Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

USING A RELATIONAL GEODATABASE TO MANAGE PALEONTOLOGICAL RESOURCES AT FLORISSANT FOSSIL BEDS NATIONAL MONUMENT

M.A. BARTON[1], B. FRAKES[2] AND H.W. MEYER[1]

[1]Florissant Fossil Beds National Monument, National Park Service, Florissant, CO 80816, m.alanebarton@gmail.com; Herb_Meyer@nps.gov; [2]Rocky Mountain Inventory and Monitoring Network, National Park Service, Ft. Collins, CO 80525, Brent_Frakes@nps.gov

Abstract—Florissant Fossil Beds National Monument, as of 2006, has 63 documented paleontological sites. Many of these sites are vulnerable to visitor disturbance, vandalism and theft, and all are affected by the elements, including weathering. Sites are monitored on cycles ranging from one to five years according to various factors such as fragility, proximity to trails and abundance of fossils. In order to monitor and protect these sites, an inventory and monitoring program was established by the park in 1992. The program operates primarily in summer, by workers who take Global Positioning System readings, photographs, notes, fossil surveys and condition evaluations of the sites.

Initial efforts to manage this information included maintaining printouts and photographs in binders and the creation of a simple IDEALIST database to organize the information contained in the paper records. As the Inventory and Monitoring program grew in complexity and scope, this database proved inadequate for efficient record storage.

In response, a new relational database application was designed and developed in the summer of 2005 to better serve the needs of the park's inventory and monitoring program. This database consolidates information from the original tables, site evaluation files, plot monitoring data and digital photographs. Forms were customized to facilitate data entry and minimize entry errors, while a variety of reports were developed for common reporting requirements. The new database allows for more detailed documentation of monitoring procedures, such as photograph information. The tabular information is also related to feature classes (georeferenced points and polygons) that describe the location of the various sites and study areas within the park.

To minimize use problems and loss of information the database is fully documented. Documentation includes relationships among the tables, data definitions and data collection procedures (i.e., monitoring protocols). The thorough documentation minimizes the learning curve for new student interns managing the database and ensures that the information will survive in perpetuity.

In the future, the park hopes to obtain portable digital photo viewers for workers to take with them when monitoring sites. This new database improves the organization of Florissant Fossil Beds National Monument's Inventory and Monitoring program as well as encouraging more complete documentation and evaluation of paleontological sites.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

USE OF GIS IN MANAGING FOSSILS ON FEDERAL LANDS, THE USDA FOREST SERVICE FOSSIL YIELD POTENTIAL CLASSIFICATION (FYPC) SYSTEM

BARBARA BEASLEY

USDA Forest Service, Chadron, NE

Abstract—The Rocky Mountain Region of the USDA Forest Service has actively developed a paleontological program since 1992. In that time, the program has refined a number of management tools used by agency paleontologists for planning purposes. Although the primary functionality of these tools is land management, they also serve a useful role in education and research.

The primary tool employed by the USFS Paleontological Program is the Fossil Yield Potential Classification (FYPC). The FYPC assigns a numerical value to all geologic units on national forests and grasslands. The FYPC values indicate the probability of fossil resources occurring, on the surface and shallow subsurface. FYPC values are determined primarily by base geologic maps, but other factors are surficial deposits, vegetative cover, topography and accessibility.

GIS is used to combine all of this information and produce FYPC maps. Maps are produced at the finest resolution possible, usually limited to the degree of geologic resolution available. Map scale is variable and is determined by the overall size of a particular Forest or Grassland. These predictive potential maps allow non-specialists to quickly get an overall sense of the paleontological scenario in any particular part of the Forest System. By consulting such maps, planners can qualitatively assess the likelihood that management-relevant paleontological resources will be impacted by land management activities. Likewise, agency paleontologists use the maps to determine prolific fossil areas to target for survey and salvage efforts.

The Forest Service is in the process of formalizing FYPC efforts across the Rocky Mountain and Northern Rocky Mountain regions. The intent is to produce a widely utilized national model. As we continue to accumulate baseline data about paleontological resources on National Forest System lands, the FYPC system will continue to be refined and updated. Ultimately, the goal of the FYPC system is to establish a permanent cyclical program of survey, salvage, conservation, and law enforcement efforts that provide the maximum preservation and protection to fossil resources on public lands.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

GOOD DATA VS. BAD DATA: THE IMPORTANCE OF QUALITY DATA MANAGEMENT IN PALEONTOLOGY

RACHEL BENTON[1] AND REKO HARGRAVE[2]

[1]Badlands National Park, Interior, South Dakota, 57750; rachel_benton@nps.gov;
[2] Norman, Oklahoma

Abstract—Data collection management should begin in the early planning stages of project development. For example, emphasis is often placed on field work, and not enough funding is secured for fossil preparation and curation. Unfortunately, when follow-up fossil preparation and curation are not completed in a timely manner, field notes are often lost, key researchers leave for other positions and uncataloged collections are often scattered. These deficiencies became apparent when the staff at Badlands National Park received funding to catalog collections that had been acquired over 30 years ago. Field notes were missing, and the fossil specimens were not stored in an orderly fashion. Efforts are now being made to archive field notes for all research completed in the park regardless of whether collections were made or not. All grant proposals drafted for paleontological projects now include funding for fossil preparation and curation in the proper proportion to the amount of field work completed and fossils collected.

Several ongoing paleontological projects at Badlands National Park provide important examples of the use of data management in vertebrate paleontology. Many of these projects have lasted for several years and have included a large number of participants. Certain strategies have been used to ensure that data collection is consistent and accurate. During the past six years, the park has completed two major paleontological field surveys. To ensure accurate field notes, all survey participants are given a note-taking template in which to follow. Global Positioning System units with associated data dictionaries are used to document site localities. Aerial photos are used as a secondary backup when satellite signals cannot be obtained in rough terrain. For paleontological quarry operations, a quarry protocol has been developed and is revised on a yearly basis. A Pentax electronic total station is used in addition to a meter grid mapping system to document the position of individual fossils. "Data Checks" are integrated into the data collection process to ensure that major errors are not being made. These include, taking three readings off of known fixed points at the beginning of each data collecting session and recording all readings on paper as well as collecting data via the data logger. Data are also exported into ArcView on a weekly basis to ensure proper output. Field technicians are also encouraged to check all total station readings immediately after recording to see if numbers match the proper grid address.

Because shape files are generated for both the paleontological field surveys and quarry collection, detailed metadata are developed to document all aspects of Global Positioning System and Geographic Information System data collection. Metadata provide a way to document the type of equipment and software used, give details on data collection methods and list any types of problems encountered and their subsequent resolution. They also include a listing of people involved and their contact information. Because paleontological locality data can be highly sensitive, metadata include a discussion on data access and recommended security levels.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

THE RED GULCH DINOSAUR TRACKSITE: PUBLIC PARTICIPATION IN THE CONSERVATION AND MANAGEMENT OF A WORLD-CLASS PALEONTOLOGICAL SITE

BRENT H. BREITHAUPT[1], ELIZABETH H. SOUTHWELL[1], THOMAS ADAMS[2] AND NEFFRA A. MATTHEWS[3]

[1]Geological Museum, University of Wyoming, Laramie, WY 82071, uwgeoms@uwyo.edu; [2]Dept. of Geological Sciences, Southern Methodist University, Dallas, TX; [3]National Science and Technology Center, USDOI-Bureau of Land Management, Denver, CO 80225

Abstract—The Rocky Mountain West contains some of the most important vertebrate paleontological remains in North America. Most of these fossils are located on public lands managed by the federal government. To help facilitate the preservation and protection of these nonrenewable scientific and educational resources, partnerships have been formed between institutions and land management agencies. As these fossils are public resources, it is also vital for the public to be activity involved with research projects. An example of this type of cooperative project was the work done at the Red Gulch Dinosaur Tracksite. In 1997, this project brought together researchers, students and volunteers from around the country to work with land managers to assess the paleontological significance of a previously unknown dinosaur tracksite in the Bighorn Basin of Wyoming.

The Red Gulch Dinosaur Tracksite is a 1600 square meter area of public land administered by the Bureau of Land Management. The Red Gulch Dinosaur Tracksite (the most extensive tracksite known in Wyoming) is the best studied of the various sites within the "Sundance Ichnofaunal Province" of the eastern Bighorn Basin. At this site over 1,000 tridactyl pes impressions are preserved in a ripple-bedded, oolitic, limestone of the Bathonian Canyon Springs Member of the Lower Sundance Formation. At the Red Gulch Dinosaur Tracksite (UW V-98066), the activity patterns of over 100 small- and medium-sized (10-230 kg) carnivorous dinosaurs (ranging in hip height from approximately 32-120 cm) are preserved. Irregular step lengths, variable straddle widths and swerving, parallel trackway paths may relate to variations in substrate microenvironments, tidal cycles and intracommunity dynamics. In addition, dramatic differences in track morphology both within and between scores of distinct trackways (ranging from 2 to 45 steps) may reflect lateral and vertical substrate variations, differential preservation and weathering, variable track generation episodes, ontogenic variability and individual trackmaker characteristics. Analysis of the ichnological data supports interpretations about the family structure and community dynamics of gregarious dinosaurs walking/trotting (and perhaps foraging) on the water-saturated, thixotropic sediments close to the shore of the Sundance Sea. The evidence of family groups of a monotaxonomic community of primitive tetanurine theropods (possibly ranging in age from yearling to adult) implies proximity to a nesting area and the semi-precocial nature of young dinosaurs. Interpretations of the intricate "dance" of these organisms on an ancient tidal flat is fascinating as a "live-action" glimpse of the past becomes clearer through continual, intensive research. As research work on this project continues, new chapters are being written about this Mesozoic "dark age" in Wyoming, and a better understanding is coming to light about the life and times of the Middle Jurassic of North America.

