Geologic Resources Inventory Scoping Summary
Little River Canyon National Preserve, Alabama

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The Geologic Resources Inventory (GRI) provides each of 270 identified natural area National Park System units with a geologic scoping meeting and summary (this document), a digital geologic map, and a geologic resources inventory report. The purpose of scoping is to identify geologic mapping coverage and needs, distinctive geologic processes and features, resource management issues, and monitoring and research needs. Geologic scoping meetings generate an evaluation of the adequacy of existing geologic maps for resource management, provide an opportunity to discuss park-specific geologic management issues, and if possible include a site visit with local experts.

The National Park Service held a GRI scoping meeting for Little River Canyon National Preserve on March 25, 2009 at the Chickamauga Battlefield's maintenance complex training room in Ft. Oglethorpe, Georgia. The scoping meeting was followed by a site visit at the preserve on March 26, 2009. Participants at the meeting included NPS staff from the preserve, Geologic Resources Division, and Cumberland Piedmont Network, geologists from the Tennessee Division of Geology and Geological Survey of Alabama, academics from Jacksonville State University and Western Kentucky University and cooperators from Colorado State University (see table 2). Tim Connors (NPS-GRD) facilitated the discussion of map coverage and Lisa Norby (NPS-GRD) led the discussion regarding geologic processes and features at the preserve. Geologists from the Geological Survey of Alabama, Jacksonville State University, and Western Kentucky University presented a brief geologic overview of the preserve and surrounding area.

This scoping summary highlights the GRI scoping meeting for Little River Canyon National Preserve including the geologic setting, the plan for providing a digital geologic map, a prioritized list of geologic resource management issues, a description of significant geologic features and processes, lists of recommendations and action items, and a record of meeting participants.

Park and Geologic Setting

Established on October 21, 1992, Little River Canyon National Preserve protects natural, scenic, recreational, and cultural resources in one of the most extensive canyon and gorge systems in the eastern United States. The NPS manages 5,517.06 ha (13,632.95 ac) in partnership with the Alabama state park system. The park is within the Valley and Ridge province of northeastern Alabama, a part of the Appalachian-Alleghanian orogenic belt.

Exposed within Little River Canyon National Preserve are basal Pennsylvanian sedimentary rocks of the Pottsville Formation. The lower portions of this unit contain massive, conglomeratic, quartz-rich sandstone, shale, coal, and mudstone beds deposited in prodelta, barrier and back-barrier depositional environments. The upper portions of the Pottsville contain resistant, crossbedded, quartz-rich conglomerates and sandstones deposited within a fluvial-dominated deltaic system creating repetitive sequences of coals, shales, and sands. The canyon cuts into underlying Mississippian carbonates.

Little River Canyon is incised through the Lookout Mountain syncline. This eroded broad syncline plunges gently towards the southwest and has approximately 305 m (1,040 ft) of topographic relief. The syncline formed during the last major mountain building event in the southern Appalachians– the Pennsylvanian-Permian Alleghanian orogeny. This event involved continental collision, massive regional uplift, subduction of oceanic crust, magmatism, and extensive thrust faulting and associated folding. The Valley and Ridge province in Alabama sits above a large-scale decollement (thin-skinned detachment) along which tectonic forces pushed the Paleozoic-age folded and faulted rocks westward. Rome fault dissects Lookout Mountain to the south.

The landscape at the preserve varies from gently undulating upland areas to sheer vertical cliffs to the narrow canyon floor. Outcrop exposures at Little River Canyon with sandstone glades, steep rocky trails, and shear cliffs are abundant. The Little River and its tributaries including Wolf Creek, Bear Creek, Johnnies Creek, and Yellow Creek dominate the landscape at the park. The interaction between these waterways and the underlying geology has created spectacular scenery in the preserve such as Little River Canyon, 14-m (45-ft) high Little River Falls, and Graces High Falls. This scenery can be seen from places such as Canyon View, Lynn, Hawks Glide, Crow Point, Eberhart Point, and other overlooks along Canyon Rim Drive.

