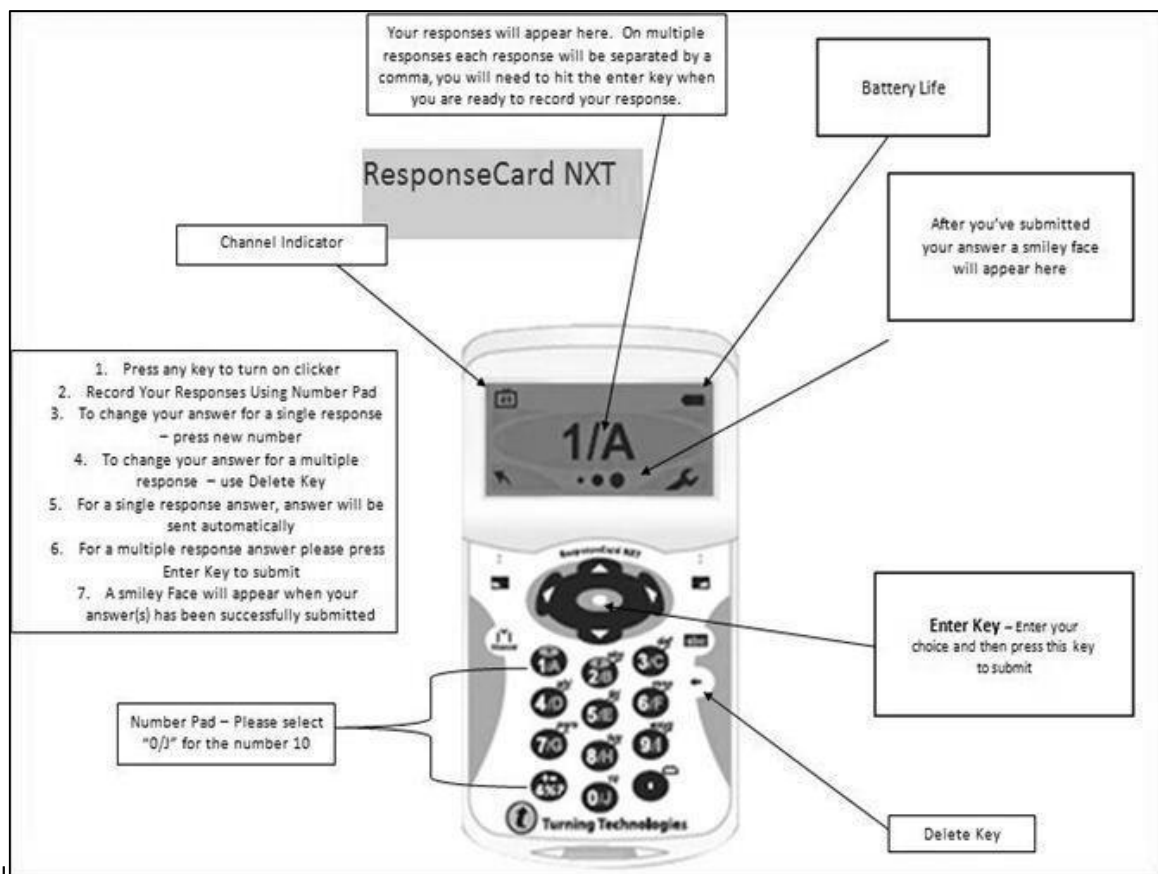
Natural Resource Center - Colorado Mesa University



2014

Participants:

- ✓ Listen, contribute, and stay focused on the subject at hand
- ✓ Feel free to keep or change your opinions in response to what you hear
- ✓ Respect others' right to share their thoughts; do not interrupt
- ✓ The moderator will stop anyone who attempts to block another's views
- ✓ Feel free to get up, obtain refreshments, or visit the restroom
- ✓ Do not engage in separate, private discussions
- ✓ Remember, participation is voluntary on all questions



To ensure that we all can use the clickers to help record your preferences throughout the focus group, let's try them now.

1. Would you start by entering your home zip-code when the slide is available and the polling bar in the corner of the slide is green.

To submit your response, select the enter key in the center of the arrows. You should see a smiley face at the bottom of your screen, if your response has been received.

2. Which of the following choices best describes your primary association with the Grand Staircase region of GSENM?

1	Visitor
2	Local Resident
3	Community Leader (elected / non-elected)
4	Outfitter/Guide
5	Business owner
6	Other

3. What are the qualities of the Grand Staircase region of GSENM that make it special for you? (Open ended discussion)

3. What are the qualities of areas along or accessed via Hole in the Rock Road that make it a special place for you? (Choose up to five.)

SP-1	1	It's my back yard
	2	It's where I spend quality time with friends and family
	3	Historic qualities - how previous generations used the area
	4	Productive qualities - grazing and hunting
	5	Biological resources - plants, animals, etc.
	6	Physical resources - geology, paleontology, etc.
	7	Cultural resources -archeology, etc.
	8	Scenic quality
	9	Spiritual and/or religious qualities
	0	Sense of freedom
SP-2	1	Wild, unspoiled, and natural
	2	Remote and rugged
	3	Sense of solitude and privacy
	4	Natural quietness
	5	Dark night skies

	6	Sense of discovery/learning opportunities
	7	Dogs and/or horses are allowed
	8	Lack of development or improvements
	9	It's where I engage in recreational activities I enjoy
	0	Other

Discussion:

4. What could or does diminish the specialness for you? (Open ended discussion)

4. What could or does diminish the specialness for you? (Choose up to five.)

DIM-1	1	Additional fees, permits, or restrictions
	2	Increased use and crowding
	3	Increased traffic
	4	Increased use of wider array of vehicles
	5	Group size limits I consider to be inappropriate (too high or too low)
	6	Limitations on historic uses and productive qualities
	7	Additional facilities and improvements
	8	Lack of facilities and improvements
	9	Increased access
	0	Limited access
DIM-2	1	Vandalism, litter, graffiti, and/or human waste
	2	Damage to soils and vegetation
	3	Lack of solitude and privacy
	4	Noise
	5	Artificial light
	6	Livestock or evidence of them
	7	Culture clashes – locals vs. visitors or long time locals vs. move-ins
	8	Lack of connection to or education about place
	9	Residential or industrial development (utility lines, pipelines, etc.)
	0	Other

Discussion:

5. At the places you enjoy visiting has use increased or decreased in the last five (5) years?

1. Strongly Decreased	2. Slightly Decreased	3. No Change	4. Slightly Increased	5. Strongly Increased
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6. If use at that these places has changed in the last five (5) years, has it been for the better or worse?

1. Much worse	2. Somewhat worse	3. No change	4. Somewhat better	5. Much better
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Why?

7. Are there particular places that are most important to you?

(Please write the names of these places on the sticky notes provided and place them on the general location of the area large map.)

Why are these areas particularly special?

8. When you go to your area of interest, which of these phrases best captures your interests and expectations for going there? (Choose up to 3)

CS-1	1	Natural Landscapes	I like to surround myself with the beauty of open space and the wildness of mountains, forests, rangeland, water and wildlife
	2	Rural Landscapes	I want to connect with the visual landscapes, sense of place and pace of rural areas where people make their living from the land
	3	Cultural & Heritage History	I am interested in how historic and prehistoric peoples lived in the area, and in exploring the connections I have with those peoples
	4	Natural History & Science	I am interested in knowing about natural processes in this area and the study of the scientific value of the landscape for enhancing our understanding of the world around us.
	5	Health & Fitness	I like being able to regularly access public lands recreation areas that help me get and stay fit or improve my mental well-being
	6	Self-Reliant Adventure	I prefer outdoor adventure on my own that challenges my outdoor skills, improves my abilities, and maybe even involves some risk
CS-2	1	Tranquil Escapes	I look forward to the quiet serenity of getting away from it all for some mental and physical relaxation, reflection, and renewal
	2	Youth, Family & Friends	I am enriched by socializing with others: young people, my family and/or friends and enjoying companionship in the outdoors together
	3	Community Life	I like seeing what the discovery and enjoyment of nearby open space recreation does for my community and our visiting guests

	4	Economic Well-being	I want to see public lands recreation areas contributing in a significant way to our economic livelihood
	5	Learning & instructing	I feel comfortable having others equip and enable me to do recreation and tourism outings—or being part of helping others learn how to do that
	6	Stewardship & Caretaking	I like giving back to the outdoors from what I've received by helping care for special sites and facilities so others can also enjoy them

9. When visiting that area, what activities do you engage in most often? (Choose up to 3)

Act-1	1	Scenic Driving
	2	Exploring or discovering new areas
	3	Hiking/Walking/Running
	4	Backpacking
	5	Car Camping
	6	Picnicking
	7	Rock Climbing/Canyoneering
	8	Nature Study (Wildlife Viewing/ Bird Watching/Geology/Plants)
	9	4x4 Driving (Jeep, Truck, SUV)
	0	ATV/UTV riding
Act-2	1	Bicycling/ Mountain Biking
	2	Horseback Riding
	3	Organized group activities (i.e. civic groups, clubs, scouts, church, etc.) including historic reenactments
	4	Ranching activities
	5	Hunting
	6	Photography
	7	Learning activities (interpretive programs, educational outings, etc.)
	8	Art/Writing activities
	9	Spiritual renewal activities
	0	Other

10. Do you recreate in this area primarily because:

1	The PLACE is inherently special to me
2	The area allows me to engage in a favored ACTIVITY
3	Both PLACE and ACTIVITY are important to me
4	Other

11. Photos & Preference: The next set of slides show images from the Grand Staircase region of GSENM. The images depict settings and travel routes in this region and we will use those to discuss your preferences.

12a. When traveling in the Grand Staircase region of GSENM are you aware when you travel across administrative boundaries (BLM, NPS, USFS, private land, state land, etc)?

If so, how does that influence what you do, your expectations, or your perceptions?

12b. When traveling in the Grand Staircase region of GSENM are you aware when you go into and out of Wilderness Study Areas?

If so, how does that influence what you do, your expectations, or your perceptions?

13. When choosing where to recreate in this region, where do you spend the most time?

Dest-1	1	Grand Staircase- Escalante National Monument
	2	Vermilion Cliffs National Monument/Paria Canyon-Vermilion Cliffs Wilderness Area
	3	BLM lands (Kanab Field Office/Arizona Strip Field Office)
	4	Bryce Canyon National Park
	5	Zion National Park
	6	Glen Canyon National Recreation Area (Lake Powell)
	7	Dixie National Forest
	8	Area Utah State Parks (Coral Pink, Kodachrome, etc.)
	9	A combination of many of these
	0	Other

14. Which sources of information do you depend upon to plan your recreation in the Grand Staircase region of GSENM?

S-1	1	Friends and family
	2	Past experience
	3	Area business owners
	4	Area residents
	5	Visitor Center staff
	6	Contact with park rangers in the field
	7	Visitor Center exhibits
	8	On-Site signage, kiosks, bulletin boards
S-2	1	Travel and tourism councils and associations
	2	Free guides and maps
	3	Guidebooks
	4	Websites
	5	Digital apps
	6	Historic references
	7	Maps (topographic, National Geographic, etc.)
	8	Other

15. What services do you depend on to have a successful recreational experience? (Choose all that apply.)

Service s-1	1	Gas stations
	2	Gear stores

	3	Grocery stores
	4	Lodging (hotels, B&B's, etc.)
	5	Outfitters/guides
	6	RV parks/campgrounds
	7	Restaurants
	8	Visitor information
	9	Wireless/cellular coverage
	10	Other

16. Where are those services located? (Choose all that apply.)

Services- 2	1	Kanab
	2	Page
	3	Bryce Area (Bryce Canyon, Tropic, Cannonville)
	4	Big Water
	5	Panguitch
	6	St. George
	7	Las Vegas
	8	Salt Lake City
	9	Online
	10	Other

17. Are there services that are missing and prevent you from having a successful experience?

18. Did your last recreational outing in the Grand Staircase region of GSENM meet your expectations? Why or why not?

19. What was the most surprising thing about your visit compared to what you expected?

We appreciate your involvement in this important focus group.
Your input is an important part of maintaining an ongoing inventory of our recreational users' preferences, expectations, and concerns.

Contact Information:


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Appendix 2 – BLM Recreational Setting Characteristic Matrix

Every Recreation Setting Can be Described:	By the Variation Within... ▶	Setting Classes					
	...its Component Attributes ▼						
		Primitive	Back Country	Middle Country	Front Country	Rural Country	Urban
BIO- PHYSICAL:	a. Remoteness:						
	b. Naturalness:						
	c. Facilities:						
SOCIAL:	d. Group Size:						
	e. Contacts:						
	f. Evidence of Use:						
OPERA- TIONAL:	g. Visitor Services:						
	h. Management Controls:						
	i. Travel Mode:						



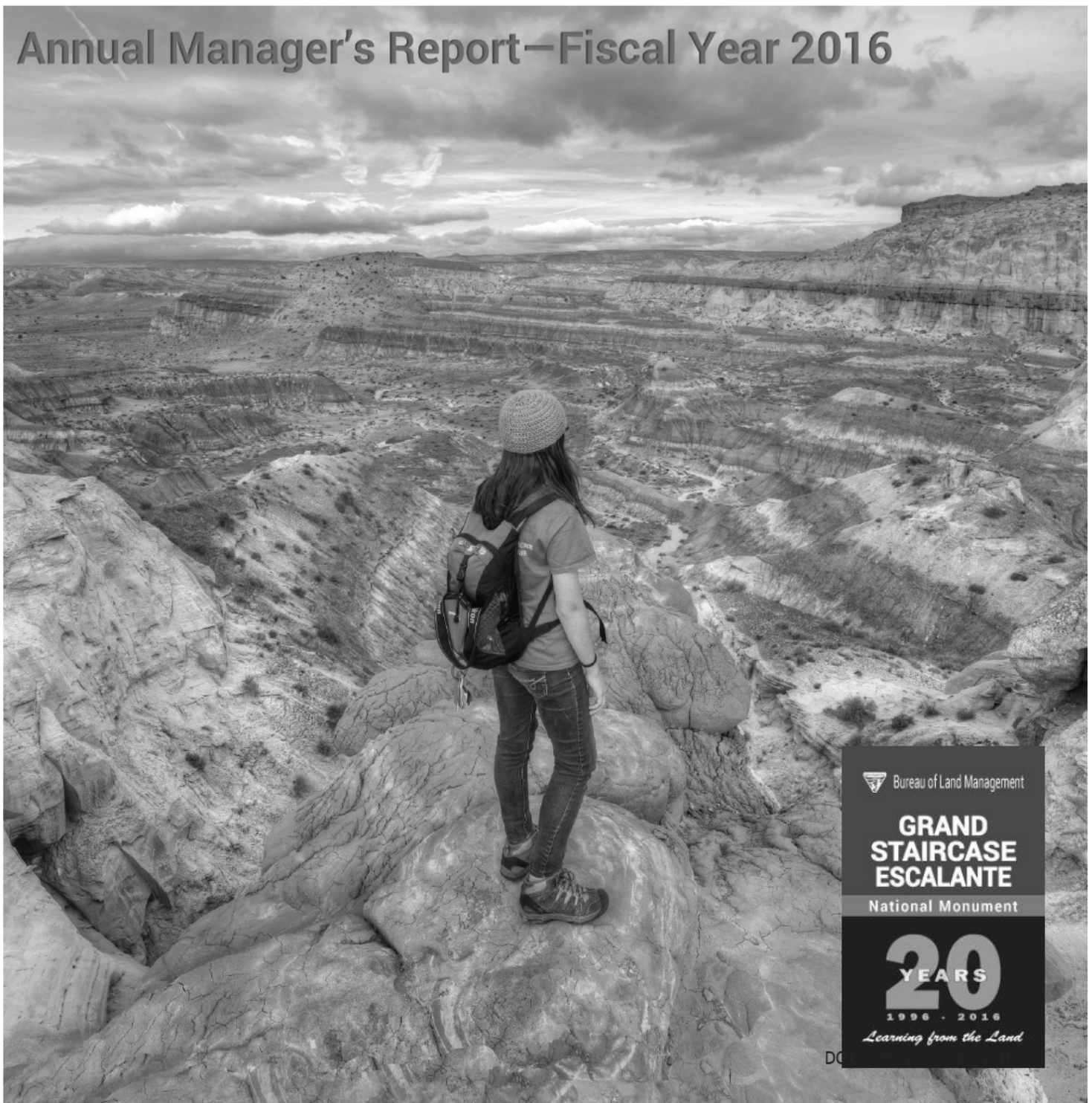
NATIONAL
CONSERVATION
LANDS

Utah

Grand Staircase-Escalante

National Monument

Annual Manager's Report—Fiscal Year 2016



Bureau of Land Management

**GRAND
STAIRCASE
ESCALANTE**

National Monument

**20
YEARS**
1996 - 2016

Learning from the Land

DO

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1 Grand Staircase-Escalante Profile

Designating Authority

Designating Authority: Presidential Proclamation 6920

Date of Designation: September 18, 1996

Acreage

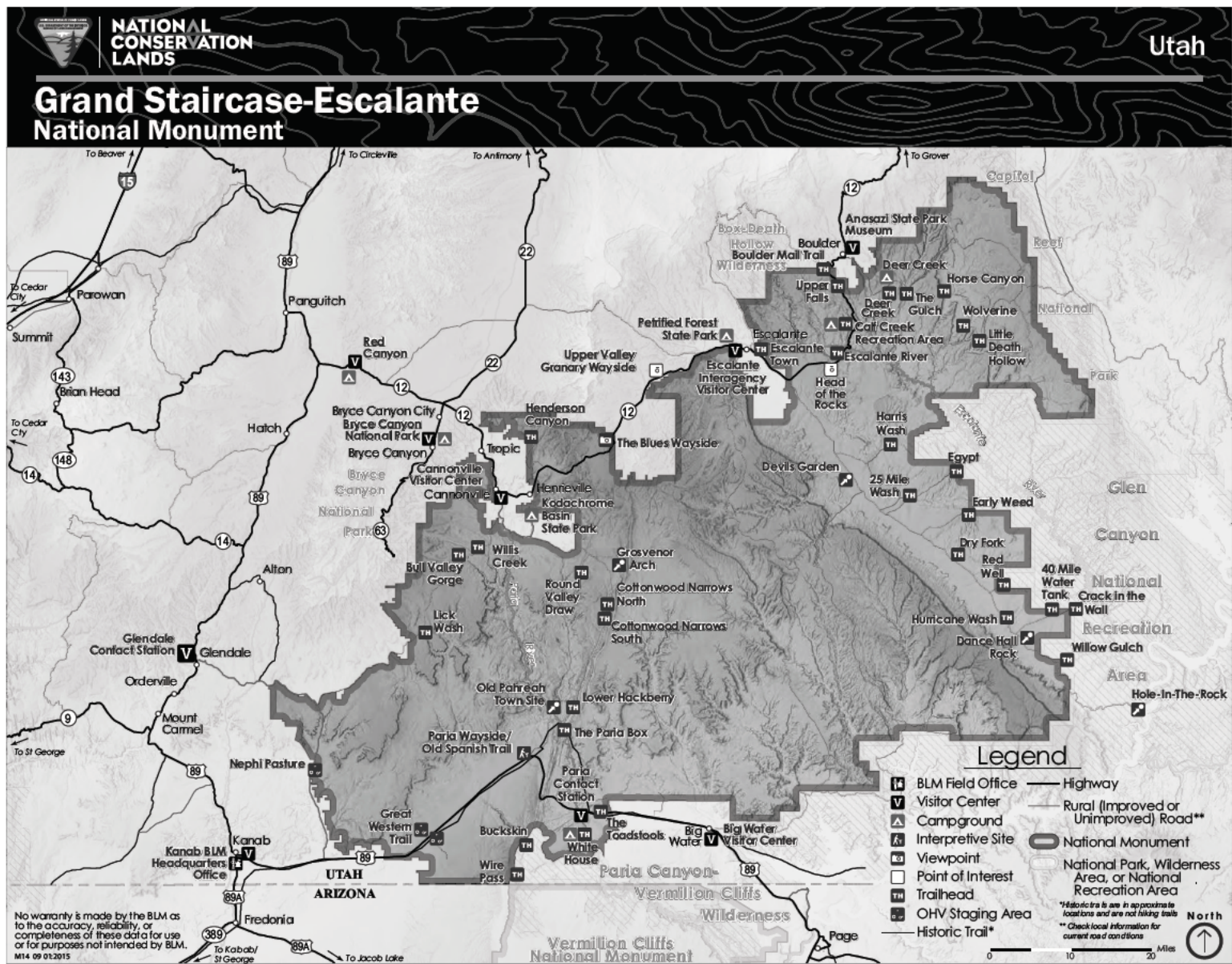
Grand Staircase-Escalante National Monument (GSENM) spans nearly 1.9 million acres of America's public lands. Managed by the Bureau of Land Management (BLM), GSENM is part of the National Conservation Lands. Reporting directly to the BLM Utah State Office, the Monument Manager oversees public lands which contain some of America's most scientifically exciting and visually stunning landscapes. The Monument boundary encompasses approximately 1,880,461 total acres including 14,130 acres that are privately held. There is no state land found within GSENM.

Total Acres in Unit	1,880,461
BLM Acres	1,866,331
Other Federal Acres	0
State Acres*	0
Private Acres*	14,130

*State and Private acres are not part of the total unit acres

Contact Information

Unit Manager	Cynthia Staszak
Phone	435-644-1240
E-mail	cstaszak@blm.gov
Mailing Address	669 South Highway 89A Kanab, Utah 84741
Field Office Name	N/A
District Office Name	N/A
State Office Name	Utah



Budget

Total Fiscal Year 2016 Budget	\$7,029,800
Subactivity 1711	\$4,728,600
Other Subactivities' Contributions	\$1,274,000
Other Funding	\$1,027,200

Managing Partners

N/A

Staffing

Grand Staircase-Escalante National Monument is the largest unit in BLM's National Conservation Lands system, and the largest national monument in the contiguous United States. The Monument is comparable in program size, complexity and land base to many BLM Districts, and considerably larger than most BLM Field Offices. In BLM-Utah's organization, the Monument is equivalent to a District Office.

In FY16, Monument staff consisted of 49 full-time employees, led by two line officers, the Monument Manager and Associate Monument Manager. Staff is organized into three major functional Divisions: Planning and Support Services, Resources, and Science and Visitor Services. Monument staff includes an administrative team, facilities management, backcountry rangers, visitor center staff, planners, a science program administrator and resource specialists. GSENM serves a nationally significant conservation role for the Bureau with programs managed by resource specialists, in paleontology, archaeology, biology, botany, ecology, history, wildlife, planning and environmental coordination, range management, realty, recreation, soil, air and water, wilderness, and visual resources. Two BLM law enforcement officers are assigned to GSENM; one full time in Escalante and one shared with the Kanab Field Office in Kanab.

The Monument shares its Headquarters building; at 669 South Highway 89A, with the Kanab Field Office (a unit within BLM-Utah's Color Country District) and the two offices share front desk and administrative staff duties. The Monument also receives administrative support, primarily in property management, but also including some contracting and engineering functions, from the Color Country District.

The Monument works with the Kanab Field Office and Arizona Strip District to administer the Paria Canyon/Coyote Buttes Special Management Area (SMA) under

a Memorandum of Understanding (MOU) between the three offices. The Monument manages the Kanab Visitor Center, the major contact point for visitors to the Paria Canyon/Coyote Buttes SMA in Utah, and location of the world-famous “Wave Lottery”. Major trailheads to the Wave originate on the Monument, and Whitehouse Campground, the primary overnight camping facility for Wave permit holders, falls within the Monument boundary.

The Escalante Interagency Center, located in Escalante, Utah, is one of four Monument Visitor Centers found in the communities surrounding the Monument. This BLM facility is the only federal building located in Escalante and provides workspace for Monument staff, the Dixie National Forest-Escalante Ranger District, and Glen Canyon National Recreation Area staff.

The Monument administers grazing permits for a number of allotments which fall fully or partially within the boundaries of three other units: the Kanab Field Office (Color Country District), the Arizona Strip Field Office (BLM Arizona, Arizona Strip District), and Glen Canyon National Recreation Area (National Park Service).

2 Planning and NEPA

Status of the Resource Management Plan

Grand Staircase-Escalante National Monument is managed under a Monument Management Plan (MMP) adopted in 2000, and a series of four Management Framework Plans (MFP), adopted in the 1980s, which govern livestock grazing. The MMP replaced any previous decisions for resource management in the four MFPs, with the exception of livestock grazing. In 1999, the Escalante MFP was amended to reallocate 5,630 AUMs of forage to purposes other than livestock grazing. This amendment also created a forage reserve to be used during emergencies or for research purposes. The MMP has been amended twice; the 2011 Record of Decision (ROD) for the Tropic to Hatch 138 kV Transmission Line Project EIS in which a 300-foot wide by approximate 3-3/4-mile long swath of the Monument was changed from Primitive Zone to Passage Zone and from Visual Resource Management (VRM) Class II to Class III and the 2015 Record of Decision (ROD) for the Utah Greater Sage-Grouse Land Use Plan Amendment which provides management for the greater sage-grouse. This includes approximately 5,841 acres identified as a Priority Habitat Management Area and 23,662 acres identified as Opportunity Habitat within the Monument.

In the latter part of FY13, GSENM launched a planning effort to prepare a Livestock Grazing Monument Management Plan Amendment with an associated Environmental Impact Statement (EIS). BLM contracted Environmental Management and Planning Solutions Inc. (EMPSi) to write the EIS in September 2013. The Plan Amendment will make land use-level decisions associated with livestock grazing, including lands available or not available for livestock grazing, forage currently available on an area-wide basis for livestock grazing and available for anticipated future demands, and guidelines and criteria for managing the land to be as productive as feasible for livestock grazing through implementation of best management practices. The EIS will analyze the effects of all alternatives on the Monument's resources.

The Notice of Intent to initiate the planning effort was published in November, 2013. In FY 2014, Public Scoping & Socioeconomic Workshops were held, the Scoping Report was completed and Alternatives were formulated. During FY15, GSENM held public meetings to receive public comment on the Preliminary Draft Alternatives for the EIS. After a 45-day comment period, GSENM worked with environmental groups and Cooperating Agencies to develop the Draft Alternatives that will be analyzed in the EIS.

In addition, the Analysis of the Management Situation and the Socioeconomic Baseline Report was completed. In FY 2016, the preliminary alternatives were revised, the comment report completed and Cooperators helped develop the Draft Chapters 1-5 of the EIS. To date, GSENM has facilitated twenty-seven Cooperating Agency meetings, twelve forage team meetings, government-to-government consultation with the Kaibab Band of Paiute Indians and Hopi Tribe, 12 public scoping meetings and/or workshops, five newsletters, 15 fact sheets, and briefings with the Monument Advisory Committee, Kane County, Garfield County, the State of Utah and the public on the livestock grazing plan amendment and EIS.

Status of Activity Plans

Transportation Management Plan

The Transportation Management Plan (TMP) for GSENM was completed and included in the MMP (2000). Open routes have been signed in Kane County (approximately 2/3 of the land area) but not in Garfield County. Some administrative routes have been signed. Due to the legal status of RS2477 road claims and ongoing litigation, many routes that were not considered necessary or desirable have not been physically closed or rehabilitated. GSENM does not have a detailed route inventory. The Monument has identified this as a priority data need.

Special Recreation Management Area Plans

Six Special Recreation Management Areas (SRMA) were established in the MMP “where more intensive recreation management may be needed because the area will be a focal point for visitation or because recreational uses within the area need to be closely managed or limited to prevent conflicts with Monument resources.” Activity plans for the six SRMAs have not been completed. The Monument is developing information for this effort through its Recreation Baseline Study, continued in FY 2016, through workshops and reports on visitor use in the Escalante Canyon Region in FY2015, through visitor satisfaction surveys conducted in FY2016 and through ongoing backcountry monitoring. These efforts are discussed elsewhere in this Report.

Status of Resource Management Plan Implementation Strategy

The MMP was the subject of an Implementation Review in 2010. Management actions taken to remedy issues and concerns noted in the review report include developing and carrying out an action plan; revising the GSENM Table of Organization;

filling critical positions where possible; renewing the GSENM commitment to a focus on science and science-based decision making; and working with interested public and applicable agencies and organizations to resolve issues regarding travel and transportation management, grazing administration, and protection of objects identified in the Monument's Proclamation.

Per the Implementation Review and resulting Action Plan, a Plan Implementation Strategy was initiated at GSENM. The Implementation Strategy identified numerous projects in the Monument's program areas. The Monument continues to identify priorities and implementing projects as staffing and funding allow.

Key National Environmental Policy Act Actions and/or Project Authorizations

GSENM completed eight categorical exclusions, and 26 Determinations of NEPA Adequacy in FY16. GSENM also completed four environmental assessments (EA). Two EAs analyzed campground improvement projects at Deer Creek Campground and at the Whitehouse campground. These projects included new vault toilets, tent pads, picnic tables, and improved parking spaces. A third EA was developed to authorize South Central Communications to install fiber optic line from their Buckskin Mountain substation to Page, AZ, within the Congressionally Designated Right-of-Way Corridor to improve Wi-Fi service to that city. The fourth EA analyzed filming in a Wilderness Study Area (WSA).

Interest in commercial film permits continues to grow at GSENM, with 5 film permits issued to support tourism marketing, event filming, and small production movies. As needed, GSENM park rangers work as film monitors and resource advisors during these productions.

Special Recreation Permits

In FY16, the number of Special Recreation Permit (SRP) holders rose from 101 to 108. More than 100 applications have been processed using the *Programmatic Environmental Assessment for Issuing Special Recreation Permits within GSENM* since it was signed in 2012, including 33 in FY16.

3 2016 Projects and Accomplishments

Fiscal year 2016 was quite successful for GSENM. In addition to celebrating the 20th Anniversary of the Monument with events, presentations, publications and a Science Forum, we improved rangeland health on many allotments, improved our developed campgrounds, improved facility security, provided authorizations for local businesses and utilities, advanced research on Bighorn Sheep, Hummingbirds, Soundscapes, Night Skies and Paleontology, and managed the steadily increasing visitation on the Monument. Monument management, staff and partners are proud to share highlights of these successes.

20th Anniversary Events

In celebration of GSENM's 20th Anniversary, GSENM in cooperation with Kanab Field Office, Grand Staircase Escalante Partners (GSENM), and Glen Canyon Natural History Association (GCNHA), sponsored 96 celebration events, presentations, field-trips, demonstrations, exhibit, commemorative items, publications, parade entries, press releases, and website stories. Included in these opportunities were birthday celebrations in each of our visitor centers held on September 18, 2016; and a special Respect & Protect National Public Land Days Event at Calf Creek Recreation Area. Overall, 2,948 people participated in the GSENM 20th Anniversary Special Events.



Participants of the special GSENM 20th Anniversary Respect & Protect National Public Lands Day Event at Lower Calf Creek Falls.



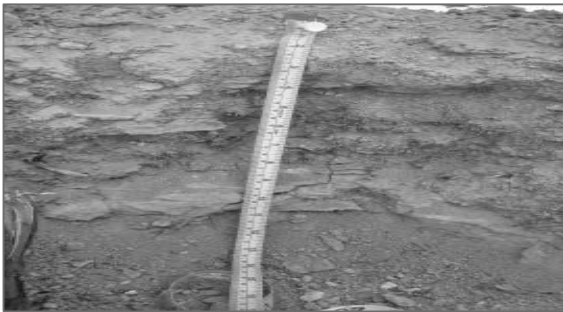
Science Symposium participants enjoy presentation on paleontology as part of the GSENM 20th Anniversary Science Symposium in Escalante.

Science Symposium: As part of its 20th Anniversary Celebration, GSENM sponsored a Science Symposium, located in Kanab and Escalante, Utah and featuring 26 lectures and fieldtrips given by prominent scientists from around the country. Drawing 309 participants, these educational presentations highlighted GSENM research, discoveries, and accomplishments. In addition, GSENM created a Science Report publication and DVD containing summaries of research conducted on GSENM over the last 10 years. A copy of the Science Report may be downloaded from the Grand Staircase Escalante Partners website at: www.gsenm.org.

Natural Resource Management Highlights

Rangeland Administration: During FY2016 the range program completed monitoring and data collection including utilization, long term trend or a combination of both at 75 locations across GSENM. Additionally, 250 livestock grazing compliance inspections were conducted throughout the 79 active GSENM-administered livestock grazing allotments. Information gathered from these activities is used to make both short and long-term decisions regarding the administration of GSENM rangelands.

AIM: Assessment Inventory and Monitoring (AIM) assessments recorded 24 AIM points across 15 allotments. Monument staff also conducted AIM on 22 sites within the Sage Grouse Priority Habitat Management Area (PHMA) located in the Kanab Field Office and GSENM. AIM points were identified in 10 selected vegetation strata using LANDFIRE Bio-physical Setting (BPS) vegetation data.



Left: AIM Soil Pit located on a Big Sage Brush LANDFIRE-BPS site. Right: AIM transect located on a Blackbrush LANDFIRE-BPS site.

Range Improvements: The range program works closely with grazing permittees, as well as the general public, to maintain infrastructure and provide for proper management of the livestock grazing program. Several projects completed in 2016 demonstrate the commitment by grazing permittees and the public to the sustainable management of livestock grazing on GSENM. This includes maintenance and repair of existing improvements such as livestock water developments, corrals and fences. Depending on the type of improvement, BLM and the grazing permittees may coordinate their efforts to accomplish these projects. This year maintenance on several important livestock water developments was completed including Cave spring, Calf Pasture Spring, Rock Seep, and Coombs Seep. Deteriorating metal tanks were replaced with low profile recycled/repurposed tire tanks that are highly durable and

have a lower profile, making water more accessible for young livestock and smaller species of wildlife.



Left: Coombs Seep tire tanks



Center: Cave Spring tire tanks



Right: Calf Pasture tire tank

Several fencing projects were also completed this year, including the Center Knoll spring protection fence and water development. This approximately 2 acre enclosure provides protection to sensitive riparian habitat while providing off site water for grazing livestock.



Left: Center Knoll Spring riparian area during protection fence construction. Right: Center Knoll Spring riparian area approximately 1.5 years later .



Also the Long Canyon stock driveway drift fence replaced a series of wire and brush stop gaps with a more functional and aesthetically pleasing structure that also aids ranchers in moving cattle more efficiently through the Long Canyon area of the Burr trail.



Long Canyon Stock Driveway Drift Fence

Weed Program: The GSENM has an active weed management program. Scotch Thistle, Knapweed, Whitetop, Russian Olive and Tamarisk are our biggest threats. Each year we try to focus on the known populations and inventory for any new ones. We are involved in the local Cooperative Weed Management Area and commit substantial time throughout the weed season assisting on these communal spray projects. As shown below we helped the Zion National Park spray Silver Nightshade which is an invasive plant that has become a threat to native plants in the area.



Left: Spraying Scotch Thistle at Nipple Lake.



Right: Canyon Country Weed Management Area spray day in Zion National Park.

Hummingbird and Bat Studies: The Monument continued long-term studies of bats and hummingbirds. During 2016 GSENM monitored bats in locations ranging from just over 4,000 feet elevation to 10,000 feet, which resulted in catching 12 out of the 18 known species from Utah. The Monument also hosted an acoustic bat

detection training session that was attended by bat enthusiasts and biologists from across the West.

In addition to noting species, weight, and key measurements on the hummingbirds, staff scientists study plant species utilized by these birds. This marked the seventh season for hummingbird monitoring and pollen collection, working with the Hummingbird Monitoring Network. Pollen swabs show the variety of plants visited by hummingbirds, including Utah penstemon and other native species critical for pollinators. Totals for the life of the project are 6,793 hummingbirds captured and 5,057 hummingbirds banded.



GSENM hummingbird and bat studies

Greater Sage-Grouse Habitat Assessment: Monument wildlife staff completed an ocular assessment of greater sage-grouse habitat on the Monument in the summer of 2016. Nearly 30,000 acres were assessed on foot and horseback to determine the current condition of our sage-grouse habitat. The Monument management plan was amended in September 2015 to include protections for sage-grouse and their habitat. In our area, encroachment of pinyon and Utah juniper trees is a major cause for concern as it leads to a decline in sage-grouse habitat condition.



Left: Phase I pinyon/juniper encroachment. Center: Tree encroachment and subsequent habitat decline led to accelerated erosion and gully formation. Right: Phase III tree encroachment - sagebrush understory is nearly completely absent

This assessment informs managers of the current condition of the habitat and helps managers make decisions about options are available to improve the habitat. Based on this assessment, the Monument is in the planning stages of future sage-grouse habitat restoration.

Wildlife Habitat Improvement and Monitoring Projects: Monument resource staff completed several wildlife water projects during 2016, leading to improved species distribution and alleviating impacts to key areas and critical natural waters. Projects included the installation of overflows and lids on three large water storage tanks. These tanks are often the only water source for miles, and wildlife is drawn to them, resulting in entrapment and mortality. The lids also help control water evaporation. Using donated funds from Sportsmen for Fish and Wildlife, materials were purchased to build water overflows and install lids at Buckskin, Five Mile, and Sink Hole water catchment sites. Overflows were constructed using 8" PVC pipe and the lids were installed using a new material called hexa-cover which consists of numerous floating discs that interlock to form a semi-solid lid that moves up and down in the tank with the level of the water.



Left: Seasonal range and fire staff assist in construction of overflows. Center: Hexa-cover discs being added to a large storage tank. Right: The floating discs are beginning to interlock to form a semi-solid lid. These lids reduce evaporation by 95% and reduce wildlife mortality.

Wildlife, range, and fire staff also joined forces to complete numerous water projects during 2016. Staff repaired major damage to several water catchment aprons. These aprons collect precipitation and flow it into large water tanks which store it for future use by wildlife and livestock. These catchments are essential for wildlife and livestock distribution and aid in maintaining a healthy rangeland. Staff replaced a water trough in the Coyote Wash area that receives substantial use by pronghorn. Approximately 4 miles of pipeline was replaced on West Clark Bench. This pipeline sustains water for three troughs which helps distribute livestock and wildlife. Water storage capacity was increased at the Timber Mountain catchment by adding an additional water storage

tank. The catchment apron and wildlife watering drinker at Timber Mountain were also repaired to a functional condition.



Left: Five Mile catchment apron before repair. Center: Five Mile apron after repair. Right: New tire trough replacing an old trough at Coyote Wash.



Left: Staff replacing valves on the West Clark pipeline. Center: Newly replaced wildlife drinker in foreground and water storage tank in background at Timber Mountain. Right: Rain water flowing into the new tank at Timber Mountain.

Monument wildlife staff completed additional inventory on reptiles and amphibians in 2016. Seventeen different reptile and amphibian species were recorded. Christmas bird counts were conducted in Escalante, Kanab and Boulder. One of the highlights of the counts was the appearance of flocks of Lewis' woodpeckers. GSENM wildlife staff also assisted the Utah Department of Wildlife Resources with midwinter bald eagle surveys, the annual bat blitz, peregrine surveys, Colorado cutthroat trout spawning and winter bird surveys.



Installation of a sediment collection structure at Old Corral Spring to control erosion and rebuild the system.

Riparian Restoration: There are many riparian systems throughout the GSENM all of which are managed to restore the functionality of a riparian system. For the past several years we have focused a lot of our time on one in particular, Old Corral Spring. This project is more than just a spring restoration project it's a Native American Native Plant Restoration Project and is an on-going Hands-on-the-Land Youth project.

Escalante River Watershed Restoration: The Escalante River Watershed Partnership (ERWP) is a collaboration among private and public stakeholders (see <http://escalanteriverwatershedpartnership.org>) to eradicate invasive woody species along one of the West's most iconic rivers. In seven years, close to 5,000 acres have been returned to open galleries of cottonwoods and willows, and 50 miles of native fish habitat have reconnected or improved in this Watershed. Crews removing Russian-olive and other woody invasive plants made great progress in 2016. A total of 78 out of 90 river miles of Escalante Main-stem plus tributaries have been cleared. This includes 233 acres of new treatments and 541 acres of re-treatment. The remaining 12 river miles, encompassing approximately 500 acres, should be very close to finishing by end of year 2018.

Grand Staircase-Escalante Partners (GSEP) functions in an important role within the partnership by coordinating private funding and by providing guidance to the conservation corps supporting the project. GSEP obtained in grants from entities such as the Walton Family Foundation, Utah Partners for Conservation and Development (UT-DNR), as well as other private foundations and organizations. GSEP also provided two employees and worked with an Americorp intern to provide field support for each crew, as they did retreatment in both GSENM and Glen Canyon National Recreation Area. Three conservation corps participated in the this year's work, Utah Conservation Corps (16 youth) Canyon Country Youth Corp (16 youth), Southwest Conservation Corp (SWCC) - Ancestral Lands Program (5 youth). The Great Old Broads for Wilderness also provided a crew 12 people who gained experience in woody invasive removal in 2016.



SWCC Ancestral Lands Program

Seeds of Success: Precipitation amount and timing during early FY2016 provided an excellent growing season for native plants. Seed from over 30 species of plants were gathered on the Monument for the Seeds of Success program and reclamation

efforts on the Monument. Through an agreement with the Chicago Botanic Garden, a crew of four researchers inventoried and collected locally-sourced seed from GSENM to be used on Monument restoration projects.



Left: *Carmin gilia* Center: Crew from the Chicago Botanic Garden Right: Inventory and seed collection

Eightmile Salinity Control Project: Monument staff have engaged over the past three years to restore Eightmile Pond, a large salinity collection structure. Several similar structures across the monument collect highly saline soils and keep them from entering the Colorado River system. Phase 1 (2013) included site stabilization work, including spillway reconstruction, spillway restoration and spreader dike construction in preparation for major site work performed in FY14. Phase 2 (2014) began capacity restoration to the impoundment reservoir. Over 60,000 cubic yards of saline material was removed from the reservoir and impounded on site. Work in 2015 finalized the impoundment area and sediment retention; much of the pond was functioning to retain soils and water.



Left: Removal of saline sediment from the north reservoir. Center: Eightmile Reservoir filled to capacity after 2015 monsoonal moisture. Right: Eightmile Reservoir with impounded saline soil captured in the background.

In 2016 the Eight Mile Salinity Control Structure collected sediment and water during the summer 2015 monsoon rains. As of July 1, 2016 the pond was inundated with water so it was not possible to measure the depth of sediment that accumulated

during the previous year. However, based on a 40 year average of 0.4 feet of sediment retention per year the estimated salt reduction was approximately 28.7 tons in 2016.

Telegraph Flat and Finn Little Wash Salinity Control Structures: In 2016, GSENM identified five salinity control structures for repair and maintenance on Telegraph Flat, north of Hwy 89 at the southern end of GSENM. Telegraph Flat and Finn Little Salinity Control Structures were excavated during the week of June 27, 2016. Telegraph Flat 1 consists of two adjacent ponds that were full of sediment. Both reservoirs were filled with sediment and the dam was breached. Approximately 1,067 yd³ of sediment was excavated from the two ponds and used to repair the breached dam and reinforce the dike structures. The last clean out date was unknown so the annual salinity load was not estimated.



Left: Telegraph Flat 1 before excavation.

Right: Telegraph Flat 1 during excavation.



Telegraph Flat 2, 3, and 4 consist of three consecutive gully plug salinity control structures installed in a gully that drains an intermittent stream to Clay Hole Wash. The Telegraph Flat 2 and 3 structures were functioning but full of sediment. The dam had been breached and blown out at the Telegraph Flat 4 structure and was in need of repair. In addition, the Telegraph Flat 4 retention pond was full of sediment. Telegraph Flat 2-4 were previously cleaned out in 2012 but have since filled in with sediment. Sediment was removed from the three ponds and used to reinforce the dam structures. The blown out dam at Telegraph 4 was also repaired. During the current cleaning we estimated that approximately 5,051 yd³ of salt-laden sediment was removed from the three salinity control structures, constituting an average of 85 tons of salt retention per year over the past four years.



Left: Telegraph Flat 2 before excavation.

Right: Telegraph Flat 2 after maintenance.





Left: Telegraph Flat 3
before excavation.

Right: Telegraph Flat 3
after maintenance.



Left: Telegraph Flat 4
gully before repair.

Right: Telegraph Flat 4
after maintenance.



The Finn Little Salinity Control Structure is a gully plug located on Finn Little Wash. The structure has not been maintained for many years and the pond was filled with sediment and the dam was blown through. Sediment was cleaned from the pond and used to reinforce the dam structure and repair the blown out portion of the dam. During the current cleaning we estimated that approximately 3,129 yd³ of salt-laden sediment was removed. The total salt retained prior to the dam being breached was approximately 209 tons, however we were not able to estimate the annual load since the last cleanout date is unknown.



Left: Finn Little gully
before repair.

Right: Finn Little salinity
control structure after
repair.



FY2016 Wildfire Suppression Support: GSENM staff assisted in wildfire suppression as members of several Incident Management Teams and as single resources in a number of overhead and firefighting positions. Staff participated on 13 separate wildfire incidents, across 7 western states, involving approximately 434,000 acres.

Non-renewable Resource Management Highlights

Cultural Resource Inventory and Monitoring: Efforts in 2016 were again largely conducted in support of the ongoing Livestock Grazing Plan Amendment EIS and the upcoming allotment-specific EAs for permit renewal, as well as for Section 106 compliance on a variety of small projects. The allotment inventories and monitoring efforts were needed to characterize the archaeology of areas within GSENM that have not seen adequate archaeological efforts to date. Inventory in 2016 resulted in more than 1100 acres being covered and documentation of 35 previously unrecorded Historic Properties. Associated monitoring efforts resulted in updated information on 80 cultural resource sites. Inventory and monitoring for the above research was carried out largely by BLM archaeologists, while the GSENM Site Stewards program monitored sites as part of the overall cultural resource site monitoring program.

As part of the Respect and Protect campaign, GSENM initiated an ethnobotanical and cultural importance inventory of springs and riparian zones across GSENM. Federal Cultural Resources programs are primarily concerned with historic and prehistoric archaeological sites, or the material culture (artifacts and sites) left behind by previous inhabitants of an area. What is often overlooked is the landscape itself, and non-site-bearing parts of that landscape that were important to the inhabitants. One example of this is water sources such as springs. Going hand-in-hand with an inventory of springs is ethnobotany, or the study of how man uses plants, and how plants in return affect human cultures. In 2016 GSENM began a research project involving the importance of springs to Native American groups such as the Paiute, Hopi, and Navajo. A Northern Arizona University graduate student undertook an inventory project designed to identify the cultural importance of 30 different springs and riparian areas across GSENM, the presence or absence of culturally important plants, and the historical and ongoing Native American use of these locations. The Graduate student

identified dozens of important plant species at GSENM springs and riparian zones, including some that may represent intentional prehistoric propagations across GSENM and the greater southwest. The research will be included in a Master's thesis at NAU (in progress).

Visitor and Recreation Management Highlights

Visitor Center Management: Recreational visitation continued to increase throughout Southern Utah and especially along the All American Highway 12 as part of the Utah Office of Tourism Mighty Five Campaign which continues to draw visitors from all over the world. In addition to the Mighty Five Campaign, the "Road To Mighty" campaign which was designed to increase visitation on routes between parks. The National Park Service celebrated their 100-year anniversary which increased visitation throughout the region. Visitation at the Monument's four key visitor centers continued to reflect the same record visitation as experienced last year with the notable exception that visitation is substantially increasing during the shoulder season. Spring and fall months continue to show the greatest increases effectively expanding the busy season to 9 ½-10 months. Two park rangers were hired just in time for the spring season to fill vacancies at the Escalante Interagency Visitor Center.

GSENM Visitor Center 2016	Visitors
Big Water Visitor Center	33,097
Kanab Visitor Center	45,479
Cannonville Visitor Center	35,796
Escalante Visitor Center	76,179

Glen Canyon Natural History Association (GCNHA) operates the Monument retail sales program in four visitor centers. An annual Aid to Park budget was funded with approximately \$24,000 granted to finish publishing the new paleontology book highlighting GSENM discoveries, which was released in fall of 2016. Six "Aid to Park" requests were also funded including Artist in Residence assistance, support for open houses and 20th Anniversary events, festivals in surrounding communities, annual Audubon Bird Count, staff training and dark skies astronomy equipment.

Recreation Visitation: Approximately 926,236 visitor contacts were made on GSENM including recreation sites and visitor centers. Visitation to GSENM continues to be collected and recorded in the BLM Recreation Management Information System (RMIS) via six different methods: foot and vehicle counters at key destinations, Visitor Center counts, fee envelope data, trailhead registers, and overnight permits in a backcountry data base. Record high visitor counts occurred at Lower Calf Creek Falls (36,437), Devil's Garden (27,802), Dry Fork Slot Canyons (27,647), Spencer Flat Road (15,275), Burr Trail (78,917), Grosvenor Arch (13,685), Paria Movie Set (19,099) and Toadstools Trailhead (18,765). The most popular trailheads experienced at least 3,000 more hikers than in 2015 and Dry Fork Slot Canyons received approximately 6,000 more hikers than the prior year.