The Red Gulch Dinosaur Tracksite is a unique site not only for our understanding of a previously unknown Middle Jurassic dinosaur fauna, but also as an experiment in resource protection and public interpretation. After five years of dedicated research, the project area has now been developed for public visitation and interaction. However, the public was never distanced from the project, but rather encouraged to visit and participate during the research investigations. Thus, the public can not only claim the site as one of their own national treasures, but also know that they assisted in making this the most intensively documented dinosaur tracksite in the world. However, as with any project involving the close association (sometimes in harsh weather conditions) of a diversity of people with various backgrounds and agendas, the "sailing of the seas" was not only always smooth. In fact, various turbulent times led to dissolving of partnerships and mutinying of volunteers. Fortunately, the project reached fruition and valuable lessons were learned regarding lines of communication and established plans, guidelines and responsibilities, as the protection and preservation of the resource needs to take precedent over personal agendas. Although the Red Gulch Dinosaur Tracksite project illustrated what was "the best and the worst of times" in a team endeavor, it also showed that a national policy for the protection of fossil resources can only succeed if scientists agree to work in a communicative and professional manner with the public. In conjunction, land managers need to help facilitate these projects and encourage, support, and acknowledge the participation of those involved. Through the efforts of hundreds of individuals, paleontological and geological work at the Red Gulch Dinosaur Tracksite resulted in a previously unknown dinosaur community coming to light, which has caused a dramatic reinterpretation of the Middle Jurassic paleoenvironment of northern Wyoming.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

FOSSILIFEROUS NODULES FROM NEW YORK GATEWAY BEACHES

J. A. CHAMBERLAIN JR.[1], P.W. STOFFER[2] AND P. MESSINA[3]

[1]Dept. of Geology, Brooklyn College, Brooklyn, NY 11210, & Doctoral Program in Earth & Environmental Sciences, City University Graduate Center, New York, NY 10016, johnc@brooklyn.cuny.edu; [2]U. S. Geological Survey, Menlo Park, CA 94025, pstoffer@usgs.gov; and SCAL, R.A., Dept. of Biological Sciences & Geology, Queensborough Community College, Queens, NY 11364, rscal@qcc.cuny.edu; [3]Dept. of Geology, San Jose State University, San Jose, CA 95192, pmessina@geosun.sjsu.edu

Abstract—Nodules preserving Holocene, and perhaps older, fossils frequently wash ashore on ocean beaches of the New York Bight. We collected nodules over a nine year span at two Bight locations in Gateway National Recreation Area—Rockaway Spit, NY, on the north shore of the Bight and Sandy Hook, NJ, on the western side—that show patterns in lithology and fossil content that suggest a complex history of nodule formation and transport. At Rockaway the most common nodules consist of small, water-worn fragments of indurated, tan-colored, micaceous sand, many of which contain shells of oysters, whelks and other species whose modern representatives typically inhabit brackish, estuarine environments rather than fully marine waters or sandy, ocean beaches. Hardened, black mud casts also occur at Rockaway, sometimes baked to a brick red color by either man-made or natural fires, and containing plant debris, and mussel and clam impressions. Sandy Hook has a wider range of common nodule lithologies. These include: (1) indurated, mica-rich sands, similar to those of Rockaway, but often with prominent *Ophiomorpha*-like burrows; (2) conglomeratic concretions composed primarily of rounded quartz grains and often preserving abundant *Anomia*, *Mytilus* and small gastropod shells; and (3) greenish, glauconite-rich, sandy concretions, occasionally with burrows. Nodules occurring at Rockaway often contain largely intact remains of juvenile, estuarine crabs, but crabs in nodules are rare at Sandy Hook. The surf clam *Spisula* and other common clams typical of New York Bight beaches today are in nodules or missing entirely from them.

The presence of undistorted shells and bioturbation structures in the nodules, as well as acicular aragonitic and high magnesian calcitic cements, implies their very early, perhaps syndepositional lithification. The fauna preserved in nodules at Rockaway are characteristic of bay-side, estuarine environments rather than fully marine, oceanic environments, while Sandy Hook nodules preserve a more oceanic fauna. We infer from this that most of these nodules derive from Holocene and perhaps late Pleistocene estuarine and beach sediments (e.g., Gardiners Clay). The nodules were probably formed from hardened material within these units that was eroded and mobilized during landward migration of the New York Bight shoreline associated with Flandrian sea level transgression. Some nodular material, especially at Sandy Hook, probably derives from glauconitic Cretaceous sediments that crop out nearby.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

PALEONTOLOGICAL PERMITTING ON BLM-ADMINISTERED LANDS IN UTAH

SCOTT E. FOSS

BLM-Utah State Office, PO Box 45155, Salt Lake City, UT 84145

Abstract—The need to apply for a permit to do paleontologically-related research, collecting or mitigation on BLM-administered lands seems onerous to many. One-hundred years ago people were able to collect from federally-owned lands with impunity and were encouraged to sell their finds to colleges, museums and research individuals for study. This is the founding history of the science of vertebrae paleontology in North America. Those days ended exactly 100 years ago with the signing of the Antiquities Act of 1906. Over the past century competing use of federal lands has made a permitting system necessary. Recent congressional mandates make it necessary for land managers to track all paleontological sites on federal lands and all specimens collected from federal lands. The combination of a new computerized database, GIS technology, and complete record-keeping from the past decade has allowed the Utah state office of the BLM to assemble a database that will allow land managers to issue and track paleontological use permits. This system allows land managers to keep track of all of the data required for annual and quarterly submissions to Congress, while continuing to allow the permittee to spend more time in the field collecting fossils and conducting research.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

WHAT IS OUR MANDATE TO MANAGE FOSSIL RESOURCES ON FEDERAL LANDS?

SCOTT E. FOSS

BLM-Utah State Office, PO Box 45155, Salt Lake City, UT 84145

Abstract—The combination of increased commercial leasing activity for energy production, continued agricultural leasing (including grazing and timber harvesting), and ever-growing recreational use are putting strains on federal lands in a way that has not been foreseen. Fossil resources are affected by many of these developments and uses of federally-administered lands. New fossil sites are continually discovered, excavated, interpreted, and protected; whereas other sites may be trampled, illegally collected, or ignored. The BLM is mandated to manage public lands "in a manner that protects the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archaeological values" while at the same time managing public lands "in a manner that recognizes the Nation's need for domestic sources of minerals, food, timber, and fiber." The need to preserve paleontological resources is recognized by both the American public and federal land managers. However, protecting fossil resources is only incidentally recognized in federal legislation. What are the greatest threats to fossil resources on federal lands, what can be done and what should be done?

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

DEVELOPING SCIENTIFICALLY ACCURATE PALEONTOLOGY EXHIBITS FOR THE NATIONAL PARK SERVICE

THEODORE J. FREMD

John Day Fossil Beds National Monument, National Park Service, 32651 Hwy. 19, Kimberly, OR 97848, Ted_Fremd@nps.gov

Abstract—Many complexes of fossil localities, such as can be found in the John Day Basin of Oregon, are very good places to be if you are a paleoecologist, but very complex places if you are not. To clarify an important, but daunting, scientific area the NPS constructed a new museum facility which opened in 2005, the Thomas Condon Paleontology Center. It was designed to facilitate research and explain the scientific and curatorial aspects of paleontology, the excitement of ongoing discoveries and expose the public to concepts such as "deep time" and evolutionary theory.

The basin consists of roughly 10,000 square miles of outcrop and subcrop containing a fossiliferous section over 3,000 meters thick and there are sites throughout the column entombing rich floras and faunas. The decision was made to focus on 8 critical "slices" of this composite section, approximately 5 million years apart, so as to display the profound changes in climate and the ecosystems tracking them.

Initially, we were confronted with certain parameters for new fixed exhibitry, such as "reduce terminology to a minimum", "target specific audiences", "comprehension to a 6th grade level or less" and so forth. Instead, our project has applied a "get everybody with multiple layers of info" approach. Our methodology can be summarized as follows:

- Scientific exhibits prepared by scientists, working in collaboration with contracted writers, professional designers *and* input from NPS interpreters.
- If the significance of the resource is its very complexity, don't oversimplify and don't apologize for it.
- Everything should undergo rigorous scientific peer review, akin to the professional vetted literature.
- Employ a "Shakespearean" approach: something for everyone.

An important component of the facility is to permit an interface between the visitor and the actual functions of the museum. Viewing areas with associated lobby cases were designed into the building to permit the usual examination of the laboratory function, but also other critical components of the discipline: field and accession areas, dedicated systematic storage and the library function. In addition, the active process of scientific investigation has been highlighted using lobby cases covering topics such as radiometric dating, taphonomy, biostratigraphy, fossilization, curation, preparation, fieldwork and more.

The exhibit gallery itself features rockwork produced from actual molds of the locality outcrop in many cases, with realistic features cast in massive layers of cementitious materials. The striking colors of these rock artifices are easily associated with the colors of the actual geologic features in the field; and a series of "icons" was developed to reinforce the point that there is not just one "fossil bed", but a great many stacked throughout a wide area spanning 45 million years. Across from the rockwork are panels with actual rock samples and a detailed treatment of the stratigraphy. Atop or within the rockwork are displayed nearly 500 fossil specimens, ranging from massive skulls and leaves to tiny teeth stored in drawers equipped with magnifiers. In each of the eight separate "time slices", detailed and painstakingly accurate murals were created – each the best "testable hypothesis" at this point in our analysis. If new data falsify some of the scenes or reconstructions, the murals will be painted over to reflect the new information and this point is made clear in additional interpretive panels.

Reconstruction of many aspects of the biotas was challenging in that most had never been illustrated before. These include a full sized reconstruction of *Pogonodon davisi*, a hypertragulid and some mylagaulids as well as a variety of different paleoflora elements. A central exhibit concerns the "lessons learned" from analysis of the fossil record, including specialized panels on coevolution, global climate change, functional morphology and a new depiction of the detailed sequence of equid phylogeny. This features what is possibly the longest and most complete biostratigraphic sequence of equid morphotypes in an accessible (if complex) tree.

Contrary to some expectations, it appears most of the visiting public consumes this information quite readily. Some have wondered why the NPS has such scanty or bland information at other visitor centers. It may be that the conventional wisdom that the public will not consume scientific information at parks without translation/interpretation by non-scientists may be askew. Displays should be flexibly designed and written based on the nature of the data, rather than forcing the data to fit a pre-existing static interpretive methodology. This should lead to digestible content meant to inform and challenge the interested visitor.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

MANAGEMENT OF SIGNIFICANT PALEONTOLOGICAL LOCALITIES: INTRA-AGENCY AND INTERAGENCY

THEODORE J. FREMD

John Day Fossil Beds National Monument, 32651 Highway 19, Kimberly, OR 97848, ted_fremd@nps.gov

Abstract—Within the NPS, the paleontological focus has traditionally and reasonably been focused "inside" existing park boundaries, usually in parks established specifically because of the fossil deposits. Paleontologists have long known that strata "cross fences", of course, and in many instances localities of equal or greater scientific importance are proximal to such "fossil park" boundaries or are found in parks with little or no idea that such paleobiotas exist.

NPS paleontologists are developing projects of various scales that analyze strata both within and external to parks. The idea for doing this dates back a long time. In 1960, the NPS directorate fostered a series of analyses concerning "NPS participation in the preservation of paleontological values." A key objective was "... to encourage participation of other Federal, State, university, scientific, conservation, and similar organizations so as to provide a well-rounded program for the preservation of paleontological values in the United States." This concept seems to embody the ideal of an agency with the word "Service" in its title – being of benefit to others and thinking beyond the "my institution" plan.

Forty-five years since those words were written, we see that the inventory and monitoring of parks with paleontology as a "core mission" is well underway. The Geological Resources Division established a service wide paleontologist position, the Western Region includes a paleontologist as one of the Regional Science Council and there are more paleontologists working for the agency than at any time previously. These are major strides along what apparently is a rather long and winding road.

Assuming that the idea of preserving paleontological values is still of interest, there are now a number of steps that remain undone in order to establish a "well-balanced" program, using a variety of organizations. Among the important considerations include:

- Within a given age or depositional environment, what are the most significant localities or "values," and are they being preserved?
- How is this significance evaluated, and by whom?
- What is the extent of the deposits, both spatial and temporal?
- What are the research and conservation options, with what "organizations"?

Two examples of different approaches and scales of conservation are presented: The Wrangell-St. Elias NP and Preserve in Alaska (intra-agency) and the John Day Basin in Oregon (inter-agency). In the Alaskan example, paleontologists assisted a "non-core paleontology" park assess remarkable fossil resources. While WRST is certainly not known as a "paleo park" the literature suggested there probably were some interesting assemblages. In consultation with the park geologist, a reconnaissance survey was initiated. Workers provided management with an overview of the important units of strata and preliminary sections, identification of new localities, review of the available literature and curation of collected specimens. Thanks to this fieldwork funded by the NPS GRD, WRST emerges as an important paleontological park.