Geologic Mapping for Little River Canyon National Preserve

During the scoping meeting, Tim Connors (NPS-GRD) showed some of the main features of the GRI's digital geologic maps, which reproduce all aspects of paper maps, including notes, legend, and cross sections, with the added benefit of being GIS compatible. The NPS GRI Geology-GIS Geodatabase Data Model incorporates the standards of digital map creation for the GRI Program and allows for rigorous quality control. Staff members digitize maps or convert digital data to the GRI digital geologic map model using ESRI ArcGIS software. Final digital geologic map products include data in geodatabase and shapefile format, layer files complete with feature symbology, FGDC-compliant metadata, an Adobe Acrobat PDF help document that captures ancillary map data, and a map document that displays the map, and provides a tool to access the PDF help document directly from the map document. Final data products are posted at http://science.nature.nps.gov/nrdata/. The data model is available at http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm.

When possible, the GRI Program provides large scale (1:24,000) digital geologic map coverage for each park's area of interest, which is often composed of the 7.5-minute quadrangles that contain park lands (fig. 1). Maps of this scale (and larger) are useful to resource managers because they capture most geologic features of interest and are spatially accurate within 12 m (40 ft). The process of selecting maps for management begins with the identification of existing geologic maps (table 1) and mapping needs in the vicinity of the park. Scoping session participants then select appropriate source maps for the digital geologic data or develop a plan to obtain new mapping, if necessary.

Table 1. GRI Mapping Plan for Little River Canyon National Preserve

Covered Quadrangles	Relationship to the park	Citation	Format	Assessment	GRI Action
Dugout Valley	Intersects the park boundary	Raymond, D. 2009 (in press). Geology of the Dugout Valley Alabama 7.5' quadrangle. Scale 1:24,000. Series XXXX, Map XXX. Geological Survey of Alabama.	Will be digital	The digital map has not been finalized yet, but the shapefiles will soon be available to the GRI. Note that the Pottsville Formation is undifferentiated in this quadrangle.	Obtain GIS shapefiles and convert to GRI Geology-GIS Geodatabase Data Model. The Pottsville Formation needs to be subdivided if possible.
Valley Head, AL	Intersects the park boundary	Raymond, D. 2009 (in press). Geology of the Valley Head Alabama 7.5' quadrangle. Scale 1:24,000. Series XXXX, Map XXX. Geological Survey of Alabama.	Will be digital	The digital map has not been finalized yet, but the shapefiles will soon be available to the GRI. . Note that the Pottsville Formation is undifferentiated in this quadrangle.	Obtain GIS shapefiles and convert to GRI Geology-GIS Geodatabase Data Model. The Pottsville Formation needs to be subdivided if possible.

Fort Payne	Intersects the park boundary	Raymond, D. 2009 (in press). Geology of the Fort Payne Alabama 7.5’ quadrangle. Scale 1:24,000. Series XXXX, Map XXX. Geological Survey of Alabama.	Will be digital	The digital map has not been finalized yet, but the shapefiles will soon be available to the GRI. . Note that the Pottsville Formation is undifferentiated in this quadrangle.	Obtain GIS shapefiles and convert to GRI Geology-GIS Geodatabase Data Model. The Pottsville Formation needs to be subdivided if possible.
Jamestown, AL	Intersects the park boundary				Needs to be mapped – GRI staff is soliciting a mapping proposal from Geological Survey of Alabama and Jacksonville State University to map all or part of this this quadrangle.
Little River, AL	Intersects the park boundary				Needs to be mapped – GRI staff is soliciting a mapping proposal from Geological Survey of Alabama and Jacksonville State University to map all or part of this quadrangle.
Gaylesville	Intersects the park boundary				Needs to be mapped – GRI staff is soliciting a mapping proposal from Geological Survey of Alabama and Jacksonville State University to map all or part this quadrangle.