Fee Program: The Monument administers a fee program for day-use and camping at Calf Creek Recreation Area and camping at Deer Creek Campground. Day-use visitation continues to rise at Calf Creek Recreation Area. Resultant parking issues require staff to direct traffic on busy weekends and holidays. Calf Creek Recreation Area Recreation Use Permits (RUP) for standard amenity day-use numbered 8,629 with 24,232 visitors purchasing permits totaling \$40,543 in fee revenue ; Calf Creek Campground expanded amenity RUP permits numbered 2,077 serving more than 5983 campers totaling \$29,780 in fee revenue; and Deer Creek Campground had 362 permits and received 760 campers totaling \$3308. The recreation fee program deposited a total of \$84,985 in a dedicated a recreation fee account in 2016.

In 2016, the Monument continued an agreement with Glen Canyon Natural History Association to sell *America the Beautiful* passes at Monument Visitor Centers. The NHA purchased 100 passes at the beginning of the spring season, adding \$7,200 into a recreation fee account.

Backcountry Program: Backcountry Rangers responded to multiple incidents of vandalism of graffiti on cultural sites as well as canyon walls. One project was submitted and awarded grant funding for a new Respect and Protect campaign. The project is a series of community exhibits designed to reach visitors and locals who do not come into visitor centers with messages aimed at reducing vandalism at cultural sites.

In spring and summer the backcountry program had a focus on staff training in the inventory process for lands with wilderness characteristics. Two sessions of lands with wilderness characteristics inventory training were conducted on-site with participation of 12 interdisciplinary staff from GSENM, KFO and SGFO. A week long

training session conducted by the Utah State Office National Landscape Conservation System (NLCS) program lead, was conducted for the Upper Kanab Creek unit.

During Fiscal Year 2016, visitor center and backcountry ranger staff issued 2,602 backcountry permits for 205,847 visitor use days, and 1,497 car camping permits and 12,559 visitor use days for a total of 4,099 overnight backcountry and car camping permits and 218,406 visitor use days. Free overnight camping permits are mandatory.

Backcountry rangers conducted the majority of 1,044 backcountry patrols. Highlights include a total of 2,333 visitor contacts in remote areas of the Monument, more than 250 square feet of graffiti was removed, 1,210 feet of social trails were removed, 6,661 feet of vehicle tracks were removed and 622 campsites monitored with 98 fire pits removed and 66 cleaned. Human waste continues to plague day use hiking locations and more than 300 human waste incidents were hauled out of the canyons and plateaus. GSENM continued to install new trailhead signs as well as regulatory signs targeting resource, permittee and land owner issues.

Backcountry Monitoring Program: An assistance agreement was awarded to Penn State University. This project is intended to continue to inventory and monitor recreation impacts primarily in backcountry and dispersed areas throughout GSENM. This will include monitoring for both overnight camping and road-based impacts through a network of more than 700 dispersed campsites and 800 miles of roads as well as newly identified recreation nodes in backcountry areas. Monitoring will focus on dispersed recreation impacts at newly identified sites associated with wilderness therapy programs permitted to operate in the backcountry on the south side of the Monument. This project is based on a planning approach entitled Limits of Acceptable Change which assumes that the number and extent of physical human impacts on any recreation site are useful indicators. A variety of indicators were developed historically to measure physical impacts. The recipient will continue to monitor using these existing indicators and be given access to build on existing data compiled over a 12 year period, as well as develop and implement new monitoring protocols based on indicators and thresholds to address growing day-use visitation impacts for subsequent years of the project.

Escalante Interagency Interpretive Workshop: An interagency team comprised of 15 recreation staff, mid-level and Monument managers from the Dixie National Forest, Glen Canyon National Recreation Area and BLM GSENM staff was facilitated in Escalante during early January 2016. This day-long workshop was designed to review record visitation in 2015 and discuss priority needs and next steps for serving visitors

in the Escalante Interagency Visitor Center. A common vision was articulated by the group which identified the top areas for funding emphasis to assist staff. An interagency funding mechanism was established through a Service First agreement and \$55,000 was targeted from BLM, USFS and the NPS. Monument staff established the agreement and wrote the Scope of Work and Technical Requirements for Interpretive Planning, Graphic Design, Writing, Art/Photos and Fabrication for Exterior Interpretive Exhibits and Audio Media. The contract was written awarded in September of 2016.

2016 BLM Visitor Satisfaction Survey: Calf Creek Recreation Area was the site of a BLM Utah Visitor Satisfaction Survey conducted on-site by an intern from the Southern Utah University Intergovernmental Internship Cooperative (IIC) program who was hired with recreation fee dollars. The intern administered approximately 300 random surveys over the course of two months in the summer, contacting 1286 visitors at the Calf Creek picnic and parking area. The survey was developed to measure the site's performance related to *BLM GPRA Goal 3.1, Provide for a quality recreation experience, including access and enjoyment of natural and cultural resources on DOI managed and partnered lands and waters*. Results revealed that the proportion of site visitors satisfied overall with visitor information, facilities, management, interpretation/education, staff services and programs exceeded the GPRA Goal at 98%. Other highlights found 90% of all respondents felt the fee was about right and respondents also indicated a high level of cleanliness for the site.

Recreation Experience Baseline Study: Colorado Mesa University's Natural Resource Center and GSENM used base funding (1711) and Federal Lands Recreation Enhancement Act (FLREA) fees to support the fourth phase of a multi-year study aimed at helping the BLM better respond to the public's desires and expectations for how recreation on the Monument is managed. Phase 4 studied the areas in the northern and eastern portions of the Monument - areas accessed by Scenic Byway 12 and Burr Trail Road. Thirteen focus groups in four communities occurred in March, August, and October 2016. Four webinar style focus groups occurred in July. There were a total of 100 participants in this phase of the study. The results of Phases 1, 2, and 3 were presented by Dr. Tim Casey at the GSENM 20th Anniversary Science Forum in August. Phase 5 will synthesize the data collected in the four data collection phases.

Respect and Protect Community Exhibits: Support from the Utah State Office (UTSO) provided funding for an interpretive project aimed at protecting cultural resources with specific focus on an anti-graffiti and anti-vandalism campaign.

Monument staff are working with the design firm, Blueraven-Creative, to develop sign panels and messaging. The design process will continue into 2017 and exhibits will be installed in a variety of community and business locations surrounding the Monument to target a public audience.

SUU Agreement for Acoustic Baseline: The Department of Psychology at Southern Utah University (SUU) conducted a final phase of baseline acoustic monitoring in 2016 in order to continue to identify current soundscape conditions and develop a better understanding of how natural sound and noise affect visitor experience and monument resources. Due to the size of the Monument and the distance from major urban areas, GSENM is suspected to be one of the quietest areas in the nation. Due to the size of GSENM, additional acoustic monitoring data was needed to produce a more robust understanding of current soundscape conditions based on vegetation type, terrain and visitor use patterns. This project continued the work from the first two phases of the acoustic monitoring program of research. The final phase, which continues into the fall of 2017, will provide a complete representation of soundscape conditions in remote and heavily visited locations, including Devils Garden, Wolverine Canyon, No Man's Mesa, and Fifty Mile Mountain. More sensitive equipment was deployed at Dry Fork slot canyons, one of the quietest areas discovered during Phase I and II of this project in an effort to determine if this site is truly the quietest recorded in the US. Results from this research will continue to inform the future protection and management of natural soundscapes as a previously unknown scientific resource of the Monument. Students in the project have also started work on a listening library of sounds recorded as part of the project.



Night sky over Escalante Canyons

Dark Skies Research: In the spring of 2016, a research team from Weber State University and the International Dark Sky Association operating under a Monument Science permit collected baseline night sky quality measurements using hand-held sky quality meters that were calibrated with satellite images at 12 different locations within GSENM. Analysis of the results indicates that not only is the Monument dark, it may be the darkest place in the lower 48 states. The

research team approached the Monument about being recognized as a Dark Sky Sanctuary, a new recognition status that is suggested for places like GSENM as some

of the most remote and darkest places in the US. A working team was formed consisting of GSENM staff as well as two BLM science and resource staff at the Grand Canyon-Parashant National Monument to explore the possibility of pursuing this recognition. In the summer, after dialogue with BLM WO staff, a communication plan for internal and external audiences was developed. It is anticipated that the draft proposal will be written in the winter of 2017 for review.

Paria Team: The Paria Team (staff from Vermillion Cliffs National Monument, Kanab Field Office, and GSENM) met every other month in 2016 to discuss issues associated with the Business Plan for managing North and South Coyote Buttes (The Wave) and the Paria Canyon-Vermillion Cliffs Wilderness. GSENM continued to host the daily walk-in lottery for the Wave at the Kanab Visitor Center with more than 49,000 visitors contacted and oriented to recreation opportunities on GSENM, Vermillion Cliffs and the KFO.

Education, Outreach, and Interpretation

Youth Employment Program: In partnership with Southern Utah University's Intergovernmental Internship Cooperative, Great Basin Institute, and the Escalante River Watershed Partnership, GSENM sponsored 154 youth internships and CORPS crews who worked on a wide variety of agency programs and projects including Assessment, Inventory, and Monitoring (AIM); Escalante River Watershed Project; Sage Grouse Habitat Restoration; Range Management; Native Plant Restoration; Recreation; Facility Management; Wildlife Assessment and Monitoring; and Paleontology.

Administered through our partner organizations, these BLM mentored employment opportunities promote professionalism in land stewardship and create opportunities to learn about, contribute to, and benefit from land management and resource conservation. In fiscal year 2016, youth provided 28,819 hours of service to the GSENM.

In continuation of the Title I Native American, Underserved, & Rural Disadvantaged Youth Engagement, Education, & Employment Program, interns provided by Southern Utah University IIC disseminated federal career recruitment information for diversity students, created by program sponsored Native American interns in 2015.



Paiute Youth Conservation Corps (YCC) crew working on experimental planting bed as part of on-going Native Plant Restoration

Native Plant Restoration Project: GSENM continued the Native Plant Restoration Project at Old Corral Spring in partnership with Grand Staircase Escalante Partners (GSEP), Glen Canyon Natural History Association, Youth Conservation Corps, Kaibab Paiute Band of Indians (KPBI), Paiute Tribe of Utah (PTU), and Southern Utah University Intergovernmental Internship Cooperative (IIC). In support of the program, IIC applied for and received a grant from the National Fish and Wildlife Foundation for Riparian Restoration in 2016 and 2017 at the Old Corral Springs test site.

The project is part of the Native American, Underserved, & Title I Youth Engagement, Education, & Employment Program. This STEM-based service learning project engages Native American and other Title I underserved youth in researching, restoring, and monitoring native plants within the BLM GSENM and Kanab Field Office (KFO).

Overseen by GSENM and KFO staff, GSENM sponsored 5 Youth Conservation Corps participants providing 400 hours of service. The YCC crew repaired flood damage to the exclosure fence at the Old Corral Spring test site, constructed two erosion control structures, cleaned out brush from inside the exclosure fence, prepared seedbeds for experimental plantings in 2017, and monitored native plant plantings from 2015. In addition, to encourage tribal youth to consider careers in natural resource management or in other science base fields, YCC members participated in GSENM's 20th Anniversary Science Symposium, attending presentations on archaeology, botany, and biology.



GSENM Paleontologist Alan Titus guided Kanab Elementary 4th grade students through classroom fossil identification activities

Frontier Science School: In cooperation with GSENM, KFO, and IIC, Grand Staircase Escalante Partners (GSEP) coordinated the pilot educational program called Frontier Science School and companion website: <http://www.frontierscienceschool.org/>.

This program provides regional educators (K-12) opportunities to collaborate with agency staff in the development of Science, Technology, Engineering, and Math (STEM) and Play, Learn, Serve, and Work (PLSW) based natural and cultural resource related hands-on

learning activities disseminated via classroom visits, school assembly presentations, field excursions, summer camps, and/or sponsored programs (i.e. 4H, Future Farmers, Girls Scouts, Boy Scouts, Native American youth camps, etc.).

GSENM provided educational events for 2,529 regional youth (including 1719 fourth graders as part of the Every-Kid-in-Park program). In working with educators in the development of lesson plans, the BLM insures that activities meet educator expectations and needs, and Utah and Arizona curriculum standards. At the same time, this collaboration allows GSEP and BLM to build mutually beneficial relationships with educators and their students grounded within a solid foundation of public land stewardship. As a result, BLM is better able to communicate and recruit participants for progressively more engaging land management opportunities to a wider and more receptive audience.



Students participate in an Every-Kid-in-Park information scavenger hunt at the GSENM Kanab Visitor Center

Kwiyamuntsi and Kaibab Paiute Youth Camp: In cooperation with the Kanab Field Office, National Park Service, United States Forest Service, Grand Staircase Escalante Partners, and Glen Canyon Natural History Association (GCNHA), GSENM co-sponsored Camp Kwiyamuntsi Event and participated in the Kaibab Paiute Camp for regional Paiute Youth. GSENM staff gave 10 formal presentations to 36 participants.

Junior Ranger Program: The Junior Ranger Program targets children six through twelve years old, and provides parents and children a fun and educational way to enhance their experience on public lands. Discovery Backpacks contain equipment, supplies, and information on how to perform rudimentary experiments and identify specimens using scientific methodology. Parents may check out and return a backpack to any of the four GSENM visitor centers without charge. For those children not able to take advantage of the Discovery Backpacks, a Junior Scientist Booklet is available at visitor centers free of charge. The booklet offers children fun activities, highlighting visitor center interpretive exhibits and the scientific process. GSENM issued 1000 badges to youth who completed the activity guide for the Junior (Scientist) Explorer program.



Artist-in-Residence Workshop
participants show off artwork in
Escalante, Utah,

Artist-in-Residence (AiR) Program: The purpose of the GSENM Artist-in-Residence (AiR) Program is to promote awareness of the exceptional natural and cultural treasures preserved and protected by GSENM - part of our National Conservation Lands - through the celebration of art. By bringing professional artists into the GSENM landscapes for a determined length of time to create works that inspire and promote stewardship of public lands is truly "Taking Public Lands to Heart."

In 2016, GSENM and our local community partner organizations offered four artist-in-residence opportunities in Music, Writing, Photography, and Graphic Art during two community events. One was the Artist-in-Residence in May hosted in Kanab, Utah, in conjunction with the annual Amazing Earthfest community event. The second was the Artist-in-Residence Plein Air held in September and hosted in Escalante, Utah, in conjunction with the Escalante Canyons Art Festival annual community event. As part of the program, GSENM provided 27 presentations, activities, website stories, and a booth at a convention in support of the program drawing 1,293 participants. In addition, AiR participants combined their unique musical compositions, exceptional photographic perspectives and thought provoking written insights into an extraordinary DVD production for public enjoyment.

Interpretive Events: Drawing 36,067 participants, BLM staff or partner organizations, Grand Staircase Escalante Partners or Glen Canyon Natural History Association, provided 2,287 visitor center or community based interpretive opportunities, including: showings of GSENM's Traces in Time DVD; ranger talks; Walks & Talks Presentations; offsite guided fieldtrips; booths at community events such as the Audubon Xmas Bird Count Event Balloons & Tunes Festival, Shamrocks & Red Rocks Festival, Earth Day Festival, Amazing Earthfest, Escalante Art Fair, Bryce Canyon NP Geology Festival, Western Legends, National Public Lands Day, Big Water Dinosaur Festival; presentations at science or resource related conferences or professional organizations; and news releases or radio interviews.

Interpretive Media: In fiscal year 2016, GSENM updated two interpretive and visitor service publications. GSENM printed 55,000 copies of the Visitor Information Brochure and 35,000 copies of the Calf Creek Guide.



Featuring a five-foot reconstructed *Deinonychus hatcheri* skull, GSENM loaned the Department of Interior one of their Traveling Exhibits for display at the Main Interior

Traveling Exhibits (TE): The Paleontological Traveling Exhibit Program was devised to help generate public appreciation and participation in GSENM's paleontology program. The TE program provides opportunities for an estimated 12,000 or more people a year to see real fossils and related reconstructed specimens of dinosaurs, excavated in GSENM, in public forums that are more convenient and locally accessible than distant curator museums in Salt Lake City or other urban areas. Exhibits are self-contained and include interpretive panels and informational hand-outs. GSENM, Kanab Field Office, and Grand Staircase Escalante Partners featured traveling

exhibits at several regional school assemblies or in-class presentations, public outreach events, visitor centers, and public venues, and school program. In addition, TEs were loaned to Kane County for exhibition at their administrative and Travel Council offices in Kanab, Utah; the John Wesley Powell Museum in Page, Arizona. One Monument exhibit was in on a long term loan to the BLM Washington Office and is displayed prominently at BLM offices at Main Interior.

Audubon Society Christmas Bird Count (CBC): A Hands on the Land/Take it Outside event, GSENM co-sponsored the CBC with the BLM Kanab Field Office (KFO) and in partnership with the Audubon Society, Bryce Canyon NP, Glen Canyon NRA, Grand Staircase Escalante Partners, Glen Canyon Natural History Association, Dixie/Arizona Strip interpretive Association, Bryce Canyon Natural History Association, and Kane, Garfield, Page, and Fredonia Schools. At area schools, GSENM and KFO staff set up bird feeders, and distributed bird identification materials. In addition, the GSENM Biologist provided two in-class presentations to 80 students and fieldtrip for 30 students and teachers. Over 1500 students from around the region participated in the CBC event, identifying and collecting bird and migration data.

BLM-GSENM Meets with University of Georgia Interdisciplinary Field

Program: On July 1, 2016, nineteen University of Georgia undergraduate students along with several instructors met with a Monument staff member to learn about the BLM, National Conservation Lands, and the history of the GSENM as part of the universities' Interdisciplinary Field Program (IFP). The IFP is an eight-week field-based program that takes university students across the Western U.S teaching them about North American landscapes and environments. The group visited over 20 national parks and monuments during their trip. Students participating in the course come from a variety of majors, including: Anthropology, Art-Ceramics, Business, Ecology,

English, Environmental Chemistry, Environmental Economics, Environmental Engineering, Health Promotion, Geology, Journalism, Landscape Architecture, Mass Media Arts, Music, Natural Resources and Tourism, Physical Education, Social Work, and Theater. The students visited the GSENM to learn about the geology, history, and ecology of the area.

Cultural Resource Educational and Interpretive Presentations: Public education and interpretation have always been considered important parts of the overall GSENM Cultural Resources program. 2016 was considered another very successful year in this regard, with presenting or contributing to presentations at 37 different events and opportunities. These included a variety of both field and non-field presentations to a wide variety of attendees, from grade school Native Americans to professional archaeologists. Several events deserve particular merit:

GSENM participated in the first involved filming of the GSENM archaeologist for ARTE TV (roughly a French/German equivalent American public TV), featuring archaeology along Highway 12. GSENM contacted 898 people directly through the 2016 presentation of this film, and it is unknown how many thousands more will be exposed (and educated!) in Europe as a result of this project. Then, in the first week of August, GSENM held its third Learning from the Land Science Symposium. These symposia are put on by GSENM every ten years in an effort to showcase the wide variety of scientific investigations and projects happening at GSENM, including sections for paleontology, geology, biology, sociology, and a wide variety of other disciplines. Papers in the Archaeology/History block included research presentations by the GSENM Archaeologist as well as two seasonal cultural resource staff, recent graduate research regarding GSENM pollen core analysis, and research by the University of Utah into prehistoric use and distribution of a wild, local species of potato. It was a very successful symposium, and made public the stunning amount of research ongoing at GSENM. Unrelated to the Science Symposium but very strong along the lines of GSENM Cultural Resource research is the publication of The Formative Chronology of GSENM. This publication (Utah Cultural Resource Series No. 28 / Grand Staircase-Escalante National Monument Special Publication No. 4) was authored by retired GSENM Archaeologist Douglas McFadden, and represents the summation of more than 20 years of archaeological research in the northeastern edge of the Virgin Anasazi area. This will prove to be the “go to” reference for archaeological investigators in the GSENM and Arizona Strip area for decades to come.

Paleontological Resource Educational and Interpretive Presentations: Highlights of the first quarter include leading a Kanab High School field trip into the

Monument, and the Monument Paleontologist giving a lecture series on the evolution of birds for the Audubon Christmas bird count. Also, special temporary exhibits were put up and lab tours offered for National Fossil Day (October 15th). Through much of the spring, Christa Sadler's beautiful full color book on the fossil resources of the southern Utah (with a focus on GSENM), was finalized for printing. Although officially in print in FY16, the book, titled "Where Dinosaurs Roamed: Lost Worlds of Utah's Grand Staircase", did not reach the shelves of Glen Canyon NHA shops until late October.

In July, the paleontology program ran a portion of the Utah State University's Master Naturalist course. Later in the summer the program also supported the Western Legends, Escalante Arts Fair, and Big Water Dinosaur Festivals with booth staffing and exhibits. Paleontology was also a major theme for the 20th anniversary celebration (Learning from the Land Forum), which featured a number of excellent presentations on recent research as well as a field trip to the Rainbows and Unicorns tyrannosaur bonebed site in the northern Kaiparowits Plateau.

Near the end of the year a collaborative effort with the Denver Museum of Nature and Science led to a live broadcast from the field to thousands of school children across the US. BLM's new cultural and paleontological "Respect and Protect" theme was featured, as well as the museum's latest excavations and research. The event was interactive with the students and was a great success. Also near the end of the fiscal year, the contract for completely new exhibits in the Big Water Visitor Center was awarded and installation began in mid-September. The new exhibit outlines the evolution of the one of the most majestic and awe inspiring fossil animals found in GSENM, the rhinoceros-like ceratopsids. Six replica skulls and accompanying interpretive panels and artwork tell the unique story of these animals in the southwestern US, much of which has only come to be known from recent work done in the Kaiparowits Plateau.

In addition to these special events, the paleontology program conducted 56 tours, radio interviews, and lectures to thousands of members of the public. Also, rangers at the Big Water Visitor Center continue to give annually dozens of presentations on paleontology to hundreds of members of the public in organized tour groups.

Partnerships

The Monument's extensive research, outreach, and educational programs were supported by more than 50 active partnerships in FY16. These included the Monument's non-profit friends groups, Grand Staircase Escalante Partners and Glen Canyon Natural History Association (GCNHA) as well as private foundations, academic institutions and individual researchers, regional and statewide partnerships, and interagency partnerships. In addition to stewardship and restoration-focused initiatives, GSENM also maintains nearly 4 dozen active research programs with academic institutions and individuals. These programs are identified individually in Section 4 of this report.

Volunteers

Grand Staircase Escalante National Monument sponsored 103 volunteers (including 8 youth volunteers) and 93 hosted workers for a total of 196 in FY16. These volunteers and Hosted Workers preformed a total of 42,628 duty hours to our programs, with a monetary value of \$983,428. Volunteers were recruited and managed through several Monument programs, including our Site Steward Heritage stewardship initiative, our watershed restoration work, and the paleontology laboratory. Several organized volunteer groups donated time and effort to the Monument in FY16, including Great Old Broads for Wilderness, Wilderness Volunteers, Utah Backcountry Volunteers, and the Grand Staircase Escalante Partners. The Escalante River Watershed partnership (ERWP) also continues in collaboration with Grand Staircase Escalante Partners, coordinating our largest workgroups on the Monument.

In light of our 20 year anniversary, we held an appreciation picnic for all Volunteers providing 250 hours of service or more. We had approximately 50 attendees from near and far. Support was provided by both nonprofit partners: Glen Canyon Natural History Association and Grand Staircase Escalante Partners. All volunteers received recognition by certificate for achieving over 250 hours of volunteer work on behalf of the monument; of those, 7 volunteers received special awards (Brazos walking sticks with GSENM medallions) for service above & beyond.

Land (or Interests in Land) Acquisitions

GSENM initiated no acquisitions in 2016.

4 Science

Moving Bureau-wide Science Initiatives Forward

GSENM is surrounded by other large tracts of federal and state lands, and shares borders with three National Park Service units, two state parks, and a National Forest. Together, these units include over 4 million acres of lands managed for conservation. In FY16, GSENM worked with Great Basin Institute project leaders and field crews to establish an additional 24 Assessment, Inventory, and Monitoring (AIM) stations on the Monument and worked with the National Operations Center and with the Utah State Office, and Utah State University scientists to begin work on a step-down project of the Colorado Plateau Rapid Ecoregional Assessment (REA) to the Escalante River watershed and develop a toolkit for Monument planning purposes.

Current Science Projects

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds
GSENM Archaeological and Historical Assessment Assistance Agreement L16AS00140 L16AC00252	The purpose of this project is to research and produce a comprehensive grazing and ranching history for the GSENM area (Kane and Garfield Counties) as well as produce interpretive information for the old Paria townsite.	grazing, ranching, archaeology	Jerry Spangler, Colorado Plateau Archaeological Alliance	Reports in progress	\$45,500
Archaeological Inventory and Monitoring (part of Assistance Agreement L11AC20222: NLCS GSENM Archaeological Assessment)	The purpose of this project is to gather baseline data on the Archaeological sites and distributions within GSENM, as well as monitoring the conditions of these sites.	archaeology, history, monitoring	Jerry Spangler, Colorado Plateau Archaeological Alliance	Report awaiting final BLM review	\$0

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
Meadow Canyon Archaeological Inventory (part of Assistance Agreement L11AC20222: NLCS GSENM Archaeological Assessment Project)	The purpose of this inventory is to characterize the archaeology in the vicinity of the Meadow Canyon Pollen Core so that data from the core can be used in conjunction with historic and prehistoric use of the landscape and climate change over time.	archaeology, paleoenvironments, palynology, botany, climate change	Jerry Spangler, Colorado Plateau Archaeological Alliance	Final report awaiting BLM review (NOTE: funds for this project lumped with those for "Archaeological Inventory and Monitoring"--same Assistance Agreement) Analysis in progress	\$0
Lake Pasture Archaeological Inventory (part of Assistance Agreement L11AC20222: NLCS GSENM Archaeological Assessment Project)	The purpose of this inventory is to characterize the archaeology in the vicinity of the Meadow Canyon Pollen Core so that data from the core can be used in conjunction with historic and prehistoric use of the landscape.	archaeology, paleoenvironments, palynology, botany, climate change	Jerry Spangler, Colorado Plateau Archaeological Alliance	Final report awaiting BLM review. (NOTE: funds for this project are combined with those for "Archaeological Inventory and Monitoring"--same Assistance Agreement)	\$0
GSENM Pollen Core and Ethnobotanical Analysis Assistance Agreement L16AS00143 L16AC00252	The purpose of this inventory is to further analyze the pollen cores collected and initially analyzed under agreement L11AC20222; this information can be used in conjunction with historic and prehistoric use of the landscape and climate change over time.	archaeology, paleoenvironments, palynology, botany, climate change	Dr. Scott Anderson, Northern Arizona University	Report in progress	\$30,000
Identification and collection of Penstemon taxa native to Utah for diversification, documentation, and genotyping studies	Purpose: To produce a Penstemon field guide for Utah, and to gain a better understanding of the genetic diversity of Penstemon within Utah.	botany	Mikel R. Stevens, Brigham Young University Plant and Wildlife Sciences Department	Research in progress; one public presentation at GSENM	\$0

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
Baseline Inventory of Bryophytes of GSENM (Assistance Agreement L14AC00275)	This proposal will examine questions/issues dealing with (1) what species of bryophytes occur within the GSENM?, (2) where are the "hot spots" of bryophyte diversity within the GSENM?, and (3) characterizing rare, regionally disjunct, or new species to science within the GSENM.	botany, bryophyte, inventory, taxonomy, diversity	Lloyd Stark, University of Nevada-Las Vegas	Project initiated in FY14	\$38,000
Scent-mediated diversification of evening primrose (Onagraceae) flowers and moths across western North America	This project will examine the role of floral scent in the diversification of a model plant-pollinator-enemy system in the western North American evening primroses (Onagraceae), focusing on how chemically-mediated interactions between flowering plants, pollinators, and enemies affect diversification at population, species, and higher levels.	botany, ecology, plant ecology, pollination	Dr. Krissa Skogen, Jeremie Fant, Rick Overson, Tania Jogesh, Matt Rhodes, Evan Hilpman: Chicago Botanic Garden	Research in progress; annual report submitted	\$0
Special Status Species: Threatened and endangered species monitoring (L11AC20161)	Annual monitoring and surveying of three federally listed plant species. Ute Ladies'-tresses, Jones' Cycladenia, and Kodachrome bladderpod. Monitoring is used to detect trend and surveys occur to find unknown population sites	botany, endangered species	Amber Hughes, GSENM	Research in progress	\$0

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
Seeds of Success	Seeds of Success (SOS) was established in 2001 by the Bureau of Land Management (BLM) in partnership with the Royal Botanic Gardens, Kew Millennium Seed Bank (MSB) to collect, conserve, and develop native plant materials for stabilizing, rehabilitating and restoring lands in the United States. The initial partnership between BLM and MSB quickly grew to include many additional partners, such as botanic gardens, arboreta, zoos, and municipalities. These SOS teams share a common protocol and coordinate seed collecting and species targeting efforts. SOS is a vital part of the Native Plant Materials Development Program.	botany, native plants, restoration	Amber Hughes, GSENM	Research in progress	\$0
Phylogeography and evolution of <i>Mentzelia cronquistii</i> (Loasaceae) and the <i>Mentzelia marginata</i> complex	This project will explore how geographic and topographic complexity shape migration routes, gene flow, and plant speciation on the Colorado Plateau through a study of the geographic patterning of genetic diversity in the <i>Mentzelia marginata</i> complex.	botany, plant speciation	Dr. Larry Hufford and Joseph Grissom, Washington State University; Wendy Hodgson, Desert Botanical Garden, Phoenix, AZ	Research in progress	\$0
Learning from native 'winners'	Purpose: to identify native species and populations that can perform well in degraded sites and potentially facilitate succession to diverse native communities.	botany, restoration	Andrea Kramer et al, Chicago Botanic Garden	Research in progress; annual report submitted	\$0

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
BLM Utah rare plant research and ex-situ conservation of plant species	The purpose for this project is to conduct ex-situ conservation through seed collection and long-term storage of threatened, endangered, candidate, BLM sensitive and native species in southwestern and other areas of Utah. Seed collected will be stored as long-term ex-situ conservation germ plasm at both Red Butte Garden and CGRP in Fort Collins. If seed numbers allow, a small portion will be used to conduct non-destructive seed viability and propagation studies.	botany, seed conservation	Rita Reisor, Red Butte Garden, University of Utah	Research in progress	\$0
USDA Forest Service National Forest Inventory and Analysis program	Purpose: To conduct forest inventory at selected locations throughout the Monument to determine: status and trends in forest area and location; species, size, and health of trees; total tree growth, mortality, and removals by harvest; wood production and utilization rates by various products; and forest land ownership.	ecology, forestry, forest ecology, forest inventory	Maryfaith Snyder, USDA Forest Service Rocky Mountain Research Station, Interior West Forest Inventory and Analysis	Research in Progress.	\$0
Paleoecology study of the GSENM	Assistance Agreement L11AC20143	ecology, paleoecology, paleoenvironment, cultural resources	Scott Anderson, Northern Arizona University and Ken Cole, USGS	Closed. Master Thesis (report) delivered in FY2016.	\$0

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
untitled	Purpose: To test the hypothesis that habitat near or at ecological potential will show significantly reduced impacts from the expected effects of climate change.	ecology, plant ecology, climate change	Jim Catlin, Wild Utah	Research in progress; annual report submitted.	\$0
Restoration Studies (and dust collection study)	Determines what mechanisms of disturbance create the greatest opportunity for success in restoration processes. Dust collection study is designed to collect data on soil loss from disturbed sites.	ecology, restoration, soil, erosion	Raymond Brinkerhoff, GSENM; UPCD; Color Country District BLM; Utah Cooperative Extension Service; NRCS	Research in Progress.	\$8500
Sandstone Weathering Profiles	The purpose of this project is to study weathering processes and their products in the Navajo Sandstone, and to compare them with those in Japan and related areas in Asia with different geologic and climate settings.	geochemistry, weathering	Hirokazu Yoshida, Nagoya University	Project initiated in FY14. No fieldwork in FY2016. Peer reviewed publication expected in FY2017.	\$0
Geomorphology and geochronology of andesitic boulder deposits in the Escalante Canyons section of GSENM	This project will study the andesitic boulder deposits around the southern Boulder Mountain and Aquarius Plateau piedmont, including the effect that andesitic boulder gravels have on modern river incision rates.	geology	David Marchetti and Amy Ellwein, Western State Colorado University; Scott Hynek and Thure Cerling, University of Utah	Research in progress.	\$0
Mass Extinction Recovery	This project will focus on the biotic recovery after the end-Permian mass extinction (252 Ma ago) in order to better understand patterns and processes of diversity dynamics during the Early Triassic	geology, geochemistry	Arnaud Brayard et al, Centre National de la Recherche Scientifique, France (National Center for the Scientific Research)	Research in progress; no field work in FY16.	\$0

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
Iron Geochemistry in Sandstone Formations.	Purpose: To study various iron- oxide rich concretions using petrography and SEM, and to measure the orientation of more pipe-like concretions that define the flow direction and geochemical evolution of a paleoaquifer.	geology, geochemistry	David B. Loope, University of Nebraska Department of Geosciences	Research in progress.	\$0
Early Laramide influenced sedimentary patterns along the East Kaibab Monocline.	The purpose of this project is to examine the geology of the East Kaibab Monocline, especially with respect to sag ponds.	geology, sedimentology	Dr. Ed Simpson, Kutztown University of Pennsylvania, Department of Physical Sciences and Dr. Mike Wizevich, Central Connecticut State University	Research ongoing. Two scientific publications in FY2016. Annual Report submitted.	\$0
Upper Paleozoic and lower to middle Mesozoic eolian quartzarenites on the western Colorado Plateau Province	This project will study quartzarenites from upper Paleozoic and lower to middle Mesozoic lithostratigraphic units of mainly eolian origin on the western Colorado Plateau Province in southwestern Utah. Several specific eolian stratification types (wind-ripple, sandflow, and grainfall strata where preserved in the Lower Jurassic Navajo Sandstone, Middle Jurassic Page Sandstone, particularly the Thousand Pockets Tongue and Leche-e Member and eolian beds in the Middle Jurassic Entrada Sandstone) will be sampled. Textural attributes will be compared with eolian calcarenites from the Bahamas.	geology, sedimentology	Dr. Mario Caputo, San Diego State University & California State Polytechnic University, Pomona	Research in Progress.	\$0

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
The Permian-Triassic boundary and the Early Triassic in Transcaucasian pelagic sections	This project will examine early Triassic microbialites to determine mode of deposition (abiotic, microbially-control, or microbially-induced), and to characterize the relationship between microbialite occurrence and oceanic conditions at deposition.	geology, sedimentology	Dieter Korn, Berlin Museum of Natural History	Project closed in FY2015	\$0
NSF Earth Life Transitions (ELT) Project: Perturbation of the Marine Food Web and Extinction During the Oceanic Anoxic Event at the Cenomanian/Turonian Boundary	The purpose of this project is to test for evidence of ocean acidification during the OAE 2 event. This permit authorizes the team to drill a hole in the Tropic Shale to collect samples of unaltered bivalves, snails, and ammonites for analysis.	geology, sedimentology, paleobiology	Brad Sageman (Northwestern); Mark Leckie (UMass-Amherst); Tim Bralower, Mike Arthur, Matt Fantle, and Lee Kump (Pennsylvania State U); Mick Follows, Julio Sepulveda; (Massachusetts Institute of Technology)	Core was drilled summer of FY2014. Samples currently undergoing analysis.	\$0
Correlation and Environments of the Cretaceous age Naturita Formation	This study is establishing detailed correlations between the Naturita in GSENM and outcrops elsewhere in the Colorado Plateau region.	Geology Stratigraphy.	Brad Sageman (Northwestern University).	New project for FY2016. Fieldwork conducted in FY2016.	\$0
Regional correlation of the Triassic age Chinle Formation	This study is attempting to establish a detailed time based correlation of Late Triassic strata in the Circle Cliffs area with that of the	Geology, stratigraphy	Dr. Jeff Martz, University of Houston.	New project for FY2016. Research ongoing Fieldwork was conducted summer of FY2016.	\$0

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
Soft Sediment Deformation and Injectites in the Jurassic Carmel Formation, Southern Utah: Implications for Reservoir Characterization, and Geomorphic Features on Mars	This study will examine a well-exposed example of numerous injectites/clastic pipes in the Jurassic Carmel Formation south of Big Water, Utah and to compare them to similar pipes along the White House Trailhead road, South of the Paria Contact Station. The objectives are to: characterize the sedimentology, mineralogy, and diagenesis of the pipes; map population clusters; measure size hierarchies; and examine spatial relationships of regional tectonics, faulting, and relation to paleoshorelines.	geology, sedimentology paleoshorelines	Dr. Marjorie Chan, University of Utah	Research In Progress; annual report submitted; Peer reviewed journal article published in FY2016.	\$0
Isotopic Signatures of Carbonates in Kaiparowits Formation	This study seeks to characterize environmental parameters (temperature, hydrologic function) of 75 million year old Kaiparowits Formation.	Paleo environmental studies.	Dr. Celina Saurez, University of Arkansas.	Ongoing. Second season of fieldwork conducted in FY2016. Report submitted.	\$0
Tar sands generation and migration study	This project is sampling tar sand deposits in the Circle Cliffs to understand the origins of such deposits at a regional scale.	Fluid hydrocarbon generation studies.	Jason Flaum, Exxon-Mobile Research Dept.	Ongoing. No fieldwork conducted in FY2016.	\$0
EarthScope Program	Purpose: To install one GPS monument in GSENM as part of a network of 33 sites in the southwest to study the crustal motion and deformation of the Colorado Plateau and the transition zones with the northern and southern Basin and Range.	geology, seismology	Cornelius Kreemer, University of Nevada Reno Nevada Bureau of Mines and Geology	Permit expired in FY2014, but station is still installed and reporting data to network.	\$0

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
Paleomagenti Survey of Late Cretaceous Strata Kaiparowits Plateau, Utah L16AC00160	Purpose: To refine the temporal characterization of late Cretaceous strata through magnetostratigraphic analysis and its correlation to the Global Geomagnetic Polarity Time Scale (GPTS) in order that the hundreds of fossil localities currently known can be accurately placed in time. Field collection of rock samples to analyze at the UC Berkeley Geochronology lab for remnant magnetism to determine polarity and age.	geology, stratigraphy, dating	L. Barry Albright III, University of North Florida Department of Physics	Research ongoing. Peer reviewed paper published FY2016. Funded for an additional 5 years.	\$6,000
Facies analysis, correlation, and reservoir prediction in nonmarine shallow marine strata: Cretaceous Straight Cliffs Formation, Utah	Purpose: To document fluctuating marginal marine successions, explain facies variation in correlative nonmarine strata, and address the possible primary factors driving development of sequence and stratigraphic architecture (e.g., tectonic and eustatic controls).	geology, stratigraphy, deposition	Cari Johnson, University of Utah Department of Geology and Geophysics	Research in progress; annual report submitted; Four peer reviewed papers published; one dissertation finished and submitted.	\$0
Stratigraphy, sedimentology and taphonomy of Upper Cretaceous strata in the Kaiparowits Basin	This project will resolve the temporal, taphonomic, paleogeographic, and paleoenvironmental framework of the Upper Cretaceous Kaiparowits, Wahweap, and Straight Cliffs formations by: 1) developing a chronostratigraphic record from volcanic ashes; 2) making paleoenvironmental interpretations from invertebrate and ichnological fossils; and 3) analyzing paleosols and associated fluvial and paludal sediments.	geology, stratigraphy, paleoenvironments	Dr. Eric Roberts, James Cook University, Queensland, Australia.	Research in progress	\$0

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
Ground Water Study to Inventory and Map Water Wells in the Grand Staircase Escalante National Monument (L16PG00016)	The USGS, Utah Water Science Center, will complete an update of the water well inventory was done in 2000 - 2001. The area of coverage will be same as the previous inventory, to include the entire GSENM as well as the lands adjacent to the GSENM on the north side in the vicinity of the town of Boulder, and the lands on the west side of the monument in the vicinity of the town of Escalante. The inventory will include 1) review and completion of missing data elements in the existing inventory (where additional data is available), 2) updating the inventory data base with all new wells drilled since the last inventory, and 3) the inventory of wells will be mapped into GIS coverage, so that individual wells can be reviewed for relevant information, such as date drilled, total depth drilled, producing aquifer, producing yield, screened interval, etc. Approximately 12 data attributes will be selected to comprise the well data, and will be selected by mutual agreement with USGS and BLM.	hydrology, ecology	Bert Stolp, USGS Utah Water Science Center	Project ongoing.	\$45,000

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
BLM Assessment, Inventory and Monitoring (AIM) Project (Assistance Agreement L13AC00126)	This project will collect data on land health for the Utah pilot implementation project of BLM's national Assessment, inventory and Monitoring (AIM) strategy. The study will follow a probabilistic (random, stratified) sampling design developed in conjunction with USDA ARS Jornada Experimental Range. Data will be collected in accordance with AIM standard methods.	land health	Jerry Keir, Great Basin Institute	Research in progress; annual report and datasets submitted	\$80,000
Toward an integration of historical and contemporary data to inform assessment, monitoring, and decision-making on the Grand Staircase-Escalante National Monument (Assistance Agreement L13AC00249)	Purpose: to conduct a retrospective study of existing vegetation assessment and monitoring data and to compare the results of that study with anticipated results under the AIM strategy. This study will: a) evaluate the representativeness of existing GSENM vegetation monitoring data previously sampled using both probabilistic and non-probabilistic designs; b) summarize and compare methodologies used to collect these data in a rigorous analytical framework; and c) evaluate the potential for integration of these data into the stratified probabilistic design to be developed through the application of the AIM strategy for land health assessment on GSENM.	landscape ecology, land health, range assessment, range monitoring	Brett Dickson, Northern Arizona University	Research in progress; preliminary results submitted.	\$0
Cretaceous microvertebrate diversity.	To sample mudstone facies to recover small terrestrial vertebrate fossils and assess overall diversity of different times and facies.	paleontology (vertebrate)	Dr. Jeff Eaton, Natural History Museum of Utah	Research in progress; annual report submitted	\$6,000

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
Cretaceous Paleobotanical Heritage Resource Inventory/Specimen Protection (L11AC20100)	Purpose: To inventory Cretaceous paleobotanical resources in the Kaiparowits Plateau region. Ground inventory for significant plant fossils using GPS technology, field notes, and photographs to document resource location/condition. Significant specimens are collected to preserve them. Collected specimens are stabilized and prepared for long term curation by volunteers at the DMNS.	paleobotany	Dr. Ian Miller, Denver Museum of Nature and Science.	Research in progress; annual report submitted.	\$0
Kaiparowits Basin Project-Invertebrate Survey L12AC20541	Intensive sampling of freshwater mollusks in a variety of sedimentary facies should allow for characterization of ecological preferences of each species. This in turn will help refine paleoecological models for all Late Cretaceous fossil taxa.	paleontology (invertebrate), paleoenvironment	Dr. Lief Tapanila, Idaho State University	Research in Progress.	\$0
Cretaceous marine vertebrate diversity.	Inventory of Tropic Shale outcrops mostly for marine reptiles, but also for fish and the rare dinosaur.	paleontology (vertebrate)	Dr. David Gillette, Museum of Northern Arizona, with Dr. Beck Schmeisser, Norbert College.	Research in Progress.	\$0
Kaiparowits Basin Project (L14AC00302)	Quantification of fossil vertebrate diversity and ecological disparity of vertebrate taxa in Kaiparowits and Wahweap formations through inventory and collection and research on existing collections. Emphasis is on crocodilians and theropod dinosaurs, but all vertebrate groups will be assessed.	paleontology (vertebrate)	Dr. Joseph Sertich, Curator of Vertebrate Paleontology, Denver Museum of Nature and Science	Research in progress; annual report submitted. Abstract/poster presented at professional mtg.	\$24,000

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
Late Cretaceous Squamate Diversity	Collection and research on fossil squamates (lizards and snakes) of the Kaiparowits Plateau region.	paleontology (vertebrate)	Dr. Randall Nydam, Midwestern University.	Project closed in FY2016.	\$0
Late Cretaceous Vertebrate Diversity- Kaiparowits Formation	Collection and research on vertebrate fossils from the Kaiparowits Fm. near Canaan Peak.	paleontology (vertebrate)	Drs. Don Lofgren and Andy Farke, Raymond Alf Museum.	One scientific publication in FY2016. Annual Report submitted.	\$0
Cretaceous Vertebrate Heritage Resource Inventory/Specimen Protection (includes NMHU L12AC20378)	Purpose: To survey and research vertebrate paleontological resources from Late Cretaceous deposits within the Monument.	paleontology (vertebrate), paleontology (invertebrate), paleobotany, Paleoenvironment	Randall Irmis, Natural History Museum of Utah at the University of Utah	Research in progress; annual report submitted. Two peer reviewed papers submitted in FY2016. One MSc. Thesis submitted.	\$52,000
Late Cretaceous Biodiversity GSENM region.	Inventory, collection, and research on late Cretaceous fossil ecosystems of the Grand Staircase and Kaiparowits Plateau areas.	paleontology (vertebrate, invertebrate, paleobotanical, ichnology).	Dr. Alan Titus, Monument Paleontologist, Grand Staircase-Escalante National Monument.	One additional scientific publication. Annual report submitted.	In-house
BLM-Utah State Office Monitoring	New long term trend monitoring designed to make data collection uniform across the state.	range management	BLM Utah State Office, Univ. of Arizona	Research in progress	\$0
Visitor Capacity of the Dry Fork slot canyons and within the Calf Creek watershed and analysis of existing data (Interagency Agreement with Aldo Leopold Wilderness Research Institute (L14PG00241))	This research will rely primarily on existing data from two locations to determine visitor experience and resource conditions that are needed for future backcountry management related to day- use and implementation of a SRMA or SMA, workshops and report submitted in FY2015	wilderness study areas, visitor experience, visitor capacity, day-use, resource impacts	Dr. David Cole	Research began in spring 2015	\$0

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
GSENM-Recreation Experience Baseline Study (L12AC20566)	<p>This study is designed to facilitate social science research aimed at understanding recreation experiences at GSENM. Project uses focus groups, conducted in face-to-face sessions as well as via web-based sessions, to determine interests and expectations of recreationists, desired outcomes, setting characteristic preferences, sense of place, and tolerance for changes such as crowding and physical setting changes. Focus groups have been conducted with local residents, commercial guides, local officials, and members of the tourism support industries in the area. Data collection has been aided by audience polling technology and the BLM project lead has assisted in populating the focus groups, developing the scripts, and securing locations and times for the focus group sessions.</p> <p>Phase 1 was conducted in 2013 and studied the Hole in the Rock area; Phase 2 was conducted in 2014 and studied the Grand Staircase region.</p>	recreation experience, visitor experience, sense of place, user preferences	Dr. Tim Casey, Colorado Mesa University	Research in progress; annual report submitted	\$15,000

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
Baseline Acoustic Monitoring at GSENM (assistance Agreement L14AC00078)	This agreement was initiated in 2014 to conduct baseline acoustic monitoring at GSENM to determine current soundscape conditions and develop a better understanding of how natural sound and noise affect visitor experience and monument resources.	recreation, acoustics, visitor experience	Britton Mace, Grant Corser, Larissa Reynolds, Shelly Ewen, Jennifer Anderson, Cassi Hoffmeister, Stuart Clements, Alex Vittum- Jones, Glenn Beacham and Kaitlin Potter: Southern Utah University, Dept. of Psychology	Research in progress; Three sets of monitoring equipment were loaned to GSENM in Sept 2014 by NPS. Training on deployment, data collection, extraction, data analysis and reporting was conducted by NPS Natural Sounds Office. Training attended by PI, 8 student research assistants and 8 GSENM staff. PI and research assistants check equipment every two weeks and download data once per month. Planning, site selection, and scoping were conducted with GSENM staff, the PI, research assistants, and NPS personnel. Equipment deployed along Calf Creek and Deer Creek Trails and in the Dry Fork Canyons area. Data sets consisting of 25 days of complete acoustic recordings and decibel measurements were collected at these three locations over a three month period.	\$32,000