In the Oregon example, we see that many of the resources that make the basin significant are actually outside of the congressional boundaries. The NPS simply assumed management of some pre-existing State park lands and rejected several that were very scientifically significant (for reasons unknown). It turns out that the vast majority of interesting localities are on lands administered by the BLM; thus, for a cohesive management program to exist, cooperative agreements over a large basin have been required. The goal of this effort is to encompass the complete geographic range of important strata, using all investigative methods available throughout the entire range of depositional sequences and taxonomic affinities, with a long-term funded commitment to structured fieldwork and research. The products have included dozens of new peer-reviewed interdisciplinary research papers, region-level approved management plans and in this instance a new paleontology center devoted to curation, research and education concerning 750 major localities covering 10,000 square miles.

To achieve protection and understanding of a variety of localities managed by different agencies, a number of tools are available. For example, a very important locality (Logan Butte, one of the most important Oligocene deposits in North America) administered by the BLM has been established as an Area of Critical Environmental Concern (ACEC). Using designations such as an ACEC, Resource Natural Area (RNA) and/or a National Natural Landmark (NNL) we hope to establish a new system of protecting and providing for the study of important paleontological areas in eastern Oregon. Most are on BLM, and many are on USFS and FWS lands. A unified network of localities, administered by different agencies and private organizations such as the Paleontology

Academy, can be recognized as Cooperative Areas for the Management of Paleontology (CAMPs) that use one or more of the management designations. Perhaps such a network in other significant paleontological strata will achieve the long-proposed but bureaucratically elusive goal to establish "a well-rounded program for the preservation of paleontological values in the United States."

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

RESULTS OF A THREE-YEAR PALEONTOLOGY INVENTORY AT HAGERMAN FOSSIL BEDS NATIONAL MONUMENT, SOUTHERN IDAHO

PHIL GENSLER AND MARY C. CARPENTER

Hagerman Fossil Beds National Monument, Hagerman, ID

Abstract—Hagerman Fossil Beds National Monument in southern Idaho contains one of the richest Pliocene-aged (Blancan NALMA) vertebrate fossil localities in the world. The nearly 183 m (600 ft) of loosely consolidated stratigraphy exposed here contain fossils that date from 3.0-4.0 Ma and are spread throughout the relatively small 4,300-acre monument.

Using crews of summer seasonal employees and Student Conservation Association volunteers, the monument has conducted a three-year (1999-2001) inventory of paleontological resources located in the monument. The goal of this inventory was to collect baseline paleontological resource data to support the protection and management of these non-renewable fossils and their associated localities.

This inventory was accomplished by relocating previously identified fossil localities for which spatial data was available and by identifying new paleontological localities. Vertebrate paleontology research in the Hagerman area spans nearly 80 years. Important collectors in the past include paleontologists from the U.S. Geological Survey, the Bureau of Land Management, the University of Michigan, Los Angeles County Museum and Idaho State University. A base map of paleontological localities discovered by the previously mentioned entities was compiled by G. Cunningham in 1983 under contract with the Bureau of Land Management. This map was digitized and used as a primary source of information in the relocation of these historical fossil localities. Unfortunately, locality data for many of the sites were unclear or nonexistent, some indicated only by a hand drawn point and locality number on a map.

At the end of this three-year survey nearly 600 historic and new fossil localities were recorded within the Monument boundary. The remains of the Hagerman Horse, numerous species of rodents, artiodactyls, carnivores, birds, fish, mollusks and ostracods were recovered. Notable discoveries include nearly complete skeletons of a peccary (*Platygonus pearcei*), the giant marmot (*Paenemarmota barbouri*) and a pond turtle (*Clemmys owyheensis*). Locality information includes Global Positioning System data (X,Y,Z), photographs, locality description, locality condition, specimen information and any geologic information. The results of this three-year project is a working database that is used to make resource management decisions, establish monitoring timeframes for the localities and as an aid in paleontological research.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

CORRELATION OF A RARE PLANT SPECIES WITH FOSSIL SITES ON THE GRAND RIVER NATIONAL GRASSLAND

KURT HANSEN

Supervisory Range Management Specialist, USDA Forest Service, Lemmon, SD

Abstract—The Grand River National Grassland (GRNG) lies in northwestern South Dakota in Perkins, Corson and Ziebach counties. The terrain is a mixture of rolling hills and isolated buttes intersected by the North and South Forks of the Grand River and its tributaries. These drainages have cut through several sedimentary layers including the Upper Cretaceous Hell Creek Formation. This formation is known to be very fossiliferous on the Grand River National Grasslands. These areas are also a habitat for Dakota buckwheat (*Eriogonum visheri*), an endemic plant found only in western South Dakota, western North Dakota and extreme southeastern Montana. On the GRNG, Dakota buckwheat has been found to be very abundant in recent, extensive surveys of potential buckwheat habitat. It appears to favor the badlands clay slopes and outwashes of the Hell Creek and Ludlow formations. The correlation of the Dakota buckwheat populations to the existing fossil sites is very closely related and appears to be more than coincidence. Preliminary findings suggest that Dakota buckwheat could be used as an indicator species for finding additional fossil sites on the GRNG. This connection is also more evident as preliminary surveys of disjunctive Hell Creek exposures on the GRNG have yielded neither Dakota buckwheat populations nor fossils to date. Therefore, data from the Dakota buckwheat surveys have the potential to be utilized to target specific areas for future fossil surveys.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

MOWRY SHALE ICHNOFOSSILS – MANAGEMENT OF A UNIQUE FOSSIL TRACKSITE IN AN OFF-HIGHWAY VEHICLE RECREATION PARK

DALE A. HANSON[1] AND MELISSA CONNELY[2]

[1]Bureau of Land Management, P.O. Box 1828, Cheyenne, WY, 82003, Dale_Hanson@blm.gov;
[2]Casper College, 125 College Drive, Casper, WY, 82601, mconnely@caspercollege.edu

Abstract—A recently rediscovered ichnofossil locality in central Wyoming contains a variety of tracks and traces, including tracks and body impressions that are probably crocodilian in origin, plus examples of *Asterichnites octoradiatus*, unusual star-shaped impressions attributed to a cephalopod. These ichnofossils are preserved by a sandpaper-like, thin ash coating on the uppermost layer of the Mowry Shale (upper Lower Cretaceous) where it locally contacts the "Clay Spur" bentonite. A shallow water paleoenvironment is suggested based on long, curving impressions, probably from the swimming motion of tails and feet dragging through the mud. Numerous wide shallow impressions are also quite evident, probably indicating body imprints. The locality is within a BLM designated Off-Highway Vehicle (OHV) Recreation Park and receives a moderate level of use by riders of ATVs, motorcycles and four-wheel drive vehicles. The area is the site of an abandoned bentonite mine, which was floored by the hard, track-bearing layer. Remnant mounds and layers of the bentonite-bearing unit remain and protect any underlying tracks and traces. Where exposed, the track-bearing layer weathers readily to fragments. A brief study was done in late 2004 to quickly record, photograph and document the tracks and traces, with the goals of determining the present condition and trend of the tracks and traces, developing short-term management directions and establishing some baseline data for a larger research project. Based on this study, it was decided to allow the OHV Park to remain open at this time, but to begin a long-term monitoring project to document any change in condition of the tracks caused by both OHV actions and natural weathering. It is intended that this long-term project continue the detailed research of this site and conduct a survey of surrounding areas to determine the extent of the fossil-bearing layer. The junior author has received an NSF grant to continue research efforts at this locality and BLM is exploring options for cooperative efforts.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

COOPERATIVE AGREEMENTS, TOOLS FOR PARTNERSHIP MANAGMENT OF PUBLIC FOSSIL RESOURCES, ONE EXAMPLE

PATRICIA M. HESTER

BLM Regional Paleontologist, 435 Montano, Albuquerque, New Mexico 87107,
patricia_hester@blm.gov

Abstract—New Mexico State Legislation created the New Mexico Museum of Natural History and Science (NMMNH&S) to serve as the state museum of natural history and to collect, preserve, study and interpret materials representative of the natural history of the state and region. For the benefit of the citizens, the NMMNH&S is responsible for developing and maintaining educational exhibits and programs. The Federal Land Management Policy Act of 1976 (FLPMA) gives the Bureau of Land Management (BLM) the authority to enter into cooperative agreements. The Federal Grant and Cooperative Agreement Act of 1977 (FGCAA) established agency procedures to award Federal assistance. Since BLM manages important fossil-producing formations in New Mexico and has the responsibility to manage those resources for the public benefit, the cooperation serves the mission of both BLM and NMMNH&S. Initially established as a Memorandum of Understanding in 1989 with no funding involved, a Cooperative Agreement replaced the MOU in 1992 and included the New Mexico Museum of Natural History and Science Foundation (NMMNHF). The NMMNHF allowed for funding to go directly to the support of the NMMNH&S. The agreement includes a repository agreement for public fossils discovered on BLM lands in New Mexico. The preparation of an umbrella agreement identified a broad range of acceptable activities appropriate for support and the final agreement created built-in flexibility to accommodate changing priorities. In addition to curation of public fossils, projects completed under the agreement include: development and upkeep of an on-line database for collections, exhibits, teachers notes, brochures, retrieval of at risk public collections held by other institutions and educational films. The cooperative agreement continues to be an effective tool that benefits the public through preservation of public fossil resources, educational outreach and scientific study.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

PALEOSENSITIVITY MAP FOR NEW MEXICO— A TOOL FOR LAND USE PLANNING

PATRICIA M. HESTER[1] AND DAVE SIMONS[2]

[1]Bureau of Land Management, 435 Montano NE,Albuquerque, New Mexico 87107 patricia_hester@blm.gov;
[2]Bureau of Land Management, PO BOX 27115, Santa Fe, New Mexico 87801 Dave_Simons@nm.blm.gov

Abstract—A paleontology sensitivity map was developed for New Mexico using bedrock geology and classifying geologic formations based on Potential Fossil Yield Classification (PFYC), which will assist BLM field offices in the management of public land fossil resources. PFYC ranks geologic formations on their potential to produce significant fossil material with ranks ranging from 1 (lowest) to 5 (greatest). The BLM planning handbook (1601-1) requires specific land use decisions for paleontology. During planning, BLM must identify area wide criteria or site-specific use restrictions to ensure those areas containing, or likely to contain, vertebrate or noteworthy occurrences of invertebrate or plant fossils that are identified and evaluated prior to authorizing surface-disturbing activities. Although limitations of scale are great, the purpose of the GIS layer is to raise awareness level for field personal in New Mexico and give the field a tool to address paleontological resources. The map and associated database provide formation descriptions, rationale for classification, ranking and range of ranking within a formation that can help BLM New Mexico meet planning and management requirements for paleontological resources. The map coupled with other data, including resource specialist knowledge, digital orthophoto quads, the nature of a specific project and locality information, will enable reasonable and effective resource decisions to be made.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

MITGATION OF FOSSIL RESOURCES DURING OIL AND GAS DEVELOPMENT

SHERRIE LANDON

BLM Surface Protection Specialist, 1235 La Plata Highway, Farmington, New Mexico, Sherrie_Landon@blm.gov