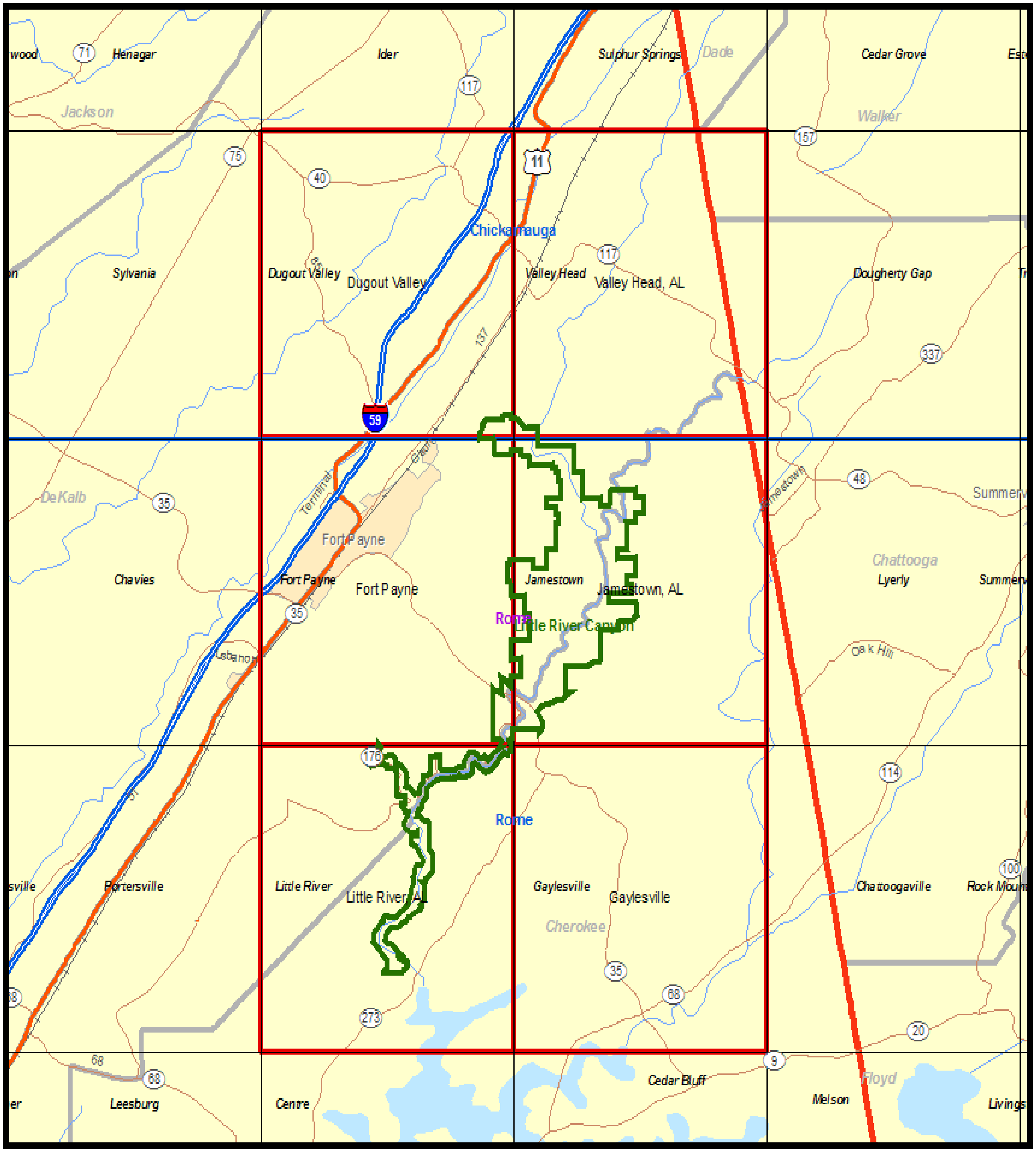

Figure 1. Area of interest for Little River Canyon National Preserve, Alabama. The 7.5-minute quadrangles are labeled in black; names and lines in blue indicate 30-minute by 60-minute quadrangles, whereas names and lines in purple indicate 1x2 degree quadrangles. Green outlines indicate national preserve boundaries.