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
Big Horn Sheep Connectivity Study	Determines sheep movement across the monument to identify populations and genetics	wildlife, animal ecology, habitat connectivity, climate change, bighorn sheep	Ryan Monello, National Park Service; also Oregon State University, Utah Dept of Wildlife Resources	Research in progress	\$0
Cougar Connectivity Study	GSENM is the last area to be studied on the Colorado Plateau. Determines the movement and ranges of cougars	wildlife, animal ecology, habitat connectivity, climate change, cougar, mountain lion	David Mattson, USGS; also NPS and Utah Division of Wildlife Resources	Research in progress	\$0
Bat population and pollen study	Identify species, movement, and populations; sample pollinators to identify the various types of pollen and where it came from	wildlife, bats, ecology, zoology, botany	Terry Tolbert, GSENM; also volunteers, Dixie National Forest, BCNP	Research in progress	\$1 500
Hummingbird migration study	Banding and tracking migration of the different species of humming birds and their importance to pollination.	wildlife, hummingbirds, botany	Terry Tolbert, GSENM; also volunteers, Dixie National Forest, BCNP	Research in progress	\$2000
Pronghorn Location Monitoring	Tracking the migration, reproduction, and forage use of five different populations of pronghorn.	wildlife, zoology, animal ecology, Pronghorn	Cameron McQuivey, GSENM; also Utah Department of Wildlife Resources, volunteers	Research in progress	\$0

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
Global Survey and Inventory of Camel Spiders (Arachnida, Solifugae)	The purpose of the proposed research is to collect and inventory camel spider diversity in sites near the type localities of species previously collected and largely known only from historical records. Specimens will be used for both a higher level phylogenetic analysis of Solifugae, for a phylogenetic analysis of the Eremobatidae, and to investigate the taxonomy, ecology, behavior, and morphology of the group.	zoology, animal ecology, arachnids	Paula Cushing, Denver Museum of Nature and Science	Research in progress	\$0
Estimating Occupancy Rates, Reproductive Effort and Effects of Recreation on Mexican Spotted Owls in Southern Utah	Purpose: This research project involves studying the prey dynamics of the threatened Mexican Spotted Owl in the Monument. The objective of this project is to develop a long-term (i.e., >10 year) monitoring study concerning trends in prey abundance and factors that influence spotted owl population dynamics in the Monument. A second objective of this research will be to assess the effects of climate changes on both spotted owls and their primary prey.	zoology, animal ecology, Mexican Spotted Owl, endangered species	David W. Willey, Montana State University Department of Ecology	Research in progress	\$0
A study of American Black Bears (<i>Ursus americanus</i>) on the Paunsaugunt Plateau, Utah	This project will to identify the movements of black bears on the Paunsaugunt Plateau in relation to centers of human activity and anthropogenic food sources, including: documenting movement, association with anthropogenic food sources, annual reproduction and survival data, evaluating methods for aversively conditioning food-conditioned bears.	zoology, animal ecology, wildlife, behavioral ecology	Dr. Tom Smith, Brigham Young University, Wildlife and Wildlands Conservation Program	Research in progress; quarterly progress reports submitted	\$0

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
untitled	This project will conduct a taxonomic revision and provide an identification key for the New World species of <i>Heliophila</i> .	zoology, arthropods, bees	Michael Orr, Terry Griswold, Harold Ikerd, Skyler Burrows, Jonathan Koch, Zachary Portman, Joan Meiners, David Denlinger, Emily Sadler, Zachary Valois: Utah State University, Dept of Biology and USDA-ARS National Pollinating Insect Collection	Research In progress; annual report submitted	\$0
Habitat and Biodiversity Monitoring Using Terrestrial Arthropod Surveys	This project seeks to search for and collect a new moth species in the genus <i>Plagiomimicus</i> (Noctuidae, Amphipyrinae), conduct a general sampling of moths, and search for and collect a new subspecies (possible new species) of butterfly diurnally (net) in the genus <i>Euphilotes</i> (Lycaenidae).	zoology, ecology, animal ecology, lepidoptera, arthropods	Paul Opler and David Wikle, Colorado State University	Research in progress; annual report submitted; one publication in a peer-reviewed journal	\$0
untitled	Purpose: To conduct bird surveys and surveys for tamarisk beetle in the Escalante-Grand Staircase National Monument.	zoology, ecology, ornithology, invertebrate zoology	Jason Beason, Rocky Mountain Bird Observatory	Research in progress	\$0
Diversity and distribution of GSENM Lepidoptera (butterflies)	This project will develop a baseline inventory of the Lepidoptera (primarily butterflies) of GSENM, with emphasis on diversity and distribution. It is expected to provide data with which other studies can be compared. Other arthropods will also be collected and documented as the opportunity presents itself.	zoology, Lepidoptera	Dr. Richard Zweifel	Research in progress; annual report submitted	\$0

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
Diversity of insect populations with a focus on systematic biology and life history of Southwestern moth species	This project is part of ongoing research exploring insect diversity on public lands in Texas, New Mexico, Arizona and Utah. It focuses on moths in the family Geometridae in an effort to gain insight into the taxonomic position and host plant associations of selected species in the genus Nemoria.	zoology, Lepidoptera	John W. Gruber, Friends' Central School and Jason D. Weintraub, Academy of Natural Sciences of Philadelphia	Research in progress	\$0
Colorado Plateau Rapid Ecoregional Assessment (REA) Step-down for the Escalante River Watershed	The Utah State University Department of Watershed Sciences is working with the GSENM and Utah State Office to integrate the Colorado Plateau REA and step-down analysis to the Escalante River Watershed to aid in management planning. This project will identify resource conditions, stressors, and management priorities in the Escalante River watershed and determine if an integrated assessment can be meaningfully applied to local resource management with the objective of developing and integrating appropriate assessment tools into watershed resources planning.	Aquatics, Vegetation, Riparian, Rapid Ecoregional Assessment	Scott Miller; BLM National Aquatic Monitoring Center Brian Laub, Wally MacFarlane, Joe Wheaton; Department of Watershed Sciences Utah State University	Research in progress currently in Phase 1	\$130,000
BLM Utah GSENM IIC Youth Outreach, Education and Title I Crew and Internship Wildlife and Resource Management Project - Assistance Agreement L16AC00118	The purpose of this agreement is to provide enhanced academic or educational opportunities to Title 1 Native American, underserved, and rural disadvantaged youth from 16-35. These opportunities also serve as an introduction to careers in the BLM under the mentorship of a wide variety of public land management specialists. .	Youth, Education, Public Land Corps, Internships, Natural and Cultural Resource Conservation	Brian Raper, Partnership Director, Southern Utah University Intergovernmental Internship Cooperative (IIC)	Accomplishment included in Youth Partner Employment Report	\$73,500.00

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
GSENM Volunteer, Science, and Education Program - Assistance Agreement L14AC000324	Provides volunteer, educational, and interpretive services including educational and visitor services staff, the production of interpretive and educational materials, funding for interpretive, educational, and research purposes, and cooperating services and funding for research and development of materials of interpretive and educational value to enhance the public knowledge and appreciation of BLM's role in the research and management of public lands, including recreation and natural, cultural, and historic resources.	Volunteers, Education, Interpretation, Public Outreach	Noel Poe, Grand Staircase Escalante Partners Executive Director	Accomplishments included as part of division reports, i.e. Volunteer; Education, Interpretation; Archeology Site Steward; Paleontology Program; and Escalante River Watershed Partnership	\$204,140.00

Project Name	Project Description	Project Key Words	Principal Investigator	Project Status/ Accomplishments	BLM Contributed Funds (FY16)
Ground Water Study to Document MODFLOW groundwater model developed for GSENM in an Open-File report and update 2013 well inventory to include new 2014 and 2015 well locations.	The USGS, Utah Water Science Center, will document the construction and results on an existing numerical groundwater model (MODFLOW) developed for the GSENM in an Open-File Report. The model can be used as a tool for simulating and testing the conceptual understanding of the GSENM groundwater system. The USGS also plans to update the 2013 well inventory to include new wells drilled in 2014 and 2015. The area of coverage will be same as the previous inventory, to include the entire GSENM as well as the lands adjacent to the GSENM. The inventory will include 1) review and completion of missing data elements in the existing inventory (where additional data is available), 2) updating the inventory data base with all new wells drilled since the last inventory, and 3) the inventory of wells will be mapped into GIS coverage, so that individual wells can be reviewed for relevant information, such as date drilled, total depth drilled, producing aquifer, producing yield, screened interval, etc. Approximately 12 data attributes will be selected to comprise the well data, and will be selected by mutual agreement with USGS and BLM.	hydrology, groundwater, ecology	Melissa Masbruch USGS Utah Water Science Center	Research in progress	\$45,000

5 Resources, Objects, Values and Stressors

Scientific Study and Landscape-Related Values

The GSENM's vast and austere landscape embraces a spectacular array of scientific and historic resources. This high, rugged, and remote region, where bold plateaus and multi-hued cliffs run for distances that defy human perspective, was the last place in the continental United States to be mapped. Even today, this unspoiled natural area remains a frontier, a quality that greatly enhances the monument's value for scientific study. The monument has a long and dignified human history: it is a place where one can see how nature shapes human endeavors in the American West, where distance and aridity have been pitted against our dreams and courage. Remoteness, limited travel corridors and low visitation have all helped to preserve intact the monument's important ecological values.

The values described in the Proclamation include: a vast and austere landscape; a rugged and remote landscape character; an unspoiled natural area, where natural processes are unaltered by man; a frontier character; and a long and dignified human history. The primary value of the Monument is its value for the scientific study of human history, flora and plant refugia, geology and the formation of the earth, paleontology of the late Cretaceous Era, modern vegetative communities, endemic plants and pollinators, relict vegetation, wildlife, soils and soil crusts, and unusual isolated biological communities.

Status and Trend		
Scientific Study and Landscape-related Values		
Value	Status	Trend
Scientific study	Good	Stable
Vast and austere landscape	Good	Stable
Rugged and remote character	Good	Stable
Unspoiled natural area	Good	Stable
Frontier character	Good	Stable
Long, dignified human history	Good	Stable

Inventory, Assessment, Monitoring Scientific Study and Landscape-related Values				
Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc)	Amount Monitored (acres, miles, etc.)
Scientific study	N/A; see project listing, Section 4	See project listing, Section 4	See project listing, Section 4	See project listing, Section 4
Vast and austere landscape	Visual Resource Management System (Scenic Quality, Sensitivity, Distance Zones)	1.9 million acres	1.9 million acres	Monument lands monitored as needed per individual project requirements. Updated Visual Resource Inventory anticipated completion 2016.
Rugged and remote character	1980 BLM Utah Wilderness Inventory; 1999 BLM Utah Wilderness Inventory	881,997 acres of Wilderness Study Area or Instant Study Area; 208,438 additional acres of lands with wilderness characteristics	1,090,435	881,197
Unspoiled natural area	1980 BLM Utah Wilderness Inventory; 1999 BLM Utah Wilderness Inventory	881,997 acres of Wilderness Study Area or Instant Study Area; 208,438 additional acres of lands with wilderness characteristics	1,090,435	881,197

Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc)	Amount Monitored (acres, miles, etc.)
Frontier character	1980 and 1999 BLM Utah Wilderness inventory; see also cultural resource inventory	881,997 acres of Wilderness Study Area or Instant Study Area; 208,438 additional acres of lands with wilderness characteristics	1,090,435	881,197
Long, dignified human history	See cultural resource inventory	130,000 acres	5,000 sites	Approximately 100 sites monitored annually through Site Steward program and in house monitoring; otherwise, Monument lands spot checked and/or inventoried to a Class III standard per individual project requirements

Stressors Affecting Scientific Study and Landscape-Related Values

Climate change: Climate change is a broad environmental stressor with the potential to drastically change the character of the landscapes within GSENM, our ability to protect objects and values for which GSENM was designated (especially natural resources), and to manage resource use. In the next 50 years, the Colorado Plateau REA has predicted the Monument will be severely impacted by drought, which may result in the loss of critical elements of major plant communities, including loss of pinyon pine in the pinyon pine-juniper vegetation community which currently covers nearly 35% of the Monument, and associated impacts to wildlife, water quantities and quality, and increased erosion. This change will alter the area's value for scientific research, and will probably push Monument research in the direction of applied studies focused on climate change impacts to Monument resources. Adequate planning to mitigate impacts and to address management challenges will increase workloads in the long-term. Potential effects include drought and severe flash floods.

Increasing Recreational Use: GSENM is experiencing constantly increasing recreational use as a result of national and international advertisement promoting it as an iconic canyon country destination. Tourism promotion through campaigns such as The Mighty Five: Utah's National Parks draw increasing amounts of visitors to the Bryce Canyon, Capitol Reef, and Zion National Park. GSENM is located squarely in the midst of these parks which presents management challenges in balancing use with adequate protection of GSENM objects and values. Increased backcountry visitor impacts include increased graffiti, human waste issues, water quality concerns and parking congestion. Dispersed campsites are proliferating. Planning efforts are needed to insure adequate use management and resource protection.

R.S. 2477 litigation and travel management plan implementation: R.S. 2477 litigation has pulled key specialist positions (including GIS and Realty specialists, but also including Range Management specialists, Backcountry Rangers, and others) away from day to day workload needing completion. Meeting the data requirements of, and supporting Solicitor and Department of Justice needs has meant a reduction in staff ability to support GSENM programs and accomplish work on the ground. The on-going litigation has also hindered effective implementation of the travel management plan. As noted previously, routes have not been effectively closed and/or rehabilitated, and on-going communication and coordination issues have hampered signage and maintenance efforts.

Geological Objects and Resources

"The monument is a geologic treasure of clearly exposed stratigraphy and structures. The sedimentary rock layers are relatively undeformed and unobscured by vegetation, offering a clear view to understanding the processes of the earth's formation. A wide variety of formations, some in brilliant colors, have been exposed by millennia of erosion. The monument contains significant portions of a vast geologic stairway, named the Grand Staircase by pioneering geologist Clarence Dutton, which rises 5,500 feet to the rim of Bryce Canyon in an unbroken sequence of great cliffs and plateaus. The monument includes the rugged canyon country of the upper Paria Canyon system, major components of the White and Vermilion Cliffs and associated benches, and the Kaiparowits Plateau. That Plateau encompasses about 1,600 square miles of sedimentary rock and consists of successive south-to-north ascending plateaus or benches, deeply cut by steep-walled canyons. Naturally burning coal seams have scorched the tops of the Burning Hills brick-red. Another prominent geological feature of

the plateau is the East Kaibab Monocline, known as the Cockscomb. The monument also includes the spectacular Circle Cliffs and part of the Waterpocket Fold, the inclusion of which completes the protection of this geologic feature begun with the establishment of Capitol Reef National Monument in 1938 (Proclamation No. 2246, 50 Stat. 1856). The monument holds many arches and natural bridges, including the 130- foot-high Escalante Natural Bridge, with a 100 foot span, and Grosvenor Arch, a rare "double arch." The upper Escalante Canyons, in the northeastern reaches of the monument, are distinctive: in addition to several major arches and natural bridges, vivid geological features are laid bare in narrow, serpentine canyons, where erosion has exposed sandstone and shale deposits in shades of red, maroon, chocolate, tan, gray, and white. Such diverse objects make the monument outstanding for purposes of geologic study."

The geological resources of GSENM contribute to the regional geology acknowledged worldwide for its scenic beauty. As noted in the Proclamation, these resources are clearly exposed, providing windows on geologic processes such as erosion, deposition and deformation, which represent "outstanding" opportunities for scientific study.

Status and Trend Geological Objects and Resources		
Value	Status	Trend
Grand Staircase	Good	Stable
White Cliffs	Good	Stable
Vermillion Cliffs	Good	Stable
Kaiparowits Plateau	Good	Stable
Circle Cliffs	Good	Stable
East Kaibab Monocline The Cockscomb	Good	Stable
Waterpocket Fold (portion of it)	Good	Stable
Upper Paria Canyon System	Good	Stable
Upper Escalante Canyons	Good	Stable
Burning Hills coal seams	Good	Stable
Escalante Natural Bridge	Good	Stable
Grosvenor Arch	Good	Stable
Arches and Natural Bridges	Good	Stable

Inventory, Assessment, Monitoring Geological Objects and Resources				
Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc)	Amount Monitored (acres, miles, etc.)
Grand Staircase	USGS topographic and geologic maps	1.9 million acres (all of GSENM)		known physiographic feature
White Cliffs	USGS topographic and geologic maps	1.9 million acres (all of GSENM)		known physiographic feature
Vermillion Cliffs	USGS topographic and geologic maps	1.9 million acres (all of GSENM)		known physiographic feature
Kaiparowits Plateau	USGS topographic and geologic maps	1.9 million acres (all of GSENM)		known physiographic feature
Circle Cliffs	USGS topographic and geologic maps	1.9 million acres (all of GSENM)		known physiographic feature
East Kaibab Monocline - The Cockscomb	USGS topographic and geologic maps	1.9 million acres (all of GSENM)		known physiographic feature
Waterpocket Fold (portion of it)	USGS topographic and geologic maps	1.9 million acres (all of GSENM)		known physiographic feature
Upper Paria Canyon System	USGS topographic and geologic maps	1.9 million acres (all of GSENM)		known physiographic feature
Upper Escalante Canyons	USGS topographic and geologic maps	1.9 million acres (all of GSENM)		known physiographic feature
Burning Hills coal seams	USGS topographic and geologic maps	1.9 million acres (all of GSENM)		known geologic feature
Escalante Natural Bridge	individual known geologic feature	1.9 million acres (all of GSENM)	1 each	individual known geologic feature
Grosvenor Arch	individual known geologic feature	1.9 million acres (all of GSENM)	1 each	individual known geologic feature

Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc.)	Amount Monitored (acres, miles, etc.)
Arches and Natural Bridges	USGS topographic and geologic maps	Unknown	unknown	many known geologic features mapped; no separate GSENM-wide inventory

Stressors Affecting Geological Objects and Resources

Some recreational use, especially technical climbing, and vandalism, have the potential to adversely affect geological resources. Such impacts are typically localized, although they have the potential to be locally significant. The Recreation program has been considering ways such impacts can be better managed, a Canyoneering and Climbing Plan for SRP management is scheduled to begin by 2017.

No other stressors known.

Paleontological Objects and Resources

The monument includes world class paleontological sites. The Circle Cliffs reveal remarkable specimens of petrified wood, such as large unbroken logs exceeding 30 feet in length. The thickness, continuity and broad temporal distribution of the Kaiparowits Plateau's stratigraphy provide significant opportunities to study the paleontology of the late Cretaceous Era. Extremely significant fossils, including marine and brackish water mollusks, turtles, crocodilians, lizards, dinosaurs, fishes, and mammals, have been recovered from the Dakota, Tropic Shale and Wahweap Formations, and the Tibbet Canyon, Smoky Hollow and John Henry members of the Straight Cliffs Formation. Within the monument, these formations have produced the only evidence in our hemisphere of terrestrial vertebrate fauna, including mammals, of the Cenomanian-Santonian ages. This sequence of rocks, including the overlaying Wahweap and Kaiparowits formations, contains one of the best and most continuous records of Late Cretaceous terrestrial life in the world.

The Monument's paleontological resources are becoming better known to the greater research community as a result of 17 years of BLM sponsored collaborative, interdisciplinary research. During that time, teams from more than two dozen museums and universities have documented thousands of new fossil sites. From these sites many truly world class fossils have been collected including over twenty

new species of dinosaur, giant alligators, turtles, fish, mammals, and a spectacular fossil tropical flora. The result has been that the expectations of the Proclamation have actually been exceeded, placing GSENM in the unique position as the most diverse and significant southern Laramidian terrestrial Cretaceous locality, that rivals the importance of the Dinosaur Provincial Park World Heritage site in Alberta, Canada. Monument finds are causing the research community to revise long held ideas on Cretaceous dinosaur diversity and ecology and serve as a touchstone for most new hypotheses on these topics. The Kaiparowits Formation (76-74 million years old) consistently produces spectacular fossil finds of all types, but the Wahweap, Tropic, Straight Cliffs and other formations (see Management Recommendations, below) have also yielded many highly significant sites. Jurassic and the Triassic strata also contain significant resources, but at a much lower volume.

Status and Trend Paleontological Objects and Resources		
Value	Status	Trend
Late Cretaceous fossils	Generally good. Looting of fossil wood occurs regularly in the Head of the Creeks areas. Looting of bone occurs intermittently in the Four Mile Bench and "The Blues" areas.	Generally stable
Petrified wood – Circle Cliffs	Subjected to periodic looting near Wolverine Trailhead. Most other localities are good.	Generally stable

Inventory, Assessment, Monitoring Paleontological Objects and Resources				
Object or Value	Inventory Type	Amount Inventoried (acres, miles,	Amount Possessing Object (acres, miles, etc)	Amount Monitored (acres, miles, etc.)
Late Cretaceous fossils	Fossil resources occur unpredictably in bedrock outcrop areas (badlands and sparsely vegetated/thinly soiled over areas). These areas are covered by pedestrian surveys with experienced crews.	134,466 acres (7% of GSENM) surveyed through FY15; 4,957 new acres surveyed in FY16 Totals are taken from annual reports published by formal partners and the in house GSENM paleontologist.	139,423 acres. About half of that acreage contains known resource. 54 new fossil sites were documented by BLM crews during FY16; and additional 126 sites were documented by the DMNS and NHMU. All but seven are vertebrate sites; all of the sites are in Cretaceous age strata of the Kaiparowits Basin. 16 sites were excavated or required intensive surface collection by larger BLM crews.	A total of 35 sites were monitored in FY16
Petrified wood – Circle Cliffs	Pedestrian Survey. Fossil forest area is estimated at 50,000 acres. Inventory has not been started.	0 (Circle Cliffs wood resource has been claimed by Sid Ash to be the 2nd largest in North America next to Petrified Forest National Park)		The Wolverine Trailhead site (one site, ~5 acres) is monitored every year, including FY16, for qualitative condition. No unauthorized collection was noted in FY16.

Stressors Affecting Paleontological Objects and Resources

The primary stressor affecting paleontological resources is natural erosion from deeply rooted xeric plants, freeze thaw, and intense precipitation events, followed by anthropogenic ground-disturbing activities, looting, and vandalism. When disturbances would result from Proposed Actions on Federal land they can be analyzed in advance through the NEPA process, allowing for mitigation to protect paleontological resources. Land uses (such as recreation and grazing) are believed to have minimal impacts to fossil resources. At the other end of the spectrum are fossil theft and vandalism which pose serious threats. Active in house BLM inventory programs, as well as those of other institutions, help to identify where high value resources are at risk and allow for prioritization of mitigation measures. Scientific collection and curation in an approved public repository is frequently the best solution for at risk vertebrate body fossils and collaborative work between the BLM, the Natural History Museum of Utah, and the Denver Museum of Nature and Science ensure that the highest priority specimens are protected.

Cultural Resources (Archaeological and Historic) Objects and Resources

“Archeological inventories carried out to date show extensive use of places within the monument by ancient Native American cultures. The area was a contact point for the Anasazi and Fremont cultures, and the evidence of this mingling provides a significant opportunity for archeological study. The cultural resources discovered so far in the monument are outstanding in their variety of cultural affiliation, type and distribution. Hundreds of recorded sites include rock art panels, occupation sites, campsites and granaries. Many more undocumented sites that exist within the monument are of significant scientific and historic value worthy of preservation for future study.

The monument is rich in human history. In addition to occupations by the Anasazi and Fremont cultures, the area has been used by modern tribal groups, including the Southern Paiute and Navajo. John Wesley Powell's expedition did initial mapping and scientific field work in the area in 1872. Early Mormon pioneers left many historic objects, including trails, inscriptions, ghost towns such as the Old Paria townsite, rock houses, and cowboy line camps, and built and traversed the renowned Hole-in-the-Rock Trail as part of their epic colonization efforts. Sixty miles of the Trail lie within the monument, as does Dance Hall Rock, used by intrepid Mormon pioneers and now a National Historic Site.”

Cultural resources on GSENM include both historic and prehistoric sites, as named in the Proclamation. The cultural resource program also addresses Traditional Cultural Properties (TCP), Native American Sacred Sites, and cultural landscapes. Several

potential TCPs have been identified by the Paiute and the Navajo, but have not yet been finalized.

Status and Trend Archaeological Objects and Resources		
Value	Status	Trend
Archaeological sites	generally good, although examples ranging from "Poor" to "Excellent" can be found across GSENM	generally stable, perhaps with a slight downward trend primarily due to natural erosional processes, but also including human impacts from visitation, looting, and vandalism
Historic object and values	generally good	generally stable

Inventory, Assessment, Monitoring Archaeological Objects and Resources				
Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc.)	Amount Monitored (acres, miles, etc.)
Archaeological sites	Primarily pedestrian inventory and recording, although aerial techniques (helicopters) have been used to record inaccessible, cliff side sites.	130,000 acres (~7% of GSENM)	Approx. 5,000 sites NOTE: The site types listed in the Proclamation (Anasazi cultural sites, Fremont cultural sites, rock art panels, occupations sites, campsites and	80 sites

Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc.)	Amount Monitored (acres, miles, etc.)
Modern tribal use (Southern Paiute, Hopi, and Navajo)				"Inventory" not applicable to this category; Native American use of GSENM continues on an opportunistic basis, use restrictions are generally not applied.
Powell Expedition Routes/Sites	pedestrian inventories			No inventories for the Powell expedition routes initiated.
Mormon Pioneer Trails				Primary trails are well known; no other systematic GSENM wide inventory except an ongoing, low priority project to map the old cowboy trails before they disappear; priority may increase due to the grazing EIS.
Historic Inscriptions	pedestrian inventories	130,000 acres (~7% of GSENM)	270 sites	Historic inscriptions are a common element at historic sites, and are common across GSENM; numbers approximate.

Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc.)	Amount Monitored (acres, miles, etc.)
Ghost towns	(see Old Paria Townsite, below)	1.9 million acres (all of GSENM)	1 site	The Old Paria Townsite is the only known "ghost town" within GSENM. The historic community of Rock House was located on GSENM, but it is suspected to have been washed away by flooding of the Paria River in historic times.
Rock houses	pedestrian inventories			"Rock house" is not a specific historic structure type. Any historic cabin or structure may be recorded as such, with construction technique being secondary. Examples of rock constructed houses can be found in the Old Paria Townsite (see below)

Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc.)	Amount Monitored (acres, miles, etc.)
Cowboy line camps, currently used	Sites, Permit, RAS/RIPs	300,000 acres (~16% of GSENM)	9 each	To date approximately 56 line camps have been inventoried; each year different line camps are utilized depending on where the workload is identified
Cowboy line camps, historic	pedestrian inventories	130,000 acres (~7% of GSENM)	80 each	Historic livestock related camps, number approximate

Stressors Affecting Cultural Resources Objects and Resources

Interest in Hole in the Rock corridor: Management of the Hole in the Rock corridor is complicated by one long-standing issue, and several rising issues. These include a need to complete SRMA planning for the Escalante Canyons area, a task identified in the 2000 Monument Management Plan; resource concerns arising from increasing traffic on the road; State of Utah litigation to settle RS2477 ROW claims, including the Hole in the Rock Road; Garfield County interest in reducing maintenance issues on the road through changing the surface character; and the identification of the Hole in the Rock route and associated historic sites as eligible for consideration as Traditional Cultural Properties by the culturally-affiliated Church of Jesus Christ of Latter-day Saints.

Other stressors affecting slight downward trend in condition: Other stressors include erosion and other natural processes and human impacts from recreation, looting and vandalism. Additionally, there may be grazing impacts such as trampling, trailing, and resultant increased erosion.

Biological Objects and Resources

“Spanning five life zones from low-lying desert to coniferous forest, with scarce and scattered water sources, the monument is an outstanding biological resource. Remoteness, limited travel corridors and low visitation have all helped to preserve intact the monument's important ecological values. The blending of warm and cold desert floras, along with the high number of endemic species, place this area in the heart of perhaps the richest floristic region in the Intermountain West. It contains an abundance of unique, isolated communities such as hanging gardens, tinajas, and rock crevice, canyon bottom, and dunal pocket communities, which have provided refugia for many ancient plant species for millennia. Geologic uplift with minimal deformation and subsequent downcutting by streams have exposed large expanses of a variety of geologic strata, each with unique physical and chemical characteristics. These strata are the parent material for a spectacular array of unusual and diverse soils that support many different vegetative communities and numerous types of endemic plants and their pollinators. This presents an extraordinary opportunity to study plant speciation and community dynamics independent of climatic variables. The monument contains an extraordinary number of areas of relict vegetation, many of which have existed since the Pleistocene, where natural processes continue unaltered by man. These include relict grasslands, of which No Mans Mesa is an outstanding example, and pinon-juniper communities containing trees up to 1,400 years old. As witnesses to the past, these relict areas establish a baseline against which to measure changes in community dynamics and biogeochemical cycles in areas impacted by human activity. Most of the ecological communities contained in the monument have low resistance to, and slow recovery from, disturbance. Fragile cryptobiotic crusts, themselves of significant biological interest, play a critical role throughout the monument, stabilizing the highly erodible desert soils and providing nutrients to plants. An abundance of packrat middens provides insight into the vegetation and climate of the past 25,000 years and furnishes context for studies of evolution and climate change. The wildlife of the monument is characterized by a diversity of species. The monument varies greatly in elevation and topography and is in a climatic zone where northern and southern habitat species intermingle. Mountain lion, bear, and desert bighorn sheep roam the monument. Over 200 species of birds, including bald eagles and peregrine falcons, are found within the area. Wildlife, including neotropical birds, concentrate around the Paria and Escalante Rivers and other riparian corridors within the monument.

This proclamation does not reserve water as a matter of Federal law. I direct the Secretary to address in the management plan the extent to which water is necessary for the proper care and management of the objects of this monument and the extent to which further

action may be necessary pursuant to Federal or State law to assure the availability of water.”

The values described in the Proclamation include a broad diversity of plants, animal, communities and ecosystems. The plants include warm and cold desert flora and a high number of endemic species. Plant communities include: hanging gardens, tinajas and rock crevice, canyon bottom and dunal pocket communities and biological soil crusts. A wide diversity of animals are supported by the varied plant communities, precipitation/elevation zones and soils including: mule deer, mountain lion, bear, desert bighorn sheep, pronghorn, birds (including many raptors), numerous reptiles and amphibians and countless invertebrate species. Ecosystems include widely variable desert, semi-desert, mountains, canyon, slickrock, aquatic systems and relict grasslands. The remoteness and relative inaccessibility of much of the Monument provides unique opportunities for studying past, present and future population, community, ecosystem and landscape dynamics, including biogeochemical and hydrological cycling.

Proclamation language regarding aquatic resources is limited, as shown by the quotes above, which are the only mentions of water or aquatic resources. However, it is clear from the Proclamation’s requirement for “... the Secretary to address ... the extent to which water is necessary for the proper care and management of the objects...,” that we are to manage water insofar as it is important for other objects (e.g., to sustain ecological processes that affect soils, plants, animals and all resources that constitute this “outstanding biological resource”). The Monument’s objectives with respect to water are to ensure that appropriate quality and quantity of water resources are available for the proper care and management of the objects of the Monument;; to increase public education and appreciation of water resources through interpretation; and to facilitate appropriate research to improve management of water resources.

All plants and animals are ultimately dependent on soils, without which there can be no terrestrial life. The biodiversity on GSENM described in other sections is a result of the diversity of soils coupled with variation in other environmental variables (such as precipitation, temperature regime, landform, elevation, topography, aspect). Continued protection of soils and soil productivity, especially from loss due to erosion that is controllable by management practices, is of paramount importance to sustainable management of the Monument.

Status and Trend Biological Objects and Resources		
Value	Status	Trend
Hanging Gardens Floristic Communities	Mostly unassessed; where assessed conditions are good.	The sites that have been observed are stable.
Tinajas Floristic Communities	Unassessed	unknown
Rock Crevice Floristic Communities	Unassessed	unknown
Canyon Bottom Floristic Communities	Unassessed	Unknown
Dunal Pocket Floristic Communities	Unassessed	Unknown
Endemic plants and their pollinators	Mostly unassessed; <1% of the GSENM	Unknown
Relict Plant Communities	Unassessed	unknown
No Man's Mesa	Poor if considered a relic grassland	Static to Downward (due to natural succession)
Pinyon Juniper Communities with up to 1,400 to trees	Good	Stable
Mountain lion	Good	Stable
Bear	Good	Stable to Increasing
Desert Bighorn Sheep Habitat	Good	Increasing
200 Bird Species	Good	Stable
Bald Eagles	Good	Stable to Increasing
Peregrine Falcons	Good	Stable to Increasing
Neo tropical Birds in riparian corridors (Paria and	Good	Stable
Riparian Corridors	Varies; conditions range from Proper Functioning Condition (PFC; most), to Functioning at Risk (FAR), with a few Non Functioning (NF)	Varies; PFC mostly stable; most of FAR and NF are upward to PFC
Cryptobiotic Crusts (biological soil crusts)	Where known, ranges from good to poor, but generally unknown	Varies, but mostly unknown
Packrat Middens	Good	Stable

Value	Status	Trend
Water sources (streams, springs, seeps, tinajas, wells)	Where assessed conditions range from good to poor (a number of stream segments do not meet UT water quality standards and are included on the 303(d) list. Springs have mostly been assessed and protected where possible	Varies, but most springs are stable, many seeps are unknown. Actively running streams have been assessed.
Soils	Where known, ranges from good to poor, but generally unknown	Unknown
Forestry (Ponderosa Pine)	Good	Stable

Inventory, Assessment, Monitoring Biological Objects and Resources				
Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc.)	Amount Monitored (acres, miles, etc.)
Hanging Gardens Floristic Communities	no systematic GSENM wide inventory; extent unknown			0
Tinajas Floristic Communities	no systematic GSENM wide inventory; extent unknown			0
Rock Crevice Floristic Communities	no systematic GSENM wide inventory; extent unknown			0

Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc.)	Amount Monitored (acres, miles, etc.)
Canyon Bottom Floristic Communities	Modified Whitaker Plots no systematic GSENM wide inventory; extent unknown	Tom Stohlgren with CSU performed baseline vegetation surveys in the late 1990s early 2000s that recorded some of this community		0
Dunal Pocket Floristic Communities	no systematic GSENM wide inventory; extent unknown			0
Endemic plants and their pollinators	Ocular Surveys	16 sites	200,000 acres	2 sites
Relict Plant Communities	no systematic GSENM wide inventory; extent unknown			0
No Man's Mesa	Long Term Trend Studies	1,500 acres	1,500 acres	750 acres
Pinyon Juniper Communities with up to 1400 year old trees	Modified Whitaker Plots, Buckskin monitoring plots 1000' meter. no systematic GSENM wide inventory; extent unknown	38,000 acres		4 projects monitored in Pinyon Juniper (JC)

Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc.)	Amount Monitored (acres, miles, etc.)
Diversity of wildlife species	Trapping, Sampling, point counts, mist netting, vehicular surveys, wildlife observation reports, telemetry	Since 1999, numerous universities, permanent and seasonal staff, have contributed to roughly 1,425,000 acres of inventory. Nearly all habitat types have been inventoried.	1.9 million acres (entirety of GSENM) contributes to diversity due to a wide array of habitats and ecosystems.	Annually, a percentage of the Monument is monitored for continued presence of diverse species through mist netting, point counts, and observations.
Mountain lion	Wildlife observation reports, hunter harvest reports, tracking and trapping	Not inventoried specific for Mountain Lion. Relying mostly on observations, hunter harvest reports, and a recent study involving tracking and collaring of several mountain lions for scientific study.	1.9 million acres (entirety of GSENM) has the possibility of having mountain lion presence at one time or another as they travel in search of home ranges and food sources.	In 2013, a collared male lion was tracked through his habitat for a period of nine months using GPS technology. The area involved included roughly 20 square miles or 256,000 acres. The lion was legally harvested in 2015, ending project.
Bear	Wildlife observation reports, hunter harvest reports	Not inventoried specific for black bear. Relying mostly on observations, and hunter harvest reports.	Approximately 300,000 acres have habitat suitable to provide life cycle requirements for bears.	N/A; Rare species occasionally inhabiting the Monument. Not monitored with a specific program.

Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc.)	Amount Monitored (acres, miles, etc.)
Desert Bighorn Sheep Habitat	UDWR census flights, telemetry data, wildlife observation reports, hunter harvest reports	Approximately 1,500,000 acres have been aerially inventoried by UDWR in recent years.	Approximately 750,000 acres have habitat requirements suitable for bighorn sheep.	Annually, the UDWR flies vast acreage on the Monument conducting census counts on four separate herd units. Additionally, BLM uses telemetry to keep track of reintroduced sheep.
200 Bird Species	Point count surveys, winter raptor surveys, Christmas bird count	Approximately 1,500,000 acres have been surveyed at one time or another in search of bird species. This accounts for all of the major habitat types within the Monument.	1.9 million acres (entirety of GSENM) contributes to diversity due to a wide array of habitats and ecosystems.	Annually, BLM staff conduct point count surveys in pinyon juniper woodland, sagebrush, mixed conifer, and riparian habitats for bird diversity. Additionally winter raptor surveys and the Christmas bird
Bald Eagles	Winter raptor surveys	Approximately 200 miles of highway are surveyed annually.	1.9 million acres (entirety of GSENM) has the potential for bald eagles during migration and winter months. Use on the Monument is primarily centered around major highways where they feed on carrion during winter months before returning to summer habitat.	Winter raptor surveys along highway corridors are carried out annually to account for bald eagle trends. Approximately 200 miles are surveyed several times throughout the winter months. Bald eagles appear to be stable to increasing.

Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc.)	Amount Monitored (acres, miles, etc.)
Peregrine Falcons	Territory monitoring, raptor surveys, wildlife observation reports, winter raptor surveys.	Approximately 1,500,000 acres of GSENM have been surveyed for bird species.	Approximately 500,000 acres with habitat on cliff faces is suitable for peregrine falcon.	14 Peregrine falcon territories are monitored annually. This accounts for the known territories. Sighting reports indicate birds doing well and are expanding.
Neo tropical Birds in riparian corridors (Paria and Escalante Rivers)	Point count surveys, mist netting	Nearly the entirety of these two streams have been surveyed by BLM or UDWR for migratory birds either through point count surveys or mist netting	These two stream corridors account for approximately 50,000 acres of habitat.	Mist netting was used for baseline data in the early years of the Monument. No mist netting has been conducted in recent years. Point count surveys continue to be conducted annually at several locations along these stream corridors.
Packrat Middens	No systematic inventory to date			
Riparian Corridors	Escalante: ocular, Point Count Transects, repeat photography. Paria: Henrieville Creek.	<19,000 acres (<1% of GSENM)	Escalante: 13,500 acres	Escalante and Paria: 13,500 acres

Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc.)	Amount Monitored (acres, miles, etc.)
Cryptobiotic Crusts (biological soil crusts)	systematic survey of low disturbance sites on ~25 40% of GSENM to develop predictive model for biological soil crust abundance GSENM wide	(~25 40% of GSENM)	Unknown	Bowker, MA, J Belnap and ME Miller. 2006. Spatial modeling of biological soil crusts to support rangeland assessment and monitoring. Rangeland Ecology and Management 59(5):519 529.
Water sources (streams, springs, seeps, tinajas, wells)	1:24,000 scale topographic maps (USGS 7½ minute series)	1.9 million acres (all of GSENM)	Unknown	Unknown
Water sources (streams, springs, seeps, tinajas, wells)	water rights database (State of UT)	1.9 million acres (all of GSENM)	Unknown	Unknown
Water sources (streams, springs, seeps, tinajas, wells)	characterization of water sources (stream gauging, spring/seep flow rates, water chemistry, aquifer characterization, groundwater/ surface water exchange, human effects on quantity and quality, etc.)	380,000 acres (~20% of GSENM) estimated 20% based on previous and ongoing studies	unknown	routine water quality monitoring was conducted at 10 sites (5 year round and 5 seasonal sites); additional bacteriological monitoring timed with storm events was conducted in FY15 at recreational sites in Calf Creek

Object or Value	Inventory Type	Amount Inventoried (acres, miles, etc.)	Amount Possessing Object (acres, miles, etc.)	Amount Monitored (acres, miles, etc.)
Soils	soil survey (3rd Order)	1.9 million acres (all of GSENM)	1.9 million acres	Systematic monitoring began FY13 with AIM; 21 sites monitored in FY15; 24 sites monitored in FY16.
Soils	ecological site description (final ESD with state and transition model)	1.9 million acres (all of GSENM)	23 ESDs	S&T models define "community dynamics"; GSENM has 58 ecological sites: 23 have final ESD w/ S&T; 21 have final ESD w/o S&T; 9 have draft ESD w/ S&T; 5 have no ESD
Forestry (Ponderosa Pine)	Stand Exams	6,000		Plot based inventory system samples 5 10% of inventoried stands for species composition, tree density (trees per acre, basal area, stand density index), wood volumes (tons of biomass, cords, and board feet of sawtimber), damaging agents (insects, diseases, mechanical damage), tree diameters, tree heights, tree age, etc.

Stressors Affecting Biological Objects and Resources

Climate change: Climate change is a broad environmental stressor with the potential to drastically change the character of the landscapes within GSENM, our ability to protect objects and values for which GSENM was designated (especially natural resources), and to manage resource use. In the next 50 years, the Colorado Plateau REA has predicted the Monument will be severely impacted by drought, which may result in the loss of critical elements of major plant communities, including loss of pinyon pine in the pinyon pine-juniper vegetation community which currently covers nearly 35% of the Monument, and associated impacts to wildlife, water quantities and quality, and increased erosion. This change will alter the area's value for scientific research, and will probably push Monument research in the direction of applied studies focused on climate change impacts to Monument resources. Adequate planning to mitigate impacts and to address management challenges will increase workloads in the long-term. Potential effects include drought and severe flash floods.

Increasing Recreational Use: GSENM is experiencing constantly increasing recreational use as a result of national and international advertisement promoting it as an iconic canyon country destination. This presents management challenges in balancing use with adequate protection of GSENM objects and values. Increased backcountry visitor impacts include increased graffiti, human waste issues, water quality concerns and parking congestion. Dispersed campsites are proliferating. Planning efforts are needed to insure adequate use management and resource protection.

Erosion: Erosion is the primary stressor on soil resources (including biological soil crusts). Erosion is a natural process that can be changed by human activities. In addition to the direct effects of erosion on the soil itself (through soil loss and the resulting losses in productivity and hydrologic and biogeochemical capacity), erosion is an indirect threat to many other resources. Management should seek to avoid, minimize and mitigate human-caused changes to natural erosion processes wherever possible (including restoration of soil and soil processes where possible).

Land disturbing activities/land use: Land-disturbing activities and land uses can be significant stressors on soil resources (including biological soil crusts). The primary effect is through increased erosion (disturbance can remove or alter plant cover or otherwise destabilize soils) and trampling (by people, wildlife, and livestock). The effects of land disturbance/use are generally localized, but can be wide-spread

(e.g., due to livestock grazing, or recreation if not properly managed). It is important to note that the effects of grazing use are known through rangeland health assessments (soil health is one of the Utah Rangeland Health Standards: "Standard 1. Upland soils exhibit permeability and infiltration rates that sustain or improve site productivity, considering the soil type, climate, and landform."), although this does not necessarily mean the condition of the soils is known. Soils can also be affected by the introduction of nutrients and toxins, either through atmospheric deposition (uncontrollable) or the intentional application of toxic chemicals (e.g., for weed control).

Water withdrawals (*NOTE: this refers to removal of water from aquifers and surface waters for various human uses: irrigation, grazing, etc.; not really sense of "withdrawal."*): Water withdrawals have the potential to seriously affect our ability to manage and protect water-dependent resources. As noted above, the Proclamation did not "reserve water as a matter of Federal law," although BLM holds numerous water rights on GSENM, primarily associated with livestock grazing, but also associated with culinary water for the Town of Henrieville, Kodachrome State Park, and the Calf Creek Campground. In the MMP's "Strategy for Assuring Water Availability" (pp. 31-34), it is noted that new water appropriations are still available, which may in the future affect our ability to manage and protect water-dependent resources. Instream flows are not assured, although at the time the MMP was written, it was believed "that both currently and into the reasonably foreseeable future, sufficient water will continue to be available for these purposes" (instream flows assure there is enough water in streams to sustain ecological processes habitat for aquatic plants and animals, hydrologic process such as discharge and recharge, and biogeochemical processes such as nutrient cycling required for the proper management and protection of some Objects and Values). Whether this continues to be the case is unknown, but the subject of study with the USGS (see Section 4, "Science"). We need to fully implement the recommendations of the MMP (Decisions WAT-1, WAT-2 and WAT-3; pp. 31-34) to assure continued viability of water-dependent resources, especially in the face of uncontrolled stressors.

Threats to water quality: Threats to water quality come from various sources, including direct effects from most human uses (e.g., recreation, livestock grazing, ground-disturbing activities), and indirect effects from the consequences of poor management of those uses (e.g., increased erosion). As noted above, as the State of Utah improves their assessments of surface water quality, they continue to add stream segments (or entire watersheds) to the 303(d) list (the Clean Water Act-required report

to U.S. EPA of streams that do not meet designated uses). In FY14 the State of Utah issued a new draft 303(d) list, which added numerous parameters to already listed segments, and some new segments. While most of the causes (where known) are associated with natural processes such as erosion (which affects Total Suspended Solids, TSS or sediment; Total Dissolved Solids, TDS or salts/salinity; and various metals), we can manage so as to reduce erosion and its effects, both by managing to protect plant cover and by restoring erosion (and salinity) control structures. Other watershed-scale restoration projects have been (and should continue to be) developed with water quality improvement as a goal (e.g., the Escalante River restoration projects done with the Escalante River Watershed Partnership; see Section 3, “Year’s Projects and Accomplishments”). Other causes, while unknown, may be associated with water withdrawals (discussed above), e.g., stream segments listed in 2010 for poor benthic macroinvertebrate habitat. Programmatic requirements for water quality monitoring (i.e., those associated with use authorizations, such as livestock grazing water quality is one of the Utah Rangeland Health Standards) should be coordinated with baseline monitoring, and both should be coordinated with the State of Utah Division of Water Quality.

The lack of reliable funding for routine baseline water quality monitoring and other water programs also stresses (limits) our ability to properly manage water.

6 Summary of Performance Measure

The objects, resources, and values identified in the Monument proclamation are generally in good condition, and have remained in good condition since the Monument was established. The values which the Monument was created to conserve, including the opportunity for scientific study, the landscape character, and the diversity of plant and animal communities and individual species found in this region of the Colorado Plateau, are still present and are still drawing scientists, the visiting public, and users from local communities. Many of the scientific objects are geological in nature, and will remain largely unchanged except for the effects of natural erosion. This is also true of paleontological resources and archaeological and historic resources, although natural erosion and a historical practice of unauthorized collecting continue to pose threats to the scientific value of these resources. Many of the biological objects for which the Monument was recognized have yet to receive systematic inventory, however, and GSENM staff cannot accurately characterize trends in their condition. This is true for many of the special biological communities hanging gardens, tinajas, rock crevice, dunal pocket, relict plant communities, and cryptobiotic crusts as well as the Monument's water resources, and will remain an issue until we have been able to conduct baseline inventory and condition assessments. The AIM program, launched in FY13 and continued in FY14, FY15, and FY16, will remedy some of these information gaps; dedicated inventory targeting these resources is still needed.