Abstract—Vertebrate fossils from the San Juan Basin have contributed and continue to contribute to our understanding of Cretaceous, Paleocene and Eocene ecosystems. Over the last 60 years, the basin has been an important producer of oil and gas resources. Drilling activity continues through infill of fields and development of unconventional gas resources. Since areas known to produce significant fossil resources and active energy development continues, an efficient method for mitigation of the paleontological resource while expediting the permitting process is required. Where exposed bedrock occurs at the surface within areas of known potential, pedestrian surveys for fossil resources are conducted. The focus of the fieldwork is to locate paleontological resources within the boundary of a project area. Mitigation occurs when: (1) data and fossil material are collected; (2) by obtaining representative samples of the fossils; (3) by avoidance; or (4) in some cases by no action. In some cases, surface disturbance may have a beneficial impact on paleontological resources where it exposes additional outcrop area to erosion. When significant fossil material is discovered, a locality form is completed, GPS coordinates are taken and the material is collected. The Field Office holds the material until transport, with locality data, to the New Mexico Museum of Natural History and Science in Albuquerque. If significant fossil material occurs on the surface that cannot be completely collected, a digital photo is taken, locality information and GPS data are recorded. The project can be modified to avoid the locality; this is done immediately to allow the project to proceed.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

CLEVELAND-LLOYD DINOSAUR QUARRY: RESTABILIZATION AND INTERPRETATION; SUCCESSES AND PITFALLS

MICHAEL LESCHIN

BLM Geologist, Price Field Office, 125 S 600 W, Price Utah 84501, mleschin@blm.gov

Abstract—Fossils are often the spark for a lifetime's passionate interest in the world we live in. Seeing and experiencing an authentic paleontological site often has a much greater impact than seeing specimens or replicas in a school or museum setting. Making a federally-managed paleontological site available to be visited by the public has many benefits both to the visitors and to the surrounding communities. Unfortunately, it also has the potential to see the resource destroyed by thieves, vandals or inappropriate stewardship. Renovations begun late in 2005 at the BLM-managed Cleveland-Lloyd Dinosaur Quarry National Natural Landmark and the planning preceding them are an example of the opportunities and challenges faced by government employees involved in managing such a site. Structural engineering, mechanical engineering, landscape architecture, interpretive programming, display design, resource protection, visitor expectations, local involvement, partnering, cooperative agreements and budgeting are issues that came up during the planning process. Some of the problems raised and how they were dealt with will be presented in this talk.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

IMPLEMENTING INVENTORY-MONITORING, RESEARCH AND INTERPRETIVE PLANS FOR EL BOSQUE PALEONTOLOGICO PIEDRA CHAMANA IN THE NORTHERN ANDES OF PERU

HERBERT W. MEYER[1], DEBORAH WOODCOCK[2], JENNIFER YOUNG[3], WILLIAM MCINTOSH[4], NELIA DUNBAR[4], LINDA LUTZ-RYAN[5] AND KIM SIKORYAK[5]

[1] Florissant Fossil Beds National Monument, Florissant, CO 80816, herb_meyer@nps.gov;
[2] Clark University, Worcester, MA; [3] Portland, OR; [4] New Mexico Bureau of Geology & Mineral Resources, Socorro, NM;
[5] National Park Service, Denver, CO

Abstract—El Bosque Paleontologico Piedra Chamana is an Eocene petrified forest located in the northern Peruvian Andes (northern Cajamarca; 79°10'E, 6°35'S). The site is designated as protected under the Cultural Patrimony of the Nation by the government of Peru. Our work, supported by a grant from the National Science Foundation, involves a dynamic combination of scientific research, conservation, development of an inventory and monitoring database and design of an interpretive plan.

The petrified forest occurs in volcanic and volcaniclastic rocks of the Huambos Formation and contains a diverse assemblage of well-preserved permineralized woods. Preliminary 40Ar/39Ar dating of associated rocks yields a date of 39 Ma (Middle Eocene). The fossiliferous sequence includes a paleosol overlain by ashfall and lahar deposits. Woods and leaves associated with the paleosol and ashfall deposits, including trees buried in situ, provide a highly localized representation of the paleovegetation. Fossil wood is also present in high abundance and diversity in the overlying lahar. Various lines of evidence, such as the diversity of monocots (palms and other monocots) and the low incidence of growth rings among the dicot woods, indicate that the assemblage represents wet tropical forest growing at an elevation at or close to sea level. This suggests significant post-depositional uplift.

The site was brought to attention during the early 1990s and is rarely visited, providing opportunities to assess its condition while it is still relatively undisturbed and to make recommendations for conservation. Our work has involved completing a paleontological inventory of the site, preparing a map and database showing the distribution of 14 individual localities, identifying potential natural and human threats and providing recommendations for stabilization and preservation.

The National Science Foundation grant that supports this project includes funding to develop a research station on site, and two buildings were constructed for this purpose in 2005. In addition, we are developing an interpretive plan following the guidelines that are used by the U.S. National Park Service to identify the interpretive themes and develop plans for exhibits and brochures that will help to educate the local people, school students and tourists. The route for a trail has been mapped, and a trail brochure will provide another format for interpreting the significance of this important site. Development and promotion of ecotourism to aid the local economy remains an important concern for the nearby community of Sexi.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

THE DIVERSITY AND STRATIGRAPHIC DISTRIBUTION OF PRE-DINOSAURIAN COMMUNITIES FROM THE TRIASSIC MOENKOPI FORMATION, CAPITOL REEF NATIONAL PARK AND GLEN CANYON NATIONAL RECREATION AREA, UTAH

DEBRA L. MICKELSON

Rocky Mountain Paleo LLC, 9151 E. 29th Ave. Denver, CO 80238, mickelsond@aol.com

Abstract—Recent discoveries in the Moenkopi Formation (Early Triassic) of Capitol Reef National Park, Glen Canyon National Recreation Area and San Rafael Swell, Utah have revealed important new terrestrial and subaqueous vertebrate track localities. The San Rafael Swell area to the north has also yielded important footprint horizons. These well-preserved tracks occur on multiple stratigraphic horizons and are the oldest and most laterally extensive Mesozoic track-bearing horizons documented in the western U.S. The ichnogenera *Chirotherium*, *Rhynchosauroides* and *Rotodactylus* are the dominant forms. Rare fish fin drag marks *(Undichna)* and fish skeletal remains have been identified in the Torrey Member and equivalent strata of the Moenkopi Formation.

Tracks are preserved either as positive relief "casts" filling impressions in the underlying mudstones or on plane bed surfaces as negative relief "impressions." Exposed traces occur on the undersides of resistant sandstone ledges where the mudstone has eroded away and in finer-grained sediments such as mudstones and siltstones. The Torrey Member represents deposition on a broad, flat-lying coastal delta plain. Both nonmarine (fluvial) and marine (principally tidal) processes influenced deposition. Even-bedded mudstones, siltstones, claystones and fine-grained sandstones, containing abundant ripple marks and parallel laminations dominate lithologic types. Ichnites indicating swimming/floating behavior are associated with the walking trackways. The water depth was sufficiently shallow to permit the vertebrates to touch the substrate with manus and pes when moving through the water.

Tracks form locally dense concentrations of toe scrape marks that sometimes occur with complete plantigrade manus and pes impressions. Well preserved, skin, claw and pad impressions are common. Occasional, well-developed tail-drag marks frequently occur in many of the trackway sequences. Fish fin drag marks and fish skeletal material are preserved with tetrapod swim tracks. In addition to vertebrate ichnites, the fossil invertebrate traces *Arenicolites*, *Paleophycus*, *Fuersichnus*, *Kouphichnium* (horseshoe crab), centipede and fossil plants of *Equisetum* are abundant.

Lateral correlations of the ichnostratigraphic units identified in the Moenkopi Formation throughout Utah's National Parks and Public Lands will aid interpretations about the paleoecology and diversity of the Western Interior during the Early Triassic, "the dawn of the dinosaurs."

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

SUBAQUEOUS TETRAPOD SWIM TRACKS FROM THE MIDDLE JURASSIC: BIGHORN CANYON NATIONAL RECREATION AREA (BCNRA), WYOMING, U.S.A.

DEBRA L. MICKELSON[1], MICHAEL RYAN KING[2], PATRICK GETTY[3] AND KATHERINE A. MICKELSON[4]

[1]Rocky Mountain Paleo LLC, 9151 E. 29th Ave. Denver, CO 80238, mickelsond@aol.com; [2]Tennessee Technological University, Cookeville, TN; [3]University of Massachusetts Amherst, Springfield, MA; [4]University of Colorado at Boulder, Department of Geological Sciences, UCB 399, Boulder, CO 80309-0399

Abstract—Recent discoveries indicate that marine carbonates and carbonate-rich siliciclastics of the Middle Jurassic (Bajocian) Gypsum Spring Formation contain tetrapod tracks of swimming animals. There are two distinctive vertebrate swim track types tentatively assigned to crocodilians and to possible bipedal dinosaurs. This swim track horizon is laterally extensive and can be traced throughout the Bighorn Canyon National Recreation Area (BCNRA) wherever the Gypsum Spring Formation crops out.

Importantly, the swim track horizon is located stratigraphically one meter above a well-documented, multiple-layered, tridactyl dinosaur footprint bed. The tridactyl tracks are preserved on multiple surfaces and geographic localities in the northeastern Bighorn Basin. The swim tracks are preserved as convex hyorelief "negative relief impressions" on a single, exposed, flat bedding-plane surface. The swim traces are subparallel and parallel scrape marks or dimples" that occur either in pairs or (rarely) in threes. Lateral spacing between the sub-parallel marks is typically a few centimeters. Many traces in the Gypsum Spring Formation are characterized by two parallel, 1-cm-wide grooves, spaced approximately 3.5 cm apart. Each groove set is approximately 4-8 cm long. "Dimples" are subequal or equal, non-linear, indentations sometimes preserved in twos, threes and rarely in fours. Tracks exhibit "impact rims" and/or "pressure release structures"at the termination of the "grooves" or "dimples," suggesting a piling-up of the sediment behind the track. In most cases, the grooves are perpendicular to the bedding plane. However, some arcuate forms have been found. These traces are interpreted to represent toe/claw scratch marks made by buoyed animals briefly touching bottom while swimming over a muddy carbonate substrate.

These unusual, nearly in-line Gypsum Spring traces reflect swimming behavior of a dinosaur rather than crocodile. The in-line traces do not seem to be consistent with a sprawling swim pattern, but rather a more erect motion of bipedal (?) swimming. The more arcuate (inclined to the bedding plane) traces may, however, reflect a more crocodile-like, sprawling-gait swim behavior.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

FEDERAL, STATE AND VOLUNTEER COOPERATION ON VERTEBRATE PALEONTOLOGY PROJECTS ON FEDERAL LAND: EXAMPLES FROM PLEISTOCENE SITES IN NEW MEXICO

GARY S. MORGAN[1], PATRICIA M. HESTER[2], BRUCE A. SCHUMACHER[3] AND LAWRENCE GORE[4]

[1]New Mexico Museum of Natural History and Science, 1801 Mountain Rd. NW, Albuquerque, NM 87104;
[2]U. S. Bureau of Land Management, 435 Montano Rd. NE, Albuquerque, NM 87107;
[3]US Forest Service, 1420 E. 3rd St., La Junta, CO 81050; [4]US Forest Service, Cuba, NM

Abstract—Various agencies of the U. S. Government, including the Bureau of Land Management (BLM), Forest Service (USFS), Bureau of Reclamation (BOR), National Park Service (NPS) and the White Sands Missile Range (WSMR) of the U. S. Army, have worked in close cooperation with the New Mexico Museum of Natural History and Science (NMMNH&S) and the NMMNH&S-sponsored volunteer group, the New Mexico Friends of Paleontology (NMFOP), on vertebrate paleontology projects throughout New Mexico located on Federal land. We briefly discuss several of those projects involving the excavation and collection of Pleistocene fossils. The NMMNH&S is the official natural history museum of the State of New Mexico and as such serves as the designated repository for paleontological specimens from the State and for several Federal agencies through signed Memoranda of Understanding and Cooperative Agreements.