Map coverage will soon be available at the 1:24,000 scale for the Valley Head, Dugout Valley, and Fort Payne 7.5 minute quadrangles of interest for Little River Canyon National Preserve. However, the Pottsville Formation has not been subdivided on these maps. According to Ed Osborne of the

Geological Survey of Alabama, it may be possible to map the Little River area as a cooperative project with Jacksonville State University (JSU). The state and JSU may be able to match funds to complete the mapping. Geologic mapping is needed for the Gaylesville, Jamestown, AL, and Little River, AL quadrangles, and the Pottsville Formation needs to be subdivided in the Fort Payne, Dugout Valley, and Valley Head quadrangles. It may be best to map only the National Preserve part of the six quadrangles. According to Ed Osborne, the geology of the Gaylesville quadrangle is quite complicated. Map coverage of the Little River, AL quadrangle is of top priority because of its exposure of Pennsylvanian units where the Pottsville Formation is undifferentiated on the east side of the canyon where geologists have not yet mapped prominent sandstones at the top of the canyon. Because the Little River cuts down plunge of the Lookout syncline, the preserved thickness of the Pottsville Formation is unknown. Consequently, it is unclear if the underlying Pennington Formation is exposed within the park. There are limestone boulders on the canyon floor below Bear Creek (but not above) that could be the Pennington Formation. Except for beds on the southeast limb of the syncline at the canyon mouth, the strata at the park are nearly horizontal. Geologic mapping will be difficult due to the steep terrain in the canyon. Detailed examination and subdivision of the Pottsville Formation in the Little River, AL quadrangle would be useful for subdividing the Pottsville in adjacent quadrangles.

Geologic Resource Management Issues

Participants at the scoping session for Little River Canyon National Preserve developed a list of geologic features and processes, which will be further explained in the final GRI report. During the scoping meeting, participants prioritized the most significant issues as follows:
(1) Flooding and fluvial processes,
(2) Slope processes, and
(3) Geologic connections with the ecosystem

Other geologic resource management issues discussed include seismicity, and historical resource development and disturbed lands.

Flooding and fluvial processes

The Little River and its tributaries including Bear Creek, Wolf Creek, Johnnies Creek, Straight Creek, Hurricane Creek and Yellow Creek dominate the landscape at the preserve. These streams are incising in to the resistant sandstones of the Lookout Mountain syncline. Most of the canyon is a scoured bedrock channel with little fine-grained sediment. The primary fluvial issue at the preserve is streambank stabilization. Structures have been constructed to stabilize the streambanks along the Little River. Gabions have been installed in backwater areas to absorb energy from seasonal floods such as at the picnic area at Canyon Mouth. Unfortunately, artificial stabilization in one area tends to increase erosion in adjacent areas. The preserve's budget does not allow for large-scale stabilization solutions.

Within the preserve, safety hazards exist along riverside trails where they have been undercut by streamflow. Stabilization efforts at some of these areas are only short-term solutions. Other issues regarding fluvial processes involve certain parties' desires to remove trees for recreation purposes such as establishing campsites. This removal of stabilizing vegetation could exacerbate erosion, channelization, and gullying on park slopes in addition to increasing sediment load within the river system.

Flooding is a significant management concern. Data on the location of the 100-year floodplain at Little River are virtually nonexistent (see recommendations section). Little River often experiences intense increases of flow following precipitation events. Because of the narrowness of the Little River Canyon, much of the streambank areas are prone to inundation. Three primitive campsites within the preserve often flood (one at Sandy Dune). In addition to natural flood hazards, many uninspected ca. 1920s dams exist on Little River tributaries including Cash, Temple, Owens Lake, Rotch and Cassidy, Sharp Branch, Camp Corner, A. A. Miller, and Lahusage dams. These were constructed to create lakes (reservoirs) for residents in upland housing developments. Most of the dams are derelict, poorly maintained, concrete and steel structures. At this time, there are not responsible parties for ownership and/or maintenance of the dams. No flood warning system is in place in the preserve. If the dams were to fail, an unexpected flood could inundate reaches of Little River Canyon. Dambursts within the watershed have caused devastating flash floods, several of which required rescues from the roof of the building at Canyon Mouth (possibly on Johnnies Creek). Dams at Alpine and Lake Lahusage have partially failed in the past, resulting in large slabs of sandstone being sucked from the riverbed at Little River Falls creating large pools. Another dam-related feature that poses a safety hazard for kayakers is a wooden cofferdam that is rock-filled and contains iron spikes on the main branch near Eberhart Point. In the past, this structure may have been used to float logs or supply controlled rushes of water for recreational purposes.