Resources, Objects, and Values Status Summary Table		
Resource, Object, or Value	Status	Trend
Scientific study	Good	Stable
Vast and austere landscape	Good	Stable
Rugged and remote character	Good	Stable
Unspoiled natural area	Good	Stable
Frontier character	Good	Stable

Resource, Object, or Value	Status	Trend
Long, dignified human history	Good	Stable
Grand Staircase	Good	Stable
White Cliffs	Good	Stable
Vermilion Cliffs	Good	Stable
Kaiparowits Plateau	Good	Stable
Circle Cliffs	Good	Stable
East Kaibab Monocline—The Cockscomb	Good	Stable
Waterpocket Fold (portion on Monument)	Good	Stable
Upper Paria Canyon System	Good	Stable
Upper Escalante Canyons	Good	Stable
Burning Hills coal seams	Good	Stable
Escalante Natural Bridge	Good	Stable
Grosvenor Arch	Good	Stable
Arches and Natural Bridges	Good	Stable
Late Cretaceous fossils	Generally good	Generally stable
Petrified wood – Circle Cliffs	Generally good; some periodic looting at Wolverine Trailhead	Generally stable

Resource, Object, or Value	Status	Trend
Archaeological sites	Generally good; range from "Poor" to "Excellent"	Generally stable, some natural erosion
Historic objects	Generally good	Generally stable
Hanging Gardens Communities	Good, where assessed	Stable
Tinaja Communities	Unassessed	Unknown
Rock Crevice Communities	Unassessed	Unknown
Canyon Bottom Communities	Unassessed	Unknown
Dunal Pocket Communities	Unassessed	Unknown
Endemic plants and pollinators	Mostly unassessed	Unknown
Relict Plant Communities	Unassessed	Unknown
No Man's Mesa Relict Grassland	Poor (not a relict grassland)	Stable to Downward, due to natural succession
Pinyon Juniper Communities	Good	Stable
Mountain lion	Good	Stable
Bear	Good	Stable to increasing
Desert Bighorn Sheep Habitat	Good	Increasing
200 Bird Species	Good	Stable
Bald Eagle	Good	Stable to increasing

Resource, Object, or Value	Status	Trend
Peregrine Falcon	Good	Stable to increasing
Neo tropical birds (Paria and Escalante Rivers)	Good	Stable
Riparian corridors	Most at Proper Functioning Condition, few are Non Functioning	Varied
Cryptobiotic Crusts (biological soil crusts)	Good to poor; mostly unassessed	Unknown
Packrat Middens	Good	Stable
Water sources	Good to poor	Varied
Soils	Good to poor	Unknown
Forestry (Ponderosa Pine)	Good	Stable

Manager's Letter

The 20th Anniversary of Grand Staircase-Escalante National Monument provided an excellent opportunity to reflect on, promote and celebrate the many opportunities and accomplishments seen since this Monument was established on September 18, 1996. The Science Symposium focused on and highlighted Science Research and discoveries over the past 10 years. This Managers Report highlights the opportunities and accomplishments over the past fiscal year. In addition to celebrating the 20th Anniversary of the Monument with events, presentations, publications and a Science Forum, we expanded our public outreach efforts with our Traveling Exhibits program, the Artist-in-Residence Program, and many interpretive events, presentations, talks and programs. We initiated plans for new interpretive exhibits including outside interpretive panels at the Escalante Interagency Center, interior exhibits at the Big Water Visitor Center and a series of Respect and Protect Community exhibits. We focused on managing and protecting resources through improving rangeland health on many allotments, updating range improvements, completing AIM monitoring on additional sites, continued studies on hummingbirds and bats, initiated Greater Sage-Grouse habitat assessments, completed salinity control projects, completed wildlife habitat improvement and monitoring projects and worked on riparian restoration projects and Escalante River Watershed Restoration. We completed improvements at Deer Creek Campground and started work at the Whitehouse campground. We improved facility security and provided authorizations for local businesses and utilities. We advanced research and monitoring of acoustics/soundscapes, Dark Skies and Paleontology, and managed the steadily increasing visitation on the Monument. Progress was made on the Grazing EIS, with the Draft scheduled to be released to the public in 2017. Monument management, staff, volunteers and partners are proud to share highlights of these successes.

The Anniversary also provided an opportunity to look to our roots, the Monument Proclamation, to assess our mandate for management of the Monument, not only for the past 20 years and the past fiscal year, but also for the future management of Grand Staircase-Escalante National Monument. The very first words of the Proclamation identify the Monument's birth in science and the reason for its designation as a Monument: "The GSENM's vast and austere landscape embraces a spectacular array of scientific and historic resources." We are all committed to this vast and austere landscape that embraces a spectacular array of scientific and historic resources. We are all committed to see that this "unspoiled natural area remains a frontier, a quality that greatly enhances the monument's value for scientific

study.” We are all committed to see that the exemplary opportunities for science on the Monument continue and expand. We are all committed to preserve, protect and restore Grand Staircase Escalante National Monument.

Our thanks and appreciation to all of our current and former staff, volunteers, partners, and supporters for all of your hard work and efforts to help manage, restore, protect and promote GSENM, and remain true to the directives in the Proclamation.

A handwritten signature in cursive script that reads "Cynthia Staszak".

Cindy Staszak
Monument Manager



Grand Staircase-Escalante

National Monument

Bureau of Land Management
669 South Highway 89A
Kanab, Utah 84741
Phone: 435-644-1200

December 31, 2016

The mention of company names, trade names, or commercial products does not constitute endorsement or recommendation for use by the federal government.

**UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT**

**COMMERCIAL
STATE WIDE SPECIAL RECREATION PERMIT STIPULATIONS**

Special Recreation Permit Details

Name of Company:

Special Recreation Permit Number:

Pre-trip Itineraries Required:

Deductions or Discounts Applicable:

In addition to the General Terms listed on page two of Form 2930-2, this permit is subject to the following additional stipulations:

BLM Utah Terms and Stipulations

A. General

- 1) Permits issued for more than one year are subject to annual validation. To secure validation the permit holder must:
 - a. have performed satisfactorily under the terms and conditions of this permit and be in conformance with applicable Federal, State, and local laws, ordinances, regulations, orders, postings, and written requirements applicable to the area and operation covered by the permit,
 - b. ensure that all persons operating under the permit have obtained all required Federal, State, and local licenses or registrations,
 - c. have on file, with the office issuing the permit, current insurance that meets or exceeds the BLM's minimum insurance requirements for the event or activity and identifies the United States Department of the Interior – Bureau of Land Management as additional insured, and
 - d. have no outstanding, past due, or unpaid billing notices.
- 2) Permittees may not leave unattended personal property on public lands administered by the Bureau of Land Management for a period of more than 48 hours without written permission of the authorized officer, with the exception that vehicles may be parked in designated parking areas for up to 14 consecutive days. Unattended personal property is subject to disposition under the Federal Property and Administrative Services Act of 1949 as amended.
- 3) The permit only authorizes the use for the activity, the time(s) and in the area(s) specifically described in the approved area(s) of operation section of this permit (page one of Form 2930-2) or on the list of authorized routes or maps attached to the SRP.
- 4) The permittee must maintain on file with the BLM a current and correct list of employees who will be conducting services for the company on public land. Persons providing services under this permit must be an employee of the permittee.

- 5) Placement of caches of supplies and food or equipment for future activities is not allowed without written permission of the authorized officer.
- 6) The permittee and any persons providing services under this permit must present or display a copy of the Special Recreation Permit (Form 2930-2) to an authorized officers-representative, or law enforcement personnel upon request to determine the validity of the permit, ascertain if the group has a copy of the permit and are operating within authorization (locations and activities), check all required equipment, and to orient trip participants about the use of public lands and safety.
- 7) The permittee shall post a copy of the Special Recreation Permit (Form 2930-2) and these special stipulations in prominent view where all participants and public may view them (e.g., at the start of an event, staging area, in a commercial outfitters office or on their website).
- 8) If the permittee wishes to sell or otherwise terminate his or her business and desires that permit privileges be transferred to a new owner, the permittee shall notify the authorized officer in advance, in writing, and receive advance written approval for the permit transfer. Additionally, the permittee shall advise the authorized officer in advance of any action that would result in a change in ownership or controlling business interest.
- 9) When a non-permitted company/group (e.g., booking agent, advertiser) is working with a commercially permitted company to provide a service on public lands, the advertising must reflect this partnership. For example, Company Y is not permitted but they work with Company X who is permitted. Company Y must include 'working in conjunction with Company X, a commercially permitted outfitter on all advertisements.

B. Financial

- 1) All fees associated with commercial use are established by the BLM Director, updated every three years based on the Implicit Price Deflator Index, and published in the Federal Register. Commercial use fees are based on a percentage (3% as of March, 2014) of the adjusted gross revenue derived from use authorized under the Special Recreation Permit. The permittee will pay at least the minimum annual fee (\$105.00 as of March, 2014), plus any commercial use fees due in excess of the minimum fee. Additionally, if more than 50 hours of BLM staff time is required for processing the permit, cost recovery of direct expenses related to the permit will be charged. If the 50-hour cost recovery threshold is anticipated to be exceeded, then recovery of costs begins with the first hour.
- 2) When Special Area fees are applicable, commercial operators must collect the fees from their guests, spectators, or participants, and list the Special Area fee as a separate item assessed by BLM on trip invoices. At the end of each use season, the permittee must include a trip by trip accounting of the number of guests using the Special Areas in their year-end post use report.
- 3) A minimum annual fee or prepayment of estimated use fees is due prior to use occurring. This amount is based on either the amount of fees paid the previous year or an annual revenue estimate agreed to by both the permittee and the authorized officer. For commercial use, periodic payments are allowed if the prepayment amount due exceeds \$1,000.00. At least 25% of the total amount due must be paid prior to use.
- 4) The permittee must submit a post use report (see Appendix A) thirty days after the last use of the permit in a calendar year, or as agreed upon with the field office administering the permit.

Alternative reporting arrangements may be established by written agreement with the authorized officer. An extension of this due date may be approved by the issuing office on a case-by-case basis. All post use reports are due by January 31 of each calendar year unless specified in the permit. The report must contain a trip-by-trip log of: trip location, beginning and ending dates of each trip, number of clients, number of guides, and gross receipts for the trip. In reporting gross receipts, the outfitter will report all payments made by the customer including, but not limited to, activity-related equipment rental, gratuities, donations, and gifts, with the only exceptions being state and local sales tax and retail sales of durable goods that remain the property of the customer and have utility after the activity. The request for deductions based on pre- and post-trip transportation and lodging expenses and percentage of time on public land, if being claimed, must also be submitted at this time. Requests for transportation and lodging deductions must be accompanied by copies of supporting receipts documenting proof of payment.

- 5) The permittee must submit a post use report to the authorized officer for every year the permit is in effect. If the post use report is not received by the established deadline, the following late fee schedule, set by the Utah BLM Director, will be initiated:
 - a. More than 15 calendar days but less than 30 calendar days after the due date: \$125
 - b. More than 30 calendar days after the due date, but less than 45 calendar days: \$250
- 6) Post use reports submitted more than 45 calendar days after the due date may result in criminal, civil, and/or administrative action to protect the interest of the United States.
- 7) The permittee must maintain the following internal accounting records pertaining to the permit for a minimum of three years after the expiration of the permit:
 - a. W-2 records or a similar record of employment for all employees conducting activities under the permit,
 - b. a record of all financial relationships with booking agents or advertisers,
 - c. a record of all receipts or compensation including payments, gratuities, donations, gifts, bartering, etc., received from any source during activities conducted under the permit, and
 - d. a record of all payments made by the permittee and claimed as a deduction in the permittee's fee submission.
 - e. a complete and reconcilable accounting system that includes the following items:
 - i. customer cash receipt deposit ledger or statements. These include the deposit transactions with continuous sum totals.
 - ii. bank statements/ledgers, or the deposit slip ledger receipts

C. Insurance

- 1) Self-insured, Federal, and State Government agencies are not required to list the United States Department of the Interior – Bureau of Land Management as an additional insured. In lieu of insurance, a written statement is required from the comptroller or risk manager that the SRP activity is in fact agency sponsored and the agency accepts liability. If a state or state subdivision, or quasi-governmental agency is not self-insured, all insurance requirements apply.
- 2) At a minimum, the permittee shall have in force a property damage, personal injury, and comprehensive public liability insurance policy that meets or exceeds the BLM's minimum insurance requirements for the event or activity.

General Guidelines for Minimum Insurance Requirements

SRP Event or Activity	Per Occurrence	Per Annual Aggregate
Low Risk: general non-competitive and non-commercial activities such as group camping, group activities, mounted orienteering, backpacking, or dog trials.	\$300,000	\$600,000
Moderate Risk: whitewater boating, horse endurance rides, OHV events, mountain bike races, rock climbing (with ropes), ultra-light outings, rodeos	\$500,000	\$1,000,000
High Risk: bungee jumping, speed record events, unaided rock climbing, aerial or aerial delivery	\$1,000,000	\$2,000,000 - \$10,000,000

- 3) The policy shall state that the insurance company shall have no right of subrogation against the United States of America.
- 4) Such insurance must name the United States Department of the Interior – Bureau of Land Management as an additional insured and provide for specific coverage of the permittee's contractually assumed obligation to indemnify the United States.
- 5) The permit is not valid unless the permittee maintains a current authenticated certificate of the required insurance on file with the office issuing the permit. The insurance need only be valid during periods of actual use (which may include a set-up and break-down period).
- 6) The permittee shall indemnify and hold harmless the United States against any responsibility or liability for damage, death, injury, or loss to persons and property which may occur during the permitted use period or as a result of such use.
- 7) The name of the insured on the insurance policy must be the same as the name on the permit. Those permittees holding insurance policies which only insure the permittee and not the permittee's employees must ensure that their employees also have the required insurance in effect, and that a certificate of insurance is furnished to the authorized officer.

D. Marking of Outfitter Vehicles

- 1) Every street-legal motor vehicle used to transport clients or equipment shall be marked with at least one sign, decal, or placard on each side of the vehicle. The sign shall at a minimum include the company name and must be readable from a distance of 50 feet.

E. Pre-Trip Itinerary

- 1) If required, the permittee will file a notice of intent in writing with the BLM prior to each trip. The notice of intent must specify the intended dates of the trip, number of clients, number of guides, name of the lead guide and area to be visited, including the location of camps. See Special Recreation Permit Details on page one of this document for itinerary requirements for this permit.

F. Environmental and Resource Protection

All activities must conform to *Leave No Trace* principles.

- 1) For all activities and at all base camps with locations served/supported by a motorized vehicle, the permittee must have a toilet system that allows for the proper carry-out and disposal of solid human body waste in a responsible and lawful manner that is adequate for the size of the group and length of the trip. Toilets must be accessible for use by passengers and crew at all sites where a company motorized vehicle is present, except in developed locations where public restrooms are provided. In locations remote from a permittee's vehicle, solid human waste must be cat holed in a sunny location in bare soil or carried out (unless otherwise stipulated). Toilet paper must be carried out and not buried or burned.
- 2) Cans, rubbish, and other trash shall not be discarded, buried, or dumped on public lands or related waters. Wet garbage such as egg shells, orange peels, leftover solid food, bones, melon rinds, etc., must be carried out. Trash cleanup at campsites and day use areas will include all litter or discarded items including small items such as bottle caps, cigarette butts and micro-trash.
- 3) Washing or bathing with soap is not permitted in tributary streams, springs or other natural water sources. Dishwater must be strained prior to dispersal (scattering). Dishwater and bathwater may not be dispersed within 200 feet of streams, springs, or other natural water sources.
- 4) The permittee will be responsible to ensure that historical, archaeological, cultural, or ecological values are not damaged, destroyed, or removed by any participants during authorized activities.
- 5) The permittee must conduct operations authorized by the permit in accordance with applicable BLM management plans and the permittee's own operating plan submitted to the BLM in support of this permit.
- 6) The number of participants on any trip, including guides, may not exceed the number specified in the permittee's operating plan and approved permit. The exception to this requirement is over-the-road bus tours using state and Federal highway and class B county roads.
- 7) No camping is permitted within 300 feet of a known prehistoric or historic site. These resources include, but are not limited to, archaeological sites such as prehistoric camps, quarries, structures, middens, and rock art, and historic sites such as corrals, line cabins, dumps, historic signatures and signature panels, trails, mines and related structures, and historic roads.
- 8) No camping is permitted within 300 feet of a water source other than perennial streams unless prior written permission is received from the authorizing officer.

G. Fires

- 1) This permit does not waive any applicable fire restrictions and orders that may affect the use of camp fires, charcoal or cooking fires. The following stipulations apply unless specifically waived by written permission of the authorized officer:
- 2) At sites accessed by the permittee's motor vehicle(s), the permittee must provide its own fuel wood.

- 3) At sites accessed by the permittee's motor vehicle(s), the permittee must use a fire pan to contain the fires, ash, and charcoal. Charcoal and ash from the fire pan must be hauled out.
- 4) Gathering wood from standing trees, live or dead, is prohibited.
- 5) Use of dead and down wood is permitted only at backcountry sites not accessed by the permittee's motor vehicle(s). In such cases, if a fire pan is not used, burn all wood to ash and naturalize the area before leaving.
- 6) Scatter fuel wood piles and rock lined fire rings before leaving the site.

H. Informed Risk

- 1) The permittee shall inform clients of the inherent risks involved with the activity.
- 2) The permittee shall review potential safety concerns, contingency plans and potential consequences with its clients prior to operations.
- 3) The permittee shall utilize the appropriate and proper equipment and gear for the activity.
- 4) The permittee shall ensure that all persons operating under the authorization are made aware of the physical safety hazards associated with abandoned mine openings and the potential for encountering abandoned mines within the permitted area. The permittee must present or display a copy of the attached *Utah Abandoned Mine Safety: Stay Out and Stay Alive!* brochure in prominent view where all participants and public may view it. To obtain additional copies of the brochure, contact your local BLM office.

I. Safety and Equipment

- 1) The permittee will ensure that activities are conducted in compliance with all laws and regulations relating to vehicle operations, land use restrictions, food handling, and any other applicable regulations.
- 2) Every person serving as a guide on public land must at a minimum be trained and currently certified in Basic First Aid and Cardio-pulmonary Resuscitation (CPR). Each guide must have legible copies of certification cards in his/her possession while operating under a BLM Special Recreation Permit in Utah. In addition, certification cards must be filed at the permittee's headquarters and available for BLM review if requested.
- 3) The following equipment must be carried on all commercial trips:
 - (a) A first aid kit adequate to accommodate each activity, group, or subgroup will be carried on all trips.
 - (b) Adequate repair kits and spare supplies appropriate for the trip and activity.
- 4) The following procedures must be followed during all commercial activities:
 - (a) Unless specifically authorized in the permit, discharge of firearms is allowed only for legal pursuit of game animals by a licensed hunter.
 - (b) Use of explosives and fireworks is prohibited.

SUPPLEMENTAL STIPULATIONS FOR GUIDING HUNTERS

- 1) The permittee must ensure the hunt is conducted in full compliance with State of Utah and Federal wildlife laws and regulations and the rules of fair chase.

SUPPLEMENTAL STIPULATIONS FOR OUTFITTERS USING RIDING OR PACKSTOCK

- 1) Livestock use must be specifically provided for in the permit and operating plan.
- 2) All riding and pack animals must be fed certified weed-free feed for 48 hours in advance of and for the duration of the trip on public lands.
- 3) Riding and pack animals may not be tied for more than one hour to live trees.
- 4) Livestock shall not be tied, hobbled, or picketed for more than one hour within 300 feet of a natural water source other than perennial streams.
- 5) Permittees may not clean out stock trucks or trailers onto public land.
- 6) All animals will be under control en route and in camp to protect wildlife, other livestock, and range forage.
- 7) Corrals located on public lands may not be available for public or permittee use. Prior written permission from the authorized officer is required for the use of such corrals.
- 8) Lost or dead animals shall be reported within 48 hours of end of trip. An appropriate response will be determined by the Authorized Officer.

SUPPLEMENTAL STIPULATIONS FOR PERMITTEES USING OFF HIGHWAY VEHICLES AND MOUNTAIN BIKES

- 1) OHV and mountain bike use must be specifically provided for in the permit and operating plan.
- 2) Only routes specifically approved in the permittee's operating plan may be utilized.
- 3) Permittees must be familiar with and comply with State of Utah OHV laws. All activities and activity participants must follow state regulations and manufacturer's recommendations regarding operations.
- 4) OHV operators must be familiar with and comply with BLM's OHV designations whether posted on the ground or not.
- 5) Permittees must operate in accordance with 43 CFR 8341 concerning OHV use on public lands. To obtain a printed copy of these regulations, contact your local BLM office or visit BLM-Utah's Recreation Permits website at: http://www.blm.gov/ut/st/en/prog/recreation_home/permits.html
- 6) OHV operators must yield to non-motorized users. Mountain bikers must yield to pedestrians and riding or pack animals.
- 7) Operators shall not intentionally chase or harass wildlife.

- 8) The permittee shall be responsible for clean-up and remediation in event of accident or mechanical failure resulting in the spillage of fuels, lubricants, coolants, hydraulic fluids, or other petroleum-based or synthetic organic compounds.

GRAND STAIRCASE – ESCALANTE NATIONAL MONUMENT RESOURCE STIPULATIONS

GENERAL

- 1) For “multi-year” SRPs, two consecutive seasons of nonuse may result in cancellation of the SRP. If a permit is cancelled, the permittee would be required to apply for a new SRP.

RESOURCE PROTECTION

- 1) All SRP operators will use Leave No Trace and TREAD Lightly stewardship practices.

Camping

1. Dispersed primitive camping is not allowed in the Frontcountry and Passage Zones. Camping in the Frontcountry and Passage Zones must be in developed campgrounds or in designated primitive camping areas. Designated primitive camping areas have not been identified in the Monument to date. Therefore, if a permittee intends to camp in areas not designated as primitive camping areas in the Frontcountry and Passage Zones, they must identify these areas in their operating plans.
- 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. All operators are required to use previously disturbed areas. No roadside disturbance is allowed where signed and adjacent to Wilderness Study Areas, endangered plant areas, relict plant areas and riparian areas.
- 3) Camping within 300 feet of an isolated water source, i.e., spring, pond, rock pool, water pocket, is prohibited.
- 4) There is no camping allowed in the Kodachrome Bladder pod restoration area along Rock Spring Bench Road and Paria River. Camping in existing disturbed areas is allowed.

Fire

- 1) Campfires are not allowed in the Escalante and Paria/Hackberry Canyons, No Mans Mesa or other identified relict plant areas, and in archaeological sites, rock shelters and alcoves throughout the Monument.
- 2) Campfires are allowed only where designated fire grates, exist, or by using mandatory fire pans in Frontcountry and Passage Zones. Wood collection for campfires is not allowed in Frontcountry and Passage Zones. Permittee must bring firewood from the immediate area and remove all unused wood from the campsite upon departure.
- 3) Campfires are allowed in Outback and Primitive Zones. Use of fire pans or fire blankets are encouraged and only dead and down wood can be collected or bring your own. Burn wood to

ashes and douse with water, making sure that your fire is DEAD OUT and that the area is restored to a natural condition before leaving.

- 4) When using designated fire grates in the Frontcountry and Passage Zones, burn all wood and coals to ash, put out campfires completely, then leave cool ashes.
- 5) Permittee may be held responsible for fire suppression costs resulting from wildfire caused by the permittee, employees, agents, and/or representatives and by all clients, customers and participants under the permittee's supervision.
- 6) Wildfires should be reported immediately to the nearest BLM office. Permittee is responsible for informing employees, clients, and participants of the current fire danger and required precautions that may be placed in effect by BLM or the State of Utah.

Group Size Limits

- 1) Group size is limited to 25 people in the Passage and Outback Zones including guides. Groups sizes over 12 people must be disclosed in the Letter of Authorization.
- 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, permits could be approved for groups over 12 people up to a maximum of 25 people. Group sizes over 12 people must be provided in writing in the permit.
- 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.

Transportation and Access

- 1) All machinery (street legal motorized vehicles, non-street legal all-terrain vehicles, dirt bikes, mountain 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 and mechanized travel within the Monument must be along open roads listed on the transportation map in the Grand Staircase-Escalante National Monument Management Plan.
- 3) Cross-country motorized or mechanized travel on the Monument is prohibited. All motorized and mechanized (bicycles, skateboards, deer carts, etc.) vehicles must stay on designated open roads while traveling in the Monument.
- 4) Permittee shall not construct new trails or maintain existing trails without written authorization from the Authorized Officer.
- 5) Permittee shall not use paint or flagging or construct cairns to mark trails, unless specifically allowed for in its Annual SRP Authorization.

Sanitation

- 1) Permittee must use a portable self-contained toilet system when operating in an area less than a 300-foot distance from water sources. In many locations of GSENM such as Upper and Lower Calf Creek, the geography makes it impossible to access a cathole location that is 300 feet from water. Carry and use wag bags. All human waste must be packed out and disposed of at a certified disposal site.
- 2) 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 a rock overhang or shelter.
- 3) If necessary, i.e., 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.

Supplemental Stipulations for Permittees Guiding Hunters

- 1) Hunters are prohibited from field dressing game animals within 300 feet of trails and water sources.

Supplemental Stipulations for Permittees Guiding Climbers

- 1) Climbing, bouldering, or any form of canyoneering is not allowed unless specified in the permit. Climbing is not allowed in archaeological sites, on natural bridges or arches, or within identified threatened and endangered species nesting areas.

Supplemental Stipulations for Permittees Using Riding or Packing Animals

- 1) Horses or other pack animals are not allowed in relict plant communities, archaeological sites, rock shelters, or alcoves. Guides and their guests must enter these sites on foot to reduce resource impacts.
- 2) Sheep species are not allowed as pack or companion animals.
- 3) Riding and pack stock are limited to 12 animals in the Primitive Zone.
- 4) Riding and pack stock may not be confined within 200 feet of water sources, camp and trails, or 100 feet of an archaeological site. If it is necessary to keep riding and pack stock confined for an extended period of time, select a site where damage to vegetation is minimized.
- 5) Stock may not travel in streams except when crossing.
- 6) Stock may not travel in the riparian zone of Deer Creek to avoid habitat for the endangered species Ute Ladies Tresses (*Spiranthes diluvialis*). Stock needs to remain on the high trail through Deer Creek canyon.

Archaeological and Historical Site Etiquette

Archaeological and Historical sites are fragile and irreplaceable resources. These resources include, but are not limited to, archaeological sites such as prehistoric camps, quarries, structures, middens, rock art, and historic sites such as corrals, line cabins, dumps, historic signatures and signature panels, trails, mines and related structures, and historic roads. No collection of archaeological or historical materials is allowed except by permit, which are issued only to qualified research institutions. When artifacts are encountered on the surface, they can be examined and gently handled, but must be returned to their exact location. Removal of artifacts from a subsurface context is not allowed as such removal will damage the archaeological or historical site. Do not drive on, or ride livestock across, such sites unless on an existing, Monument-approved road or trail. Do not touch or use tracing techniques at rock sites, as rubbing, pressure, and hand oils permanently damage rock art sites. Enjoy the archaeological or historical site, but assure that the site remains undamaged for future permittees, the general public, and for future research.

Paleontological Resource Etiquette

Paleontological resources are fragile, non-renewable resources. In GSENM they come in five different categories, bone sites, track and trace sites, wood sites, paleo-botanical sites, and invertebrate sites. No collecting of any materials is allowed except by permit, which are only issued to qualified research institutions. The handling of botanical and invertebrate fossils is ok, but these resources should be returned to their original location. The removal of vertebrate fossils from the ground is not allowed as it destroys the context of rare resources. When vertebrate fossils (bones, scales, and teeth) are encountered, enjoy them in place and report their location to Monument staff. Tracks and trace fossil localities such as dinosaur footprint sites can be very fragile and experience high visitation. Avoid standing on or trampling them which can accelerate their erosion. No molding or casting of any sort is allowed on fossil footprints without a permit, issued by the BLM's Utah State Office.

Biological Soil Crust Etiquette

Concentration of recreational use is generally desirable. Use designated or existing campsites to reduce impacts of haphazard placement of rest sites or campsites by individuals. Use existing trails to minimize the amount of biological soil crust that is disrupted by trampling. When possible, use hardened surfaces, such as rocks, or areas with minimal crust potential. When hiking in areas that lack trails, please use washes, walk on rock or in erosional channels to minimize impacts to soil crust.

Wilderness Study Areas Etiquette

GSENM has 16 Wilderness Study Areas (WSA) located in the primitive zone that are managed and monitored to protect their suitability for designation by Congress as wilderness. The Monument's approximately 881,997 acres of lands identified as WSA's are protected for their qualities of naturalness and remain predominantly untouched by human activity. They offer outstanding opportunities for solitude and primitive and unconfined recreation. In addition, nearly all possess at least one or more ecological, geological, scientific or scenic value. BLM is required to provide stewardship of these lands so as not to impair suitability of WSA's until Congress makes a final determination on designation.

Permittee's are responsible for knowing boundaries of primitive zones that include wilderness study areas (WSA) or other special management areas and for complying with legislative and permit conditions that may exist in such areas. Maps and information concerning WSA's are available on the GSENM website and at Monument Visitor Centers.



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Alan L. Titus, Jeffrey G. Eaton, and Joseph Sertich



A Field Guide Prepared For
SOCIETY OF VERTEBRATE PALEONTOLOGY
Annual Meeting, October 26 – 29, 2016
Grand America Hotel
Salt Lake City, Utah, USA



Post-Meeting Field Trip October 30–November 1, 2016

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Cover

View looking west over the Blues from the upper view point along Utah SR 12. The lower 400 m of the Upper Cretaceous Kaiparowits Formation is seen from this view as well as the pink and white cliffs of the Paleocene Eocene Claron Formation.



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Late Cretaceous Stratigraphy and Vertebrate Faunas of the Markagunt, Paunsaugunt, and Kaiparowits Plateaus, Southern Utah

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ABSTRACT

The Late Cretaceous succession of southern Utah was deposited in an active foreland basin circa 100 to 70 million years ago. Thick siliciclastic units represent a variety of marine, coastal, and alluvial plain environments, but are dominantly terrestrial, and also highly fossiliferous. Conditions for vertebrate fossil preservation appear to have optimized in alluvial plain settings more distant from the coast, and so in general the locus of good preservation of diverse assemblages shifts eastward through the Late Cretaceous. The Middle and Late Campanian record of the Paunsaugunt and Kaiparowits Plateau regions is especially good, exhibiting common soft tissue preservation, and comparable with that of the contemporaneous Judith River and Belly River Groups to the north. Collectively the Cenomanian through Campanian strata of southern Utah hold one of the most complete single region terrestrial vertebrate fossil records in the world.

INTRODUCTION

The primary purpose of this field trip is to highlight the Late Cretaceous vertebrate paleontology and stratigraphy of southern Utah. This is a daunting task in three days and at best this can only be an overview of what is easily accessible along the road from Cedar City to Escalante (figure 1). The emphasis of this trip is on the terrestrial faunas and facies (figure 2), although the marine Tropic Shale and its fauna will also be examined. There are many other road logs available that highlight broader aspects of the geology of the region and these include Eaton and others (2001), Biek (2014), Knudsen and Biek (2014), and we have borrowed richly from these. This region has also been recently mapped by Biek and others (2015) and we make constant ref-

erence to that exhaustive study. Vertebrate faunal lists for Cretaceous formations and members, organized by plateau, are presented in the appendix.

Overview of Cretaceous Stratigraphy and Vertebrate Paleontology, Southwestern Utah

Upper Cretaceous strata crop out (figure 2) across an almost continuous 210-km-wide band between the Hurricane fault system (west) and the southeast edge of the Kaiparowits Plateau. Scattered outcrops of Late Cretaceous strata also occur west of the Hurricane fault system around the Pine Valley Mountains, Gunlock Reservoir, and Parowan Gap. All of the rock units in these exposures were deposited within the Western Interior

Citation for this article.

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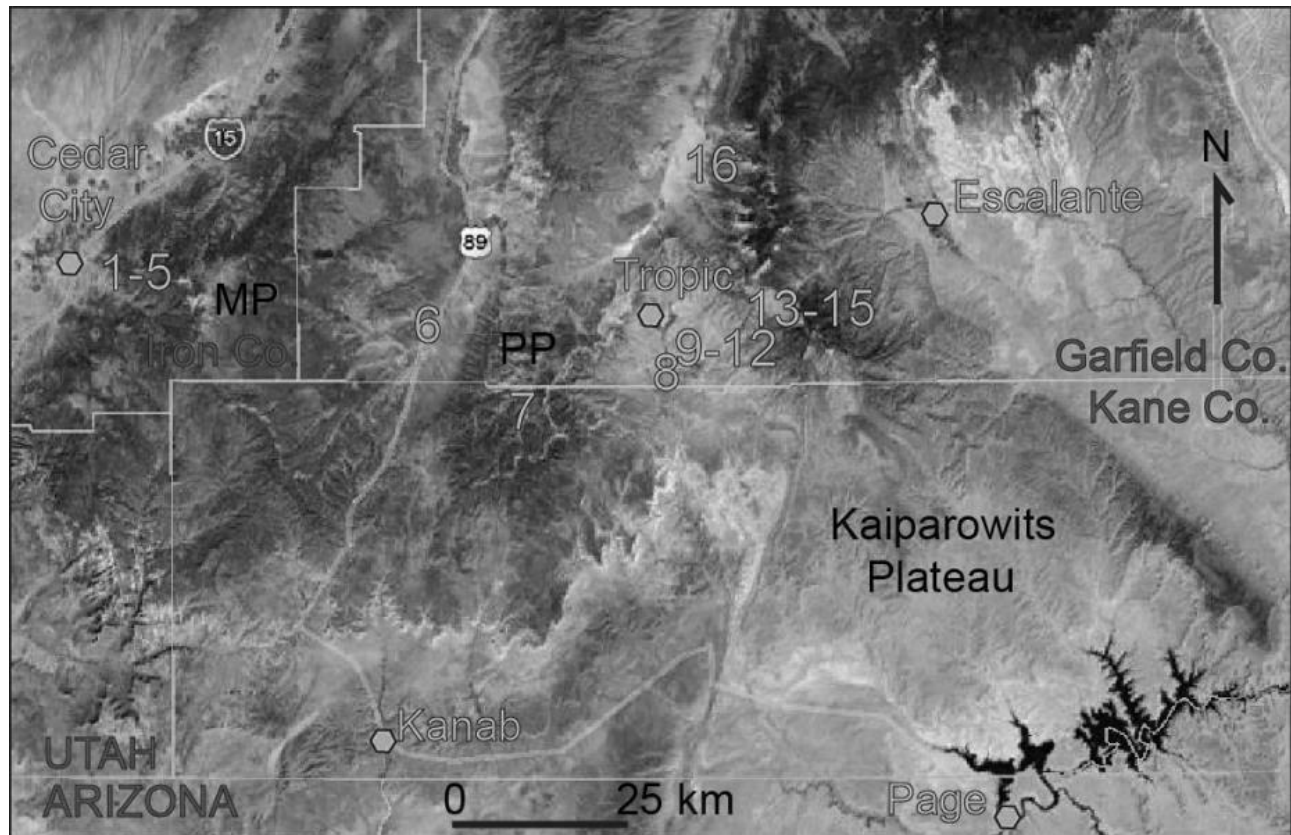


Figure 1. Google Earth image of area covered by this road log. Numbers refer to stops in the road log. MP=Markagunt Plateau, PP=Paunsaugunt Plateau.

basin (figure 3) between late Albian and Maastrichtian time, during the Sevier and early Laramide phases of the North American Cordilleran orogeny (figure 3). As a generalization, the southern Utah Cretaceous section is mostly terrestrial in the western half, and to the east, mixed marine-terrestrial in the lower half and dominantly terrestrial in the upper half (figure 4).

The Cretaceous stratigraphy of the Kaiparowits Plateau, which has become the framework for most of the region, was established by Gregory and Moore (1931), Lawrence (1965), Peterson (1969), and Eaton (1991). The general stratigraphic section is similar throughout the region, but there are some marked facies changes in formations, mostly trending east-west (figure 4).

Paleontological investigations of these outcrops were initiated by the Powell Survey starting in the 1870s. However, during the subsequent 100 years, the region lay largely unnoticed by vertebrate paleontolo-

gists, who were content to work in other, more immediately gratifying, and easily accessed regions. This started to change in the 1970s when crews from the University of Utah and Brigham Young University began prospecting the fossil-rich badlands of the Late Campanian Kaiparowits Formation for vertebrates with good results (Weishampel and Jensen, 1979; DeCourten and Russell, 1985). Soon after, J. Eaton and R. Cifelli began long term collaborative investigations on the microvertebrate faunas of the Kaiparowits Basin (e.g., Cifelli and Eaton, 1987; Cifelli, 1990a, 1990b, 1990c, 1990d; Eaton, 1993a, 1993b, 1995), emphasizing mammalian evolution and biostratigraphy. Eaton and Cifelli were the first researchers to intensively sample the entire Late Cretaceous terrestrial record for vertebrates, and it was their work that led to recognition of the exceptional continuity and quality of the Kaiparowits' vertebrate fossil record. Among other things, the region can claim to yield

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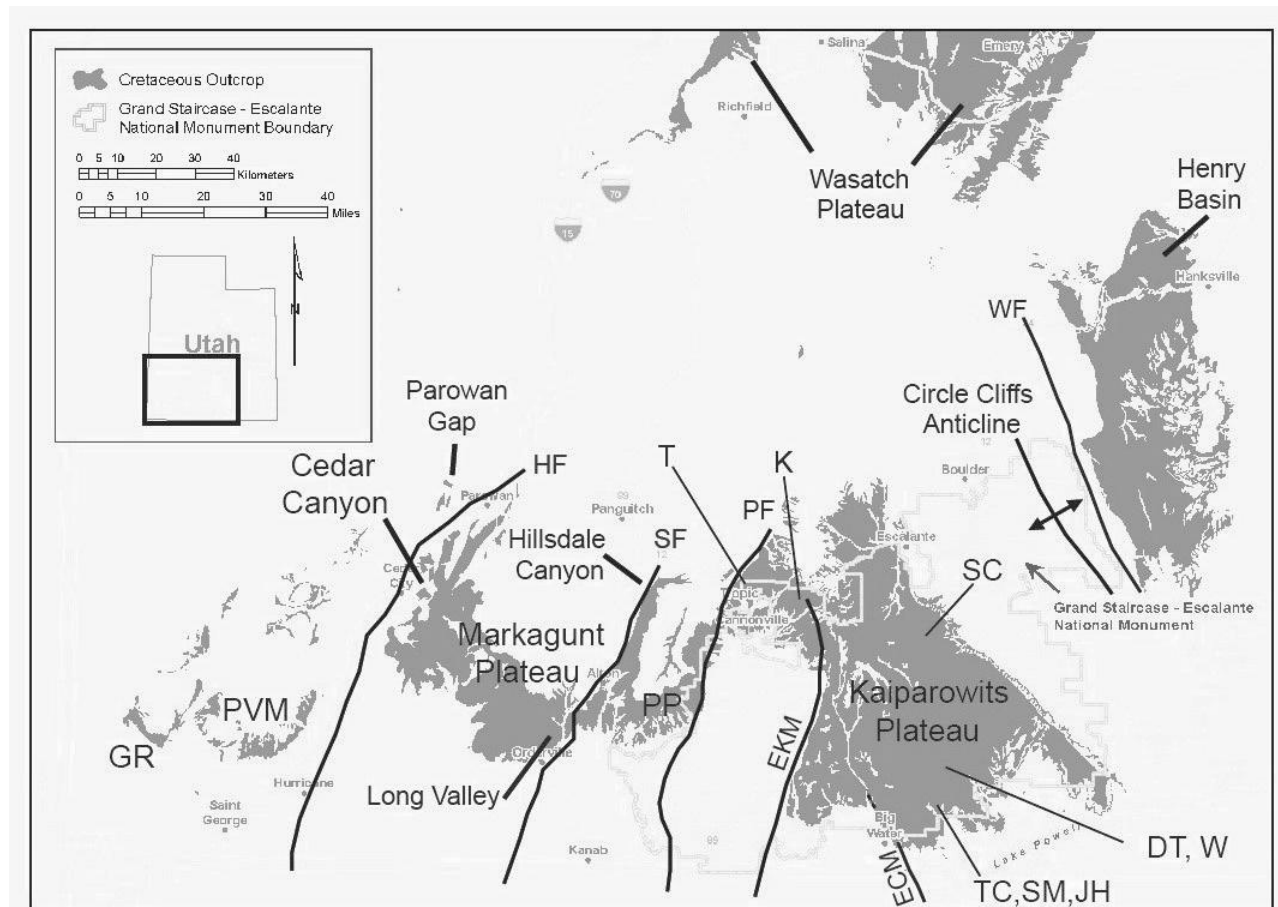


Figure 2. Map showing Cretaceous outcrops in southern Utah. Also shown are major structural features, landforms, location of measured sections, and type sections for the Tropic (T), Straight Cliffs (SC), Wahweap (W), and Kaiparowits (K) Formations and the type sections for the Tibbet Canyon (TC), Smoky Hollow (SH), John Henry (JH), and Drip Tank (DT) Members of the Straight Cliffs Formation. Abbreviations as follows: GR – Gunlock Reservoir; PVM – Pine Valley Mountains; HF – Hurricane fault; SF – Sevier fault; PP – Paunsaugunt Plateau; PF – Paunsaugunt fault; EKM – East Kaibab monocline; ECM – Echo Cliffs monocline; WF – Waterpocket fold. Modified from Titus and others (2013).

diverse terrestrial vertebrate faunas from every stage of the Late Cretaceous except the Maastrichtian. When supplemented by the emerging understanding of the adjacent Paunsaugunt and Markagunt Plateaus, this record becomes truly exceptional, with nearly continuous sampling possible for a 26-million-year time span (ca 100–74 Ma) in facies ranging from shallow marine and coastal plain to alluvial fan (figure 4).

The establishment of Grand Staircase-Escalante National Monument (GSENM) by presidential proclamation on September 18, 1996, led to the need for assessment of condition and significance of all known fossil sites so that a management framework could be

built with the latest and most accurate data. Toward this end, the Monument formed a partnership with the Utah Geological Survey, who initiated field studies in early 1998. One of the results of this work (Foster and others, 2001) was the realization that many areas within GSENM with high potential for fossils had never been adequately surveyed. As a direct result, a key management plan decision was formed that required ongoing annual inventory of geological formations with potential to produce significant fossils (GSENM Management Plan, 2000: PAL-1).

After the Monument Management Plan was put into practice, the Monument-Utah Geological Survey

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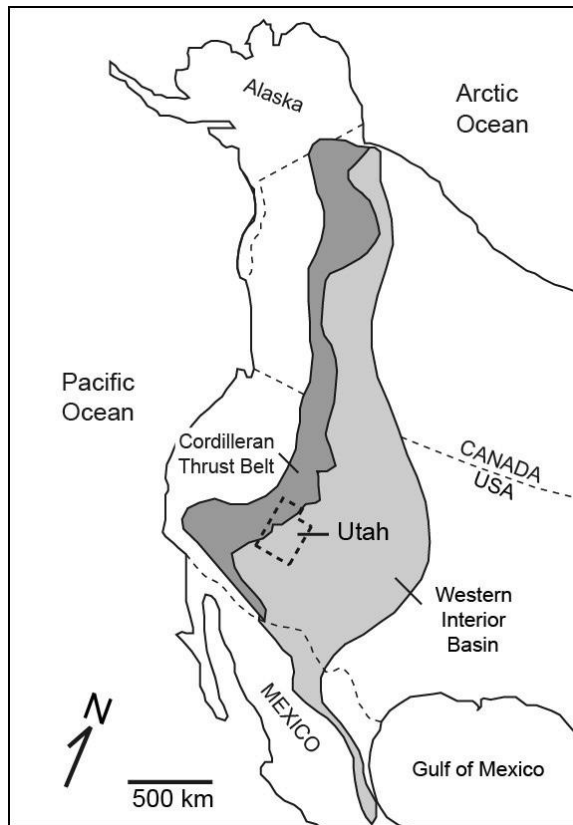


Figure 3. Map showing relationship of the Cordilleran thrust belt (i.e., Sevier fold and thrust belt) with the adjacent Sevier foreland basin or Cretaceous Western Interior basin. From Titus and others (2013).

partnership was expanded to include the Natural History Museum of Utah (NHMU; formerly named the Utah Museum of Natural History [UMNH]) and the Museum of Northern Arizona (MNA) with the intention to intensively survey the Late Cretaceous section of the Kaiparowits Basin region, emphasizing macrovertebrates. A number of articulated or associated specimens of dinosaurs or other macrovertebrates were documented the first year of this effort in 2000. The first new dinosaur taxon named from the Kaiparowits Basin, *Hagryphus giganteus* (Zanno and Sampson, 2005), was based on a partial articulated skeleton of a large oviraptorid collected by the NHMU. Subsequently, 11 other new dinosaur taxa have been named from the Kaiparowits Basin. Intensive recent efforts by the Denver Museum of Nature & Science begun in 2011 have focused largely on the Wahweap and Kaiparowits Formations

underscoring a rare modern model of collaboration between major U.S. institutions (e.g., NHMU, MNA, and others) and GSENM land managers. The marine macrovertebrate record continues to expand as well, with at least five taxa of plesiosaur and a mosasaur (the region's first) discovered and/or published since 1996. Perhaps most importantly, synthesis of the area's outstanding macrofloral record is also underway, which will provide an extremely robust ecological framework within which to place the various vertebrate species. Also occurring in the last 20 years was the expansion of Eaton's original Kaiparowits Plateau work into the Markagunt and Paunsaugunt Plateaus, and the western peripheral outcrops of the Iron Springs Formation (e.g., Eaton, 1999b). The most recent summary of available faunal data for the region's Late Cretaceous succession is found in the 2013 dated Indiana University Press volume "At the Top of the Grand Staircase—The Late Cretaceous of Southern Utah," edited by Titus and Loewen (2013) and much of the appendix is derived from that work.

DAY 1: CRETACEOUS STRATIGRAPHY AND PALEONTOLOGY OF CEDAR CANYON, WESTERN MARKAGUNT PLATEAU

0.0 miles – Set trip odometer to 0 at intersection of State Road (SR) 130 (Main Street) and SR 14 (Center Street), Cedar City.

0.4 miles – Cross the Hurricane fault system. This marks the boundary between the Colorado Plateau to the east and Basin and Range Province to the west. The Lower Triassic Moenkopi Formation is evident here.

0.9 miles – Prominent hogback of the resistant Shinarump Member of the Triassic Chinle Formation.

1.0 miles – Normal fault and lower Chinle strata (purple and gray mudstones) exposed.

1.2 miles – The sequence visible to the north includes the Petrified Forest Member of the Chinle (Upper Triassic), the Dinosaur Canyon Member of the Moenave Formation (Upper Triassic and Lower Jurassic), the Springdale Sandstone Member and main body

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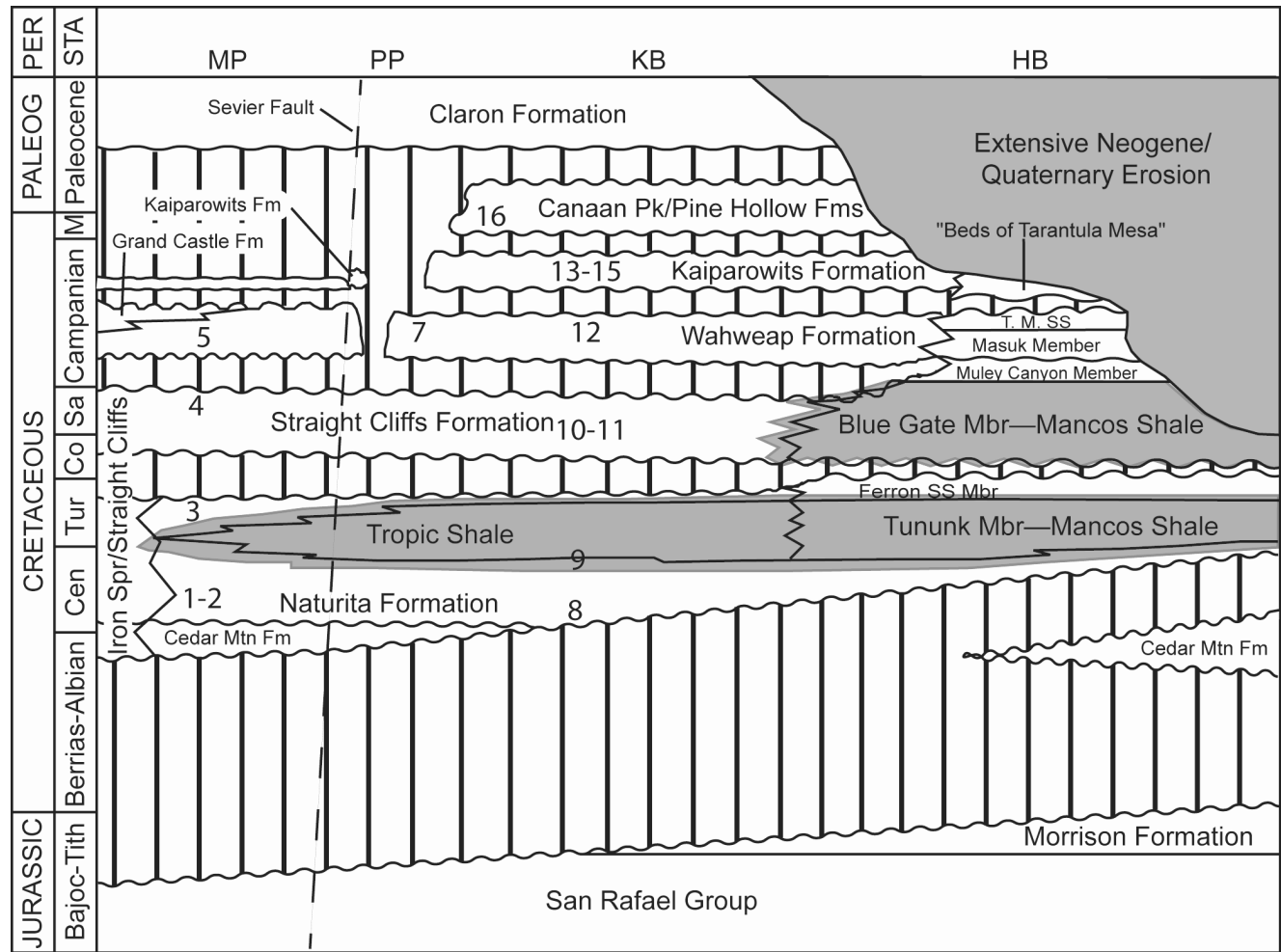


Figure 4. Generalized cross section of Cretaceous rocks covered in this road log showing relative chronostratigraphic relationships and stratigraphic position of field trip stops (numbered). No vertical thickness implied. Blue color indicates marine facies. Abbreviations as follows: PER – Period; PALEOG – Paleogene; STA – Stage; M – Maastrichtian; Sa – Santonian; Co – Coniacian; Tur – Turonian; Cen – Cenomanian; Berrias – Berriasian; Bajoc-Tith – Bajocian to Tithonian; T.M. SS – Tarantula Mesa Sandstone; Upp – Upper; Mid-Middle; MP – Markagunt Plateau; PP – Paunsaugunt Plateau; KP – Kaiparowits Plateau; HB – Henry Mountains basin.

of the Kayenta Formation (Lower Jurassic), and the base of the Navajo Sandstone (Lower Jurassic).