While hiking, Frederick Haessly discovered a proboscidean tusk eroding from Starvation Draw, an arroyo located on BLM land north of Deming in Luna County, southern New Mexico. Dr. Haessly contacted archaeologists at the Las Cruces BLM office, who then contacted Michael O'Neill, the former paleontologist at the BLM office in Albuquerque. The BLM (including PMH and MO'N), NMMNH&S (including GSM) and NMFOP, with help from archaeology professors and students at New Mexico State University, excavated the Starvation Draw site (NMMNH&S locality 4637) during several days in January and February 2001. The most important fossils found at the Starvation Draw site were two complete associated tusks of the Columbian mammoth (*Mammuthus columbi*). The tusks measured just a few inches short of 10 feet in length (about 3 m) along the outside curve, the largest mammoth tusks yet found in New Mexico. The site also yielded several other mammoth bones, including a nearly complete scapula, as well as a lower tooth of a horse (*Equus conversidens*). Large samples of aquatic snail shells and frog (*Rana*) bones were found in the sediment surrounding the tusks, which suggests deposition in a freshwater environment such as a pond or marsh. We tried to obtain a radiocarbon date from one of the mammoth tusks but were unsuccessful, suggesting the Starvation Draw site is older than 40,000 years Before Present.

Vertebrate fossils were first discovered along Perico Creek in northeastern New Mexico in the early 1990s by USFS archaeologists James Hall and Joseph Tainter. The Perico Creek site (NMMNH&S locality 4638) is located on the Kiowa/Rita Blanca National Grassland, southeast of Clayton in Union County. The site was revisited in 1997 by Greg Liggett, a paleontologist from the Sternberg Museum of Natural History in Hays, Kansas and again in 2000 by BAS. The Perico Creek site was excavated for three days in October 2001 by personnel from the USFS (including BAS), NMMNH&S (including GSM) and NMFOP and again for a week in June 2004 by GSM, Amy Sheldon from Oklahoma Panhandle State University (OPSU) and a group of high school students participating in Dr. Sheldon's summer program sponsored by OPSU. The fossils are derived from an actively eroding cutbank on the north side of Perico Creek and occur in channel sands distributed through a stratigraphic interval of about 5 m. The Perico Creek vertebrate fauna consists of 15 species, the most common of which are the giant llama (*Camelops hesternus*), the flat-headed peccary (*Platygonus compressus*) and an extinct horse (*Equus niobrarensis*). The presence of mammoth confirms a Pleistocene age.

In the spring of 2004, firefighters at the Jemez Ranger Station on the Santa Fe National Forest found several horse teeth while digging a small hole. The site is located north of Jemez Springs on the east side of the Jemez River in Sandoval County, northwestern New Mexico. Preliminary examination of the site in March 2004 indicated that more of the horse was present and the site was excavated in May and August 2004 by personnel from the USFS, Santa Fe National Forest (LG, Rita Skinner and summer interns Katrina Gobetz and Elizabeth Chesser), NMMNH&S (GSM and volunteer Warren Slade) and Kevin Madalena from Jemez Pueblo. The Jemez Springs horse site (NMMNH&S locality 5767) occurs in a Quaternary terrace deposit associated with the nearby Jemez River. The fossil consists of a partial articulated skeleton (skull, lower jaws, most of the vertebral column, both front limbs and one hind limb) of the large extinct horse *Equus niobrarensis*, as well as several associated bones of a smaller individual of the same species.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

DRAFT PALEONTOLOGY RESOURCE MANAGEMENT PLAN FOR GLEN CANYON NATIONAL RECREATION AREA, SOUTHERN UTAH AND NORTHERN ARIZONA

LEX NEWCOMB[1] AND DAVID D. GILLETTE[2]

[1]Glen Canyon National Recreation Area, P.O. Box 1507, Page, AZ 86040-1507 Lex_Newcomb@nps.gov;
[2]Museum of Northern Arizona, 3101 N. Fort Valley Road, Flagstaff, AZ 86001 dgillette@mna.mus.az.us

Abstract—This draft resource management plan for fossils in GLCA is the first comprehensive approach to paleontology in that park. Paleontologists and managers have recognized the existence of fossils in the Park for several decades, but the importance of paleontology became apparent only recently with the discoveries of plesiosaur skeletons and other fossils in the park and new dinosaur track sites found as a consequence of low lake level in Lake Powell. The recognition of nationally significant fossils in the newly established Grand Staircase-Escalante National Monument, adjacent to GLCA, signaled increasing potential for important discoveries in GLCA. The Paleontological Resource Management guidelines in NPS 77 identify the nature of management actions available to managers, reasonable options that should be considered for intensive management, and roles and responsibilities of each park, each region and the Washington Office. The present draft resource management plan for paleontology in GLCA seeks to establish a long-term plan that meets these standards. Specific recommendations for application of the provisions of NPS-77 are elaborated in the plan. This plan is one product of a series of research projects conducted by researchers from the Museum of Northern Arizona sponsored by GLCA.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

PALEONTOLOGICAL RESOURCE DAMAGE FROM "POOR SCIENCE:" EXAMPLES FROM PETRIFIED FOREST NATIONAL PARK

WILLIAM G. PARKER AND KAREN A. DORN

Petrified Forest National Park, Division of Resource Management, Box 2217, Petrified Forest, AZ 86028

Abstract—A quick perusal through various NPS publications and guidance dealing with paleontological resource management will turn up numerous references to the threat of fossil resource damage due to theft and/or natural processes. However, a recent paleontological inventory of Petrified Forest National Park (PEFO) has determined that the majority of the damage done to vertebrate fossil resources is the result of "poor science" being conducted by permitted researchers. Examples include a significant specimen that was partially excavated, abandoned and later destroyed by exposure; an important specimen that was improperly prepared and heavily damaged; as well as numerous specimens collected without a clear research plan and without proper documentation. Various sites have been "vacuumed" by untrained collectors working for permittees with minimal locality data being collected, obfuscating later attempts by park staff to relocate these sites for the purpose of documentation. The scientific data lost as a result of these activities far outweighs that lost due to minimal visitor theft or vandalism of vertebrate fossils. Whereas some of these examples occurred before the issuance of NPS policy regarding management of paleontological resources (NPS-77), many have occurred since. Theoretically, researcher ethics should prevent such resource damage; however, ultimate blame lies with the resource managers of NPS units. Resource managers need to apply the guidelines listed in NPS 77, ensure that researchers understand these policies and enforce them. Failure to do so not only causes irreparable damage to paleontological resources and their stratigraphic context but also hinders managers in meeting reporting goals (GPRA) mandated by Congress for paleontological resources and localities.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

PALEONTOLOGICAL RESOURCE INVENTORY OF CALIFORNIA'S JURASSIC TRACKWAYS

ROBERT E. REYNOLDS

LSA Associates, Inc. 1650 Spruce Street, Riverside, CA. 92507,
Bob.Reynolds@lsa-assoc.com, rreynolds220@yahoo.com

Abstract—California's only tracks of dinosaurs, therapsids and pterosaurs occur in the early Middle Jurassic Aztec Sandstone of the Mescal Range in eastern California. Ongoing inventory of these unique trackway panels and associated sedimentary structures began in 1986 and was augmented in 2001 with the use of GPS/GIS equipment. The latter inventory used a Trimble Pro-XRS GPS Unit (with submeter accuracy) to precisely map 116 track panels. This information was gathered along with bedding plane attitudes (dip and strike) and digital photographs of each panel. Annual re-inventory has resulted in detailed measurement of individual tracks and trackways, scale drawings and additional digital photographs. Replication of selected trackway panels has been accomplished using Room Temperature Vulcanizing (RTV) silicone rubber technique.

The inventory of quadruped tracks has resulted in recognition and systematic morphometric description of three named and five unnamed therapsid ichnospecies, and the description of the westernmost occurrence of pterosaur tracks from North America. Associated research produced a systematic classification and categorization of the quadruped tracks.

Twenty-five years of annual prospecting and inventory demonstrates that site visitation is derived from five sources: museum researchers under BLM permit; biologists; cactus collectors; seasonal game hunters; and collegiate groups intent on "studying" the tracks without BLM authorization. Track resource integrity has been consistent over the last 25 years, but interest in the site by the latter group has compromised certain panels by poor replication techniques, lack of clean up after replication and removal of loose tracks without permission. One removed trackway designated as an ichnogenus holotype is no longer available for study. Recent inventory noted that the sandstone panel containing California's only pterosaur tracks had been severely compromised by chisel marks from attempted removal.

Considering the recent removal of one important specimen and the continuing damage to track panels at the locality through illegal collecting activities, an active resource management plan for the nation's westernmost Jurassic dinosaur tracks and California's only dinosaur, therapsid and pterosaur track locality is required. A stewardship program including cyclic field surveys for new trackways, annual inventory of known panels and museum quality replication is recommended. In addition, all materials gathered through this program, including observations of the area by stewards, should be deposited in a suitable museum repository. Identified panels should be routinely reburied to prevent malicious or inadvertent damage. Research team members must be recruited for this stewardship program. Interested college students and their professors should be instructed about the necessary permits required to study and replicate the tracks and should receive training in non-destructive replication techniques to ensure trackway panels are not damaged. Once trained, these individuals may form a nexus for the stewardship program. Partners in the stewardship program should, in cooperation with the identified repository, develop a comprehensive database where the location of all research results, along with replicas, are stored for future study, research and exhibit.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

PALEONTOLOGICAL RESOURCE INVENTORY OF MIOCENE (BARSTOVIAN) TRACKWAYS AT OWL CANYON CAMPGROUND, BARSTOW, CALIFORNIA

R. E. REYNOLDS

LSA Associates, Inc. 1650 Spruce Street, Suite 500, Riverside CA 92507,
bob.reynolds@lsa-assoc.com, rreynolds220@yahoo.com

Abstract—Volunteers from the Mojave River Valley Museum (MRVM) and the Bureau of Land Management's Desert Discovery Center (DDC), under the direction of LSA Associates, Inc. (LSA), conducted a fossil trackway inventory in the vicinity of the Owl Canyon Campground. This area is managed and maintained by the Barstow Field Office of the Bureau of Land Management (BLM). This work was done under BLM permit CA-05-00-01P.

In 2005, paleontologists and BLM management reacted with concern to reports of vandalism to 15 million-year-old trackways of North American camels in the Barstow Formation. This prompted the BLM to initiate an inventory of paleontological resources within one-half mile of the Owl Canyon Campground. This inventory provides base-line data for ongoing management of paleontological resources in the high-use campground area and serves as a resource assessment to help planning proposed campground renovations.

A previous BLM-supported paleontological inventory was conducted by the author in 1982, with replication of selected trackway panels completed in 1996. These prior data were expanded and precise locality information was gathered through use of Global Positioning System Receivers. Data were recorded and stored electronically into a database that includes images of the locality in overview, the complete bedding plane panel showing track relationships and images of individual tracks. The data recovered by this inventory were structured to aid in locality relocation and annual evaluation of resource condition as part of the Agencies Resource Management Plan. Trackway panel status can change through natural erosion and burial, degradation through foot trampling and by non-permitted efforts to replicate or remove tracks. The vandalism reported in 2005 was from efforts to collect the trackways with hammer and chisel. This illegal activity probably destroyed the tracks in the process of removal. Elsewhere in Rainbow Basin, amateur attempts at replication without mold release have left tracks covered with latex or have physically damaged tracks when the latex was peeled from the panel.