Slope processes

Blockfall is a natural process contributing to the formation of Little River Canyon (fig. 2). Shaley and coal-rich layers within the Pottsville Formation create zones of weakness where failures could occur within the rock column. Rock falls could pose a safety hazard to visitors within the canyon. Overlook areas may also be at risk for failure due to blockfall (fig. 3).

Slope processes may be contributing to road stabilization and trail erosion in the park. Canyon Rim drive skirts the edge of the canyon in many areas without guardrails. This poses a safety hazard when visitors use the roadway. Occasionally, vehicles and assorted debris have been pushed off the canyon rim, resulting in damage to park resources. Lack of guardrails may encourage increased use at non-designated sites, which may increase mass wasting locally. The shear canyon walls attract abundant climbing interest and climbers have installed thousands of rock bolts for climbing and rappelling in the preserve. These and other visitor activities cause concentrated erosion along social trails and other off-trail use sites. Park attempts to curb these adverse effects have had limited success.

Geologic connections with the ecosystem

Geology's interconnection with the ecosystem is demonstrated in the preserve where unique upland wetlands and bogs that harbor rare and endangered species have formed. Sandstone balds, such as those at Lynn Overlook are also unique habitats that developed due to the underlying geology.

Other geologic resource management issues

Seismicity

According to geologists at the Geological Survey of Alabama, Little River Canyon is within an area of moderately low seismic risk (zone 2). However, there are frequent seismic events in the area possibly associated with the East Tennessee seismic zone. Local epicenters include Hartsville, Tennessee and Ft. Payne, Alabama, the latter of which had a magnitude 4.9 earthquake event as recently as 2006. Renewed movement on several faults in the area could occur. Though not likely, potential hazards associated with seismic shaking, if strong enough, could include damage to park infrastructure including buildings, roads, trails, and bridges. Seismic shaking could also trigger massive block falls on the walls of Little River Canyon.

Historic mineral resource development and disturbed lands

A small amount of iron ore is present within the rocks in the canyon walls at Little River National Preserve. The presence of iron and coal seams in the area ignited iron furnace operations in the 1800s. The town of Ft. Payne was originally an iron town. It is unknown whether coal mines existed within the park. Active mining persists in the northeastern part of the Little River watershed. Personal use ("groundhog") pits or small-scale shafts into coal seams are present throughout the area as are shallow scrapes. In neighboring DeSoto State Park, there are closed coal prospect pits. Several abandoned and active coal mines are upstream of the national preserve. Some mill sites were constructed along the Little River and its tributaries for hydropower generation.

Logging continues throughout the area, but not within the preserve. Alabama Power Company-owned land has been logged many times in the past. These activities lead to logging scars, drag lines, ruts, ditches, compacted soils, and replanting of the area with loblolly pines.

A stone quarry, used by the Civilian Conservation Corps (CCC) to build some park structures exists within the boundaries of DeSoto State Park. No known stone quarries exist within preserve boundaries.

The preserve at times was used as a dumpsite. Urban development, poor land use planning, and improper land management practices upslope of Little River Canyon exacerbate erosion, which causes sediment loads to increase and sediment-laden water to flow into Little River Canyon National Preserve (fig. 4). Pollution and low pH in Little River tributaries are not buffered by the sandstone substrate. These water quality issues are particularly evident in Yellow Creek.

Figure 2. Blockfall littering the slopes of Bear Creek Canyon just above Little River Canyon. Photograph is by Trista L. Thornberry-Ehrlich (Colorado State University).