1.8 miles – Contact of the Navajo Sandstone and the overlying Co-op Creek Limestone Member of the Carmel Formation (Middle Jurassic).

2.0 miles – Folded and deformed gypsiferous part of Carmel Formation.

3.4 miles – **STOP 1. CEDAR MOUNTAIN, NATURITA (DAKOTA), AND TROPIC FORMATIONS:** In Cedar Canyon, basal Cretaceous beds rest unconformably (figure 5) on the Middle Jurassic Winsor Member of the Carmel Formation (Biek and others, 2015). Previously, the entire Cretaceous section below the Tropic Shale in Cedar Canyon was referred to the Dakota Formation (e.g., Eaton and others, 1999a). However, recent mapping has referred the basal conglomerate and lower 15 to 20 m of variegated, pastel colored smectitic

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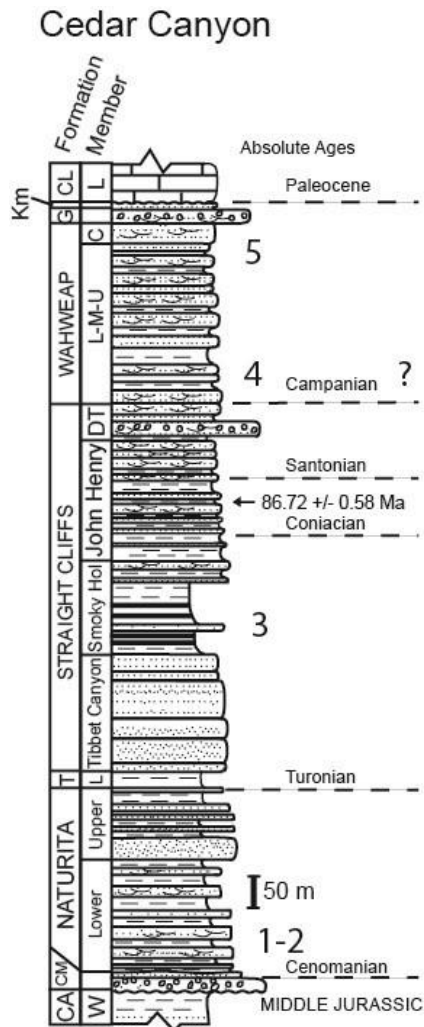


Figure 5. Stratigraphic column for Cretaceous rocks in Cedar Canyon. Numbers correspond with field trip stops in the road log. Abbreviations as follows in ascending order: CA – Carmel; W – Winsor Member; CM – Cedar Mountain; T – Tropic; Smoky Hol – Smoky Hollow; DT – Drip Tank; C – capping sandstone; G – Grand Castle; Km – Cretaceous beds on Markagunt (= lowermost Kaiparowits Formation); CL – Claron; L – Lower; M – Middle; U – Upper.

mudstone (these units are not clearly evident in figure 6), which rests unconformably on the bleached sandstones of the Middle Jurassic Winsor Member of the Carmel Formation, to the Cedar Mountain Formation. The overlying more tan, brown, and gray colored succession is now referred (Kirkland and others, 2016) to the Naturita Formation (figure 6). Dating of the Cedar

Mountain beds in the Markagunt Plateau region has been somewhat problematic; no radiometric ages older than early Cenomanian have been obtained, yet palynomorph data suggests a late Albian age (Biek, 2015). Regardless, this interval largely correlates with the Musentuchit Member of the Cedar Mountain Formation in its type area (Kirkland and others, 2016). The Cedar Mountain is overlain by the middle and upper Cenomanian Naturita Formation (formerly Dakota, [Young, 1960; Carpenter, 2014; Kirkland and others, 2016]) (figures 5 and 6), the lower portion of which is non-marine. The upper portion of the Naturita is paralic and age equivalent to the lower portion of the Tropic Shale in the Kaiparowits Basin. Overall, the Naturita is much thicker in the Markagunt region probably because of higher subsidence rates nearer to the fold and thrust belt. The non-marine part of the Naturita has produced an extensive microvertebrate fauna simply by washing a single road cut (Eaton, 2009, see appendix). Extensive research on the paleontology of the Naturita in this area remains to be done. The marine part of the Naturita Formation in Cedar Canyon has been critical to studies of Milankovitch cycles in the Western Interior Seaway (Laurin and Sageman, 2001, 2007; Tibert and others, 2003) and the Cretaceous anoxic event, OAE 2 (Barclay and others, 2010).

In Cedar Canyon, the Tropic Shale ranges from 0 to 10 m thick. The ammonites *Fagesia catinus* and *Watinoceras* sp. have been found in the formation indicating it is entirely Turonian in age, with the Cenomanian–Turonian boundary occurring essentially just below its base (Eaton and others, 1999a; Tibert and others, 2003). The Tropic fauna by volume consists mostly of inoceramid bivalves and other mollusks. Shark teeth or other vertebrate remains are rather rare and no reptilian fauna has been reported, although turtle remains are found in the underlying paralic portion of the upper Naturita Formation associated with oysters and other brackish water mollusks (Joyce and others, 2016).

5.4 miles – Maple Canyon to the north. Detailed studies of the brackish to marine history of the upper Naturita Formation, the very thin Tropic Shale, and the Tibbet Canyon Member of the Straight Cliffs Formation

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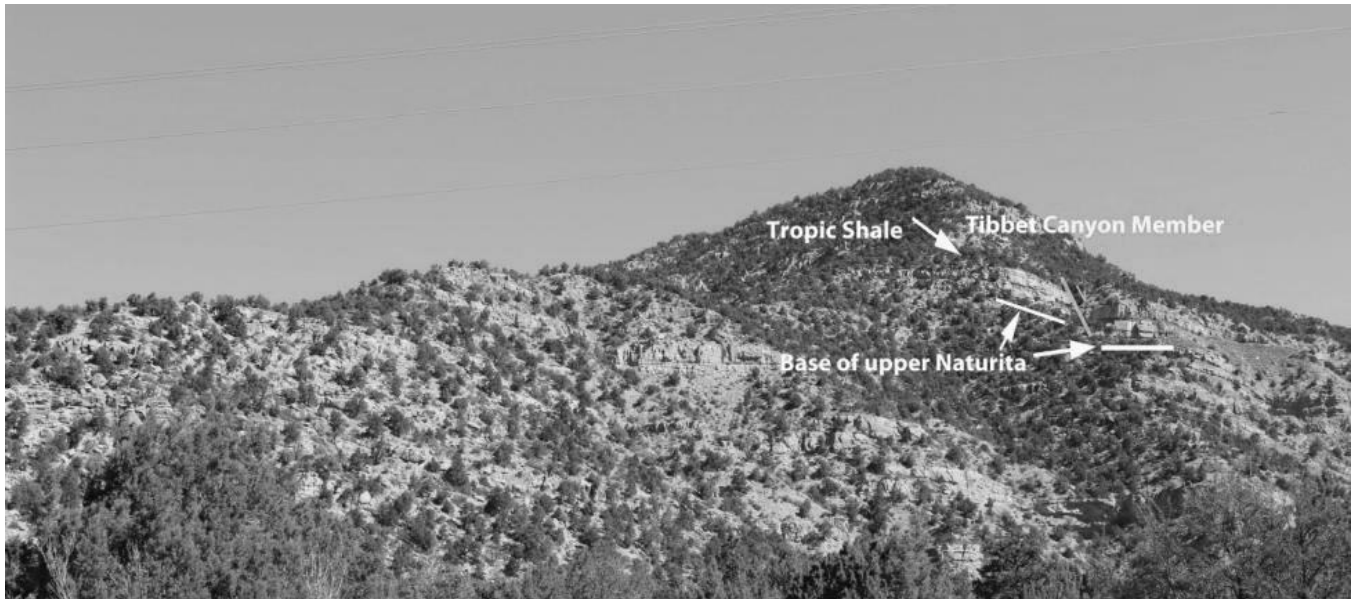


Figure 6. Looking north at Naturita (Dakota) – Tibbet Canyon Member section. Annotated by Jiri Laurin (Institute for Geophysics at the Czech Academy of Sciences).

has been undertaken here by Eaton and others (2001), Laurin and Sagemen (2001, 2007), and Tibert and others (2003).

5.8 miles – **STOP 2. UMNH VP LOCALITY 162:** Outcrops in this road cut have yielded microvertebrates, including mammals (faunal list in appendix; figure 7), through blind washing methods (Eaton, 2009). The mammalian fauna here includes a multituberculate (*Dakotamys malcolmi*) that is identical to the taxon recovered from late Cenomanian UMNH VP locality 27 on Bulldog Bench along the eastern margin of the Paunsaugunt Plateau. However, *Eoalphadon woodburnei* (figure 8) appears distinctly more primitive than species of *Eoalphadon* recovered from UMNH VP locality 27 and may suggest that the Naturita Formation here could be slightly older than the fauna from Bulldog Bench, possibly middle Cenomanian.

6.3 miles – Normal fault brings the Tibbet Canyon Member to the road level.

6.9 miles – After crossing bridge to the right, outcrop exposes Tibbet Canyon Member against coal and

mudstone beds of the Naturita Formation.

8.1 miles – Contact between Tropic Shale and vertical outcrops of the Tibbet Canyon Member of the Straight Cliffs Formation (figure 9) in road cut. The Tropic Shale is overlain by a very thick (190 m) section of late early to middle Turonian Tibbet Canyon. This marine to marginal marine section and contains abundant brackish and marine mollusks (Eaton and others, 2001).

10.2 miles – Contact between the Tibbet Canyon Member and the basal coal beds of what we have identified as Smoky Hollow Member. See discussion in Stop 3 about identification, correlation, and nomenclature of the members of the Straight Cliffs Formation.

10.6 miles (just past milepost 11) – **STOP 3. STRAIGHT CLIFFS FORMATION:** In general, recognizing the standard four members of the Straight Cliffs Formation in the Markagunt region is difficult, as compared to the type sections in the Kaiparowits Plateau (figure 2). As Biek and others (2015) have done the most recent and extensive fieldwork in the region,

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Figure 7. Looking across SR 14 at lower Naturita (Dakota) Formation (UMNH VP locality 162).

we are following their terminology. In general, here the Tibbet Canyon Member, the lower portion of which is age equivalent to the upper portion of the Tropic Shale in the Kaiparowits region, is much thicker, and the John Henry Member in the Markagunt has almost none of the paralic character seen at its type section; more closely resembling the Iron Springs Formation.

At this stop, the base of the Smoky Hollow Member contains common brackish water gastropods described by Hoffman (2005; locality "Jeff's Snail Slope"). Many of these gastropods are identical to those found in the lower Smoky Hollow Member along SR 12 at the east side of the Paunsaugunt Plateau in Bryce Canyon National Park (the Glory Cove fauna). The brackish water invertebrate fauna here is mostly mollusks, but foraminifera and ostracods have been recovered from just above the Tibbet Canyon Member (UMNH VP locality 66) just west of the Southern Utah University (SUU) center. Hoffman (2005) considered the gastropod fauna to be late middle Turonian. At UMNH VP locality 66,

very low in the Smoky Hollow Member, abundant rhinobatoid teeth and other fish teeth have been recovered (Eaton and others, 1999). The Smoky Hollow brackish section here is 54 m thick, much thicker than on the Kaiparowits Plateau indicating that subsidence rates are still higher in the Markagunt Plateau area (Eaton and others, 1999). The remaining upper part of the Smoky Hollow Member (53 m) consists of fluvial channel and floodplain deposits. No fossils have yet been recovered from the upper fluvial sequence.

The John Henry Member here consists of variegated floodplain deposits and meandering river sandstones. In its type area, the Smoky Hollow Member is usually capped by a distinctive thick and laterally continuous conglomerate referred to as the Calico bed. Overlying the Calico is the base of the John Henry. In the Markagunt Plateau, locally there is a sandy discontinuous conglomeratic unit 107 m above the base of the Smoky Hollow that may be an equivalent to the Calico bed. Unfortunately, since it is discontinuous in the Cedar

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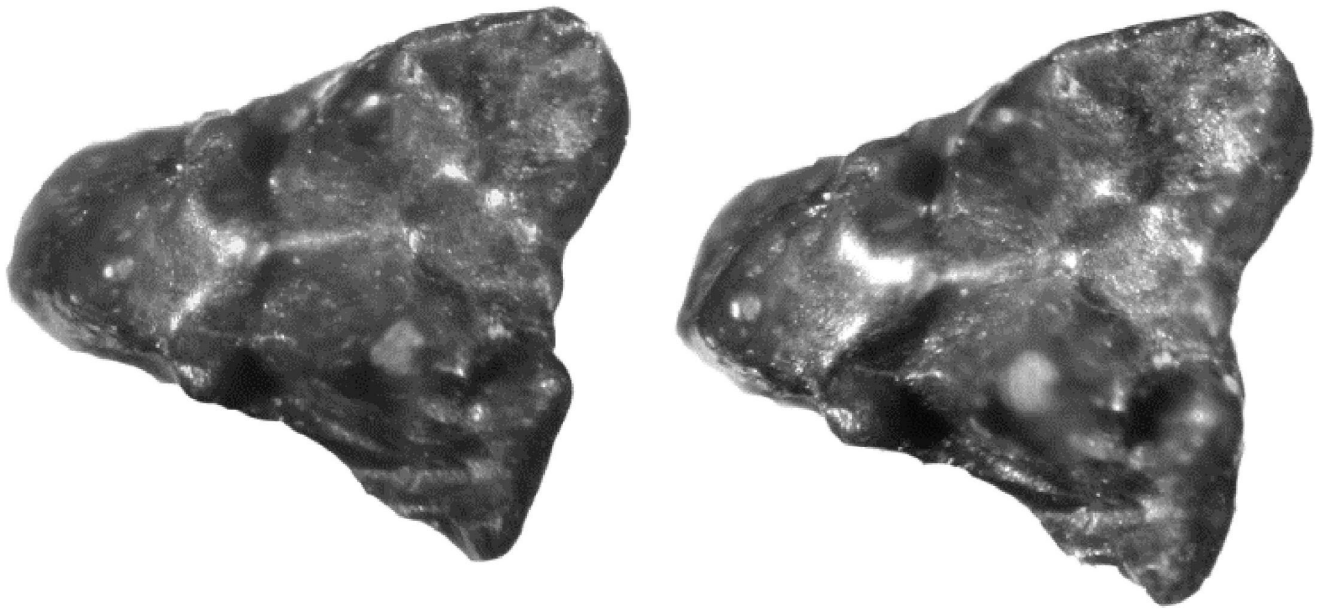


Figure 8. Stereo pair photo of a specimen of the metatherian *Eoalphadon woodburnei* recovered from UMNH VP locality 162. Specimen is approximately 3 mm in horizontal length.

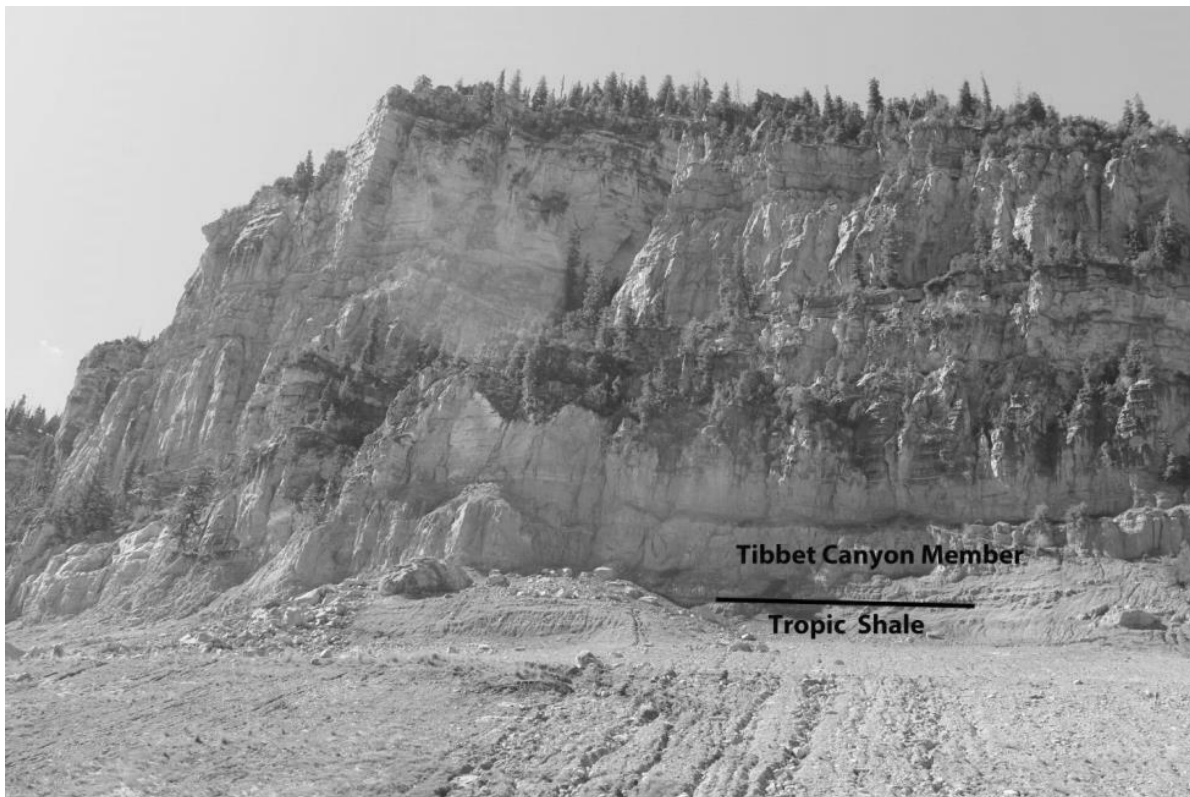


Figure 9. Contact of Tropic Shale and the Tibbet Canyon Member on south side of road in landslide area along SR 14.

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Canyon area, the boundary between the two members can be difficult to recognize.

The road on SUU property across from the center leads to ridges that have much better exposures of the Straight Cliffs Formation than is seen in Cedar Canyon. There, localities provide important age controls on the section, including UMNH VP localities 8 and 9 (vertebrate faunal list in appendix). Well above the base (115 m and 150 m, respectively) of the John Henry Member are two localities, UMNH VP 9 and UMNH VP 8 (Eaton and others, 1999, 2001; Eaton, 2006a). Both of these lie well below a horizon with an $^{40}\text{Ar}/^{39}\text{Ar}$ date, taken on euhedral biotite, of 86.72 ± 0.58 Ma (Eaton and others, 1999) corrected to 87.28 Ma in Albright and Titus (2016), suggesting a Coniacian (or older) age for these localities (see faunal lists in appendix). UMNH VP locality 8 contains abundant freshwater sharks which may represent the Coniacian transgression. These are the only freshwater sharks or rays found in the entire section in Cedar Canyon. No age-diagnostic fossils have yet been recovered above the horizon with the radiometric date and below the Drip Tank Member in which the age of the John Henry Member would presumably be Santonian. UMNH VP locality 9, the stratigraphically lowest vertebrate locality has produced a small fauna that includes marsupial and multituberculate teeth, but the producing horizon has never been located (Eaton, 2006a). UMNH VP locality 8 contains abundant freshwater shark teeth and rare mammalian specimens including the multituberculate *Cedaromys* and fragments of eutherian molars (Eaton, 2006a). Much more work needs to be done on these localities as well as prospecting for additional localities.

The uppermost member of the Straight Cliffs Formation is the Drip Tank Member (Santonian, see Albright and Titus, 2016) on the Kaiparowits Plateau (Peterson, 1969). Moore and Straub (2001) suggested that a conglomerate found 457 m above the top of the Tibbet Canyon Member is the Drip Tank Member. Along SR 14 in Cedar Canyon, this conglomerate is only a few meters thick and Eaton (in Eaton and others, 2001, figure 5) placed a question mark next to the Drip Tank in the stratigraphic column. Biek and others (2015) indicate the same conglomerate is 30 m thick just to the south. Edward Sable (U.S. Geological Survey, written

communication, 1994), Moore and Straub (2001), and Biek (2015) claimed to have traced the unit around the southern margin of the plateau to Long Valley where they correlate it with what was previously referred to as the lower member of the Grand Castle Formation.

10.9 miles – A conglomerate that crops out on the north side of the road (as much as 12 m thick) is thought to possibly represent the Calico bed, but identification/correlation is uncertain because it is not laterally continuous.

12.6 miles – Typical outcrops of John Henry Member equivalent rocks are in the road cuts. Notes these include variegated mudstone and thin sandstone; however, in this area, the section is dominated by mudstone. Macrovertebrate remains are known from the John Henry on the Markagunt Plateau, and a partial, small articulated coelurosaur-grade theropod was recovered from north of Cedar Canyon many years ago. This specimen remains undescribed. If the outcrops were more extensive, it is likely that macrovertebrate remains would be found much more frequently.

12.8 miles – Outcrop of a thin pebbly conglomerate considered to represent the Drip Tank Member (see discussion under STOP 3 above). This conglomerate does appear to be laterally continuous and is thicker elsewhere. Biek and others (2015) consider this sandstone to be equivalent to the lower conglomeratic member of the Grand Castle Formation in Parowan Canyon.

13.0 miles – **STOP 4. LOWER WAHWEAP FORMATION-UMNH VP LOCALITY 10:** Drive a short distance and walk down to UMNH VP locality 10 (figure 10). UMNH VP locality 10 (see faunal list in appendix) is located 21 m above the Drip Tank conglomerate. The site contains some taxa (see appendix) similar to those previously recovered from the Santonian part of the John Henry Member (*Cimolomys* sp.) or the Santonian Milk River Formation of Canada (*Picopsis* sp.) (Eaton, 2006a). One taxon (*Cimolodon similis*) has been recovered both from the Milk River and the Wahweap Formations and two taxa (*Symmetrodontoides* sp. cf. *S. foxi* and *Cimolodon* sp. cf. *C. nitidus*) are almost iden-

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Figure 10. Josep San Juan Girbau (American University, Beirut) at UMNH VP locality 10.

tical to those recovered from the Wahweap Formation (Eaton, 2006a). This suggests a fauna transitional between that of the John Henry Member and the Wahweap Formation. However, based on stratigraphic correlation this locality is most likely late early Campanian. The Wahweap in the type area has thick laterally accreted sandstone bodies and drab organic-rich floodplain mudstone beds (Eaton, 1991). The sequence above the Drip Tank Member in Cedar Canyon is 290 m thick and is dominated by variegated light-colored mudstone and isolated sandstone bodies representing meandering rivers (Eaton and others, 2001); as is much of the section beneath the Drip Tank Member in Cedar Canyon. For this reason (and others discussed below) Eaton and others (2001, figure 5) placed a question mark next to Wahweap in the stratigraphic column. To emphasize the uncertain identification, Eaton has sometimes applied the term “Formation of Cedar Canyon” (e.g., Roček and others, 2013, figure 12.3) for this part of the stratigraphic section. Titus and others (2013, figure 2.7) considered this part of the section to represent the John Henry Member of the Straight Cliffs Formation. The interpretation of Biek and others (2015) for the upper portion of the Cretaceous sections is followed here. ⁴⁰Ar/³⁹Ar dates of 80.6 and 79.9 Ma (Jinnah and others, 2009; Jinnah, 2013) from low in the Wahweap Formation on the Kaiparowits Plateau and paleomagnetic sections from

the formation (Albright and Titus, 2016) indicate that in the Kaiparowits Plateau region there is a significant unconformity between the Drip Tank Member and the overlying Wahweap Formation such that strata of the lower Campanian are missing. If the unit in Cedar Canyon is actually a western equivalent of the Wahweap, perhaps the lower Campanian strata are present in this area. Future research involving radiometric dating and paleomagnetic studies would be most helpful in resolving this issue.

0.0 miles (restart mileage).

1.0 miles – Note fine-grained variegated mudstone beds of the Wahweap Formation, which are essentially indistinguishable from those of the John Henry Member in Cedar Canyon.

1.3 miles – Turnoff to Webster Flats. Here the white sandstone (figure 11) is considered to represent the capping sandstone member (as defined by Eaton, 1991) of the Wahweap Formation used by Pollock (1999) and Lawton and others (2003), but this interpretation is not universal (see discussion below under STOP 5). The sandstone consists largely of reworked Navajo Sandstone. It has not yielded any identifiable vertebrate fossils but does contain the molds of plant material in iron concretions and on bedding planes.

1.4 miles – **STOP 5. UMNH VP LOCALITY 11:** This locality lies at the very top of the Wahweap Formation in Cedar Canyon (267 m above UMNH VP locality 10, Eaton, 2006a). It has a very enigmatic fauna with “pediomyids” similar to those of the Santonian Milk River Formation but also with a taxon (*Meniscoessus* sp. cf. *M. intermedius*) closer to known taxa of the Wahweap Formation or even Judithian faunas. The locality also contains an anuran (*Nezpercius dodsoni*) that has only been recovered in southwestern Utah from the Wahweap (Gardner and Demar, 2013). High in the Cretaceous section above the Wahweap, Nichols (1977) reported the recovery of no palynomorphs younger than Santonian, which supports the interpretation of Titus and others (2013); however, Lawton and others (2003) reported a distinctly middle Campanian paly-

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Figure 11. Capping sandstone member of the Wahweap Formation, Webster's Flat turnoff.

nomorph (*Dyadonapites reticulatus*) from the capping sandstone member at the Webster Flat exposures (see below) and this is the probable age for these beds.

The about 60-m-thick quartz arenite sandstone, exposed at the Webster Flat turnoff from SR 14 (mile 1.3), lies immediately above the variegated floodplain deposits of the Wahweap Formation containing UMNH VP locality 11. This unit has been variously referred to the Kaiparowits(?) Formation (Moore and Straub, 2001), the middle member of the Grand Castle Formation (Goldstrand, 1991, 1992) and the capping sandstone member of the Wahweap Formation (Pollock, 1999; Lawton and others, 2003). Eaton and others (2001) used the noncommittal term "white sandstone" for this sandstone body. We are in agreement with Biek and others (2015) that this unit is indeed the capping sandstone member of the Wahweap Formation.

The complexity of this area of been recently exam-

ined during mapping of the region by Biek and others (2015). This mapping necessarily involved trying to resolve the complex relationship between outcrops in Cedar Canyon and those in Parowan Canyon, which is the next major canyon 20 to 30 km to the north. Parowan Canyon is floored by a Cretaceous sequence of tabular sandstone beds separated by thin mudstone beds previously mapped as Iron Springs Formation (mapping that Eaton still thinks was correct) that has now been mapped as John Henry Member of the Straight Cliffs Formation in Biek and others (2015). Two localities, UMNH VP 6 and VP 64 (Eaton and others, 2001, figure 5) are known from the Iron Springs/John Henry Member of Parowan Canyon, and although UMNH VP 64 was relatively rich in non-mammalian vertebrates none of those specimens have yet been described.

Overlying the Iron Springs/John Henry Member in Parowan Canyon is the Grand Castle Formation of

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Figure 12. UMNH VP locality 11, upper Wahweap Formation below the capping sandstone member.

Goldstrand (1991, 1992) and Goldstrand and Mullett (1997). It rests on a deeply weathered surface on top of the Iron Springs/John Henry Member, enough of an unconformity that Goldstrand (1991, 1992) and Goldstrand and Mullett (1997) suggested a Paleogene age for the Grand Castle. The Grand Castle Formation was originally divided into three members. The middle sandstone member of the Grand Castle was shown to be Cretaceous by the discovery of dinosaur tracks by Hunt and others (2011) and palynomorphs reported by Biek and others (2015). The underlying lower conglomeratic member of the Grand Castle has been correlated in Biek and others (2015) to the Drip Tank Member in Cedar Canyon and assigned to that member. Biek and others (2015) correlated the few tens of meters of the lower middle sandstone member of the Grand Castle Formation in Parowan Canyon 20 km away to the 290 m of the Wahweap Formation underlying the capping sandstone member (figure 12) and the rest of the middle member directly to the capping sandstone member. This represents a remarkable thickening of capping sandstone member (formerly, the middle member of the Grand Castle Formation) from Parowan Canyon to Cedar Canyon, whereas the lower unit thins from 30 to 41 m or less. This geometric problem has not been resolved and much more work needs to be done on the relationships of the Cretaceous sequence in Parowan and Cedar Canyons.

0.0 miles – restart mileage.

0.7 to 0.8 miles – Still traveling in the capping sandstone. Upper portion of this mapped unit here contains poorly exposed pebble and cobble conglomerates that are similar to those observed at the top of the capping sandstone member of the Wahweap Formation in the western Paunsaugunt Plateau (Hillsdale Canyon) and represent distal equivalents of the Grand Castle Formation. The Grand Castle as now defined is about 55 m thick in Parowan Canyon and thins into Cedar Canyon where it is variable in thickness from 0 to 8 m.

1.1 to 1.3 miles – Road cuts are in a unit (as much as 60 m thick) that Biek and others (2015) mapped as “Km” (Cretaceous strata on the Markagunt Plateau). This series of sandstone, mudstone, and siltstone beds overlie the coarse conglomeratic facies at the top of the capping sandstone member of the Wahweap Formation and underlies the base of the Claron Formation (Paleogene). Importantly, this interval contains abundant black chert lithics and minor feldspar, which are virtually absent in the underlying capping sandstone member. Biek and others (2015) state (p. 151) that “the stratigraphic position of the Km unit precludes it being Santonian in age.” We agree even though Nichols (1977) reported Santonian palynomorphs from this same interval. Biek and others (2015) reassessed the palynomorphs from the Km beds and reported late Campanian to Maastrichtian taxa, which agrees better with the current lithostratigraphic correlations. A very similar interval was mapped by Biek and others (2015) above the capping sandstone member of the Wahweap Formation in Hillsdale Canyon on the west side of the Paunsaugunt Plateau as Kwcg (pebbly sandstone unit of the Wahweap above the capping sandstone) and Kkl (lower unit of the Kaiparowits Formation—see Biek and others, 2015; figure 28, in which Kwu Kkl). These are mostly likely facies variations within the lower Kaiparowits depositional system that arise where approaching the thrust belt and expanding the section.

1.4 miles – Basal Claron Formation (Eocene) in road cut.

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3.5 miles – Intersection with SR 148 to Cedar Breaks.

5.7 miles – Cinder cone and basalts of the Markagunt Plateau volcanic field which erupted from latest Pliocene through the Pleistocene and possibly into the Holocene (Johnson and others, 2010).

9.0 miles – Claron Formation to left and Navajo Lake to the right which formed as a result of basalts damming the drainage.

19.2 miles – Claron Formation outcrops which contain abundant trace fossils described in Bown and others (1997).

21.7 miles – Short Canyon turnoff.

22.3 miles – Mile 38 sign post.

22.7 miles – Outcrop to right is the basal Brian Head Formation (late Eocene). This blind wash locality (UMNH VP locality 1085, IP locality 186) has produced rodent teeth, ostracods, ray teeth, and miscellaneous fragments of fish. Initially, this locality was thought to be part of the Claron Formation by Eaton and others (2011) and they reported the mammals and ostracods from this locality to be from the Claron Formation. Subsequent location of a thin pebble conglomerate (the Boat Mesa Conglomerate) below this white unit demonstrates that it is instead part of the Brian Head Formation and not the Claron.

23.0 miles – Claron outcrop in road cut.

23.3 miles – Outcrops of Brian Head Formation (figure 13).

23.4 miles – Claron Formation. The lithology of the Claron in this area is unusual with abundant fine-grained, soft, pastel-colored beds of brown quartzose sandstone, and white carbonate beds. These lithologies are exposed for the next 16 km northward on U.S. Highway 89. The only bone fragments recovered from the Claron Formation anywhere are from these outcrops of brown sandstone.

25.1 miles – Junction SR 14 and US 89, Long Valley Junction. Driving north from the junction, the upper part of the Claron Formation is exposed in the road cuts.

34.5 miles – Driving on top of the Claron Formation, hills above the white carbonate are made of the lower Brian Head Formation.

35.5 miles – **STOP 6. OVERVIEW OF THE PAUNSAUGUNT PLATEAU:** To the east is the western margin of the Paunsaugunt Plateau. The Sevier normal fault exposes the Cretaceous section consisting of the upper Straight Cliffs and Wahweap Formations. Here, the John Henry Member consists dominantly of fluvial sandstone with almost no mudstone. This Cretaceous block is separated from the Claron Formation to the east by another fault, the Sand Pass fault. These faults merge just south of Hillsdale Canyon (major canyon to the north) where overlying the capping sandstone member (figure 14) of the Wahweap Formation, Biek and others (2015) delineated the following succession: Kwgc (pebbly sandstone unit in the Wahweap Formation), Kkl (lower unit of the Kaiparowits Formation), and Kk (typical Kaiparowits Formation). The Hillsdale section is critical for understanding correlations of the upper portion of the Cretaceous section between



Figure 13. Outcrop of the late Eocene Brian Head Formation showing the quarry horizon in 2011.

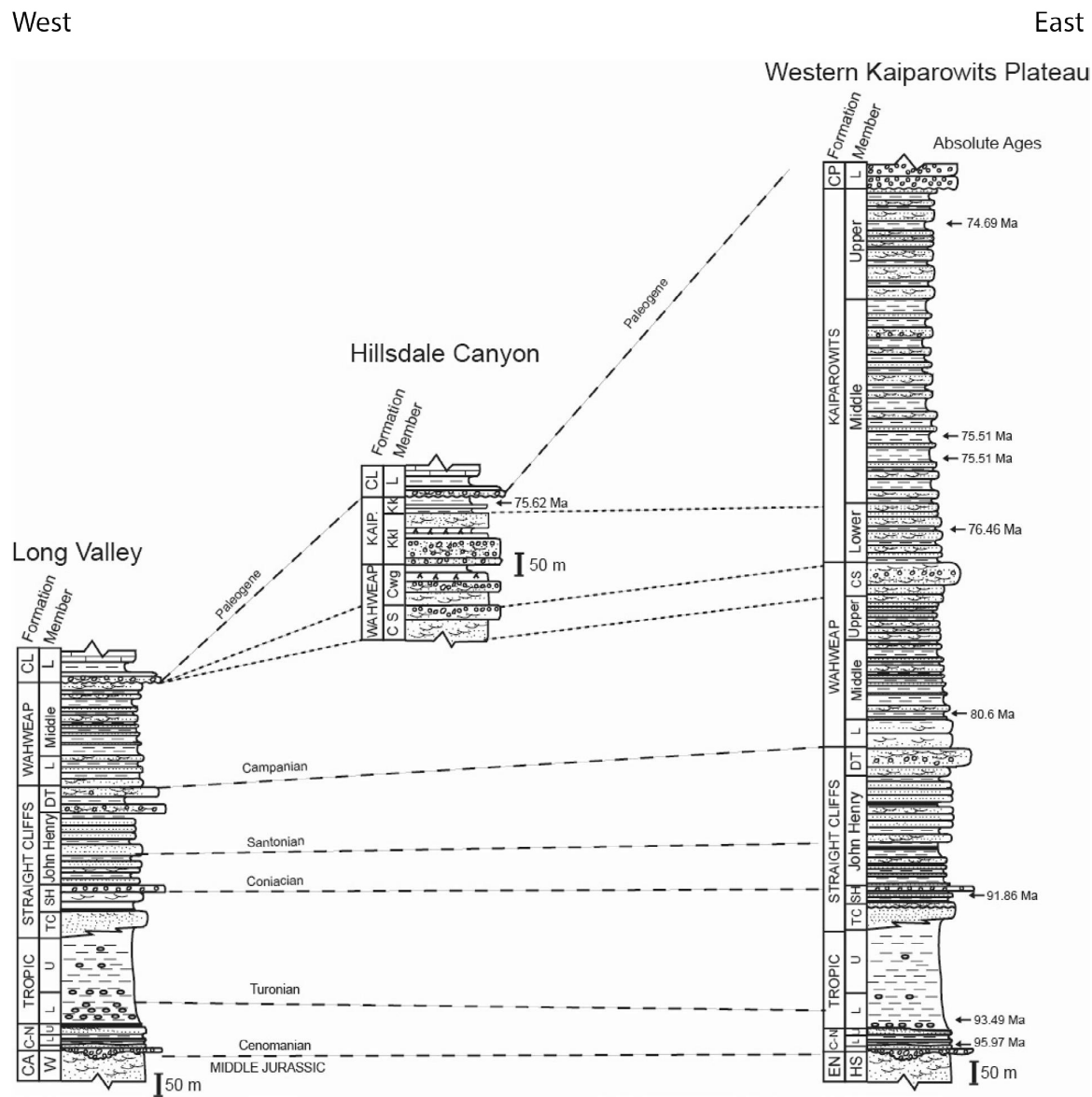


Figure 14. Upper Cretaceous stratigraphic columns for the Paunsaugunt and Kaiparowits plateaus. Abbreviations as follows: CL – Claron; GC – Grand Castle; CA – Carmel; C-N – Cedar Mountain and Naturita; L – Lower; M – Middle; Cwg – pebbly sandstone unit of the Wahweap; Kkl – lower unit of the Kaiparowits; Kk – typical Kaiparowits; DT – Drip Tank; SH – Smoky Hollow; TC – Tibet Canyon; U – Upper; W – Winsor; CP – Canaan Peak; EN – Entrada; CS – capping sandstone; HS – Henrieville Sandstone. See figure 2 for general location of sections.

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the Markagunt and Kaiparowits Plateaus. The capping sandstone member is overlain there by a conglomerate identical in character to that of the upper Grand Castle Formation, which is in turn overlain by sandstones that increase upsection in black chert lithic content, more typical of the Kaiparowits Formation. The overall coarser grain content of what are mapped as Kaiparowits Formation equivalents is largely due to its proximity to the fold and thrust belt.

The lower portion of the section, including the Cedar Mountain, Naturita, Tropic Shale, and lower Straight Cliffs Formations, are well exposed around Glendale and Orderville, farther south. In general, because of the higher altitude and associated plant cover, the outcrops on the Paunsaugunt are not as extensive as they are on the Kaiparowits, but are generally more fossiliferous with vertebrates than their eastern counterparts. Unfortunately, the Kaiparowits Formation was largely removed from the Paunsaugunt (and Markagunt) areas by pre-Claron aged Laramide uplift (figure 14).

The Cedar Mountain and Naturita Formations are exposed only around the southern and eastern margins of the Paunsaugunt Plateau. Exposures of Naturita Formation along the southwest side of the plateau have produced significant microvertebrate material near the town of Alton (MNA 939/UMNH VP 123).

The Tippet Canyon Member of the Straight Cliff Formation is quite thin (20 m) along the southern margin of the plateau (Mill Creek section of Eaton, 1993b). The overlying John Henry Member is 190 m thick (figure 5). Along the south side of the plateau a few vertebrate localities have been found (MNA 1201, 1204); but abundant private land has restricted access to the John Henry Member there. Along the eastern margin of the Paunsaugunt Plateau within Bryce Canyon National Park (BCNP), and just east of the park, the John Henry Member is relatively rich in vertebrate fossils. This includes localities in the basal Coniacian part of the member, which range from fish-rich microvertebrate localities (UMNH VP 823-826, 860-866, 1084, 1276) and macrovertebrate localities containing turtles to dinosaurs. Unfortunately, little work has yet been done on this area, the richest known for Coniacian macrovertebrate and microvertebrate fossils in the entire region. Santonian localities are also abundant (UMNH VP 419,

420, 424, 781, 799, 826, 1144) and particular UMNH VP locality 424 (a “blind wash locality”) in the uppermost part of the John Henry Member in BCNP produced a remarkably rich microvertebrate assemblage described in Eaton (2009), Roček and others (2010), Brinkman and others (2013), and Gardner and Demar (2013). The overlying Drip Tank Member is 50 m thick in the Mill Creek section, but is highly variable in thickness around the plateau and is very thin in Tropic Canyon at the northeast corner of the plateau.

The Wahweap Formation on the Paunsaugunt Plateau has been problematic. Gregory (1951) and Doelling and Davis (1989) thought the youngest Cretaceous strata on the plateau belonged to the Kaiparowits Formation. Bowers (1990) and Tilton (1991) considered the uppermost Cretaceous rocks to represent the Wahweap Formation. Eaton (1993) and Eaton and others (1993) favored the Kaiparowits Formation interpretation based on petrology and comparative faunas. Unquestionable Wahweap is found in the Campbell Creek area along the eastern margin of the plateau south of the town of Tropic. Here, the Wahweap Formation mudstones are drab colored and UMNH VP localities 77 and 82 contain abundant shark and ray teeth; both characteristics are common to the Wahweap Formation on the Kaiparowits Plateau. However, in an erosional window through the Claron Formation on top of the plateau (south of Tropic Reservoir), are exposures of colorful variegated mudstone, which contained no shark or ray teeth, but contains the turtles *Compsemys*, *Neurankylus*, as well as kinosternids, taxa that are more common in the Kaiparowits Formation than in the Wahweap (Eaton, 1993b, 1999a). Although initially favored a Kaiparowits Formation equivalency based on the vertebrate faunas, Eaton ultimately accepted the more parsimonious interpretation of Wahweap Formation (Eaton, 1999a) but suggested marked paleoecologic controls on the vertebrate fauna that reflect the shift from relatively poorly drained coastal floodplains (preserving organics, having abundant sharks and rays) to the east to better drained more upland settings (variegated mudstone, no sharks and rays) to the west.

Biek and others (2015) described a “lower unit” of the Kaiparowits Formation (Kkl) present on the western side of the Paunsaugunt Plateau that thins eastward

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and completely disappears by the East Fork of the Sevier River. They considered this unit to represent the Kaiparowits Formation, even though it is unlike the typical lithologies of that formation. It is also lithologically unlike the underlying capping sandstone of the Wahweap Formation but is somewhat like the basal Kaiparowits Formation found along Henrieville Creek. The only Kaiparowits Formation with lithologies typical of the strata in its type area is a remnant along the west margin of the Paunsaugunt Plateau in Hillsdale Canyon (Biek and others, 2015; see figure 28). Along the eastern margin of the Paunsaugunt Plateau, the Wahweap Formation has been eroded from the tops of Laramide folds such that in places the Claron Formation rests directly on the Straight Cliffs Formation and the entire Wahweap has been removed (Bowers, 1990; Biek and others, 2015).

The type section of the Limerock Canyon Formation is east of this stop (Kurlich and Anderson, 1997). Work by Kevin Rafferty (2015; a student formerly at Weber State University and now at University of Nevada, Las Vegas) has shown that much of the Limerock Canyon (Miocene) is actually Brian Head Formation. Brian Head localities in this area have produced rodent teeth, ostracods, and charophytes.

39.0 miles – Road cut is in the upper Tertiary fan alluvium (Taf) and includes an exposure of the 5.0 Ma Rock Canyon lava flow (Biek and others, 2015).

45.2 miles – Intersection of US 89 and SR 12, turn right onto SR 12. White outcrops at this intersection have been blind washed and produced latest Miocene rodents (William Korth, Rochester Institute of Paleontology, written communication to Eaton, 2016), as well as unaltered gastropods and bivalves (UMNH VP locality VP 1999, IP locality 89).

47.8 miles – Sevier fault.

48.0 miles – Red Canyon; note conglomerate on the left side of the road in the Claron Formation. Conglomerate becomes more common to the northwest.

53.5 miles – Town of Tropic, Utah, and the type sec-

tion for the Cretaceous marine Tropic Shale.

End of Day 1.

DAY 2: CRETACEOUS STRATIGRAPHY AND PALEONTOLOGY OF THE PAUNSAUGUNT AND KAIPAROWITS PLATEAUS

0.0 miles – Tropic, Utah, at the intersection of 200 North and SR 12. Proceed west on SR 12.

3.5 miles – Paunsaugunt fault. Gray beds of the John Henry Member of the Straight Cliffs Formation faulted against the lower red member of the Claron Formation. This normal fault has the same general orientation as the Sevier fault on the west side of the Paunsaugunt Plateau.

7.4 miles – Intersection with SR 63 to Bryce Canyon National Park. On the eastern flank of the park there are extensive exposures of the John Henry Member of the Straight Cliffs Formation and the Wahweap Formation. Eaton conducted a five year (2006-2010) inventory of fossil resources within the park. Both the John Henry Member and the Wahweap Formation are more fossiliferous there than on the Kaiparowits Plateau and hundreds of localities were identified. Only a few localities were intensively worked because of the lack of access. Bulk mudstone samples taken to process for microvertebrates had to be back-packed out of the park, often requiring 3 hours of hiking per sack of matrix in the middle of summer. One of the most significant localities is UMNH VP locality 424 (figure 15) which is almost at the top of the John Henry Member and is the richest microvertebrate site yet known from that member (see appendix for a complete listing of taxa).

10.3 miles – Turnoff to Tropic Reservoir. Make a left turn and proceed south.

17.3 miles – Tropic Reservoir. Continue south. From about this point south, outcrops in the lower portions of the valley are of the middle Campanian Wahweap Formation overlain unconformably by the Claron Formation.