The 2005 inventory recorded 36 localities comprised of 32 trackways, two sedimentary structures and two fossil skeletal elements within one-quarter mile of the Owl Canyon Campground. Sixteen localities have been identified since the 1982 inventory. Five of the previously recorded localities could not be relocated. The inventory noted that two localities were destroyed by erosion and the *Amphicyon* trackway, documented by the Alf Museum, was buried for preservation. Fossil tracks along ridgelines showed evidence of damage by foot scuffing. One track panel within 100 feet of a camp pergola was narrowly missed by graffiti, and the aforementioned camel tracks one-quarter mile north of the campground were removed by hammer and chisel.

As part of the Resource Management Plan for BLM lands this inventory helps form a database to identify impacts to these significant, nonrenewable, paleontological resources by visitors to the area and during campground renovation. The inventory will also be used during land-use planning to ensure these resources are protected. The possibility of indirect impacts—visitor distribution points (patterns) and increased erosion from channeled runoff—must be considered in campground planning. This baseline will allow the condition of the resource to be monitored on an on-going basis and will assist in developing improved management strategies for the BLM. Trackways susceptible to damage, or ones that have already been damaged, can be replicated to capture the surviving data.

INVESTIGATING FOSSIL THEFT FROM NATIONAL FOREST SYSTEM LANDS

STEVEN F. RUPPERT

U.S. Forest Service, Rocky Mountain Region, Law Enforcement and Investigations, Lakewood, CO 80225-0127; sruppert@fs.fed.us

Abstract—In recent years, due to necessity, U.S. Forest Service Law Enforcement and Investigations personnel have aggressively pursued criminal cases against individuals that illegally remove and steal paleontological resources from National Forest System lands. Unfortunately, within the Rocky Mountain Region of the U.S. Forest Service, in particular the states of South Dakota, Wyoming and Nebraska, incidents involving the theft of paleontological resources from NFS lands continue to increase.

This presentation will address how two separate fossil theft cases, occurring in two different states, were investigated and successfully prosecuted by the U.S. Attorney's Office. In addition to interviewing witnesses and suspects, evidence gathering and protection, to eventually presenting a fossil theft case to an Assistant U.S. Attorney, this presentation will show that a "team" effort from both law enforcement personnel and non law enforcement personnel is imperative for each successful prosecution.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

FOSSILS, OBJECTS OF ANTIQUITY AND THE ANTIQUITIES ACT (1906)

VINCENT L. SANTUCCI

National Park Service, McLean, VA 22101,Vincent_Santucci@nps.gov

Abstract—Historically, the Antiquities Act of 1906 served an important role in the establishment and protection of paleontological sites on federal lands. Despite conflicting interpretations of whether Congress intended the phrase "*objects of antiquity*" to include paleontological resources, the Antiquities Act served for nearly 75 years as the primary authority for the protection and permitting of fossils on lands administered by the Departments of Agriculture and Interior. The Antiquities Act was utilized to protect a number of significant paleontological localities through the establishment of national monuments. Since 1906, the administrative and legislative histories of the Act, combined with a number of solicitor's opinions, changed the way federal agencies have interpreted the Antiquities Act and the phrase "*objects of antiquities*" as it relates to fossils.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

THEFT AND VANDALISM OF *IN SITU* FOSSIL VERTEBRATE TRACKSITES

VINCENT L. SANTUCCI

National Park Service, McLean, VA 22101, Vincent_Santucci@nps.gov

Abstract—The growth experienced within the science of vertebrate ichnology has been accompanied by a near explosion in the discovery and documentation of new fossil track localities worldwide. The descriptions and interpretations of fossil vertebrate tracks have infiltrated scientific journals, popular publications and news media. A number of fossil vertebrate tracksites have been developed for public education. The growing popularity of fossil vertebrate tracksites is paralleled by the increasing documentation of their theft and vandalism. During 2001, over two dozen incidents of either theft or vandalism of *in situ* fossil vertebrate tracks were documented. These incidents range from damages resulting from poor or inappropriate casting techniques to the unauthorized collecting of tracks in units of the National Park Service. A well-known dinosaur tracksite in a Utah state park was vandalized by members of a Boy Scout group and received considerable national and local media attention. Fossil vertebrate tracks are becoming more visible on the commercial fossil market. The management and protection of *in situ* fossil vertebrate tracksites has become challenging. Human impacts to vertebrate ichnofossils include incidents of damage/destruction, intentional vandalism, casual theft and systematic theft. Sound management and protection strategies employed for *in situ* fossil vertebrate tracksites include: tracksite inventories, site mapping, photodocumentation, track replication, specimen collection, site stabilization, burial, site closure, construction of maintenance barriers/fencing and a variety of site monitoring strategies.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

VOLUNTEERS AND PARTNERSHIPS, EFFECTIVE MANAGEMENT OF FOSSIL RESOURCES ON NATIONAL FOREST SYSTEM LANDS

BRUCE A. SCHUMACHER[1] AND VIRGINIA TIDWELL[2]

[1]USDA Forest Service, La Junta, CO; [2]Denver Museum of Nature and Science, Denver, CO

Abstract—In 1994, the USDA Forest Service acquired a 16,000 acre area of the Purgatoire River valley in southeastern Colorado called Picket Wire Canyonlands. In this steeply carved, rugged valley the Purgatoire River has swept vast stretches of Jurassic limestone free from surrounding shale, exposing dozens of dinosaur trackways along its banks. In the last decade the Comanche National Grassland has conducted paleontological reconnaissance of this valley, leading to the discovery of significant Jurassic dinosaur skeletons and Cretaceous-aged trace fossils, including vertebrate trackways and plants.

The excavation and preparation of a large sauropod skeleton from the upper Morrison Formation discovered in 2003 is the focus of recent management efforts. The quarry lies within floodplain shale just centimeters above a 2 m thick fluvial sandstone. The uppermost surface of the sandstone bears a complex folded and contorted architecture attributable to intense trampling around the sauropod carcass. The quarry also produces numerous commingled shed carnivore teeth, and some sauropod bone bears distinct scratches and gouges attributable to tooth marks. Thus, the scattered distribution and fragmentation of some bony elements, trampling around the carcass, numerous shed carnivore teeth and bite marks all suggest an episode of scavenging prior to burial.

With about fifty percent of a large skeleton so far excavated, no duplicate elements are present suggesting a single individual. Articulated portions of axial skeleton include strings of trunk and caudal vertebrae, confirming the common association of much of the skeleton. Despite the amount of skeletal material exposed, the identity of the remains is yet elusive. A relatively elongate cervical rib, a fibula with anterior divergence of the main shaft and an equidimensional anterior caudal centrum are indicative of *Camarasaurus*. Morphology of a scapula, and tall neural spines of trunk vertebrae suggest a robust diplodocid such as *Apatosaurus*. Taphonomy of the site is complicated by the presence of two camarasaurid teeth located high within the quarry and two diplodocid teeth located at a lower level. All four sauropod teeth bear complete roots, suggesting close proximity to cranial material.

With few professional paleontologists and a small workforce, the Forest Service alone cannot provide responsible stewardship of such paramount fossil resources. Volunteerism and partnerships are crucial elements to successful management. Survey and excavation of fossils is being conducted wholly by trained volunteers along with agency paleontologists through the Forest Service Passport in Time program. The Denver Museum of Nature and Science serves as a vital partner, preparing and housing the skeleton through its own dynamic volunteer program.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

HISTORICAL RESOURCES ACT DESIGNATION OF THE GRANDE CACHE DINOSAUR TRACKSITE (LOWER CRETACEOUS, ALBIAN), GRANDE CACHE, ALBERTA, CANADA

DANIEL N. SPIVAK[1], DEAN E. WETZEL[2] AND JULIETTE CAILLAIU[2]

[1]Royal Tyrrell Museum of Palaeontology, Alberta Community Development, Drumheller, AB, Canada T0J 0Y0; [2]Heritage Resource Management Branch, Alberta Community Development, Edmonton, Alberta, Canada

Abstract—Paleontological Resources in Alberta are managed under the Historical Resources Act (HRA) and its associated regulations. The basic tenet of the HRA is that all historical resources (including palaeontological resources) found within Alberta are a Crown (government) owned resource and that private ownership of paleontological resources in Alberta is allowed only in specific situations. For the majority of palaeontological resources in the province, the protection afforded under sections 30 (Excavation Permits), 31 (Notice of discovery of historical resources), 32 (Title to historic resources), 33 (transport of historic resources out of Alberta), 34 (Damage of historic resources prohibited) and 37 (Requirement of pre-impact studies) of the act is sufficient to legally protect them.

In situations where the paleontological resource (locality) has a high scientific value it can be designated as a Provincial Historic Resource by the Minister of Alberta Community Development (ACD) pursuant to section 20 of the HRA. Designating a locality allows for greater control over research, collecting and industrial activities, it raises the status of the site in land management systems and allows local non-profit groups to access more funding for preservation and interpretation. Although there is no specific clause requiring higher penalties for illegal activities at designated localities, designation of a locality as a Provincial Historic Resource can increase the significance of a site in the view of the judicial system and increase the likelihood of a significant penalty being imposed.

Located approximately 20 km north of Grande Cache, Alberta, the Grande Cache Dinosaur Tracksite is one of the most extensive dinosaur track localities in Canada. The majority of the tracks are found in three main areas (West Limb of 12-mine, 9 Mine and South Pit Lake) within the former Smoky River Coal Mine where they were exposed after the removal of Coal Seam No. 4 of the Gates Formation (Lower Cretaceous, Albian). Several ichnotaxa are known from the tracksite including at least four types of theropod tracks, ankylosaur tracks, several types of bird tracks and possible crocodilian swim traces. Other remains include tree stump and log impressions, various plant fossils and the rare bivalve, *Murraia*.

The site was selected for designation after its tourism potential was brought to the attention of ACD by Alberta Economic Development and the Town of Grande Cache and its scientific significance was brought to the attention of ACD by Mr. Rich McCrea, a Ph.D. student studying the site. Some of the significant features of the site include the large number of footprints (over 10,000 documented tracks from the W3 locality alone), the relatively wide variety of palaeoenvironments represented and the overall size of the area (the largest footwall is approximately 2 km long and 60 m high).

Once the site was selected for designation, a stakeholder consultation process was initiated. Stakeholders included Grande Cache Coal Company (GCC), the coal mine currently working in the area, the Town of Grande Cache, the Friends of the Grande Cache Dinosaur Footprints, a volunteer non-profit organization dedicated to the preservation and promotion of the tracksite, paleontologists and several provincial government departments. From the consultation process, which consisted of several public and closed-door meetings, ACD was able to determine the expectations and concerns of the various stakeholders and develop a policy that would allow for the long-term preservation of the tracksite while accommodating many of these issues.

The biggest challenges encountered were: (1) assuring GCC, the residents of Grande Cache and other stakeholders that the designation would not impact GCC ability to mine coal from the area; and (2) developing a plan that would allow for some tourism opportunities and the long-term protection of the tracks within an active coal mine. Ultimately it was decided that an active open-pit coal mine operating in the vicinity of the tracks was beneficial to their long-term preservation. The benefits of the coal mine include: (1) restricted access to the site; and (2) new tracks are bound to be uncovered as mining progresses. Since the proposed area of designation has already been mined out, the current coal mining operations should not directly impact the tracks.