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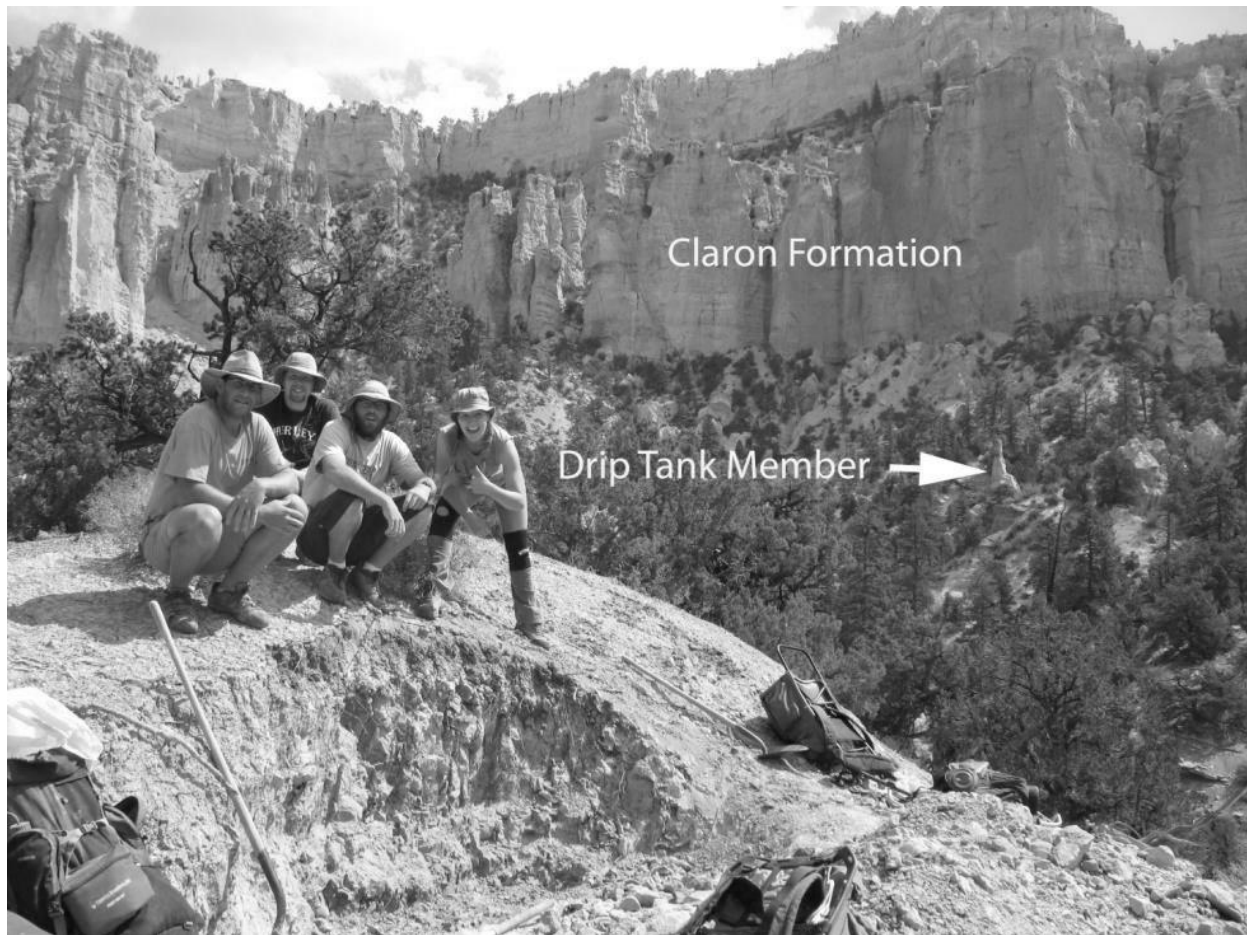


Figure 15. UMNH VP Locality 424 (Santonian), near the top of the John Henry Member of the Straight Cliffs Formation. Note the Drip Tank Member just above the locality. Here the Claron Formation rests unconformably on the Drip Tank Member due to erosion across the Laramide aged Bryce Canyon anticline.

21.6 miles – **STOP 7. WAHWEAP FORMATION ON THE PAUNSAUGUNT PLATEAU – MILL CREEK AREA** (UMNH VP locality 83/MNA locality 1073): The Wahweap Formation on the Paunsaugunt Plateau is exposed in a window eroded through the Claron Formation by the East Fork of the Sevier River and its tributaries. This stop, UMNH VP locality 83/MNA locality 1073, in the Mill Creek area, is one of the most easily accessed of all the highly fossiliferous localities (figure 16). The obvious interpretation of these strata, based on their stratigraphic position, would be the Wahweap Formation, but aspects of the lithology and fossil content were questioned (Eaton, 1993b; Eaton and others,

1993). The Wahweap Formation on the Kaiparowits Plateau (type area) consists of rather drab organic-rich floodplain mudstones and siltstones and laterally aggrading channel sandstone. Eaton and others (1993) noted that the sandstone high in the Wahweap section on the Paunsaugunt Plateau were petrologically more similar to the Kaiparowits Formation than to sandstone of the Wahweap Formation. Biek and others (2015) have now mapped these sandstone beds as the lower Kaiparowits Formation (Kkl). The Wahweap mudstone exposed here also differ markedly from those of the type area as they are variegated and very fossiliferous.

Sampling the Wahweap Formation on the Kaiparowits Plateau for microvertebrate fossils commonly

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Figure 16. Typical variegated fossiliferous mudstone of the Wahweap Formation along Mill Creek at UMNH VP locality 83/MNA locality 1073.

produces shark and ray teeth as well as crab claws, with other taxa much less common. On the Paunsaugunt Plateau recovered fossils (see appendix) include taxa that are common in the Kaiparowits Formation but rare or unknown from the Wahweap Formation of the Kaiparowits Plateau. The Paunsaugunt Wahweap strata also lack ray and shark teeth or crab claws indicating a fundamental environmental shift between the two regions, most likely a more upland, better drained environment with less coastal influence. The mammalian fauna (Eaton, 1993b) also initially did not compare well to that of the Wahweap Formation on the Kaiparowits Plateau. For these reasons Eaton (1993b) and Eaton and others (1993) kept open the possibility that these strata might represent the Kaiparowits Formation or possibly another unit. However, subsequent study of the fauna (Eaton, 2013), aided by systematic revisions by other workers, showed a reasonably good correlation with the fauna of the Wahweap Formation to the east. The difference in the overall vertebrate fauna seems to reflect a shift from relatively poorly drained coastal floodplains to better drained more upland floodplains.

Return to Tropic and reset trip meter.

0.0 miles – Intersection of 200 N with SR 12. Proceed east.

1.6 miles – Road cut exposes upper marine portion of the Naturita Formation and lowermost beds of the Tropic Shale.

4.7 miles – Entering Cannonville.

4.8 miles – Turn right (south) onto the Cottonwood Canyon Road to Kodachrome Basin State Park.

4.9 miles – **STOP 8. OVERVIEW OF NATURITA FORMATION, PAUNSAUGUNT-KAIPAROWITS TRANSITION:** To the west of the Cannonville town park and Grand Staircase-Escalante National Monument visitor center parking lots, the red- and white-banded Cannonville Member of the Entrada is in view and overlain by the Naturita Formation cutting out much of

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the intervening bleached looking Henrieville Sandstone (figure 17). The Henrieville Sandstone as described by Thompson and Stokes (1970) is somewhat controversial as a map unit and has been synonymized with the upper portion of the Entrada Sandstone by some workers (Bowers, 1983; Biek and others, 2015). Resolution of this issue awaits more detailed lithologic study of all the potentially correlative units. For this guide, we retain these beds in the Henrieville Sandstone. The Cedar Mountain Formation is locally absent, being discontinuous over much of the Kaiparowits Plateau. Thin, gravelly facies at the bottom of the Naturita in this region are probably reworked Cedar Mountain sediments. Here, on Bulldog Bench, the nonmarine lower unit of the Naturita Formation is unusually fossiliferous with vertebrates, including mesovertebrate remains such as turtles and crocodylians. Although many localities have been discovered, only one has been extensively screen washed (figure 18) – MNA 1067/UMNH VP locality 27. This remarkable locality has produced mammalian jaws, including early marsupials, but also large lungfish plates, and material of frogs and lizards (see appendix). The mesovertebrate fossil content of the Naturita appears to be highest trending between Bulldog Bench and the

southwestern margin of the Kaiparowits Plateau, where turtle and crocodylian remains are similarly abundant. The Naturita in the Kaiparowits region contains abundant coal and carbonaceous beds. Macrovertebrate skeletal remains are virtually unknown although dinosaur trackways and teeth recovered from microsites indicate the region was inhabited by larger animals.

Return to SR 12.

5.0 miles – Turn right (east) onto SR 12.

9.7 miles – Outcrops of the Middle Jurassic Henrieville Sandstone (overlying Entrada Sandstone) overlain by the lower and upper members of the Naturita Formation visible to the west of SR 12 (figure 19).

11.2 miles – **STOP 9. OVERVIEW OF KAIPAROWITS PLATEAU STRATIGRAPHY, THE NATURITA FORMATION, AND THE TROPIC SHALE:** From SR 12, hike approximately 0.16 km) due south to the Naturita-Tropic contact. The basic Cretaceous stratigraphy of the Kaiparowits Plateau (figure 20) was established by Gregory and Moore (1931), Lawrence (1965), Peter-

Figure 17. Henrieville Sandstone (Jurassic)–Naturita (Cretaceous) Formation contact on Bulldog Bench. The lower nonmarine Naturita Formation is much thicker here than anywhere else in the Kaiparowits-Paunsaugunt Plateaus region.



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Figure 18. MNA 1067/UMNH VP locality 27 quarry in the Naturita (Dakota) Formation on Bulldog Bench. This appears to be an overbank deposit immediately adjacent to a meandering river levee. Large material is found along the levee and fines rapidly away from the levee. There are clearly several flood events separated by organic mats.

son (1969), and Eaton (1991). The Upper Cretaceous section is approximately 2600 m thick and fairly similar throughout the region, but there are some marked facies changes in formations, mostly trending east-west. As a rule, exposures are much better for all of the units in this region than they are in either the Paunsaugunt or Markagunt Plateaus. The oldest unit mapped is the Cedar Mountain Formation, which in the Kaiparowits region is mostly limited to the pebbly conglomerate facies. The smectitic gray mudstone facies is absent. In the Kaiparowits Basin, the overlying Naturita Formation is relatively thin, averaging only 30 to 35 m in thickness. As it overlies the basal Cretaceous unconformity and in turn is overlain by the marine Tropic Shale, it represents a variety of terrestrial and nearshore marine environments, in a generally retrogradational sequence. With the exception of shark and fish remains, vertebrate fossils are largely confined to the lower member, occurring in floodplain, channel, and crevasse splay facies. Large mesovertbrate and macrovertbrate remains are generally uncommon and usually occur as isolated elements, but 0.3-m-diameter turtle shells can be locally abundant in lacustrine and channel facies, particularly

in the southwestern portion of the Kaiparowits Basin. The Bulldog Bench area near Tropic (Stop 8) is one of the only places where larger vertebrates besides turtles have been found in any quantity. Dinosaur trackways also occur sparingly in the middle unit (Titus and others, 2013).

The overlying Tropic Shale is as much as 300 m thick (Doelling and Davis, 1989), entirely marine in origin, and spans late Cenomanian to middle Turonian time. The formation is dominantly gray-weathering mudstone, but calcisiltites and calcarenites also occur throughout the formation. The lower half of the Tropic is more carbonate rich, whereas the upper half is more siliciclastic. Fossils, mostly invertebrates are common throughout, but vertebrate remains are only locally common. Non-fish vertebrates are uncommon to rare, but long-term collecting has revealed a highly diverse assemblage that will be discussed in more detail below.

The overlying Straight Cliffs Formation is a highly heterogeneous unit that probably exhibits the most lateral variation of any formation in the Kaiparowits Basin. Spanning much of the later Turonian, as well as the entire Coniacian and Santonian, it also represents the longest time span (~ 10 Ma) of any Cretaceous formation in the region except for the related Iron Springs Formation. In general, marine and marginal-marine facies dominate the eastern outcrops, with shoreface, beach complex, estuarine, and deltaic beds interleaved with coastal mire and distributary fluvial units (Allen and Johnson, 2010), whereas western outcrops are composed mostly of meandering fluvial and floodplain deposits. The unit was deposited during the end of the Greenhorn and throughout the entire Niobrara cyclothems (middle Turonian to late Santonian age). In the Kaiparowits Basin the Straight Cliffs locally produces abundant microvertebrate remains. However, macro and mesovertbrate sites are actually somewhat rare. The highest densities of such sites occur in the southwest portion of the Kaiparowits Plateau where alluvial-plain facies dominate. There multiple sites yielding dinosaur material, including a multi-individual ornithomimid bonebed have been found, but not in the same quantities as observed on the Paunsaugunt Plateau. Dinosaur trackways are locally known, particularly in coal seams, but bone is quite rare in the eastern half of the

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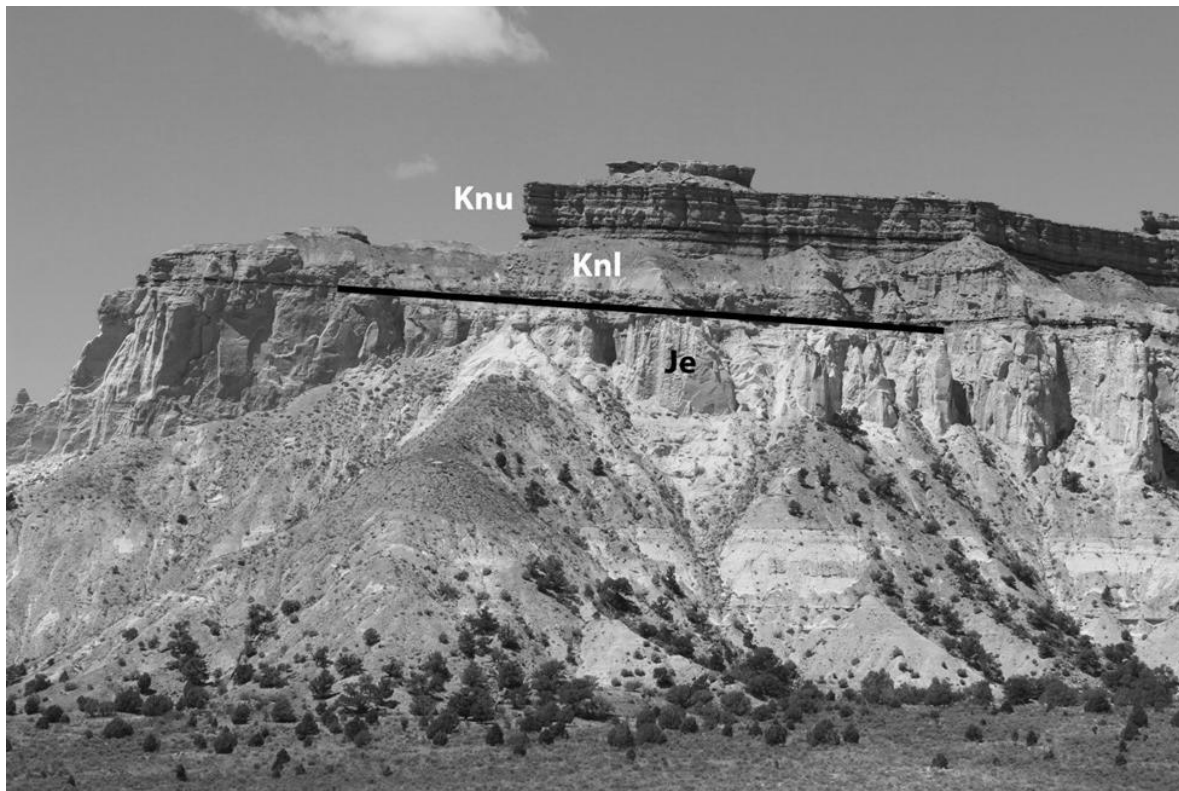


Figure 19. Henrieville Sandstone (Je) in contact with the Naturita (Knl, Knu) Formation. There is very little lower nonmarine Naturita even though this outcrop is only about 16 km from Bulldog Bench.

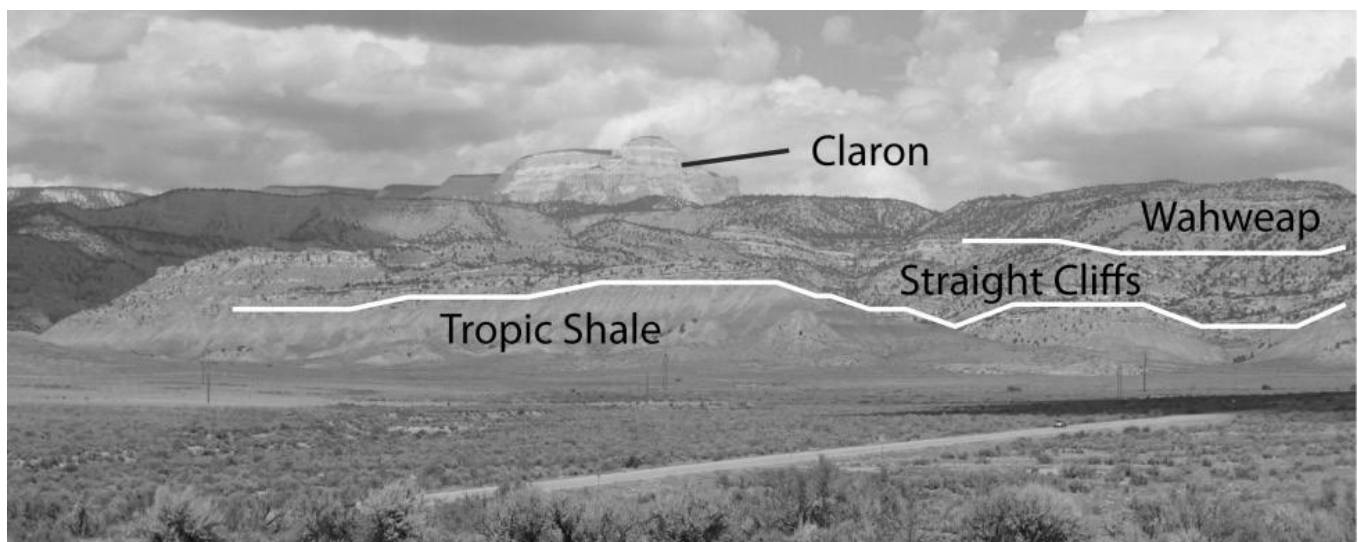


Figure 20. Kaiparowits Plateau stratigraphy visible from Stop 9. The Kaiparowits Formation is not visible, but widely exposed behind the ridge formed in the Wahweap Formation. The highest outcrops of white-colored Eocene age Claron Formation are at Powell Point, at the very south end of the Table Cliffs Plateau. See figure 23 for wide view.

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plateau, leading to the conclusion that either the depositional rates or soil conditions were unfavorable to preservation of large bone.

The seaway withdrew at the end of the Niobrara cycle never to inundate southern Utah again. As a result, the overlying Wahweap and Kaiparowits Formations are entirely terrestrial in origin and fairly homogeneous, although not without marine influence on their deposition and occasional brackish water incursions (e.g., Roberts and others, 2008).

The marine portion of the upper Naturita at this stop consists of alternating (cyclic) mudstone and sandstone deposited in a shallow, near-shore muddy shelf setting during the early Greenhorn cyclothem event. Mollusk assemblages alternate between oyster epiboles and more diverse assemblages reflecting fluctuating sea levels. A thin coal bed just below the top of the formation marks a lowstand associated with the top of the *Metoicoceras mosbyense* biozone. The biostratigraphically useful inocerimid bivalve *Inoceramus fragilis* occurs near the base of the member, whereas ammonites of the *Dunveganoceras problematicum* and *Metoicoceras mosbyense* biozones occur in the middle and top of the unit, respectively. Collectively, the marine invertebrate record indicates the upper member is entirely late Cenomanian, spanning much of that substage. Vertebrates are not common, and consist mostly of isolated elements of brackish and marine chondrichthyans and osteichthyans.

The overlying Tropic Shale (figure 21) was deposited in an open water, offshore muddy shelf setting. At peak transgression, the shoreline was over 115 km to the west. The Tropic Shale is mostly gray mudstone and contains abundant invertebrate and vertebrate fossil fauna. Ammonites in the formation indicate it spans the *Vascoceras diartianum* through *Prionocyclus hyatti* ammonite biozones (middle late Cenomanian to middle middle Turonian). The nearshore position of the Tropic Shale depocenter in a regime of relatively high accommodation space make the Cenomanian-Turonian stratigraphic record in the region especially thick and complete (Elder and others, 1994). In particular, the events surrounding ocean anoxic event II (OAE II) and the associated extinction are recorded in great detail (Elder, 1991). Most of the large vertebrate fossils are

found in the early Turonian, although rare specimens are known from the underlying Cenomanian (Gillette and others, 1999). An overview of the vertebrate fauna was given by Albright and others (2013) and the described fauna is summarized in the appendix. Chondrichthyan and osteichthyan remains including fully articulated specimens occur commonly in the Tropic, but no detailed studies have ever been published. Over the last 16 years a diverse and significant marine reptile fauna has been recovered from the unit. Plesiosaur remains are most common, but turtles, early mosasaurs, and rare dinosaur remains have also been found. Five taxa of plesiosaurs (one pliosaurid and four polycotylids) are now documented from the formation (figure 22), making the assemblage one of the most diverse known from any Greenhorn age deposits. Three significant trends/events in vertebrate evolution appear to be recorded in the Tropic: (1) the extinction of the archaic pliosaurid plesiosaurs, (2) the diversification of the polycotylid plesiosaurs, and (3) the rise of true mosasaurs in North America.

11.6 miles – View north towards Jimmy Canyon is of the open marine Tropic Shale and the shoreface facies of the Tibbet Canyon Member forming the cliff, which holds up the benches. Resting on the benches is the paludal Smoky Hollow Member (Turonian). On the bench directly to the north (figure 23) is the richest Smoky Hollow Member micro-site known, MNA 995/UMNH VP locality 129. This very productive site is difficult to recover large quantities of matrix from (figure 24). In 1991, a small helicopter made several trips to move 86 moderately sized sacks of matrix from the bench to the valley floor. This locality has provided much of the basis for the faunal list presented in the appendix.

13.0 miles – Turnoff to Henderson Canyon (figure 25). The lower John Henry Member contains coals (figure 26), is very organic rich, and produces a brackish-water fauna of both vertebrates and invertebrates (e.g., MNA 706-2/UMNH VP locality 98). The upper part of the John Henry Member in Henderson Canyon is less organic rich (figure 27) and includes UMNH VP locality 99 (Santonian), a very productive microvertebrate locality from which much of the vertebrate faunal

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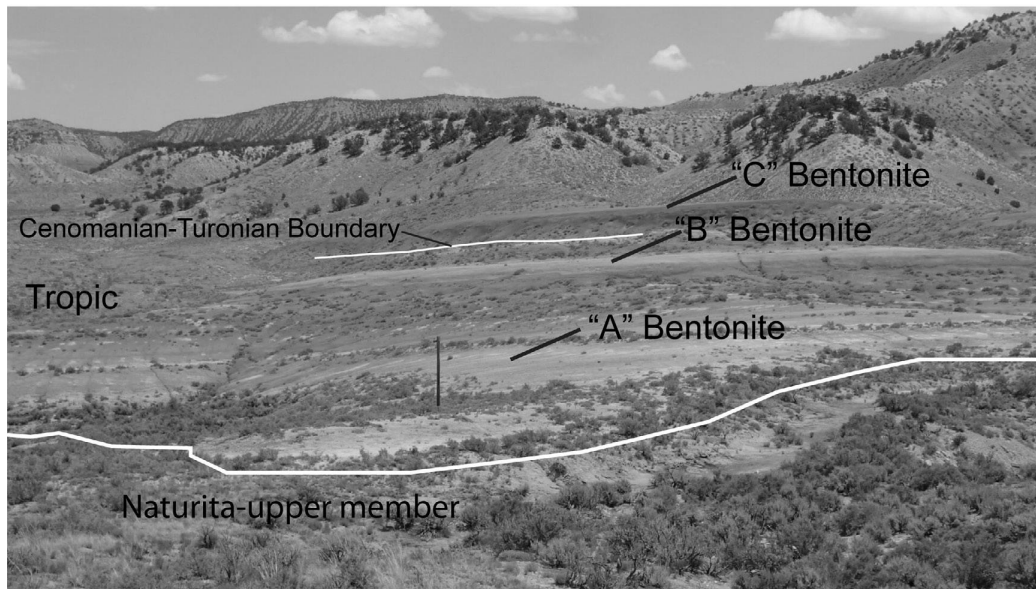


Figure 21. Overview of the Tropic Shale at Stop 9. Lettered bentonites are key marker beds (of Elder, 1991) that can be traced throughout the southern Western Interior, including the Cenomanian-Turonian Boundary Global Stratotype Section and Point near Pueblo, Colorado.

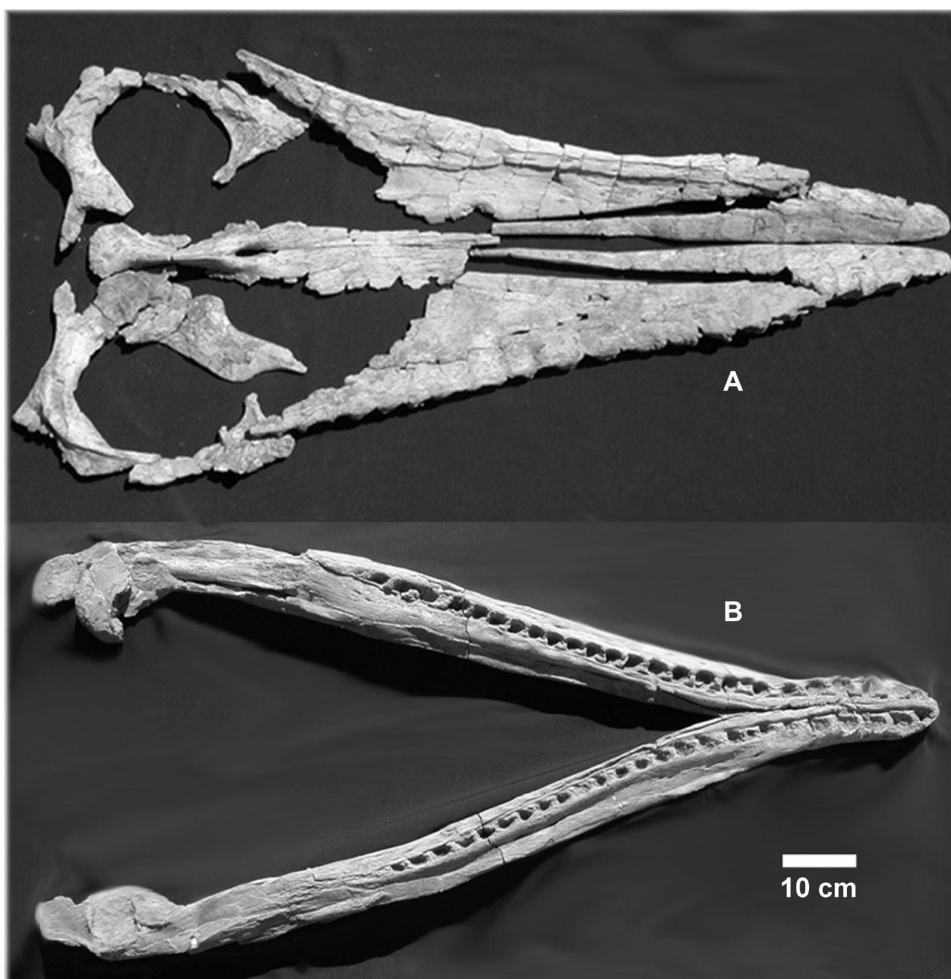


Figure 22. MNA V9433, (A) Dorsal view of nearly complete cranium, and (B) dorsal view of complete mandible of the pliosaurid plesiosaur *Brachauchenius lucasi*. From Albright and others (2013).

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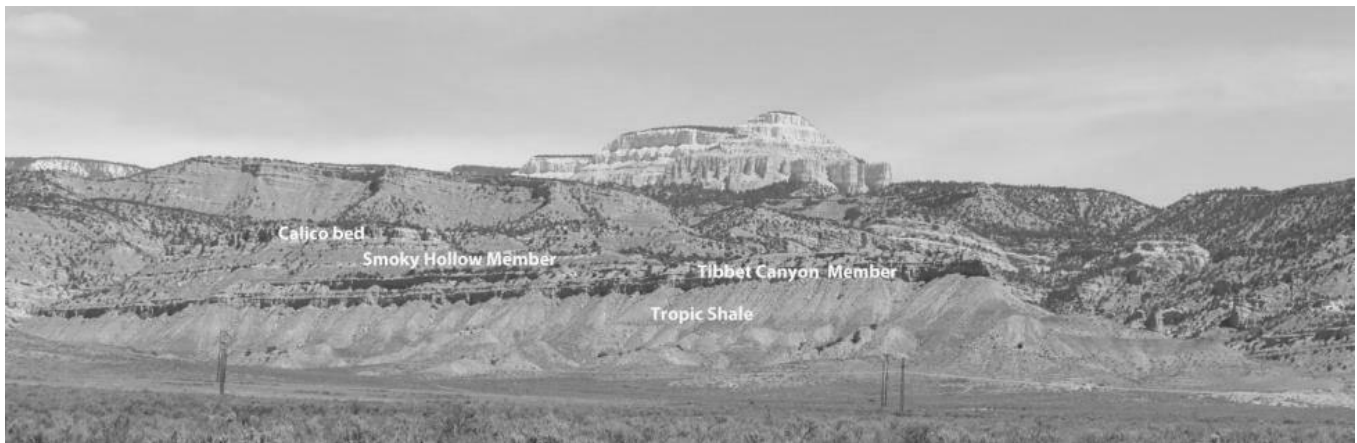


Figure 23. Looking northeast at bench with MNA 995/UMNH VP locality 129 in the Smoky Hollow Member of the Straight Cliffs Formation.



Figure 24. The late Jared Morrow at MNA 995/UMNH VP locality 129 quarry, Smoky Hollow Member of the Straight Cliffs Formation, Turonian.

list in the appendix is derived.

14.2 miles – **STOP 10. SMOKY HOLLOW AND JOHN HENRY MEMBERS OF THE STRAIGHT CLIFFS FORMATION:** The Tibbet Canyon Member is overlain by the early late Turonian Smoky Hollow Member, which has coal and lignite low in the member (figure 28). It also contains brackish-water faunas. The upper part of the member consists of beds of fluvial

deposition. The Smoky Hollow Member is capped by fluvial sandstone and conglomerate termed the Calico bed by Peterson (1969). The John Henry Member is upper Coniacian-Santonian and rests disconformably upon the Calico bed (figure 29). As with the underlying Smoky Hollow Member, the lower part of the John Henry Member is very carbonaceous and contains brackish-water faunas (listed in appendix). The upper part of the formation here is largely nonmarine; how-

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Figure 25. View of the looking north up Henderson Canyon from the SR 12 turnoff of the Tropic Shale and overlying members of the Straight Cliffs Formation.



Figure 26. Typical coal and sandstone interbeds in the lower John Henry Member in Henderson Canyon.

ever, thin sandstone tongues containing marine taxa are present in the unit. Along the eastern margin of the plateau (type section for the Straight Cliffs Formation) the John Henry Member is mostly nearshore to marine.

14.8 miles –**STOP 11. UPPER JOHN HENRY AND DRIP TANK MEMBERS, STRAIGHT CLIFFS–WAHWEAP FORMATIONS:** On the north side of the canyon, the prominent cliff-forming Drip Tank Member of the Straight Cliffs Formation (Santonian) is unconformably overlain by the less resistant ledge-forming sandstone and mudstone of the lower member of the Wahweap Formation (figure 30). The Drip Tank Member in the Kaiparowits Basin is locally fossiliferous with vertebrate material, including dinosaur bone, but owing to the high-energy nature of its depositional system, most of the material is fragmentary and non-diagnostic.

The overlying alternating sandstones and mudstones of the Wahweap Formation are well exposed in this area (figure 30), but the formation generally forms steep slopes making it difficult to prospect for fossils. In the Kaiparowits region, most of the identifiable macrovertebrate remains have been collected from along the Smoky Mountain road and the southern margin of the plateau. The unit is also more paralic in character here than in the Paunsaugunt region, commonly containing carbonaceous beds indicative of paludal environments.

The majority of the macrofauna of the Wahweap Formation is now well constrained as older than the oldest described assemblages of the Judith River and Foremost Formations (Albright and Titus, 2016), and it includes the oldest named North American representatives of the Tyrannosauridae (*Lythronax*), Lambeosaurinae (*Adelolophus*), Centrosaurinae (*Diabloceratops*), and Pachycephalosauridae dinosaur clades. At least two different species of large alligato-

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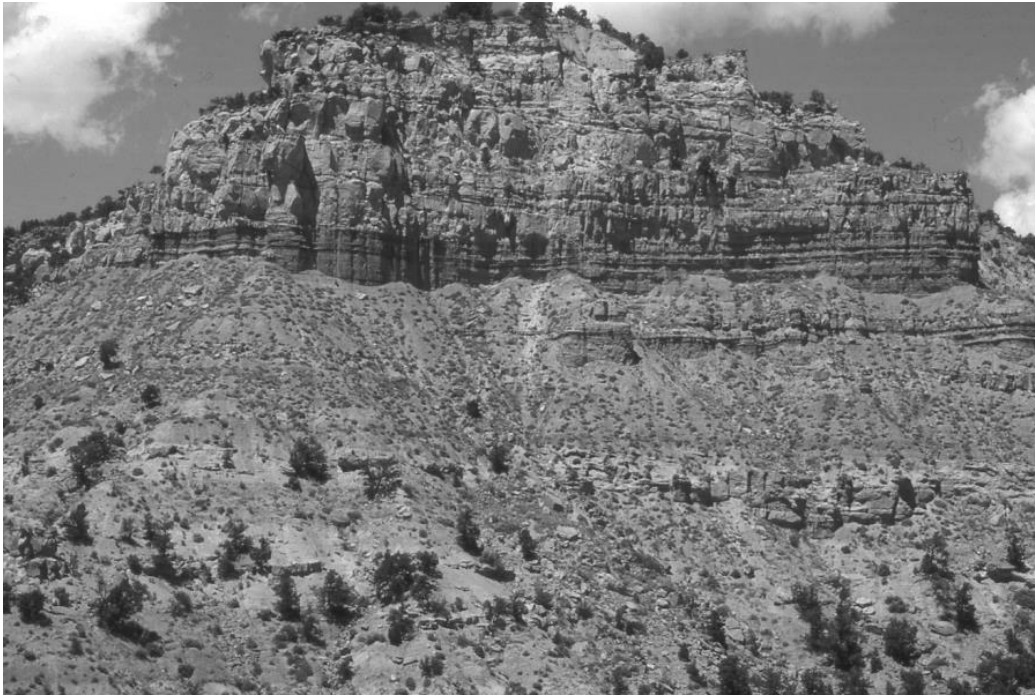


Figure 27. Upper part of the John Henry Member in Henderson Canyon. Note channel complex at the top of the member. UMNH VP locality 99 is in the underlying fine-grained part of the section.

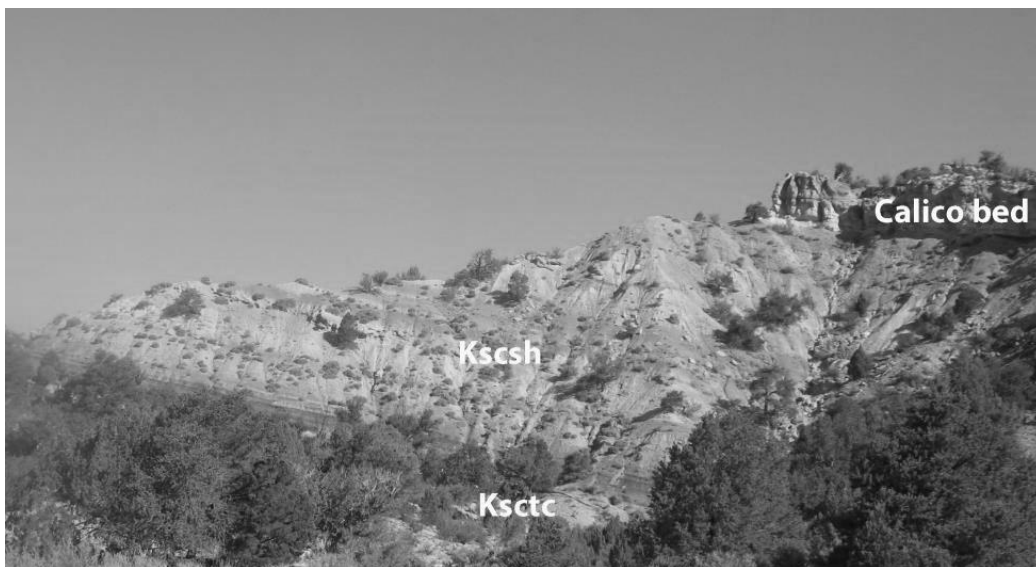


Figure 28. The Smoky Hollow Member (Kscsh) overlies the nearshore deposits of the Tippet Canyon Member (Ksctc); note the carbonaceous horizons low in the Smoky Hollow Member. The Smoky Hollow is capped by the sandstones and conglomerates of the Calico bed.

roids and a pholidosaur-like crocodylian have also been recovered, but await description. Cranial material of a nodosaurid ankylosaur was also recovered recently but is also awaiting description. Based on the hadrosaurs (Gates and others, 2014) and ceratopsids, the early middle Campanian Wahweap dinosaur assemblage has

some similarity to the slightly younger Foremost and Oldman assemblages found in Alberta, Canada.

16.4 miles – **STOP 12. CAPPING SANDSTONE MEMBER AND LOWER KAIPAROWITS FORMATION:** In this vertical cliff face exposed along Henriev-

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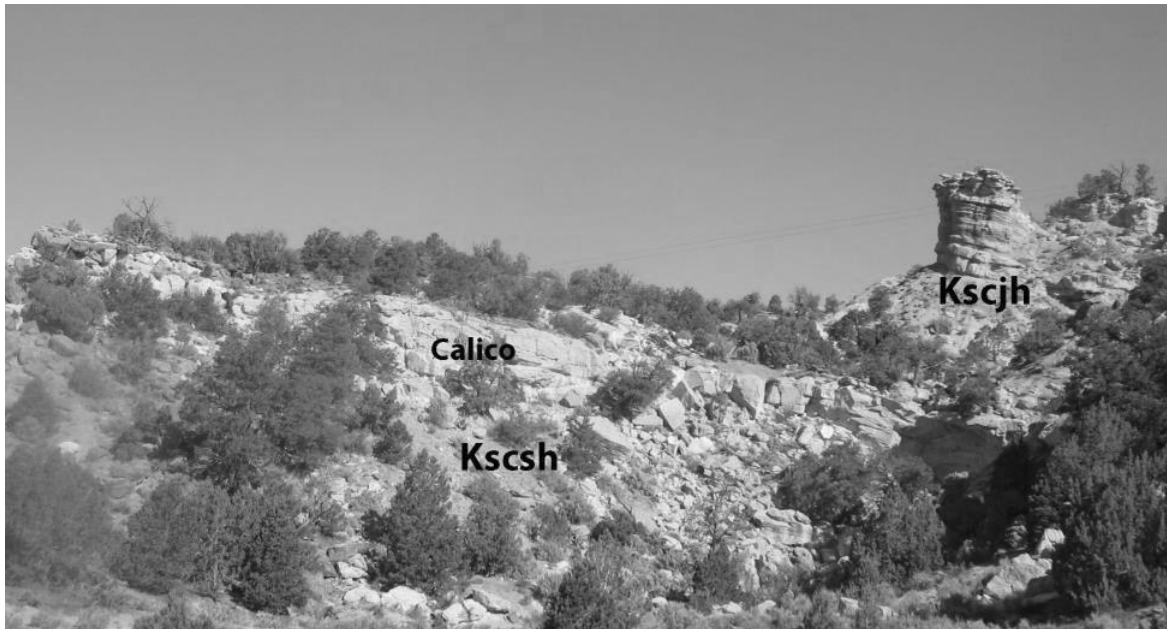


Figure 29. The Calico bed of the Smoky Hollow Member (Kscsh) is overlain disconformably by the John Henry Member (Kscjh). The lower John Henry is locally very carbonaceous and produces a brackish-water fauna.



Figure 30. Contact between the upper part of the John Henry Member and the Drip Tank Member along Henrieville Creek. The Drip Tank Member is a quartz arenite to pebbly conglomerate as opposed to the non-conglomeratic feldspathic sandstones of the upper John Henry Member. Kw = Wahweap Formation.

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ille Creek (figure 31) is the contact between the capping sandstone member of the Wahweap (Kwcs) and the base of the Kaiparowits Formation (Kk). Lawton and others (2014) noted a 26-m interval at the base of the Kaiparowits Formation, which they considered transitional between the sandstone lithology of the Wahweap Formation and the more feldspar-rich lithology of Kaiparowits Formation. Several fossil localities were found in the lowest part of the Kaiparowits, which produced ostracods and miscellaneous vertebrate materials including ray teeth (Lawton and others, 2014).

18.2 miles – Turn on small dirt road and proceed about 100 m to the north and park. **STOP 13. KAIPAROWITS FORMATION OVERVIEW:** From this view you can see most of the gray-colored middle and upper members of the Kaiparowits Formation below the prominent cliff-forming outcrops of the Claron Formation. The intervening slope between the Kaiparowits and Claron Formations is formed in the Canaan Peak and Pine Hollow Formations and other coarse clastic units referred to the Grand Castle Formation, but which cannot belong to that formation because they post-dates the Kaiparowits Formation. These formations are not visible from this vantage point because they are covered with slumps and vegetation. Outcrops to the east (figure 32) form the type section of the Kaiparowits Formation, which here is approximately 860 m thick. The immediate foreground is in the middle member, about 200 m above the base of the formation (Eaton, 1991, figure 15). Although the section appears dominantly composed of mudstone, it is close to an even mix of sandstone and mudstone. However, the sandstone beds are generally friable and weather into rounded shapes that resemble more mud-rich outcrops. Dated ash-fall tuffs in the Kaiparowits Formation have yielded an age range of 76.6 to 74.5 Ma, which spans most of the lower half of the late Campanian (Roberts and others, 2013); however, given its thickness the Kaiparowits was deposited at a remarkably fast rate (Roberts and others, 2013). What is possibly even more remarkable is that the entire formation was removed from portions of the Paunsaugunt and Markagunt Plateaus area in the early to middle Paleocene during the Laramide uplift. The Kaiparowits is by far the richest macrovertebrate-producing unit in

the entire region.

18.7 miles – **STOP 14. MIDDLE KAIPAROWITS SEDIMENTOLOGY AND TAPHONOMY:** Park on south side of highway, east of culvert. Hike down into creek and north into the culvert. Emerge on other side in small canyon carved into middle member of the Kaiparowits Formation. Many features of Kaiparowits depositional systems can be observed in the canyon walls in good detail. Exposed are overbank, fine-grained sequences that have carbonate pedogenic features, which are incised, scoured, and overlain by fluvial channel sandstones bearing large carbonized logs and fossil-rich lags. Whereas the overall vertebrate diversity of the Kaiparowits has mostly been assessed from mudstone-rich pond and floodplain lake facies, many of the articulated macrovertebrate specimens, some displaying soft tissue impressions, are found at the bases of these channel systems, above the scours. Many associated macrovertebrate specimens actually bear mudstone or pedogenic carbonate in their interstices, indicating that they were reworked into the channels from finer grained facies.

The preservation of individual Kaiparowits vertebrate specimens is sometimes spectacular (figure 33). Complete or partial articulation and preservation of softer elements such as epidermis and the keratinous portions of beaks and claws is not rare, particularly in fluvial channel facies. The turtles *Adocus* (Knell and others, 2011) and *Basilemys* have both been found preserved with clutches of eggs (figure 34). Unusual paleobiological information has also been gained from rare specimens showing predatory or behavioral traits (e.g., Boyd and others, 2013). The distribution of fossils is irregular throughout the formation although the lower and middle portions of the middle member are by far the most fossiliferous. Fossil content largely is inversely proportional to the maturation of calcic paleosol features that are pervasive in overbank sequences. Reworking of vertebrate materials of all size classes, including associated dinosaurs, out of finer grained overbank facies into fluvial channel bottom lags is a very common preservational mode. Soft tissue preservation is most often observed as primary burials in fluvial channels, although rarely hadrosaurs have been observed with soft

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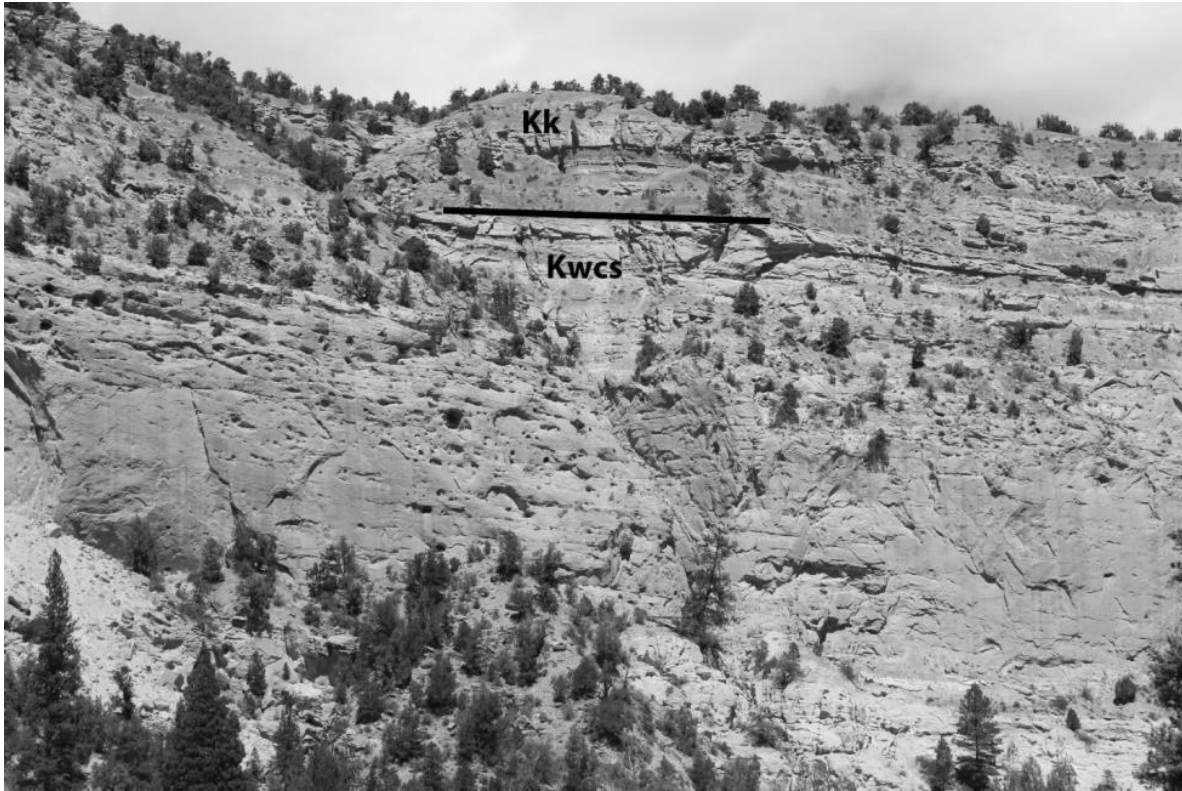


Figure 31. Contact between the capping sandstone member of the Wahweap Formation (Kwcs) and the Kaiparowits Formation (Kk) along Henrieville Creek.



Figure 32. Outcrops of the lower Kaiparowits Formation (above 200 m) in the Blues, the type section of the Kaiparowits.

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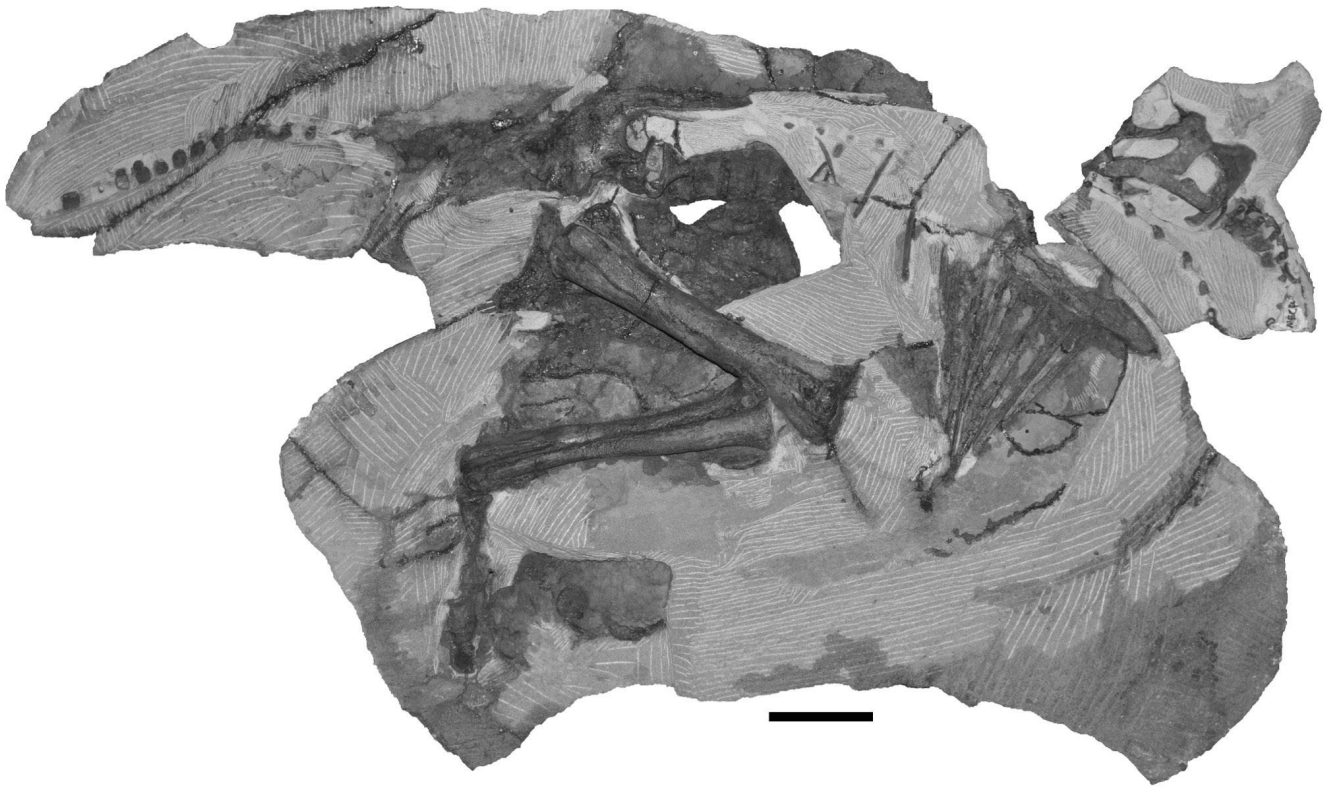


Figure 33. RAM 14000, an exceptionally well preserved juvenile specimen of the dinosaur *Parasaurolophus* sp. Individual is fully articulated and exhibits soft tissue preservation. The black scale bar is 10 cm. Photograph by Raymond Alf (Museum of Paleontology).

tissue preserved in calcite concretionary overgrowths in floodplain lake facies. Strong correlation between suites of invertebrate fossils and depositional facies (Tapanila and Roberts, 2013) shows promise for vertebrate assemblages. Indeed, anecdotal observations seem to support gross separation of fluvial and overbank assemblages of both microvertebrates and macrovertebrates. A 0.8-km-long hike to the northeast towards the very first *Utahceratops* quarry will afford a look at a typical associated hadrosaur site that includes skin impressions.

20.7 miles – **STOP 15. KAIPAROWITS FORMATION DIVERSITY- THE BLUES OVERLOOK:** The Kaiparowits Formation flora (Miller and others, 2013), invertebrate fauna (Tapanila and Roberts, 2013), and vertebrate fauna are exceptionally diverse (see appendix). Although these are the most accessible outcrops of the formation, most of the type localities for

new dinosaurs and other macro and mesovertebrate taxa are actually out of view and to the south of Canaan Peak. Two exceptions to this are the type specimens for the oviraptor *Hagryphus giganteus* and the troodontid *Talos sampsoni*, both of which were collected in the lower elevation hills due west of the overlook (figure 35).

The most common large dinosaur remains are lambeosaurine and saurolophine dinosaurs. Ceratopsids are found in lesser numbers, but are still clearly a significant part of the ecosystem, displaying exceptionally high diversity. Most other dinosaur taxa are uncommon to rare, some being represented by a single specimen (e.g., *Hagryphus*). The only larger elements of the fauna besides dinosaurs are two taxa of crocodylians, a pholidosaur very similar to *Denazinasuchus* and *Deinosuchus*. Ongoing reconnaissance efforts in the Kaiparowits Formation continue to add to its diverse vertebrate fauna and have rapidly enhanced the

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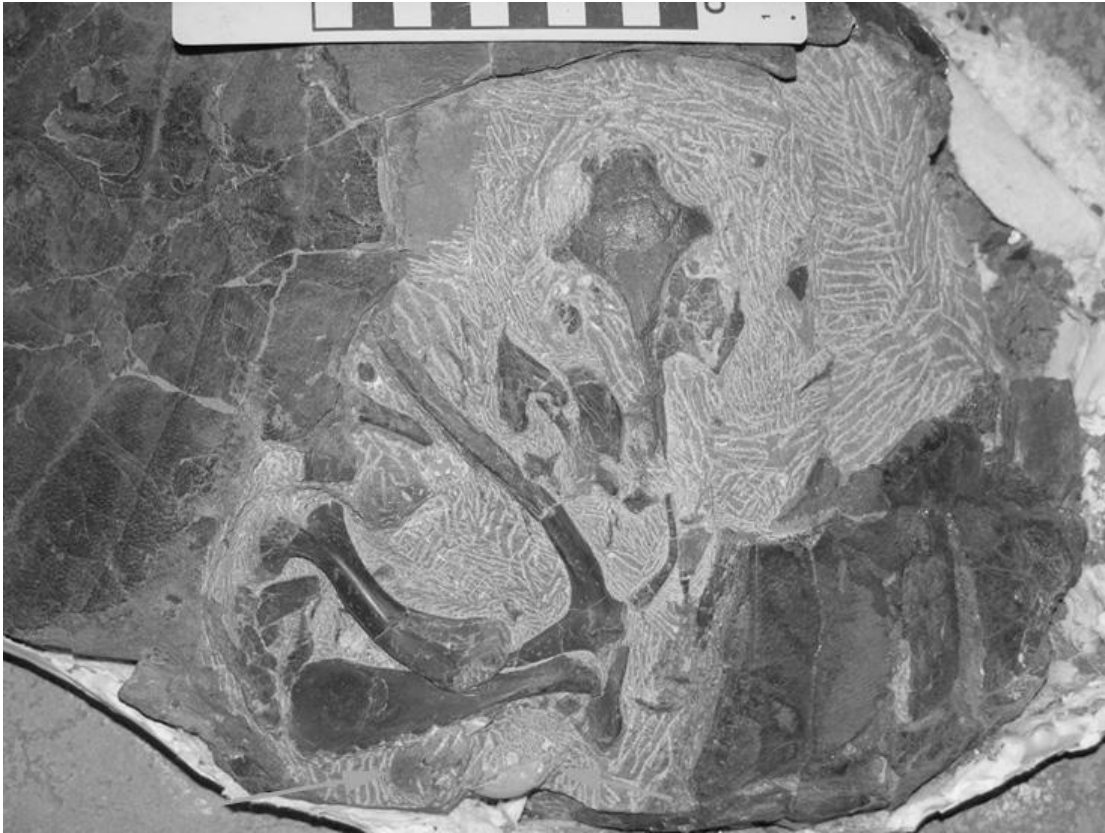


Figure 34. UMNH VP 16868, *Adocus* with skeleton and eggs, the latter are visible in the bottom center of the photo (yellow arrows). Scale = 10 cm.

macrovertebrate assemblages documented in previous published summaries (see appendix). As of now, the Kaiparowits holds the record for most diverse late Campanian assemblages of turtles, mammals, squamates, and crocodylians in North America and is rapidly closing the gap with the diverse dinosaur assemblages known from the Dinosaur Park Formation (Dinosaur Provincial Park, Alberta, Canada). New discoveries continue to add fossil materials to previously documented macrovertebrate taxa, permitting more thorough comparison and phylogenetic evaluation, and add new forms to the overall assemblage. This includes many new, exquisitely preserved crocodyliform specimens that expand the documented diversity and completeness of the group: (1) several associated pterosaur specimens that radically enhance the non-marine record of pterosaurs; and (2) new dinosaur materials that include several specimens of a new chasmosaurine

ceratopsian, two new genera of ankylosaur (Wiersma, 2016), and a possible small lambeosaurine hadrosaurid. These new finds, coupled with ongoing efforts to document the microvertebrate record, the plant macrofossil record, the invertebrate fossil record, and the geological record of the Kaiparowits Formation, promise to make it among the best-documented and understood terrestrial ecosystems in the Mesozoic. Comparison of the Kaiparowits vertebrate assemblage to contemporaneous faunas from Dinosaur Park Formation have documented significant differences in vertebrate taxa. Differences are attributed to possible physiographic barriers (e.g., Sampson and others, 2010; Gates and others, 2012) or climatic/floral differences (e.g., Miller and others, 2013; Nydam and others, 2013).

End of Day 2, return to Tropic, Utah.

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Figure 35. View looking west over the Blues from the upper view point along SR 12. Mostly the lower 400 m of the Kaiparowits Formation is seen from this view.

DAY 3: CRETACEOUS-PALEOGENE BOUNDARY IN SOUTHERN UTAH

0.0 miles – Start in Tropic at 200 North and SR 12. Proceed west on SR 12.

7.2 miles – Junction of SR 12 and SR 22 (Johns Valley Road). Turn right (north) on SR 22 and proceed north.

20.6 miles – Junction with SR 17 (Old Escalante Road). Turn right (east) and proceed east.

23.3 miles – **STOP 16. K-PG BOUNDARY AND THE CANAAN PEAK FORMATION:** The more resistant beds of the Canaan Peak Formation (figure 36) are

well exposed on this general stretch of SR17. The observable lithosomes are completely typical for the formation, and consist of trough cross-bedded pebble and cobble conglomerate with distinctive black chert clasts and other rocks derived from the lower Paleozoic siliceous strata of the Sevier fold and thrust belt as well as the earlier Antler foreland detritus. Jurassic and Early Cretaceous age volcanic clasts ranging in composition from rhyolite to andesite can locally make up as much as 30% of the total rock (Schmitt and others, 1991). The type section is located 30 km to the south (Bowers, 1972), on the south side of Canaan Peak, where it rests with slight angular unconformity on the Kaiparowits Formation and contains an identical clast composition (Schmitt and others, 1991). Goldstrand (1992) subse-

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Figure 36. Conglomerate and cross-stratified sandstone of the Canaan Peak Formation exposed in Horse Canyon, north of SR 17.

quently recognized an upper unit in the Canaan Peak which completely lacks volcanic clasts and is instead dominated by more proximally derived Paleozoic and Mesozoic sedimentary clasts from the Wah Wah thrust system. Given the similar composition of this upper Canaan Peak unit with the Grand Castle Formation in its type section (western Markagunt Plateau), these units were correlated and the term Grand Castle was extended into the Table Cliffs area by Goldstrand (1992). All of this pre-supposed that the Grand Castle in its type section was actually Paleogene (post-Kaiparowits Formation) in age. Now that the entire type Grand Castle Formation as originally conceived by Goldstrand can be demonstrated to be both Cretaceous and pre-Kaiparowits Formation in age (lower and middle Campanian [Biek and others, 2015]), use of the term Grand Castle in the Table Cliffs area should be abandoned. Based on gross clast composition, this locally occurring volcanic

clast-free lithosome in the Table Cliffs area may be genetically related to the overlying Pine Hollow Formation, but this needs further work.

Surprisingly, the areal extent of the Canaan Peak Formation is fairly limited, given its resistant nature and substantial thickness. Over most of the region the Cretaceous-Paleogene boundary represents a much more substantial hiatus (figure 14). Unequivocal Canaan Peak is known with certainty only east of the Paunsaugunt fault, around the Table Cliffs and Canaan Peak. However, it was obviously once much more widespread as current directions indicate a source area to the west and southwest (Schmitt and others, 1991).

The precise age of the Canaan Peak Formation proper is unknown as it has not yielded any age diagnostic faunal data or datable ash beds. Paleocene palynological assemblages (Goldstrand, 1990) have been reported from the upper volcanic-clast-free unit (Grand Castle of

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Goldstrand, 1992). If these palynology data are correct, then the Canaan Peak, as we define it here (excluding the non-volcanic clast-bearing part), can only be constrained as post middle upper Campanian to Paleocene. Eric Roberts (James Cook University, oral communication, 2013) has observed dinosaur bone in the lower portion of the Canaan Peak near the type section. However, it is unknown at this time whether this represents contemporaneous bone or elements reworked from the underlying Kaiparowits Formation.

The volcanic clast content of the Canaan Peak Formation ties it genetically to the underlying Kaiparowits Formation and strongly differentiates it from all overlying units (Larsen and others, 2010). From a strictly event-oriented view, since Laramide uplift completely removed the Canaan Peak and Kaiparowits Formations from the Paunsaugunt Plateau region, mostly likely in the late Paleocene or early Eocene (i.e., pre-Claron), it seems reasonable to assume that the volcanic lithic-rich Kaiparowits and Canaan Peak Formations occupy a space in time closer to each other than the Canaan Peak would with the Pine Hollow Formation because the Pine Hollow is compositionally very close to the Claron Formation (Larsen, 2007). As such, the Canaan Peak Formation, which could be Campanian-Maastrichtian in age, could also locally span the Cretaceous-Paleogene boundary.

End of Field Trip

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REFERENCES

- Albright, L.B., III, Gillette, D.D., and Titus, A.L., 2007a, Plesiosaurs from the Upper Cretaceous (Cenomanian Turonian) Tropic

Shale of southern Utah, Part 1 new records of the pliosaur *Brachauchenius lucasi*: Journal of Vertebrate Paleontology, v. 27, p. 31–40.

Albright, L.B., III, Gillette, D.D., and Titus, A.L., 2007b, Plesiosaurs from the Upper Cretaceous (Cenomanian Turonian) Tropic Shale of southern Utah, Part 2 Polycotylidae: Journal of Vertebrate Paleontology, v. 27, p. 41–58.

Albright, L.B., Gillette, D.D., and Titus, A.L., 2013, Fossil vertebrates from the Tropic Shale (Upper Cretaceous), southern Utah, in Titus, A.L., and Loewen, M.A., editors, At the top of the Grand Staircase—the Late Cretaceous of southern Utah: Bloomington, Indiana University Press, p. 536–562.

Albright III, L.B., and Titus, A.L., 2016, Magnetostratigraphy of Upper Cretaceous strata in the Grand Staircase-Escalante National Monument, southern Utah—the Santonian-Campanian stage boundary, reassessment of C33N/C33R magnetostratigraphic boundary, and implications for regional sedimentation patterns within the Sevier foreland basin: Cretaceous Research, v. 63, p. 77–94.

Allen, J.L., and Johnson, C.L., 2010, Sedimentary facies, paleoenvironments, and relative sea level changes in the John Henry Member, Cretaceous Straight Cliffs Formation, southern Utah, in Carney, S.M., Tabet, D.E., and Johnson, C.L., editors, Geology of south central Utah: Utah Geological Association Publication 39, p. 225–247.

Barclay, R.S., McElwain, J.C., and Sageman, B.B., 2010, Carbon sequestration activated by volcanic CO₂ pulse during Ocean Anoxic Event 2: Nature Geoscience Letters, DOI:10.1038/NNGEO757.

Biek, R.F., 2014, Road guide to Utah's southwestern high plateaus—Cedar City Tropic Kanab Springdale, Hurricane, in MacLean, J.S., Biek, R.F., and Huntoon, J.E., editors, Geology of Utah's far south: Utah Geological Association Publication 43, p. 799–878, compact disk.

Biek, R.F., Rowley, P.D., Anderson, J.J., Maldonado, F., Moore, D.W., Hacker, D.B., Eaton, J.G., Hereford, R., Sable, E.G., Filkorn, H.F., and Matyjasik, B., 2015, Geologic map of the Panguitch 30' X 60' quadrangle, Garfield, Iron, and Kane Counties, Utah: Utah Geological Survey Map 270DM, scale 1:62,500.

Bowers, W.E., 1972, The Canaan Peak, Pine Hollow, and Wasatch formations in the Table Cliff region, Garfield County, Utah: U.S. Geological Survey Bulletin 1331 B, p. B1–B39.

Bowers, W.E., 1983, Geologic map and coal sections of the Butler Valley quadrangle, Kane County, Utah: U.S. Geological Survey Coal Investigations Map C 95, scale 1:24,000.

Bowers, W.E., 1990, Geologic map of Bryce Canyon National Park and vicinity, southwestern Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I 2108, scale 1:24,000.

Bown, T.M., Hasiotis, S.T., Genise, J.F., Maldonado, F., and Brou

Late Cretaceous Stratigraphy and Vertebrate Faunas of the Markagunt, Paunsaugunt, and Kaiparowits Plateaus, Southern Utah
Titus, A.L., Eaton, J.G., and Sertich, J.

- wers, E.M., 1997, Trace fossils of Hymenoptera and other in
sects, and paleoenvironments of the Claron Formation (Paleo
cene and Eocene), southwestern Utah: U.S. Geological Survey
Bulletin 2153, p. 41–58.
- Boyd, C.A., 2015, The systematic relationships and biogeograph
ic history of ornithischian dinosaurs: PeerJ 3:e1523; DOI
10.7717/peerj.1523.
- Boyd, C.A., Drumheller, S.K., and Gates, T.A., 2013, Crocodyli
form feeding traces on juvenile ornithischian dinosaurs from
the Upper Cretaceous (Campanian) Kaiparowits Formation,
Utah: PLoS ONE, v. 8, no. 2, p. e57605.
- Brinkman, D.B., Newbrey, M.G., Neuman, A.G., and Eaton, J.G., 2013,
Freshwater osteichthyes from the Cenomanian to Late Campan
ian of Grand Staircase Escalante National Monument, Utah, *in*
Titus, A.L., and Loewen, M.A., editors, At the top of the Grand
Staircase—the Late Cretaceous of southern Utah: Bloomington,
Indiana University Press, p. 195–236.
- Carpenter, K., 2014, Where the sea meets the land—the unre
solved Dakota problem in Utah, *in* MacLean, J.S., Biek, R.F.,
and Huntoon, J.E., editors, Geology of Utah's far south: Utah
Geological Association Publication 43, p. 357–372.
- Carr, T.D., Williamson, T.E., Britt, B.B., and Stadtman, K., 2011,
Evidence for high taxonomic and morphologic tyrannosau
roid diversity in the Late Cretaceous (Late Campanian) of
the American Southwest and a new short skulled tyranno
saurid from the Kaiparowits Formation of Utah: Naturwis
senschaften, v. 98, no. 3, p. 241–246, doi:10.1007/s00114-011-
0762-7.
- Cifelli, R.L., 1990a, Cretaceous mammals from southern Utah
III therian mammals of the Turonian (early Late Cretaceous):
Journal of Vertebrate Paleontology, v. 10, p. 332–345.
- Cifelli, R.L., 1990b, Cretaceous mammals from southern Utah II
marsupials and marsupial like mammals from the Wahweap
Formation (Early Campanian): Journal of Vertebrate Paleon
tology, v. 10, p. 320–331.
- Cifelli, R.L., 1990c, A primitive higher mammal from the Late
Cretaceous of southern Utah: Journal of Mammalogy, v. 71,
p. 343–350.
- Cifelli, R.L., 1990d, Cretaceous mammals from southern Utah I
marsupial mammals of the Kaiparowits Formation (Judith
ian): Journal of Vertebrate Paleontology, v. 10, p. 295–319.
- Cifelli, R.L., 1990e, Cretaceous mammals from southern Utah IV
eutherian mammals from the Wahweap (Aquilan) and Kaip
arowits (Judithian) Formations: Journal of Vertebrate Paleon
tology, v. 10, p. 343–350.
- Cifelli, R.L., and Eaton, J.G., 1987, Marsupial from the earliest Late
Cretaceous of western U.S.: Nature, v. 325, p. 520–522.
- Cifelli, R.L. and Gordon, C.L., 1999, Symmetrodonts of the Late
Cretaceous of southern Utah and distribution of archaic mam
mals in the Cretaceous of Utah: Brigham Young University
Geology Studies, v. 44, p. 1–15.
- Cifelli, R.L., and Johanson, Z., 1994, New marsupial from the Up
per Cretaceous of Utah: Journal of Vertebrate Paleontology, v.
14, p. 292–295.
- Cifelli, R.L., and Madsen, S., 1986, An Upper Cretaceous sym
metrodont (Mammalia) from southern Utah: Journal of Ver
tebrate Paleontology, v. 6, p. 258–263.
- Claessens, L.P.A.M., and Loewen, M.A., 2015, A redescr
ption of *Ornithomimus velox* Marsh, 1890 (Dinosauria,
Theropoda): Journal of Vertebrate Paleontology, DOI:
10.1080/02724634.2015.1034593.
- DeCourten, F.L., and Russell, D.A., 1985, A specimen of *Ornitho
mimus velox* (Theropoda, Ornithomimidae) from the terminal
Cretaceous Kaiparowits Formation of southern Utah: Journal
of Paleontology, v. 59, p. 1091–1099.
- Doelling, H.H., and Davis, F.D., 1989, The geology of Kane County,
Utah: Utah Geological and Mineral Survey Bulletin 124, 192
p., 10 plates, scale 1:100,000.
- Eaton, J.G., 1991, Biostratigraphic framework for the Upper Creta
ceous rocks of the Kaiparowits Plateau, southern Utah, *in* Na
tions, J.D., and Eaton, J.G., editors, Stratigraphy, depositional
environments and sedimentary tectonics of the western mar
gin, Cretaceous Western Interior Seaway: Geological Society
of America Special Paper 260, p. 47–63.
- Eaton, J.G., 1993a, Therian mammals of the Cenomanian (Late
Cretaceous) Dakota Formation, southwestern Utah: Journal
of Vertebrate Paleontology, v. 13, p. 105–124.
- Eaton, J.G., 1993b, Mammalian paleontology and correlation of
uppermost Cretaceous rocks of the Paunsaugunt Plateau,
Utah, *in* Morales, M., editor, Aspects of Mesozoic geology and
paleontology of the Colorado Plateau: Museum of Northern
Arizona Bulletin 59, p. 163–180.
- Eaton, J.G., 1995, Cenomanian and Turonian (early Late Creta
ceous) multituberculate mammals from southwestern Utah:
Journal of Vertebrate Paleontology, v. 15, p. 761–784.
- Eaton, J.G., 1999a, Vertebrate paleontology of the Paunsaugunt
Plateau, Upper Cretaceous, southwestern Utah, *in* Gillette,
D.D., editor, Vertebrate paleontology in Utah: Utah Geological
Survey Miscellaneous Publication 99-1, p. 335–338.
- Eaton, J.G., 1999b, Vertebrate paleontology of the Iron Springs
Formation, Upper Cretaceous, southwestern Utah, *in* Gillette,
D.D., editor, Vertebrate paleontology in Utah: Utah Geological
Survey Miscellaneous Publication 99-1, p. 338–343.
- Eaton, J.G., 2006a, Late Cretaceous mammals from Cedar Canyon,
southwestern Utah, *in* Lucas, S.G., and Sullivan, R.M., editors,
Late Cretaceous vertebrates from the Western Interior: New
Mexico Museum of Natural History and Science Bulletin 35,
p. 373–402.

Late Cretaceous Stratigraphy and Vertebrate Faunas of the Markagunt, Paunsaugunt, and Kaiparowits Plateaus, Southern Utah
Titus, A.L., Eaton, J.G., and Sertich, J.

- Eaton, J.G., 2006b, Santonian (Late Cretaceous) mammals from the John Henry Member of the Straight Cliffs Formation, Grand Staircase Escalante National Monument, Utah: *Journal of Vertebrate Paleontology*, v. 26, p. 446–460.
- Eaton, J.G., 2009, Cenomanian (Late Cretaceous) mammals from Cedar Canyon, southwestern Utah, and a revision of Cenomanian *Alphadon* like marsupials, in Albright, L.B., III, editor, *Papers on geology, vertebrate paleontology, and biostratigraphy in honor of Michael O. Woodburne*: Museum of Northern Arizona Bulletin 65, Flagstaff, Arizona, p. 97–110.
- Eaton, J.G., 2013, Late Cretaceous mammals from Bryce Canyon National Park and vicinity, Paunsaugunt Plateau, southwestern Utah, in Titus, A.L., and Loewen, M.A. editors, *At the top of the Grand Staircase—the Late Cretaceous of southern Utah*: Bloomington, Indiana University Press, p. 329–369.
- Eaton, J.G., Cifelli, R.L., Hutchison, J.H., Kirkland, J.I., and Parrish, J.M., 1999b, Cretaceous vertebrate faunas from the Kaiparowits Plateau, south central Utah, in Gillette, D.D., editor, *Vertebrate paleontology in Utah: Utah Geological Survey Miscellaneous Publication 99-1*, p. 345–353.
- Eaton, J.G., Diem, S., Archibald, J.D., Schierup, C., and Munk, H., 1999a, Vertebrate paleontology of the Upper Cretaceous rocks of the Markagunt Plateau, southwestern Utah, in Gillette, D.D., editor, *Vertebrate paleontology in Utah: Utah Geological Survey Miscellaneous Publication 99-1*, p. 323–333.
- Eaton, J.G., Goldstrand, P.M., and Morrow, J., 1993, Composition and stratigraphic interpretation of Cretaceous strata of the Paunsaugunt Plateau, Utah, in Morales, M., editor, *Aspects of Mesozoic geology and paleontology of the Colorado Plateau*: Museum of Northern Arizona Bulletin 59, p. 153–162.
- Eaton, J.G., Laurin, J., Kirkland, J.I., Tibert, N.E., Leckie, R.M., Sageman, B.B., Goldstrand, P.M., Moore, D.W., Straub, A.W., Cobban, W.A., and Dalebout, J.D., 2001, Cretaceous and Early Tertiary geology of Cedar and Parowan Canyons, western Markagunt Plateau, Utah, in Erskine, M.C., Faulds, J.E., Bartley, J.M., and Rowley, P.D., editors, *The geologic transition, high plateaus to Great Basin—a symposium and field guide (The Mackin Volume)*: Utah Geological Association Publication 30 and American Association of Petroleum Geologists, Pacific Section Publication GB 78, p. 337–363.
- Eaton, J.G., Maldonado, F., and McIntosh, W.C., 1999, New radiometric dates from Upper Cretaceous rocks of the Markagunt Plateau, southwestern Utah, and their bearing on subsidence histories [abs.]: *Geological Society of America Abstracts with Programs*, v. 31, p. A-11.
- Eaton, J.G., Tibert, N.E., and Biek, R.F., 2011, First mammals and ostracodes from the Paleogene Claron Formation, southwestern Utah [abs.]: *Geological Society of America Abstracts with Programs*, v. 43, no. 4, p. 77.
- Elder, W.P., 1991, Molluscan paleoecology and sedimentation patterns of the Cenomanian Turonian extinction interval in the southern Colorado Plateau region, in Nations, J.D., and Eaton, J.G., editors, *Stratigraphy, depositional environments and sedimentary tectonics of the western margin, Cretaceous Western Interior Seaway*: Geological Society of America Special Paper 260, p. 113–137.
- Elder, W.P., Gustason, E.R., and Sageman, B.B., 1994, Correlation of basinal carbonate cycles to nearshore parasequences in the Late Cretaceous Greenhorn seaway, Western Interior, U.S.A.: *Geological Society of America Bulletin*, v. 106, p. 892–902.
- Evans, D.C., Williamson, T., Loewen, M.A., and Kirkland, J.I., 2013, Review of pachycephalosaurian dinosaurs from Grand Staircase Escalante National Monument, southern Utah, in Titus, A.L., and Loewen, M.A., editors, *At the top of the Grand Staircase—the Late Cretaceous of southern Utah*: Bloomington, Indiana University Press, p. 445–462.
- Farke, A.A., and Wilridge, C.A., 2013, A possible pterosaur wing phalanx from the Kaiparowits Formation (Late Campanian) of southern Utah, USA: *PalArch's Journal of Vertebrate Paleontology*, v. 10, p. 1–6.
- Farke, A.A., Henn, M.M., Woodward, S.J., and Xu, H.A., 2014, *Leidyosuchus* (Crocodylia: Alligatoroidea) from the Upper Cretaceous Kaiparowits Formation (Late Campanian) of Utah, USA: *PaleoBios*, v. 30, p. 72–88.
- Foster, J.R., Titus, A.L., Winterfeld, G.F., Hayden, M.C., and Hamblin, A.H., 2001, Paleontological survey of the Grand Staircase Escalante National Monument, Garfield and Kane Counties, Utah: *Utah Geological Survey Special Study 97*, 98 p.
- Gardner, J.D., 1999, New albanerpetontid amphibians from the Albian to Coniacian of Utah, U.S.A.—bridging the gap: *Journal of Vertebrate Paleontology*, v. 19, p. 632–638.
- Gardner, J.D., and Demar, D.G., Jr., 2013, Mesozoic and Palaeocene lissamphibian assemblages of North America—a comprehensive review: *Palaeobiodiversity and Palaeoenvironments*, v. 93, p. 459–515.
- Gates, T.A., and Sampson, S.D., 2007, A new species of *Gryposaurus* (Dinosauria: Hadrosauridae) from the late Campanian Kaiparowits Formation, southern Utah, USA: *Zoological Journal of the Linnean Society*, v. 151, no. 2, p. 351–376, doi:10.1111/j.1096-3642.2007.00349.
- Gates, T.A., Prieto Marquez, A., and Zanno, L.E., 2012, Mountain building triggered Late Cretaceous North American megaherbivore dinosaur radiation: *PLoS ONE* 7: e42135. doi:10.1371/journal.pone.0042135.
- Gates, T.A., Sampson, S.D., Zanno, L.E., Roberts, E.M., Eaton, J.G., Nydam, R.L., Hutchison, J.H., Smith, J.A., Loewen, M.A., and Getty, M.A., 2010, Biogeography of terrestrial and freshwater vertebrates from the Late Cretaceous (Campanian) Western Interior of North America: *Palaeogeography, Palaeoclimatology, Palaeoecology*, v. 291, p. 371–387.

Late Cretaceous Stratigraphy and Vertebrate Faunas of the Markagunt, Paunsaugunt, and Kaiparowits Plateaus, Southern Utah
Titus, A.L., Eaton, J.G., and Sertich, J.

- Gates, T.A., Lund, E.K., Boyd, C.A., DeBlieux, D.D., Titus, A.L., Evans, D.C., Getty, M.A., Kirkland, J.I., and Eaton, J.G., 2013, Ornithopod dinosaurs from the Grand Staircase Escalante National Monument region, Utah, and their role in paleobiogeographic and macroevolutionary studies, *in* Titus, A.L., and Loewen, M.A. editors, *At the top of the Grand Staircase the Late Cretaceous of southern Utah*: Bloomington, Indiana University Press, p. 237–272.
- Gates, T.A., Jinnah, Z., Levitt, C., and Getty, M.A., 2014, New hadrosaurid specimens from the lower middle Campanian Wahweap Formation of Utah, *in* Eberth, D.A., and Evans, D.C., *Hadrosaurs: Proceedings of the International Hadrosaur Symposium*. Bloomington, Indiana University Press, p. 156–173.
- Gillette, D.D., Hayden, M.C., and Titus, A.L., 1999, Occurrence and biostratigraphic framework of a plesiosaur from the Upper Cretaceous Tropic Shale of southwestern Utah, *in* Gillette, D.D., editor, *Vertebrate paleontology in Utah*: Utah Geological Survey Miscellaneous Publication 99-1, p. 269–273.
- Goldstrand, P.M., 1990, Stratigraphy and paleogeography of Late Cretaceous and Paleogene rocks of southwest Utah: Utah Geological and Mineral Survey Miscellaneous Publication 90-2, 58 p.
- Goldstrand, P.M., 1991, Tectonostratigraphy, petrology, and paleogeography of Upper Cretaceous and early Tertiary basins of southwest Utah: Reno, University of Nevada, Ph.D. dissertation, 205 p.
- Goldstrand, P.M., 1992, Evolution of Late Cretaceous and early Tertiary basins of southwest Utah based on clastic petrology: *Journal of Sedimentary Geology*, v. 62, p. 495–507.
- Goldstrand, P.M., and Mullett, D.J., 1997, The Paleocene Grand Castle Formation—a new formation on the Markagunt Plateau of southwestern Utah, *in* Maldonado, F., and Nealey, L.D., editors, *Geologic studies in the Basin and Range—Colorado Plateau transition zone in southeastern Nevada, southwestern Utah, and northwestern Arizona, 1995*: U.S. Geological Survey Bulletin 2153, p. 59–78.
- Gregory, H.E., 1951, The geology and geography of the Paunsaugunt region, Utah: U.S. Geological Survey Professional Paper 226, 116 p.
- Gregory, H.E., and Moore, R.C., 1931, The Kaiparowits region; geographic and geologic reconnaissance of parts of Utah and Arizona: U.S. Geological Survey Professional Paper 164, 161 p.
- Hoffman, E.N., 2005, Taxonomy and evolution of *Admentopsis* (Cretaceous brackish water gastropod): Madsion, University of Wisconsin, M.S. thesis, 99 p.
- Holroyd, P.A., and Hutchison, J.H., 2016, Fauna and setting of the *Adelolophus hutchisoni* type locality in the Upper Cretaceous (Campanian) Wahweap Formation of Utah: *PaleoBios*, v. 33, p. 1–9.
- Hutchison, J.H., Knell, M.J., and Brinkman, D.B., 2013, Turtles from the Kaiparowits Formation, Utah, *in* Titus, A.L., and Loewen, M.A. editors, *At the top of the Grand Staircase the Late Cretaceous of southern Utah*: Bloomington, Indiana University Press, p. 295–318.
- Hunt, G.J., Biek, R.F., DeBlieux, D.D., Madsen, S.K., Milner, A.R.C., Roberts, E.H., and Eaton, J.G., 2011, Dinosaur tracks confirm Late Cretaceous age for lower Grand Castle Formation, Iron County Utah—stratigraphic and tectonic implications [abs.]: *Geological Society of America Abstracts with Programs*, v. 43, no. 4, p. 16.
- Jinnah, Z.A., 2013, Tectonic and sedimentary controls, age, and correlation of the Upper Cretaceous Wahweap Formation, southern Utah, *in* Titus, A.L., and Loewen, M.A., editors, *At the top of the Grand Staircase the Late Cretaceous of southern Utah*: Bloomington, Indiana University Press, p. 57–73.
- Jinnah, Z.A., Roberts, E.M., Deino, A.D., Larsen, J.S., Link, P.K., and Fanning, C.M., 2009, New $^{40}\text{Ar}/^{39}\text{Ar}$ and detrital zircon U-Pb ages for the Upper Cretaceous Wahweap and Kaiparowits Formations on the Kaiparowits Plateau, Utah—implications for regional correlation, provenance, and biostratigraphy: *Cretaceous Research*, v. 30, p. 287–299.
- Johnson, R.L., Smith, G.I., and Biek, R.F., 2010, Subalkaline volcanism in the Black Rock Desert and Markagunt Plateau volcanic fields of south central Utah, *in* Carney, S.M., Tabet, D.E., and Johnson, C.L., editors, *Geology of south central Utah*: Utah Geological Association Publication 39, p. 109–150.
- Joyce, W.G., Lyson, T.R., and Kirkland, J.I., 2016, An early bothremydid (Testudines, Pleurodira) from the Late Cretaceous (Cenomanian) of Utah, North America: *PeerJ* 4:e2502; DOI 10.7717/peerj.2502.
- Kirkland, J.I., 1987, Upper Jurassic and Cretaceous lungfish tooth plates from the Western Interior, the last Dipnoan faunas of North America: *Hunteria*, v. 2, p. 1–15.
- Kirkland, J.I., and DeBlieux, D.D., 2010, New basal centrosaurine ceratopsian skulls from the Wahweap Formation (Middle Campanian), Grand Staircase Escalante National Monument, southern Utah, *in* Ryan, M.J., Chinnery Allgeier, B.J., and Eberth, D.A., editors, *New perspectives on horned dinosaurs—The Royal Tyrrell Museum Ceratopsian Symposium*: Bloomington, Indiana University Press, p. 117–140.
- Kirkland, J.I., Eaton, J.G., and Brinkman, D.B., 2013, Elasmobranchs from Upper Cretaceous freshwater facies in southern Utah, *in* Titus, A.L., and Loewen, M.A., editors, *At the top of the Grand Staircase the Late Cretaceous of southern Utah*: Bloomington, Indiana University Press, p. 153–194.
- Kirkland, J.I., Suarez, M., Suarez, C., and Hunt-Foster, R., 2016, The Lower Cretaceous in east central Utah—the Cedar Mountain Formation and its bounding strata: *Geology of the Intermountain West*, v. 3, p. 101–228.

Late Cretaceous Stratigraphy and Vertebrate Faunas of the Markagunt, Paunsaugunt, and Kaiparowits Plateaus, Southern Utah
Titus, A.L., Eaton, J.G., and Sertich, J.

- Knell, M.J., Jackson, F.D., Titus, A.L., and Albright, L.B., 2011, A gravid turtle fossil turtle from the Upper Cretaceous (Campanian) Kaiparowits Formation, southern Utah: *Historical Biology*, v. 23, no. 1, p. 57–62.
- Knudsen, T.R., and Biek, R.F., 2014, Road guide to the geology of Cedar Canyon and Cedar Breaks National Monument, Iron County, Utah, in MacLean, J.S., Biek, R.F., and Huntoon, J.E., editors, *Geology of Utah's far south: Utah Geological Association Publication 43*, p. 757–798.
- Kurlich, R.A., III, and Anderson, J.J., 1997, Geologic map of the Hatch quadrangle, Garfield County, Utah: Utah Geological Survey Miscellaneous Publication 97-5, 17 p., 2 plates, scale 1:24,000.
- Larsen, J.S., 2007, Facies and provenance of the Pine Hollow Formation—implications for Sevier foreland basin evolution and the Paleocene climate of southern Utah: Pocatello, Idaho State University, M.S. thesis, 119 p.
- Larsen, J.S., Link, P.K., Roberts, E.M., Tapanila, L., and Fanning, C.M., 2010, Cyclostratigraphy of the Paleocene Pine Hollow and detrital zircon provenance of Campanian to Eocene sandstones of the Kaiparowits and Table Cliffs basins, south central Utah, in Carney, S.M., Tabet, D.E., and Johnson, C.L., editors, *Geology of south central Utah: Utah Geological Association Publication 39*, p. 194–224.
- Laurin, J., and Sageman, B.B., 2001, Tectono-sedimentary evolution of the western margin of the Colorado Plateau during the latest Cenomanian and early Turonian, in Erskine, M.C., Faulds, J.E., Bartley, J.M., and Rowley, P.D., editors, *The geologic transition, High plateaus to Great Basin—a symposium and field guide (The Mackin Volume): Utah Geological Association Publication 30 and American Association of Petroleum Geologists, Pacific Section Publication GB 78*, p. 57–74.
- Laurin, J., and Sageman, B.B., 2007, Cenomanian–Turonian coastal record in SW Utah, USA—orbital scale transgressive regressive events during Oceanic Anoxic Event II: *Journal of Sedimentary Research*, v. 77, no. 2, p. 731–756.
- Lawrence, J.C., 1965, Stratigraphy of the Dakota and Tropic Formations of Cretaceous age in southern Utah, in *Geology and resources of south central Utah: Utah Geological Society Guidebook to the Geology of Utah 19*, p. 71–91.
- Lawton, T.F., Pollock, S.L., and Robinson, R.A.J., 2003, Integrating sandstone petrology and nonmarine sequence stratigraphy application to the late Cretaceous fluvial systems of southwestern Utah, U.S.A.: *Journal of Sedimentary Research*, v. 73, p. 389–406.
- Lawton, T.M., Eaton, J.G., Godfrey, K.N., and Schellenbach, W.L., 2014, Compositional, paleontological and detrital zircon data from Cretaceous strata of the Henry Mountains basin and implications with dispersal systems of Wahweap and Kaiparowits Formations in southern Utah, U.S.A., in MacLean, J.S., Biek, R.F., and Huntoon, J.E., editors, *Geology of Utah's far south: Utah Geological Association Publication 43*, p. 373–396.
- Lawton, T.F., Pollock, S.L., and Robinson, R.A.J., 2003, Integrating sandstone petrology and nonmarine sequence stratigraphy application to the Late Cretaceous fluvial systems of southwestern Utah, U.S.A.: *Journal of Sedimentary Research*, v. 73, no. 3, p. 389–406.
- Lively, J.R., 2015a, A new species of baenid turtle from the Kaiparowits Formation (Upper Cretaceous, Campanian) of southern Utah: *Journal of Vertebrate Paleontology*, v. 35, no. 6, p.e1009084. DOI:10.1080/02724634.2015.1009084.
- Lively, J.R., 2015b, Baenid turtles of the Kaiparowits Formation (Upper Cretaceous: Campanian) of southern Utah, USA: *Journal of Systematic Palaeontology*, p. 1–28, DOI:10.1080/14772019.2015.1120788.
- Loewen, M.A., Burns, M.E., Getty, M.A., Kirkland, J.I., and Vickaryous, M.K., 2013a, Review of Late Cretaceous ankylosaurian dinosaurs from the Grand Staircase region, southern Utah, in Titus, A.L., and Loewen, M.A., editors, *At the top of the Grand Staircase—the Late Cretaceous of southern Utah: Bloomington, Indiana University Press*, p. 445–462.
- Loewen, M.A., Farke, A.A., Sampson, S.D., Getty, M.A., Lund, E.K., and O'Connor, P.M., 2013b, Ceratopsid dinosaurs from the Grand Staircase of southern Utah, in Titus, A.L., and Loewen, M.A., editors, *At the top of the Grand Staircase—the Late Cretaceous of southern Utah: Bloomington, Indiana University Press*, p. 488–503.
- Loewen, M.A., Irmis, R.B., Sertich, J.J.W., Currie, P.J., and Sampson, S.D., 2013c, Tyrant dinosaur evolution tracks the rise and fall of Late Cretaceous Oceans: *PLoS ONE* 8 (11): e79420. doi:10.1371/journal.pone.0079420.
- Lund, E.K., O'Connor, P.M., Loewen, M.A., and Jinnah, Z.A., 2016, A new centrosaurine ceratopsid, *Machairoceratops cronusi* gen et sp. nov., from the upper sand member of the Wahweap Formation (Middle Campanian), southern Utah: *PLoS ONE*, v. 11, no. 5, p. e0154403. doi:10.1371/journal.pone.0154403.
- McKean, R.S., 2012, A new species of polycotyloid plesiosaur (Reptilia: Sauropterygia) from the Lower Turonian of Utah: Extending the stratigraphic range of *Dolichorhynchops*: *Cretaceous Research*, v. 34, p. 184–199.
- Miller, I.M., Johnson, K.R., Kline, D.E., Nichols, D.J., and Barclay, R.S., 2013, A Late Campanian flora from the Kaiparowits Formation, southern Utah, and a brief overview of the widely sampled but little known Campanian vegetation of the Western Interior of North America, in Titus, A.L., and Loewen, M.A., editors, *At the top of the Grand Staircase—the Late Cretaceous of southern Utah: Bloomington, Indiana University Press*, p. 107–131.
- Moore, D.W., and Straub, A.W., 2001, Correlation of Upper Cretaceous and Paleogene(?) rocks beneath the Claron Formation,

Late Cretaceous Stratigraphy and Vertebrate Faunas of the Markagunt, Paunsaugunt, and Kaiparowits Plateaus, Southern Utah
Titus, A.L., Eaton, J.G., and Sertich, J.

- Crow Creek, western Markagunt Plateau, southwest Utah, in Erskine, M.C., Faulds, J.E., Bartley, J.M., and Rowley, P.D., editors, *The geologic transition, High plateaus to Great Basin* a symposium and field guide (The Mackin Volume): Utah Geological Association Publication 30 and American Association of Petroleum Geologists, Pacific Section Publication GB 78, p. 75–95.
- Nichols, D.J., 1997, Palynology and ages of some Upper Cretaceous formations in the Markagunt and northwestern Kaiparowits Plateaus, southwestern Utah, in Maldonado, F., and Nealy, L.D., editors, *Geologic studies in the Basin and Range Colorado Plateau transition zone in southeastern Nevada, southwestern Utah, and northwestern Arizona*, 1995: U.S. Geological Survey Bulletin 2153 E, p. 81–95.
- Nydam, R.L., 2013, Lizards and snakes from the Cenomanian through Campanian of southern Utah filling the gap in the fossil record of Squamata from the Late Cretaceous of the Western Interior of North America, in Titus, A.L., and Loewen, M.A., editors, *At the top of the Grand Staircase the Late Cretaceous of southern Utah*: Bloomington, Indiana University Press, p. 370–423.
- Nydam, R.L., and Voci, G.E., 2007, Teiid like scincomorph lizards from the Late Cretaceous (Campanian) of southern Utah: *Journal of Herpetology*, v. 41, p. 215–223.
- Nydam, R.L., Rowe, T.B., and Cifelli, R.L., 2013, Lizards and snakes of the Terlingua Local Fauna (Late Campanian), Aguja Formation, Texas, with comments on the distribution of paracon temporaneous squamates throughout the Western Interior of North America: *Journal of Vertebrate Paleontology*, v. 33, p. 1081–1099.
- Peterson, F., 1969, Four new members of the Upper Cretaceous Straight Cliffs Formation in the southeastern Kaiparowits region, Kane County, Utah: U.S. Geological Survey Bulletin 1274 J, p. 1–28.
- Pollock, S.L., 1999, Provenance, geometry, lithofacies, and age of the Upper Cretaceous Wahweap Formation, Cordilleran foreland basin, southern Utah: Las Cruces, New Mexico State University, M.S. thesis, 116 p.
- Rafferty, K., 1995, Stratigraphy of middle Cenozoic strata near Hatch, Utah [abs.]: *Geological Society of America Abstracts with Programs*, v. 47, no. 6, p. 38.
- Roberts, E.M., Tapanila, L., and Mijal, B., 2008, Taphonomy and sedimentology of storm generated continental shell beds a case example from the Cretaceous Western Interior Basin: *Journal of Geology*, v. 116, no. 5, p. 462–479.
- Roberts, E.M., Sampson, S.D., Deino, A., and Bowring, S., 2013, The Kaiparowits Formation a remarkable record of Late Cretaceous terrestrial environments, ecosystems and evolution in Western North America, in Titus, A.L., and Loewen, M.A., editors, *At the top of the Grand Staircase the Late Cretaceous of southern Utah*: Bloomington, Indiana University Press, p. 85–106.
- Roček, Z., Eaton, J.G., Gardner, J.D., and Přikryl, T., 2010, Evolution of anuran assemblages in the Late Cretaceous of Utah: *Palaeobiodiversity and Palaeoenvironments*, v. 90, p. 341–393.
- Roček, Z., Gardner, J.D., Eaton, J.G., and Přikryl, T., 2013, Anuran ilia from the Late Cretaceous of Utah Diversity and stratigraphic patterns, in Titus, A.L., and Loewen, M.A., editors, *At the top of the Grand Staircase the Late Cretaceous of southern Utah*: Bloomington, Indiana University Press, p. 273–294.
- Sampson, S.D., Loewen, M.A., Farke, A.A., Roberts, E.M., Forster, C.A., Smith, J.A., and Titus, A.L., 2010, New horned dinosaurs from Utah provide evidence for intracontinental dinosaur endemism: *PLoS ONE*, v. 5, no. 9, e12292. doi:10.1371/journal.pone.0012292.
- Sampson, S.D., Lund, E.K., Loewen, M.A., Farke, A.A., and Clayton, K.E., 2013, A remarkable short snouted horned dinosaur from the Late Cretaceous (late Campanian) of southern Utah: *Proceedings of the Royal Society B, Biological Sciences*, v. 280 (1766): 20131186. doi:10.1098/rspb.2013.1186.
- Schmitt, J.G., Jones, D.A., and Goldstrand, P.M., 1991, Braid ed stream deposition and provenance of the Upper Cretaceous Paleocene(?) Canaan Peak Formation, Sevier Foreland Basin, southwestern Utah, in Nations, J.D., and Eaton, J.G., editors, *Stratigraphy, depositional environments and sedimentary tectonics of the western margin, Cretaceous Western Interior Seaway*: Geological Society of America Special Paper 260, p. 27–45.
- Tapanila, L., and Roberts, E.M., 2013, Continental invertebrates and trace fossils from the Campanian Kaiparowits Formation, Utah, in Titus, A.L., and Loewen, M.A., editors, *At the top of the Grand Staircase the Late Cretaceous of southern Utah*: Bloomington, Indiana University Press, p. 132–152.
- Thompson, A.E., and Stokes, W.L., 1970, Stratigraphy of the San Rafael Group, southwest and south central Utah: *Utah Geological Survey Bulletin* 87, 54 p.
- Tibert, N.E., Leckie, R.M., Eaton, J.G., Kirkland, J.I., Colin, J.P., Leithold, E.L., and McCormic, M.E., 2003, Recognition of relative sea level change in Upper Cretaceous coal bearing strata a paleoecological approach using agglutinated foraminifera and ostracods to detect key stratigraphic surfaces, in Olson, H.C., and Leckie, R.M., editors, *Micropaleontological proxies for sea level change and stratigraphic discontinuities*: Society of Economic Paleontologists and Mineralogists Special Publication 75, p. 263–299.
- Tilton, T.L., 1991, Upper Cretaceous stratigraphy of the southern Paunsaugunt Plateau, Kane County, Utah: Salt Lake City, University of Utah, Ph.D. dissertation, 162 p.
- Titus, A.L., Roberts, E.M., and Albright, L.B., III, 2013, Geologic overview, in Titus, A.L., and Loewen, M.A., editors, *At the top of the Grand Staircase the Late Cretaceous of southern Utah*: Bloomington, Indiana University Press, p. 85–106.