Although the stakeholder consultation process took a relatively long time to complete and required several meetings, public discussions, phone calls and e-mails, the thoroughness paid off as all stakeholders, including GCC, finally agreed that the designation could be applied to the Grande Cache Dinosaur Tracksite. The formal designation process should be completed by May 2006, and ACD can now start to work towards achieving our

short and long-term goals for the site. Short-term goals include working with GCC to discover, preserve and study new tracks within the mine site, determining whether it will be possible to stabilize the footwalls on which the tracks occur and develop a limited tourist attraction at the site including interpretive pathways and safe viewing areas for the public. In the long-term, an on-site interpretive center may be built to showcase this wonderful resource.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

PRESERVING THE PAST: GEOLOGIC MAPPING AND PALEONTOLOGIC INVESTIGATION, LAS VEGAS FORMATION, NORTH LAS VEGAS

KATHLEEN SPRINGER, J. CHRISTOPHER SAGEBIEL, CRAIG MANKER AND ERIC SCOTT

Division of Geological Sciences, San Bernardino County Museum, Redlands, CA, 92374,
kspringer@sbcm.sbcounty.gov

Abstract—Paleospring deposits as indicators of elevated water tables and increased groundwater discharge during the Pleistocene have been recognized and described throughout the southern Great Basin. These fine-grained sediments previously thought to be strictly lacustrine in origin have led to a wealth of paleoclimatic data of the last two major glacial periods.

The Las Vegas Formation, in the Tule Springs region of North Las Vegas, has yielded an assemblage of invertebrate and vertebrate fossil remains that comprise one of the best-studied late Pleistocene assemblages known from the southern Great Basin. Although recent studies have focused on the paleoclimatic and hydrologic indicators of high discharge glacial events (spring deposits, wet meadows, seeps and streams) in the southern Great Basin, vertebrate paleontologic evidence recognized from these same high discharge lithologies has been little studied or reported upon. Vertebrate faunas in deposits from the southern Great Basin recording these high discharge events demand synthetic reporting and treatment. This study is part of an effort to incorporate these records into the larger paleoclimatic and hydrologic framework of the last two glacial maxima.

Studies from the 1930s through the 1960s documented one of the most significant late Pleistocene faunas from the Mojave Desert in the Tule Springs area of North Las Vegas. Recent field investigations by the San Bernardino County Museum have broadened our knowledge of this fauna across the upper Las Vegas Wash. Seven stratigraphically ascending units, designated A through G, were first recognized in the early 1960s and were defined in several sections within the upper Las Vegas Wash. Units B_2, D and E_1 have proven fossiliferous in this area and date to >40,000 yrs, approximately 25,500 yrs, and about 14,500 to 9,300 yrs, respectively. These units have been extended beyond the original locality to deposits throughout the southern Great Basin. Paleospring discharge features in these units demonstrate correlation of spring recharge and climate changes in the late Quaternary in this region. Sedimentologic evidence, mollusk studies and most recently, ostracod analyses have clarified the paleoenvironmental conditions and related hydrologic changes through time. Radiocarbon dating on mollusks, augmented by organic carbon, combined with $d^{18}O$ values from the ostracod studies have constrained the timing of the glacial episodes and clarified specific paleoenvironments of the high discharge events.

Research by the SBCM across the Las Vegas Wash has resulted in the discovery of 526 new fossil localities since 1990. By describing the geology of these localities and exposures in the wash, the SBCM has expanded the definition and mapping of the subunits of the Las Vegas Formation to include lateral facies changes, which allowed the accurate placement of fossils within the proper stratigraphic context. Extensive geologic mapping of the bluffs that encompass the upper Las Vegas Wash was necessary to discriminate between the various units of the Las Vegas Formation and to place the fossils in the appropriate temporal context. The fossil sites are located along the wash and occur throughout deeply eroded badlands. The units of the Las Vegas Formation, through successive periods of dissection, deflation and deposition, are inset into each other and are laterally discontinuous. The methodology that we employed to recover the maximum amount of data was more comprehensive than simply creating a geologic map in plan view, but was one that extended the detail to the third dimension by using digital photography and mapping the units directly onto the images. This allowed definitive location of all of the fossil localities in space and time. Temporal and spatial clarity of >500 fossil localities was the ultimate goal for this study, and understanding the complex geologic framework of this portion of the upper Las Vegas Wash provided us with the stratigraphic control we sought.

Newly recognized faunal components include the microvertebrates *Rana* sp., *Masticophis* sp., cf. *Arizona* sp., *Marmota flaviventris*, *Neotoma* cf. *N. lepida* and cf. *Onychomys* sp. The list of megafauna has also been expanded to include a large bovid similar in size to *Euceratherium* and the first definitive fossils of *Bison* from Unit E_1. Radiocarbon dating results from locality SBCM 2.6.74 indicate that specimens of *Bison* recovered from Unit E_1 fall within the published dates for that unit, yielding a conventional radiocarbon age of 14,780 +/-40 yrs. By our study, we have undisputed confirmation of *Bison* from Unit E_1 and the youngest reliably dated record from this genus in the Mojave Desert/southern Great Basin. Radiocarbon dating (14,780 +/- 40 yrs) confirms this locality is within the reported range of unit E_1 in the southern Great Basin.

It was noted that the high discharge events of units B_2, D and E_1 are lithologically similar in that they all contain green silts and mud, as well as abundant mollusks. These lithologies result from the complex mosaic of aquatic settings, including flowing springs with or without fault influences, wet meadows, streams and wetlands. Verte

brate remains apparently are preferentially preserved in these environments, likely because increased clay and organic content results in lowered post-depositional oxidation. Ancient spring deposits may have also been animal traps.

Ongoing research by the San Bernardino County Museum focuses on synthesizing GIS mapping, digital photography of three dimensional stratigraphy, traditional mapping and geologic description with vertebrate paleontology. This synthesis has added depth of knowledge to both the geology and paleontology of southern Nevada.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

A NEW MIDDLE MIOCENE TERRESTRIAL FAUNA FROM THE TEMBLOR FORMATION OF CENTRAL CALIFORNIA

J. D. STEWART[1], ERIK ZABORSKY[2] AND MARJORIE HAKEL[3]

[1]PCR Services Corporation, 1 Venture, Irvine, CA 92618; [2]Bureau of Land Management, Hollister Field Office, 20 Hamilton Court, Hollister, CA; [3]Natural History Museum of Los Angeles County, 900 Exposition Boulevard, Los Angeles, CA 90007

Abstract—In 1913, a paleontological field party from the University of California, Berkeley, discovered a quarry that produced terrestrial vertebrate fossils in a Miocene marine sandstone (Temblor Formation) on the western edge of the San Joaquin Valley, north of the town of Coalinga, California. This occurrence permitted an important tie point for correlating terrestrial mammalian evolution events with the marine temporal and evolutionary sequences. The fauna from this quarry became known as the "*Merychippus* zone" and the North Coalinga fauna. While surprisingly diverse, these mammalian fossils were rather abraded and no associated, much less articulated, specimens were found. Bird, reptile and amphibian fossils were not represented. Ninety years after the discovery of the North Coalinga quarry, no example of a nearby terrestrial deposit containing a similar mammalian fauna had been detected.

Construction of the Path 15 500-kV Power Transmission Line from Los Banos to Avenal, California was required to mitigate its impact to paleontological resources by the National Environmental Policy Act and the California Environmental Quality Act. A small fraction of the 213 structures in the paleontologically sensitive portions lay on Federal lands. Pad construction for a tower in section 16, T16S, R13E uncovered a bonebed in a large block of landslide debris in 2004.

That section had been obtained by the Bureau of Land Management (BLM) within the previous decade. Although permission for construction and paleontological mitigation had already been granted for the pertinent sections, a mutually agreeable fossil recovery and preservation plan was negotiated among the construction firm (Maslonka and Associates), the environmental mitigation firm (Jones and Stokes), the California offices of the Bureau of Land Management and the Western Area Power Administration.

The bonebed occurrs in terrestrial facies of the Temblor Formation. Fifty-three days of excavation of the top six inches of the cross section of the upended bonebed produced more than 1,200 identifiable vertebrate fossils. These were catalogued into the collections of the University of California Museum of Paleontology. It is most probable that many times that amount of fossils remain in the unexcavated portion of the bonebed, which was covered until additional excavation is deemed appropriate.

The vertebrate fauna is dominated by merychippine horses, with a smaller representation of anchitheres. Additional ungulates include two camel species, a merycodont antilocaprid and a rhinoceros. The most abundant carnivore is a species of *Amphicyon*. Also present are two borophagine canids, *Pseudalurus, Martes* and an undescribed large mustelid. Rodent remains are rare. Avian remains are fairly abundant, especially passeriform bones in the microfauna. Abundant *Hesperotestudo* remains have been recovered. Freshwater and terrestrial gastropods are also present.

This collection demonstrates a terrestrial environment in the Temblor Formation 30 km (19 mi) north of the North Coalinga quarry that could have supplied the organisms found there in marine sediments. The two sites have several horse species in common.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

FOSSIL COLLECTION STORAGE: A STATE-OF-THE-ART CASE STUDY

MARY E. THOMPSON

Idaho Museum of Natural History, ISU Campus Box 8096, Pocatello, ID 83209, thommary@isu.edu

Abstract—The main goal of fossil collection storage is to protect the objects and information associated with them and to accommodate researchers. Museums housing Federal collections must pay particular attention to their collections, their accessibility, and their security and adhere to Federal policies. Failure to do this may result in loss of funding and their collections.

One of the most important variables in the long term preservation and conservation of objects and associated records is the overall storage environment. This encompasses both the physical area(s) where collections are kept, as well as the physical safety of the items. Oversight of the storage environment is oriented towards mitigating the risks to collections, including: physical forces (e.g., flood, earthquake, etc.), fire, water, theft, pests, pollutants, light and radiation, incorrect temperature, incorrect relative humidity (RH), health of staff, and custodial neglect. Policies and procedures, such as a detailed risk management plan, should be in place to address controlling and minimizing these risks. Their negative effects can also be minimized through proper training, decreasing handling of objects and records, controlling access, and maintaining housekeeping procedures.