Late Cretaceous Stratigraphy and Vertebrate Faunas of the Markagunt, Paunsaugunt, and Kaiparowits Plateaus, Southern Utah
Titus, A.L., Eaton, J.G., and Sertich, J.

of the Grand Staircase the Late Cretaceous of southern Utah:
Bloomington, Indiana University Press, p. 13 41.

Titus, A.L., and Loewen, M.A., editors, 2013, At the top of the
Grand Staircase the Late Cretaceous of southern Utah:
Bloomington, Indiana University Press, 656 p.

Wiersma, J.P., 2016, The evolution and biogeography of ankylo
saurid dinosaurs from the Late Cretaceous of western North
America: Salt Lake City, University of Utah, M.S. thesis, 434 p.

Weishampel, D.B., and Jensen, J.A., 1979, *Parasaurolophus* (Reptil
ia: Hadrosauridae) from Utah: Journal of Paleontology, v. 53,
p. 1422 1427.

Young, R.G., 1960, Dakota Group of Colorado Plateau: American
Association of Petroleum Geologists Bulletin, v. 44, p. 158
194.

Zanno, L.E., Gillette, D.D., Albright, L.B., and Titus, A.L., 2009, A
new North American therizinosaurid and the role of herbivo
ry in 'predatory' dinosaur evolution: Proceedings of the Royal
Society B, Biological Sciences, v. 276, p. 3505 3512.

Zanno, L.E., and Sampson, S.D., 2005, A new oviraptorosaur
(Theropoda: Maniraptora) from the Late Cretaceous (Cam
panian) of Utah: Journal of Vertebrate Paleontology, v. 25, p.
897 904.

Zanno, L.E., Varricchio, D.J., O'Connor, P.M., Titus, A.L., and
Knell, M.J., 2011, A new troodontid theropod, *Talos sampsoni*
gen. et sp. nov., from the Upper Cretaceous Western Interi
or Basin of North America: PLoS ONE, v. 6, no. 9, e24487.
doi:10.1371/journal.pone.0024487.

Zanno, L.E., Loewen, M.A., Farke, A.A., Kim, G., Claessens,
L.P.A.M., and McGarrity, C.T., 2013, Late Cretaceous thero
pod dinosaurs of southern Utah, in Titus, A.L., and Loewen,
M.A., editors, At the top of the Grand Staircase the Late Cre
taceous of southern Utah: Bloomington, Indiana University
Press, p. 504 525.



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APPENDIX

LATE CRETACEOUS VERTEBRATE FAUNAL LISTS FOR SOUTHERN UTAH

Background

Although the total number of taxa is known to be higher in every single Cretaceous formation of southern Utah, these faunal lists were generated only from published papers that documented specific specimens from specific localities with certain taxonomic assignments. Taxa listed in undocumented faunal lists (e.g., Eaton, 1999; Eaton and others, 1999a, 1999b) or overly broad taxonomic assignments are not included. As such, we only list the published turtle fauna from Hutchison and others (2013, Kaiparowits Formation) and Holroyd and Hutchison (2016, Wahweap Formation) even though turtle remains are common in nearly every formation. Similarly, a large number of additional dinosaur taxa are known from the Wahweap and Kaiparowits Formations, but either the specimens have never been described or the material is not specifically diagnostic. Irmis and others (2013) described the crocodyliform fauna at the order-suborder level and generally did not provide locality information for specimens; however, two taxa at lower levels were described from the Kaiparowits Formation, and since fossils are only known from that formation on the Kaiparowits Plateau, those are included below. The fish described by Brinkman and others (2013) are from a limited number of localities and are only recorded in the faunal lists from the specific plateau from which the specimens are documented. As such, there is a large list of fish represented from the Wahweap Formation of the Paunsaugunt Plateau, but these were not extended to the Wahweap Formation of the Kaiparowits Plateau as there is no documentation for that presented in Brinkman and others (2013). In the faunal lists, names, and years in parentheses cite the original publication naming that taxon, whereas those citations preceded by “in” merely refer to a source that documents the taxon in southern Utah. For nearly all macrovertebrates, the reference is the same as the original paper naming the taxon.

Cretaceous Vertebrate Faunas of Cedar Canyon Markagunt Plateau

Naturita Formation, Cenomanian (Localities: UMNH VP 161, 162)

Allocaudata

Albanerpetontidae

Gen. and sp. indet. (in Gardner and Demar, 2013)

Anura

Family incertae sedis

Gen. and sp. indet. (in Roček and others, 2010)

Squamata

Boreoteiioidea

Bicuspidon smikros (in Nydam, 2013)

Scincomorpha

Contogenidae

Utahgenys antongai (in Nydam, 2013)

Paramacellodid/Cordylid grade

Morphotype A (in Nydam, 2013)

Morphotype B (in Nydam, 2013)

Anguimorpha

Family incertae sedis

Gen. and sp. indet. (in Nydam, 2013)

Multituberculata

Family incertae sedis – *Paracimexomys* group

Gen. and sp. indet. (in Eaton, 2009)

cf. *Paracimexomys* sp. (in Eaton, 2009)

Cedaromys minimus (in Eaton, 2009)

Dakotamys malcolmi (in Eaton, 2009)

Cimolodontidae

Gen. and sp. indet. (in Eaton, 2009)

?Cimolodontidae

Gen. and sp. indet. (in Eaton, 2009)

Symmetrodonta

Spalacotheriidae

Gen. and sp. indet. (in Eaton, 2009)

Boreosphenida

Family incertae sedis

Gen. and sp. indet. (in Eaton, 2009)

Marsupialia

“Alphadontidae”

Eoalphadon woodburnei (in Eaton, 2009)

?*Eoalphadon* sp. (in Eaton, 2009)

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John Henry Member (Coniacian?), Straight Cliffs Formation (Localities: MNA 1260/UMNH VP 8, 9)

Elasmobranchii

Lonchidiidae

Lonchidion sp. (in Kirkland and others, 2013)

Neoselachii

Ginglymostomatidae

Cantioscyllium markaguntensis (Kirkland and others, 2013)

Neopterygii

Semionotidae

Lepidotes sp. indet. (in Brinkman and others, 2013)

Pycnodontidae

Coelodus sp. (in Brinkman and others, 2013)

Teleostii

Otophysi Order and family indet.

Gen. and sp. indet. (in Brinkman and others, 2013)

Acanthomorpha Order and family indet.

Gen. and sp. indet. (in Brinkman and others, 2013)

Urodela

Scapherpetontidae

Gen. and sp. indet. (in Gardner and Demar, 2013)

Family incertae sedis

Gen. and sp. indet. (in Gardner and Demar, 2013)

Anura

Family incertae sedis

Gen. and sp. indet. (in Roček and others, 2010)

Multituberculata

Family incertae sedis – *Paracimexomys* group

Cedaromys sp. (in Eaton, 2006a)

Marsupialia

Family “Alphadontidae”

?*Varalphadon* sp. (in Eaton, 2006a)

Eutheria

Order and family incertae sedis

Gen. and sp. indet. (in Eaton, 2006a)

“Wahweap” Formation (basal, lower? Campanian) (Locality: UMNH VP 10/MNA 1417)

Allocaudata

Albanerpetontidae

Gen. and sp. indet. (in Gardner and Demar, 2013)

Anura

Family incertae sedis

Gen. and sp. indet. (in Roček and others, 2010)

Multituberculata

Family incertae sedis – *Paracimexomys* group

cf. *Paracimexomys* sp. (in Eaton, 2006a)

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Bryceomys sp. (in Eaton, 2006a)
Cedaromys sp. cf. *C. hutchisoni* (in Eaton, 2006a)
Cedaromys sp. (in Eaton, 2006a)
? *Cimoxomys* sp. (in Eaton, 2006a)

Cimolomyidae

Cimolomys sp. (in Eaton, 2006a)
? *Cimolomys* sp. (in Eaton, 2006a)

Cimolodontidae

Cimolodon wardi (in Eaton, 2006a)
Cimolodon similis (in Eaton, 2006a)
Cimolodon sp. cf. *C. nitidus* (in Eaton, 2006a)

Neoplagiaulacidae

Mesodma sp. cf. *M. minor* (in Eaton, 2006a)

Trechnotheria

Spalacotheriidae

Symmetrodontoides sp. cf. *S. foxi* (Eaton, 2006a)

Marsupialia

Order and family incertae sedis

cf. *Anchistodelphys* sp. (in Eaton, 2006a)

“Alphadontidae”

cf. *Varalphadon* sp. (in Eaton, 2006a)
cf. *Protalphadon* sp. (in Eaton, 2006a)
Eoalphadon sp. cf. *E. clemensi* (in Eaton, 2006a, see Eaton, 2009)
Eoalphadon sp. (in Eaton, 2006a, see Eaton, 2009)
cf. *Turgidodon* sp. (in Eaton, 2006a)

?Pediomyidae

? “*Pedimys*” sp. (in Eaton, 2006a)

Boreosphenida

Picopsidae

Picopsis sp. (in Eaton, 2006a)
cf. *Picopsis* sp. A (in Eaton, 2006a)
cf. *Picopsis* sp. B (in Eaton, 2006a)

“Wahweap” Formation (high, Campanian?) (Locality: UMNH VP 11)

Urodela

Family incertae sedis

Nezpercius dodsoni (in Gardner and Demar, 2013)

Anura

Family incertae sedis

Scotiophryne pustulosa (in Roček and others, 2010; Gardner and Demar, 2013)
Gen. and sp. indet. (in Roček and others, 2010)

Multituberculata

Family incertae sedis – *Paracimexomys* group

Cedaromys sp. (in Eaton, 2006a)

Cimolomyidae

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Meniscoessus sp. cf. *M. intermedius* (in Eaton, 2006a)

Cimolomys sp. (in Eaton, 2006a)

?*Cimolomys* sp. (in Eaton, 2006a)

Cimolodontidae

Cimolodon sp. cf. *C. similis* (in Eaton, 2006a)

Marsupialia

“Alphadontidae”

Gen. and sp. indet. (in Eaton, 2006a)

Protalphadon sp. (in Eaton, 2006a)

?*Protalphadon* sp. (in Eaton, 2006a)

Eoalphadon sp. cf. *E. clemensi* (in Eaton, 2006a, see Eaton, 2009)

“Pediomyidae”

Gen. and sp. indet. (in Eaton, 2006a)

“*Pediomys*” sp. near “*P. exiguous*” (in Eaton, 2006a)

?*Aquiladelphus laurae* (in Eaton, 2006a)

Cretaceous Vertebrate Faunas of the Paunsaugunt Plateau

Naturita Formation, Cenomanian (Locality: UMNH VP 123/MNA 939)

Anura

Family, Gen. and sp. indet. (in Roček and others, 2010)

Multituberculata

Cimolodontidae

Gen. and sp. indet. (in Eaton, 1995)

Family incertae sedis – *Paracimexomys* group

Paracimexomys sp. cf. *P. robisoni* (in Eaton, 1995)

Paracimexomys sp. (in Eaton, 1995)

cf. *Paracimexomys* sp. (in Eaton, 1995)

Dakotamys malcolmi (in Eaton, 1995)

Theria

Family, Gen. and sp. indet. (in Eaton, 1993b)

Marsupialia

“Alphadontidae”

Eoalphadon lillegraveni (in Eaton, 1993b as “*Alphadon*” *lillegraveni*)

Eoalphadon sp. (in Eaton, 1993b as “*Alpahdon*” sp.)

Family incertae sedis

Pariadens kirklandi (in Eaton, 1993b)

John Henry Member (basal, Coniacian), Straight Cliffs Formation (Localities: UMNH VP 417, 823, 856, 1064)

Elasmobranchii

Hybodontidae

Hybodus sp. (in Kirkland and others, 2013)

Lonchidiidae

Lonchidion sp. (in Kirkland and others, 2013)

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Anura

Family incertae sedis

Gen. and sp. indet. (in Roček and others, 2010)

Dinosauria

Ornithopoda

Iguanodontia gen. and sp. indet. (in Gates and others, 2013)

Multituberculata

Cimolodontidae

Mesodma sp. cf. *M. minor* (in Eaton, 2013)

John Henry Member (Santonian), Straight Cliffs Formation (Localities: UMNH VP 419, 420, 424, 426, 427, 569, 781, 799, 821, 843, 1144, 1156)

Elasmobranchii

Hybodontidae

Hybodus sp. (in Kirkland and others, 2013)

Neopterygii

Lepisostidae

Lepisosteus sp. indet. (in Brinkman and others, 2013)

Neopterygii

Semionotidae

Lepidotes sp. indet. (in Brinkman and others, 2013)

Pycnodontidae

Micropycnodon sp. (in Brinkman and others, 2013)

Amiidae

Gen. and sp. indet. (in Brinkman and others, 2013)

Teleostii

Hiodontidae

Gen. and sp. indet. (in Brinkman and others, 2013)

Elopiformes Family indet.

Gen. and sp. indet. (in Brinkman and others, 2013)

Sorbinichthyidae

Diplomystus sp. (in Brinkman and others, 2013)

Otophysi Order and family indet.

Gen. and sp. indet. (in Brinkman and others, 2013)

Euteleostei Order and family indet.

Gen. and sp. indet. U-4 (in Brinkman and others, 2013)

Acanthomorpha Order and family indet.

Gen. and sp. indet. (in Brinkman and others, 2013)

Allocaudata

Albanerpetontidae

Gen. and sp. indet. (in Gardner and Demar, 2013)

cf. *Albanerpeton nexuosum* (Gardner and Demar, 2013)

Urodela

Scapherpetontidae

Scapherpeton sp. (in Gardner and Demar, 2013)

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Batracosauroididae

Opisthotriton sp. (in Gardner and Demar, 2013)

Gen. and sp. indet. (in Gardner and Demar, 2013)

Sirenidae

Habrosaurus sp. (in Gardner and Demar, 2013)

Family incertae sedis

Gen. and sp. nov. (in Gardner and Demar, 2013)

Anura

Family incertae sedis

Scotiophryne pustulosa (in Roček and others, 2010, Gardner and Demar, 2013)

Gen. and sp. indet. (in Roček and others, 2010)

Scincomorpha

Paramacellodid/Cordylid grade

Monocnemodon syphakos (in Nydam, 2013)

Anguimorpha

Family incertae sedis

cf. *Colpodontosaurus* sp. (in Nydam, 2013)

Platynota

Family incertae sedis

Morphotype B (in Nydam, 2013)

Morphotype C (in Nydam, 2013)

Autarchoglossa

Family incertae sedis

Morphotype D (in Nydam, 2013)

Scincomorpha

Family incertae sedis

Gen. and sp. indet. (in Nydam, 2013)

Serpentes

Family incertae sedis

Coniophis sp. (in Nydam, 2013)

Dinosauria

Nodosauridae

Gen and sp. indet. (in Loewen and others, 2013a)

Triconodonta

Triconodontidae

Gen. and sp. indet. (in Eaton, 2013)

cf. *Alticonodon* sp. (in Eaton, 2013)

Multituberculata

Family incertae sedis – *Paracimexomys* group

Dakotamys shakespearei (in Eaton, 2013)

Cedaromys sp. cf. *C. hutchisoni* (in Eaton, 2013)

Neoplagiulacidae

Mesodma sp. cf. *M. minor* (in Eaton, 2013)

Mesodma sp. (in Eaton, 2013)

?*Mesodma* sp. (in Eaton, 2013)

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Cimolodontidae

- Cimolodon* sp. cf. *C. foxi* (in Eaton, 2013)
- Cimolodon similis* (in Eaton, 2013)
- Cimolodon* sp. cf. *C. similis* (in Eaton, 2013)
- ?*Cimolodon* sp. (in Eaton, 2013)

Cimolomyidae

- Cimolomys* sp. A (in Eaton, 2013)
- Cimolomys* sp. B (in Eaton, 2013)
- ?*Cimolomys* sp. A (in Eaton, 2013)
- ?*Cimolomys* sp. B (in Eaton, 2013)

Trechnotheria

Spalacotheriidae

- ?*Spalacotheridium* sp. (in Eaton, 2013)
- Symmetrodontoides* sp. (in Eaton, 2013)

Marsupialia

“Didelphomorpha” - Family incertae sedis

- Gen. and sp. indet. (in Eaton, 2013)
- Apistodon* sp. cf. *A. exiguus* (in Eaton, 2013)
- cf. “*Anchistodelphys*” sp. (in Eaton, 2013)

“Alphadontidae”

- ?*Varalphadon* sp. (in Eaton, 2013)

Stagodontidae

- Eodelphis* sp. (in Eaton, 2013)

Pediomyidae

- Gen. and sp. indet. (in Eaton, 2013)
- ?*Leptalestes* sp. (in Eaton, 2013)

Wahweap Formation, Campanian (Localities: UMNH VP 61, 77, 78, 80, 83, 807, 792, 1073, 1074; MNA 1073, 1074)

Neoselachii

Hemiscyllidae

- Chiloscyllium missouriense* (in Kirkland and others, 2013)

Batomorphii

Rhinobatoidea - Family incertae sedis

- Cristomylus cifellii* (Kirkland and others, 2013)

Sclerorhynchiformes

Sclerorhynchiidae

- Columbusia deblieuxi* (Kirkland and others, 2013)

Neopterygii

Lepisostidae

- Lepisosteus* sp. indet. (in Brinkman and others, 2013)

Semionotidae

- Lepidotes* sp. indet. (in Brinkman and others, 2013)

Pycnodontidae

- Micropycnodon* sp. (in Brinkman and others, 2013)

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Actinopterygii

Albulidae

Parabula sp. (in Brinkman and others, 2013)

Otophysi Order and family indet.

Gen. and sp. indet. (in Brinkman and others, 2013)

Acanthomorpha Order and family indet.

Gen. and sp. indet. (in Brinkman and others, 2013)

Allocaudata

Albanerpetontidae

Gen. and sp. indet. (in Gardner and Demar, 2013)

Urodela

Scapherpetontidae

Scapherpeton tectum in Gardner and Demar, 2013)

Batracosauroididae

Opisthotriton kayi (in Gardner and Demar, 2013)

Family incertae sedis

Nezpercius dodsoni (in Gardner and Demar, 2013)

Gen. and sp. nov. (in Gardner and Demar, 2013)

Anura

Family incertae sedis

Scotiophryne pustolosa (in Roček and others, 2010)

Gen. and sp. indet. (in Roček and others, 2010)

Multituberculata

Family incertae sedis – *Paracimexomys* group

Paracimexomys sp. (in Eaton, 1993b)

?*Paracimexomys* sp. (in Eaton, 2013)

Cedaromys sp. cf. *C. hutchisoni* (in Eaton, 2013)

?*Cimexomys gregoryi* (in Eaton, 1993b)

Gen. and sp. indet. (in Eaton, 2002)

Neoplagiaulacidae

Mesodma sp. cf. *M. minor* (in Eaton, 2013)

Mesodma sp. cf. *M. archibaldi* (in Eaton, 2002, 2013)

Mesodma sp. cf. *M. formosa* (in Eaton, 1993b, 2013)

Mesodma sp. cf. *M. hensleighi* (in Eaton, 1993b)

Mesodma sp. (in Eaton, 1993b)

Cimolodontidae

Cimolodon similis (in Eaton, 2002)

Cimolodon sp. cf. *C. nitidus* (in Eaton, 1993b)

Cimolodon sp. cf. *C. foxi* (in Eaton, 2013)

?*Cimolodon* sp. (Eaton, 1993b)

Cimolomyidae

Cimolomys milliensis (in Eaton, 1993b)

Cimolomys sp. (in Eaton, 2013)

?*Cimolomys* sp. (in Eaton, 2013)

?*Cimolomys* sp. B (in Eaton, 2002)

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Meniscoessus sp. (in Eaton, 2013)

Trechnotheria

Spalacotheriidae

Symmetrodontoides foxi (in Eaton, 1993b)

Marsupialia

Order and Family incertae sedis

cf. *Iugomortiferum* sp. (in Eaton, 2013)

Gen. and sp. indet. A (in Eaton, 2013)

Gen. and sp. indet. B (in Eaton, 2013)

cf. *Apistodon* sp. (in Eaton, 2013)

“Alphadontidae”

Alphadon sp. cf. *A. wilsoni* (in Eaton, 1993b)

Alphadon sp. cf. *A. attaragos* (in Eaton, 1993b)

Turgidodon sp. cf. *T. russelli* (*Alphadon* sp. cf. *A. russelli* in Eaton, 1993b)

Turgidodon sp. (in Eaton, 1993b)

Varalphadon sp. cf. *V. creber* (in Eaton, 2013)

cf. *Varalphadon* sp. (in Eaton, 2013)

Pediomyidae

Gen. and sp. indet. (in Eaton, 2013)

Cretaceous Vertebrate Faunas of the Kaiparowits Plateau

Naturita Formation, Cenomanian (Localities: UMNH VP 27/MNA 1067/OMNH V808; UMNH VP 804)

Batomorphii

Rhinobatoidea Family incertae sedis

Cristomylus bulldogensis (Kirkland and others, 2013)

Pseudomyledaphus sp. (in Kirkland and others, 2013)

Elasmobranchii

Hybonontidae

Hybodus sp. (in Kirkland and others, 2013)

Lonchidiidae

Lonchidion sp. (in Kirkland and others, 2013)

Neopterygii

Semionotidae

Lepidotes sp. (in Brinkman and others, 2013)

Pycnodontidae

Coelodus sp. (in Brinkman and others, 2013)

Amiidae

Gen. and sp. indet. (in Brinkman and others, 2013)

Teleostei

Osteoglossomorpha family indet.

Coriops sp. (in Brinkman and others, 2013)

Hiodontidae

Gen. and sp. indet. (in Brinkman and others, 2013)

Elopiformes Family indet.

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Gen. and sp. indet. (in Brinkman and others, 2013)
 Ellimmichthyiformes Family indet.
 Gen. and sp. indet. type LvD (in Brinkman and others, 2013)
 Gen. and sp. indet. type U-7 (in Brinkman and others, 2013)
 Sorbinichthyidae
Diplomystus sp. (in Brinkman and others, 2013)
 Euteleostei Order and family indet.
 Gen. and sp. indet. U-4 (in Brinkman and others, 2013)
 Sarcopterygii
 Ceratodontiformes
Ceratodus gustasoni (Kirkland, 1987)
 Allocaudata
 Albanerpetontidae
 cf. *Albanerpeton nexuosa* (in Gardner and Demar, 2013)
 Urodela
 Scapherpetontidae
 Gen and sp. indet. (in Gardner and Demar, 2013)
 Batracosauroididae
 Gen. and sp. nov. (in Gardner and Demar, 2013)
 Anura
 Family incertae sedis
 Gen. and sp. indet. (in Roček and others, 2010)
 Squamata
 Boreoteiioidea
Bicuspidon smikros (in Nydam, 2013)
 Scincomorpha
 Paramacellodid/Cordylid grade
Dakotasaurus gillettorum (in Nydam, 2013)
 Morphotype C (in Nydam, 2013)
Webbsaurus lofgreni (in Nydam, 2013)
 Family indet.
 Morphotype D (in Nydam, 2013)
 ?Scincomorpha
 Family incertae sedis
 Gen. and sp. indet. (in Nydam, 2013)
 Anguimorpha
 aff. Xenosauridae
Cnodontosaurus suchockii (in Nydam, 2013)
 Platynota
 Family indet.
 Morphotype E (in Nydam, 2013)
 Anguimorpha
 Family incertae sedis
 Gen. and sp. indet. (in Nydam, 2013)
 Serpentes

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Family incertae sedis

Coniophis sp. (in Nydam, 2013)

Multituberculata

Family incertae sedis – *Paracimexomys* group

Paracimexomys sp. cf. *P. robisoni* (in Eaton, 1995)

Paracimexomys sp. (in Eaton, 1995)

cf. *Paracimexomys* sp. (in Eaton, 1995)

Dakotamys malcolmi (in Eaton, 1995)

?*Dakotamys* sp. (in Eaton, 1995)

Gen. and sp. indet. A (in Eaton, 1995)

Gen. and sp. indet. B (in Eaton, 1995)

Cimolodontidae

Cimolodon sp. cf. *C. similis* (in Eaton, 1995)

Gen. and sp. indet. (in Eaton, 1995)

?Boreosphenida

Order and family incertae sedis

Gen. and sp. indet. (in Eaton, 1993a)

Dakotadens morrowi (in Eaton, 1993a)

Dakotadens sp. (in Eaton, 1993a)

Marsupialia

Family “Alphadontidae”

Eoalphadon clemensi (in Eaton, 1993a as “*Alphadon*” *clemensi*)

Eoalphadon lillegraveni (in Eaton, 1993a as “*Alphadon*” *lillegraveni*)

Eoalphadon sp. (in Eaton, 1993a as “*Alphadon*” sp.)

Protalphadon sp. (in Eaton, 1993a)

Gen. and sp. indet. (in Eaton, 1993a)

Family indet.

Pariadens kirklandi (Cifelli and Eaton, 1987)

Tropic Shale (Late Cenomanian-Middle Turonian)

Elasmobranchii

Mitsukurinidae

Scapanorhynchus raphiodon (in Albright and others, 2013)

Anacoracidae

Squalicorax curvatus (in Albright and others, 2013)

Cretoxyrhinidae

Cretoxyrhina mantelli (in Albright and others, 2013)

Cretolamna appendiculata (in Albright and others, 2013)

Sclerorhyncoidei

cf. *Ptychotrygon* sp. (in Albright and others, 2013)

Ptychodontidae

Ptychodus decurrens (in Albright and others, 2013)

Ptychodus cf. *P. mammillaris* (in Albright and others, 2013)

Ptychodus whipplei (in Albright and others, 2013)

Ptychodus occidentalis (in Albright and others, 2013)

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Ptychodus anonymus (in Albright and others, 2013)

Ptychodus sp. indet. (in Albright and others, 2013)

Neopterygii

Pycnodontidae

Gen. and sp. indet. (in Albright and others, 2013)

Actinopterygii

Ichthyodectidae

Gillicus arcuatus (in Albright and others, 2013)

Ichthyodectes ctenodon (in Albright and others, 2013)

Ichthyodectes cf. *I. ctenodon* (in Albright and others, 2013)

Xiphactinus cf. *X. audax* (in Albright and others, 2013)

Testudinata

Protostegidae

Desmatochelys lowi (in Albright and others, 2013)

Gen. and sp. indet. (in Albright and others, 2013)

Family incertae sedis

Naomichelys sp. (in Albright and others, 2013)

Sauropterygia

Pliosauridae

Brachauchenius lucasi (Albright and others, 2007a)

Polycotylidae

Eopolycotylus rankini (Albright and others, 2007b)

Dolichorhynchops tropicensis Schmeisser McKean, 2012)

Palmulasaurus quadratus (Albright and others, 2007b)

Trinacromerum cf. *T. bentonianum* (in Albright and others, 2013)

Dinosauria

Therizinosauridae

Nothronychus graffami (Zanno and others, 2009)

Smoky Hollow Member (Turonian), Straight Cliffs Formation (Localities: UMNH VP 129/MNA 995/OMNH V843; OMNH V4, 60, 1404)

Batomorphii

Rhinobatoidea (family incertae sedis)

Cristomylus sp. cf. *C. bulldogensis* (in Kirkland and others, 2013)

Osteichthyes-Neopterygii

Lepisostidae

Lepisosteus sp. (in Brinkman and others, 2013)

Semionotidae

Lepidotes sp. (in Brinkman and others, 2013)

Pycnodontidae

Coelodus sp. (in Brinkman and others, 2013)

Amiidae

Gen. and sp. indet. (in Brinkman and others, 2013)

?*Melvius* sp. (in Brinkman and others, 2013)

Teleostii

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Hiodontidae

Gen. and sp. indet. (in Brinkman and others, 2013)

Elopiformes Family incertae sedis

Gen. and sp. indet. (in Brinkman and others, 2013)

Ellimmichthyiformes Family incertae sedis.

Gen. and sp. indet. type U-7 (in Brinkman and others, 2013)

Otophysi Order and family incertae sedis

Gen. and sp. indet. (in Brinkman and others, 2013)

Euteleostei Order and family incertae sedis

Gen. and sp. indet. U-4 (in Brinkman and others, 2013)

Order and family incertae sedis

Gen. and sp. indet. type HvB (in Brinkman and others, 2013)

Allocaudata

Albanerpetontidae

Albanerpeton cifellii (in Gardner, 1999)

cf. *Albanerpeton nexuosum* (in Gardner and Demar, 2013)

Gen. and sp. indet. (in Gardner and Demar, 2013)

Urodela

Batracosauroididae

Gen. and sp. nov. (in Gardner and Demar, 2013)

Family incertae sedis

Gen. and sp. nov. (in Gardner and Demar, 2013)

Gen. and sp. indet. (in Gardner and Demar, 2013)

Anura

Family incertae sedis

Gen. and sp. indet. (in Roček and others, 2010)

Scinocomorpha

Polyglyphanodontini

Dicothodon cifellii (in Nydam and others, 2007)

Chamops sp. cf. *C. signus* (in Nydam, 2013)

Contogeniidae

Utahgenys evansi (in Nydam, 2013)

Paramacellodid/Cordylid grade

Morphotype A-H (in Nydam, 2013)

Anguimorpha

Anguidae

aff. *Odaxosaurus* sp. (in Nydam, 2013)

aff. *Xenosaurida*

Cnodontosaurus sp. (in Nydam, 2013)

Platynota

Family incertae sedis

Morphotype I-J (in Nydam, 2013)

Anguimorpha

Family incertae sedis

Gen. and sp. indet. (in Nydam, 2013)

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Serpentes

Family incertae sedis

Coniophis sp. (in Nydam, 2013)

Dinosauria

Ornithopoda

Iguanodontia gen. and sp. indet. (in Gates and others, 2013)

Multituberculata

?Taeniolabidoidea Family incertae sedis

Gen. and sp. indet. (in Eaton, 1995)

Suborder and family incertae sedis - *Paracimexomys* group

Paracimexomys sp. cf. *P. robisoni* (in Eaton, 1995)

Bryceomys fumosus (in Eaton, 1995)

Bryceomys sp. cf. *B. fumosus* (in Eaton, 1995)

Bryceomys hadrosus (in Eaton, 1995)

Bryceomys sp. (in Eaton, 1995)

Symmetrodonta

Family incertae sedis

Gen. and sp. indet. (in Cifelli and Gordon, 1999)

Spalacotheriidae

Symmetrodontoides oligodontos (in Cifelli and Gordon, 1999)

Spalacotheridium mckennai (in Cifelli and Gordon, 1999)

Aegialodontia

Deltatheridiidae

Gen. and sp. indet. (in Cifelli, 1990a)

Family incertae sedis

Gen. and sp. indet. (in Cifelli, 1990a)

Marsupialia

Family incertae sedis

?*Varalphadon delicatus* (in Cifelli, 1990a)

?Stagodontidae

Gen. and sp. indet. (in Cifelli, 1990a)

John Henry Member (basal - Coniacian), Straight Cliffs Formation (Localities: OMNH V856; UMNH VP 663)

Batomorphii

Rhinobatoidea Family incertae sedis

Pseudomyledaphus madseni (Kirkland and others, 2013)

Allocaudata

Albanerpetontidae

Gen. and sp. indet. (in Gardner and Demar, 2013)

Urodela

Scapherpetontidae

Scapherpeton tectum (in Gardner and Demar, 2013)

Gen. and sp. indet. (in Gardner and Demar, 2013)

John Henry Member (Santonian), Straight Cliffs Formation (Localities: UMNH VP 98, 99, 567; OMNH V27; MNA 706)

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Neoselachii

Ginglymostomatidae

Cantioscyllium markaguntensis (Kirkland and others, 2013)

Batomorphii

Rhinobatoidea Family incertae sedis

Pseudomyledaphus madseni (Kirkland and others, 2013)

Allocaudata

Albanerpetontidae

Gen. and sp. indet. (in Gardner and Demar, 2013)

Urodela

Batracosauroididae

Opistotriton kayi (in Gardner and Demar, 2013)

Gen. and sp. indet. (in Gardner and Demar, 2013)

Anura

Family incertae sedis

Gen. and sp. indet. (in Roček and others, 2010)

Scincomorpha

Paramacellodid/Cordylid grade

Monocnemodon syphakos (in Nydam, 2013)

Morphotype A (in Nydam, 2013)

Multituberculata

Family incertae sedis – *Paracimexomys* group

Cedaromys sp. cf. *C. hutchisoni* (in Eaton, 2006b)

Cedaromys sp. (in Eaton, 2006b)

Family incertae sedis

Gen. and sp. indet. (in Eaton, 2006b)

Neoplagiulacidae

Mesodma sp. cf. *M. minor* (in Eaton, 2006b)

Cimolodontidae

Cimolodon foxi (in Eaton, 2006b)

Cimolodon sp. (in Eaton, 2006b)

?*Cimolodon* sp. (in Eaton, 2006b)

Cimolomyidae

?*Cimolomys* sp. (in Eaton, 2006b)

Theria

Spalacotheriidae

Spalacotherium sp. (in Eaton, 2006b)

Symmetrodontoides sp. cf. *S. oligodontos* (in Cifelli and Gordon, 1999)

Family incertae sedis

Potamotelses sp. (in Eaton, 2006b)

Picopsis sp. (in Eaton, 2006b)

Marsupialia

"Alphadontidae"

Alphadon sp. cf. *A. halleyi* (in Eaton, 2006b)

Varalphadon sp. (in Eaton, 2006b)

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?Stagodontidae

Gen. and sp. indet. (in Eaton, 2006b)

Family incertae sedis

?*Anchistodelphys* sp. (in Eaton, 2006b)

Gen. and sp. indet. (in Eaton, 2006b)

Wahweap Formation, Middle Campanian (Localities: OMNH V2, 8, 11, 16; UMNH VP 82, 130; MNA 455, 456, 702, 705, 707, 1015, 1294)

Elasmobranchii

Hybodontidae

Hybodus sp. (in Kirkland and others, 2013)

Lonchidiidae

Lonchidion sp. (in Kirkland and others, 2013)

Neoselachii

Ginglymostomatidae

Cantioscyllium estesi (in Kirkland and others, 2013)

Hemiscyllidae

Chiloscyllium missouriense (in Kirkland and others, 2013)

Batomorphii

Rhinobatoidea Family incertae sedis

Cristomylus cifellii (Kirkland and others, 2013)

Sclerorhynchiformes

Sclerorhynchiidae

Columbusia deblieuxi (Kirkland and others, 2013)

Texatrygon brycensis (Kirkland and others, 2013)

Osteichthyes-Neopterygii

Amiidae

Melvius cf. *M. chauliodous* (in Holroyd and Hutchison, 2016)

Lepisostidae

Gen. and sp. indet. (in Holroyd and Hutchison, 2016)

Actinopterygii

Polydontidae

Gen. and sp. indet. (in Brinkman and others, 2013)

Urodela

Batracosauroididae

Opisthotriton kayi (in Gardner and Demar, 2013)

Family incertae sedis

Nezpercius dodsoni (in Gardner and Demar, 2013)

Anura

Family incertae sedis

Scotiophryne pustulosa (in Roček and others, 2010)

Gen. and sp. indet. (in Roček and others, 2010)

Testudines

Baenidae

Arvinochelys sp. (in Holroyd and Hutchison, 2016)

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Denazinamys nodosa (in Holroyd and Hutchison, 2016)

Neurankylus sp. (in Holroyd and Hutchison, 2016)

Nanhsiungchelyidae

Basilemys sp. (in Holroyd and Hutchison, 2016)

Trionychidae

Gen. and sp. indet. (in Holroyd and Hutchison, 2016)

Squamata

cf. *Anguimorpha* indet. (in Nydam, 2013)

Serpentes

Family incertae sedis

Coniophis sp. (in Nydam, 2013)

cf. *Scincomorpha* – Family incertae sedis

Morphotype A (in Nydam, 2013)

Gen. and sp. indet. (in Nydam, 2013)

Dinosauria-Saurischia

Theropoda-Tyrannosauridae

Lythronax argestes (Lowen and others, 2013c).

Dinosauria-Ornithischia

Ornithopoda-Hadrosauridae

Saurolophinae

Acristavus sp. (in Gates and others, 2013)

c.f. *Brachylophosaurus* sp. (in Gates and others, 2013)

Lambeosaurinae (crested hadrosaurs)

Adelolophus hutchisoni (Gates and others, 2014)

Ceratopsidae

Centrosaurinae

Diabloceratops eatoni (Kirkland and DeBlieux, 2010)

Machairoceratops cronusi (Lund and others, 2016)

“Wahweap centrosaurine C” (in Loewen and others, 2013b)

Pachcephalosauridae

Gen. and sp. indet. (in Evans and others, 2013)

Multituberculata

Family incertae sedis – *Paracimexomys* group

Gen. and sp. indet. (in Eaton, 2002)

?*Paracimexomys* sp. (in Eaton, 2002)

cf. *Paracimexomys* sp. A (in Eaton, 2002)

cf. *Paracimexomys* sp. B (in Eaton, 2002)

Bryceomys sp. cf. *B. fumosus* (in Eaton, 2002)

Cedaromys sp. (in Eaton, 2002)

cf. *Cedaromys* sp. (in Eaton, 2002)

?*Cimexomys* sp. cf. *C. antiquus* (in Eaton, 2002)

Neoplagiaulacidae

Mesodma sp. cf. *M. formosa* (in Eaton, 2002)

Mesodma sp. cf. *M. minor* (in Eaton, 2002)

Mesodma sp. cf. *M. archibaldi* (in Eaton, 2002)

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Cimolodontidae

- Cimolodon electus* (in Eaton, 2002)
- Cimolodon similis* (in Eaton, 2002)
- Cimolodon* sp. cf. *C. nitidus* (in Eaton, 2002)
- Cimolodon* sp. cf. *C. foxi* (in Eaton, 2002)
- Cimolodon* sp. (small) (in Eaton, 2002)

Cimolomyidae

- Cimolomys* sp. cf. *C. trochuus* (in Eaton, 2002)
- ?*Cimolomys* sp. A (in Eaton, 2002)
- ?*Cimolomys* sp. B (in Eaton, 2002)
- ?*Cimolomys* sp. C (large) (in Eaton, 2002)
- Meniscoessus* sp. cf. *M. intermedius* (in Eaton, 2002)

Symmetrodonta

Family incertae sedis

- Gen. and sp. indet. (in Cifelli and Gordon, 1999)

Spalacotheriidae

- Symmetrodontoides foxi* (in Cifelli and Madsen, 1986; Cifelli and Gordon, 1999)

Order and Family incertae sedis

- Zygiocuspis goldingi* (in Cifelli, 1990c)

Marsupialia

“Alphadontidae”

- Varalphadon crebreforme* (in Cifelli, 1990b)
- Varalphadon wahweapensis* (in Cifelli, 1990b)
- Gen. and sp. indet. (in Cifelli, 1990b)

?Marsupialia

Family incertae sedis

- Iugomortiferum thoringtoni* (in Cifelli, 1990b)
- cf. *Iugomortiferum* sp. (in Cifelli, 1990b)

Insectivora

?Nyctitheriidae

- Paranyctoides* sp. (in Cifelli, 1990e)

Kaiparowits Formation, Upper Campanian (Localities: OMNH V5, 6, 9, 61; UMNH VP 24, 25, 51, 54, 56, 108, 1078, 1268; MNA 453, 454, 458, 697, 704, 1004, 1310; UCM 83240; 83258; for turtle bearing localities see Hutchison and others, 2013)

Neoselachii

Hemiscyllidae

- Chiloscyllium missouriense* (in Kirkland and others, 2013)

Batomorphii

Rhinobatoidea Family incertae sedis

- Myledaphus bipartitus* (Kirkland and others, 2013)

Sclerorhynchiformes

Sclerorhynchiidae

- Columbusia debbieuxi* (Kirkland and others, 2013)

Osteichthyes-Neopterygii

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Semionotidae

Lepidotes sp. indet. (in Brinkman and others, 2013)

Amiidae

Gen. and sp. indet. (in Brinkman and others, 2013)

Lepisostidae

Lepisosteus sp. indet. (in Brinkman and others, 2013)

Teleostei

Osteoglossomorpha Family incertae sedis

Coriops sp. (in Brinkman and others, 2013)

Hiodontidae

Gen. and sp. indet. (in Brinkman, 2013)

Albulidae

Parabula sp. (in Brinkman and others, 2013)

Clupeiformes Family incertae sedis

Gen. and sp. indet. type G (in Brinkman and others, 2013)

Otophysi Order and family incertae sedis

Gen. and sp. indet. (in Brinkman and others, 2013)

Characiformes Family incertae sedis

Gen. and sp. indet. (in Brinkman and others, 2013)

Euteleostei Order and family incertae sedis

Gen. and sp. indet. U-4 (in Brinkman and others, 2013)

Esocoidae Family incertae sedis

Estesesox foxi (in Brinkman and others, 2013)

Estesesox sp. (in Brinkman and others, 2013)

Order and family incertae sedis

Gen. and sp. indet. type BvE (in Brinkman and others, 2013)

Acanthomorpha Order and family incertae sedis

Gen. and sp. indet. (in Brinkman and others, 2013)

Allocaudata

Albanerpetontidae

Albanerpeton galaktion (in Gardner and Demar, 2013)

Albanerpeton gracile (in Gardner and Demar, 2013)

Albanerpeton nexuosum (in Gardner and Demar, 2013)

Urodela

Scapherpetontidae

Scapherpeton tectum (in Gardner and Demar, 2013)

Lisserpeton bairdi (in Gardner and Demar, 2013)

Batracosauroididae

Opisthotriton kayi (in Gardner and Demar, 2013)

Prodesmondon copei (in Gardner and Demar, 2013)

Sirenidae

Habrosaurus sp. (in Gardner and Demar, 2013)

Anura

Family incertae sedis

Scotiophryne pustulosa (in Gardner and Demar, 2013)

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Theatoniuss sp. (in Gardner and Demar, 2013)
cf. *Eopelobates* sp. (in Gardner and Demar, 2013)
Gen. and sp. indet. (in Roček and others, 2010; Roček and others, 2013)

Scincomorpha

Borioteiioidea

Peneteius saueri (in Nydam, 2013)
Meniscognathus molybrochorus (Nydam and Voci, 2007)
Chamops sp. cf. *C. segnis* (in Nydam, 2013)
cf. *Leptochamops* sp. (in Nydam and Voci, 2007)
Tripennaculus eatoni (in Nydam and Voci, 2007)

Contogeniidae

Palaeoscincosaurus pharkidodon (Nydam and Fitzpatrick, 2009)

Paramacellodid/Cordylid Grade

Morphotype A-G (in Nydam, 2013)

Anguimorpha

Anguidae

Odaxosaurus roosevelti (in Nydam, 2013)

Xenosauridae

?*Exostinus* sp. (in Nydam, 2013)

Platynota

Family incertae sedis

Parasaniwa cynochoros (Nydam, 2013)
Morphotypes H-J (in Nydam, 2013)

Serpentes

Family incertae sedis

Coniophis sp. (in Nydam, 2013)

Testudines

Pleurosternidae

Compsemys victa (in Hutchison and others, 2013)

Baenidae

Neurankylus hutchisoni (Lively, 2015b; new sp. A in Hutchison and others, 2013)
Neurankylus utahensis (Lively, 2015b; new sp. B in Hutchison and others, 2013)
Arvinachelys goldeni (Lively, 2015a)
Denazinemys nodosa (in Hutchison and others, 2013; Lively, 2015b)
Boremys grandis (in Hutchison and others, 2013; Lively, 2015b)
Plesiobaena sp. (in Hutchison and others, 2013)
Thescelus sp. (Lively, 2015b)

Chelydridae

Gen. and sp. indet. (in Hutchison and others, 2013)

Kinosternidae

Gen. and sp. indet. (in Hutchison and others, 2013)

Adocidae

Adocus sp. (in Hutchison and others, 2013)

Nanhsiungchelyidae

Basilemys nobilis (in Hutchison and others, 2013)

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Trionychidae

- Helopanoplia* sp. (in Hutchison and others, 2013)
- Aspideretoides* sp. (in Hutchison and others, 2013)
- Derrisemys* sp. (in Hutchison and others, 2013)
- Plastomenoides* sp. (in Hutchison and others, 2013)
- Gen. and sp. indet. (in Hutchison and others, 2013)

Crocodylia

Neosuchia

- cf. *Denazinasuchus* sp.

Alligatoroidea Family incertae sedis

- cf. *Leidyosuchus* sp. (in Farke and others, 2014)
- Deinosuchus hatcheri* (in Irmis and others, 2013)
- Brachychampsa* sp. (in Irmis and others, 2013)

?Pterosauria

- Gen. and sp. indet (in Farke and others, 2013)

Dinosauria-Saurischia

Theropoda-Ornithomimidae

- Ornithomimus* sp. indet. (in Claessens and Loewen, 2015)

Oviraptoridae

- Hagryphus giganteus* (Zanno and Sampson, 2005)

Dromaeosauridae

- Morphotype A (cf. *Dromaeosaurus*) (in Zanno and others, 2013)
- Morphotype B (cf. *Saurornitholestes*) (in Zanno and others, 2013)

Troodontidae

- Talos sampsoni* (Zanno and others, 2011)

Aviales

- Avisaurus* sp. (in Zanno and others, 2013)

Tyrannosauridae

- Teratophoneus curriei* (Carr and others, 2011)

Dinosauria-Ornithischia

Hypsilophodontidae

- Gen and sp. nov. (in Boyd, 2015, "hypsilophodontid" in Gates and others, 2013)

Hadrosauridae-Saurolophinae

- Gryposaurus* cf. *G. notabilis* (in Gates and others, 2013)
- Gryposaurus monumentensis* (Gates and Sampson, 2007)

Hadrosauridae-Lambeosaurinae

- Parasaurolophus* sp. (in Gates and others, 2013)

Ceratopsidae-Chasmosaurinae

- Utahceratops gettyi* (Sampson and others, 2010)
- Kosmoceratops richardsoni* (Sampson and others, 2010)

Ceratopsidae-Centrosaurinae

- Nasutoceratops titusi* (Sampson and others, 2013)
- "Centrosaurine B" (in Loewen and others, 2013b)

Pachycephalosauridae (dome-headed dinosaurs)

- Gen. and sp. indet. (in Evans and others, 2013)

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- Nodosauridae (spike-tailed armored dinosaurs)
 Gen. and sp. indet. (in Loewen and others, 2013a)
- Ankylosauridae
 New genus and species A (in Viersma, 2015)
 New genus and species B (in Viersma, 2015)
- Mammalia-Multituberculata
 Family incertae sedis
Cimexomys sp. cf. *C. judithae* (in Eaton, 2002)
Cimexomys or *Mesodma* sp. (in Eaton, 2002)
- Family incertae sedis – *Paracimexomys* group
Cedaromys hutchisoni (in Eaton, 2002)
Cedaromys sp. (in Eaton, 2002)
Dakotamys magnus (in Eaton, 2002)
- Neoplagiulacidae
Mesodma archibaldi (in Eaton, 2002)
Mesodma sp. cf. *M. archibaldi* (in Eaton, 2002)
Mesodma minor (in Eaton, 2002)
Mesodma sp. (large) (in Eaton, 2002)
- Cimolodontidae
Cimolodon foxi (in Eaton 2002)
Cimolodon sp. cf. *C. nitidus* (in Eaton, 2002)
Cimolodon sp. cf. *C. similis* (in Eaton, 2002)
- ?Cimolodontidae
Kaiparomys cifellii (in Eaton, 2002)
- Cimolomyidae
Meniscoessus sp. cf. *M. intermedius* (in Eaton, 2002)
Meniscoessus sp. cf. *M. major* (in Eaton, 2002)
Cimolomys sp. A cf. *C. clarki* (in Eaton, 2002)
Cimolomys sp. B cf. *C. clarki* (in Eaton, 2002)
- ?Cimolomyidae
Cimolomys butleria (in Eaton, 2002)
- Marsupialia
 Family incertae sedis
Aenigmadelphys archeri (in Cifelli, 1990d; Cifelli and Johanson, 1994)
- “Alphadontidae”
Varalphadon wahweapensis (in Cifelli, 1990d)
Turgidodon lillegraveni (in Cifelli, 1990d)
Turgidodon sp. cf. *T. lillegraveni* (in Cifelli, 1990d)
Turgidodon madseni (in Cifelli, 1990d)
Turgidodon sp. (in Cifelli, 1990d)
Alphadon halleyi (in Cifelli, 1990d)
- “*Alphadon attaragos*” (in Cifelli, 1990d)
- Insectivora
 Leptictidae
Gypsonictops sp. (in Cifelli, 1990e)
 ?Nyctitheriidae
Paranyctoides sp. (in Cifelli, 1990e)
 Order and family incertae sedis
Avitotherium utahensis (in Cifelli, 1990e)