The Idaho Museum of Natural History Vertebrate Paleontology Collection, with the implementation of a National Science Foundation Biological Collections Improvement Grant, addressed deficiencies in its storage area. Installation of a state-of-the-art mobile storage system and the resulting changes have created a storage layout that has minimized the risks to the collection, while maximizing accessibility for staff and researchers.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

INITIAL RESULTS OF A FIVE-YEAR COOPERATIVE INTERAGENCY PALEONTOLOGICAL SURVEY, GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT, UTAH AND SURROUNDING AREA: THE PROOF IS IN THE POOLING (OF RESOURCES)

A.L. TITUS[1], S.S. SAMPSON[2], J.I. KIRKLAND[3], D.D. DEBLIEUX[3], D.D. GILLETTE[4], L.B. ALBRIGHT[1] AND M.A. GETTY[2]

[1]Grand Staircase-Escalante National Monument, Kanab, UT 84741, Alan_Titus@blm.gov;
[2]Utah Museum of Natural History, Salt Lake City, UT; [3]Utah Geological Survey, Salt Lake City, UT;
[4]Museum of Northern Arizona, Flagstaff, AZ

Abstract—The Kaiparowits Basin, located mostly in Grand Staircase-Escalante National Monument, preserves the only relatively complete Cenomanian to Maastrichtian (Late Cretaceous) foreland basin stratigraphic sequence in southern Utah. Totaling over 2000 m in thickness, the Kaiparowits Basin section is mostly nonmarine and highly fossiliferous through much of its thickness. Based on microvertebrate sampling, several specialists concluded that the Kaiparowits Basin preserves one of the most continuous records of Late Cretaceous terrestrial vertebrates in a small geographic area in the world. Ironically, at the time Grand Staircase-Escalante National Monument was created in 1996, very few identifiable macrovertebrate remains had been collected. This is in spite of the relative abundance of such remains in the upper portion of the section. To gain a better understanding of the significance and scope of the Kaiparowits Basin Late Cretaceous vertebrate fossil resource, Grand Staircase-Escalante National Monument sought out specialists with either work histories in the Kaiparowits Basin or specialized knowledge of Late Cretaceous macrovertebrates. By coincidence, three separate institutions (Utah Museum of Natural History, Utah Geological Survey and the Museum of Northern Arizona) had all independently decided that Grand Staircase-Escalante National Monument held exciting research opportunities and were planning extended field campaigns in the region. By combining the collective resources of these three partners, all of which had independent research goals in the area, the Monument was able to achieve a five year, field-intensive inventory of the Kaiparowits Basin with a substantially lower funding level that would normally be required from such an effort. Also critical to the economy of the project was the Colorado Plateau Ecosystems Study Unit collective agreement though which partners agree to keep overhead below 17.5%. After five years and 45,000 acres (5% of area) of inventory, the Monument has reaped a bountiful harvest of data. Cenomanian and Turonian marine units previously perceived as barren have yielded several large associated plesiosaur, turtle and fish sites, and even a rare therizinosaurid dinosaur. The middle Campanian portion of the Wahweap Formation has produced several sites yielding potentially new dinosaur taxa, including what may be one of the most spectacular ceratopsid skulls ever found from that time period. The Late Campanian Kaiparowits Formation has also yielded a wealth of new data, including the world's oldest known caiman fossil, a new genus of oviraptorosaur, a new genus of ceratopsid, a new species of *Gryposaurus* hadrosaur and a new genus of tyrannosaurid. Preservation in some cases is exceptional and at least one dozen dinosaur specimens showing preservation of integument or other soft tissue have been collected or field documented. As our appreciation of the significance of this resource grows, so does the concern that it be carefully researched, managed and protected. The knowledge gained from this inventory is a crucial first step.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

THE FRIENDS OF THE FLORISSANT FOSSIL BEDS: PARTNERSHIP SUPPORT OF EDUCATION AND RESEARCH IN GEOLOGY AND PALEONTOLOGY

STEVEN WADE VEATCH

Friends of the Florissant Fossil Beds, Inc., P.O. Box 851, Florissant, CO 80816, sgeoveatch@att.net

Abstract—The Friends of the Florissant Fossil Beds, Inc. was organized in 1987 as a 501(c) (3) non-profit organization by a group of dedicated individuals interested in assisting the National Park Service in its mission to preserve and protect the natural and cultural resources of Florissant Fossil Beds National Monument. As the official private sector partner to the Monument, the Friends is a membership organization that raises funds from members, individuals, corporations, other non-profit organizations and foundations to assist the Monument in meeting its mission. Generally, Friends' groups work with national parks to preserve, restore and enhance natural and cultural resources, provide improved services and facilities and increase visitor awareness and support of the park.

The Friends of the Florissant Fossil Beds is emerging as a national leader in developing innovative programs for enhancing educational, interpretive and research activities in paleontology. These programs and initiatives include many projects and activities. An accredited summer seminar series attracts adults and teachers and involves the Monument's paleontologist as the instructor of record. Each seminar carries graduate credit for teacher recertification through Adams State College. Every summer the Friends present a keynote geology field trip that is technical in nature and investigates a significant regional site. These field trips, conducted by the site expert, benefit area college students, regional scientists and other interested parties. During the fall and winter, the Friends sponsor community science seminars for the general public at The Colorado College. The Friends supported the production of an interpretive film for visitors that emphasizes the paleontology of the park. The quarterly Friends' newsletter features science, nature and history of the Monument and the Pikes Peak region.

Support of the Monument's paleontology program includes: (1) financial support for paleontological research and attendance at conferences for the Monument's paleontologist; (2) funding to assist other geologists and paleontologists in attending conferences relating to Florissant; (3) establishment of a perpetually-funded internship that directly supports a paleontology intern each summer; (4) funding and support for interns, student scholars and others to contribute to original research and investigation at the Monument; and (5) sponsorship of special events in paleontology, including the 2006 Centennial of the T.D.A. Cockerell Florissant Expeditions. These activities demonstrate that as budgets grow tighter, partnerships with Friends groups can be a beneficial means for units of the National Park Service to expand their capability to preserve, research and understand their fossil resources.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

ESTABLISHING A FUTURE FOR FOSSILS IN THE NATIONAL PARK SERVICE: THE DEVELOPMENT OF A SERVICE-WIDE GUIDEBOOK AND PALEONTOLOGICAL DATABASE

C. C. VISAGGI, V.L. SANTUCCI, J.P. KENWORTHY, A.L. KOCH AND T.B. CONNORS

[1] National Park Service, McLean, VA 22101, ccvisagg@syr.edu; [2] National Park Service, Geologic Resources Division, McLean, VA; [3] Curecanti National Recreation Area, Gunnison, CO; [4] National Park Service, Geologic Resources Division, Denver, CO

Abstract—The stewardship of non-renewable paleontological resources in parks across the nation requires service-wide baseline information. Nearly half of all 388 park units administered by the National Park Service contain fossiliferous material, but very few of these parks actively monitor paleontological resources as part of a management program. NPS fossils consist of invertebrates, vertebrates, plants, ichnofossils and more that cover almost the entire expanse of geologic time in the history of life. Present methods for assessing paleontological resources include: (1) comprehensive park-specific inventories; (2) service-wide thematic inventories; (3) state by state inventories; and (4) research as grouped by Inventory and Monitoring Networks. These survey strategies are useful for individual parks or groups of parks; however, the future of fossils in parks nationwide necessitates an alternate course of action that incorporates the entire park system.

The assembly of a preliminary guidebook highlighting the stratigraphic and paleontologic context of all areas managed by the National Park Service provides a foundation for the development of innovative monitoring techniques. The report utilizes customized graphics and conceptual diagrams for straightforward interpretation and establishment of icons in future NPS publications. Two main sections constitute the outline of the paleontological guidebook. The first portion focuses on the age of rocks mapped at the park as divided by geologic period or epoch. Temporal slices are regarded as fossiliferous, potentially fossiliferous or not at all fossiliferous based on geologic descriptions of park formations and the presence of fossils at the park or elsewhere. Fossils catalogued in NPS collections that do not correspond to local rocks are also noted. This chart offers the chance for park staff to recognize current fossil-bearing units, evaluate potentially prolific units and minimize investigation of non-fossiliferous units.

The second section exhibits the range of fossils observed inside park boundaries and management concerns including collections, interpretation and probable threats. Paleontological resources are categorized in five basic taxonomic groups that consist of invertebrates, vertebrates, plants, ichnofossils and other (e.g., stromatolites). Inventories completed for individual parks (park-specific, thematic, state-wide, I&M network) and collection location (park, outside repository, prior to NPS status) are also documented. Forms of interpretation (e.g., exhibit, wayside, brochure, etc.) and resource threats such as erosion, theft and vandalism that may affect paleontological resources are identified. These numerous paleontological fields of interest depicted for all fossiliferous parks impart an opportunity for comparison of resources and developing management plans. Data-mining fundamental to this project is still in progress as many parks are unaware of their paleontological status or potentially fossiliferous stratigraphic units.

Types of fossils and corresponding geologic units are recorded for most parks containing paleontological resources; however, ongoing research continues to uncover new resources and new parks not previously recognized as fossiliferous. The next step is compiling service-wide data on management issues as only a handful of parks supplied that level of information in response to initial paleontological queries.

One final aspect of this project is the development of a paleontological database. The guidebook allows for a basic understanding of current paleontological resources in the entire park system; however the establishment of a formal National Park Service database serves a greater purpose as a means for efficiently updating paleontological resource information over the years. Database categories follow the classification scheme outlined in the preliminary guidebook and incorporate more detailed information of unique paleontological occurrences such as state fossils, holotypes and historically significant fossils. Links to NPS geologic maps, reports and collections are an additional benefit of having information stored in the form of a database.

The documentation of baseline geologic and paleontologic data is essential for effective stewardship of paleontological resources in parks nationwide. The production of a service-wide guidebook gives park employees a comprehensive source for future paleontological research and education. The often overwhelming complexity of scientific information is reduced in this user-friendly publication as difficult concepts are conveyed through graphical means. The creation of customized symbols promotes paleontological awareness and sets a standard for reinforcing these ideals in future NPS publications. The database initiative compliments guidebook objectives and presents a future direction for the preservation of paleontological resources in national parks.

Fossils possess great scientific and educational value in parks across the nation. Prospective growth for paleontological research and education in national parks is unlimited as long as fossils are maintained for future generations. The assembly of a National Park Service paleontological guidebook and associated database provides a framework for parks to expand their knowledge of current paleontological concepts and thereby learn how to effectively protect these non-renewable resources. The future of NPS paleontology becomes more secure once a service-wide guidebook and formal database are established that can meet the changing needs of individual parks as management issues are continually revisited.

Lucas, S.G., Spielmann, J.A., Hester, P.M., Kenworthy, J.P. and Santucci, V.L., eds., 2006, Fossils from Federal Lands. New Mexico Museum of Natural History and Science Bulletin 34.

TRANSFER OF UALP SAN JUAN BASIN VERTEBRATE FOSSIL COLLECTION TO THE NMMNH

THOMAS E. WILLIAMSON[1], PATRICIA M. HESTER[2] AND SHEILA P. BEDNARSKI[1]

[1]New Mexico Museum of Natural History, 1801 Mountain Road, NW, Albuquerque, NM 87104;
[2]US Bureau of Land Management, 435 Montano, NE, Albuquerque, NM, 87107

Abstract—The University of Arizona Laboratory of Paleontology (UALP) collected Late Cretaceous (Judithian and Lancian), early Paleocene (Puercan and Torrejonian) and early Eocene (Wasatchian) vertebrates from BLM lands of the San Juan Basin in the 1970's from over 400 localities. Most specimens are accompanied by precise locality information based on plots on USGS 7.5' maps. These collections were utilized in numerous theses, dissertations and scientific publications. However, for approximately the last decade, the University of Arizona had stored the collection off campus among various facilities, making it nearly inaccessible to researchers. Ultimately, the University of Arizona (UA) agreed to transfer this collection to the New Mexico Museum of Natural History and Science (NMMNH).

In September 2005, a crew from the NMMNH traveled to Tucson to pack up and move this collection to Albuquerque. Specimens were stored offsite in two different storage areas: one a commercial storage facility and the other, the Duval Street garage building. A rented U-Haul truck was loaded with storage cabinets at the NMMNH and driven to Tucson. The packing and transfer of specimens were accomplished in just three days. The specimens have subsequently been cataloged into the NMMNH collection (a total of over 2,800 cataloged specimens). The locality database has also been incorporated into that of the NMMNH. In addition, the UTM coordinates have been estimated for all locality plots so that data can be easily shared between agencies and utilized for land-use decisions.