Figure 3. Overhanging sandstone ledge at an overlook along the Canyon Rim Road. Photograph is by Trista L. Thornberry-Ehrlich (Colorado State University).

Figure 4. Sediment-laden water from Bear Creek (right) flowing into Little River after a period of high precipitation. Photograph is by Trista L. Thornberry-Ehrlich (Colorado State University).

Features and Processes

Little River Canyon

Little River Canyon and its tributary waterways are the primary resource at the preserve. The canyon is more than 183 m (600 ft) deep and approximately 19 km (12 mi) long. At the top of Lookout Mountain, Little River begins at 580 m (1,900 ft) above sea level and plunges along its course to 198 m (650 ft) above sea level at Weiss Lake. Resistant layers in the rock form ledges that create waterfalls such as Little River Falls which is 14 m (45 ft) high (fig. 5). The discharge in Little River and its tributaries can range from nearly dry to a raging torrent after rainfall events. There appears to be a spatial relationship between geologic faults and joints and the orientation of stream drainages.

Karst features

There are some karst features such as sinkholes on the edges of the preserve. One sinkhole collapsed beneath a local church cemetery. Most of the rocks exposed within the park are sandstones, siltstones, and shales that are not prone to dissolution. Certainly, dissolution of limestone underlying the insoluble units affects the hydrogeologic system at the preserve.

Paleontological resources

According to the NPS Paleontological Inventory for Little River Canyon National Preserve (Hunt-Foster et al. 2009), the Pottsville Formation contains fossil resources within the park boundaries (in the canyon walls), presenting opportunities for resource management including field surveys, inventory, and monitoring, education, and interpretation. These documented fossils include carbonized plant fragments such as *Lepidodendron* (found at Little River Falls), horsetails (at Canyon View), crinoid remains (along the river floor along Eberhart Trail), bark impressions, and ferns. Other fossilized remains regionally include amphibian footprints, and invertebrate fossils. Coal seams within the Pottsville contain Pennsylvanian peat swamp flora. The Canyon View site may present a good opportunity to interpret the paleontologic resources in the preserve. Fossils present elsewhere in the Pottsville and potentially within Little River Canyon National Preserve include bryozoans, brachiopods, mollusks, echinoderms, plant spores, scale trees, fossil tracks, and insects. Mississippian fossils such as crinoids, *Archimedes* screws, and corals may be present in float in bottom of the canyon.

Unique features

The type locality for the Mississippian Fort Payne chert is in the vicinity of the preserve. A type locality refers to an area where a specific geologic unit is well exposed and defined for comparison with other exposures. Hundreds of rock shelters with archaeological material, including the Fort Payne chert (used for making stone implements and arrowheads) correlate with the prominent sandstone ledges and overhangs within the Pottsville Formation at Little River Canyon (fig. 6).

Some shelters contain remains of historic moonshine stills.

Sandstone glades are areas underlain by resistant, weathered sandstone with little to no soil development along the canyon rim and elsewhere. These are similar in nature to the unique cedar glade habitats in areas underlain by limestone.

The upland areas of Little River Canyon support unique upland bogs and wetlands–southern Appalachian low mountain seepage bogs. These wetlands provide habitat for several rare and/or endangered species such as the green pitcherplant (*Sarracenia oreophila*) and Kral's water plantain (*Sagittaria secundifolia*).

Figure 5. Little River Falls at high flow. Photograph is by Trista L. Thornberry-Ehrlich (Colorado State University).

Figure 6. Rock shelter areas in the cliffs at Little River Canyon National Preserve. Photograph is by Trista L. Thornberry-Ehrlich (Colorado State University).

Recommendations

1. Work with GRD to create a paleontological resources management plan and conduct a formal inventory of fossil resources within Little River Canyon National Preserve.
2. Use the FEMA Map Service Center to locate public flood maps and flood-related maps searchable by state, county, city, and street address: http://gis1.msc.fema.gov/Website/newstore/Viewer.htm

Action Items

1. GRI mapping coordinator will submit a letter requesting priority for mapping areas of interest for Little River Canyon National Preserve.
2. GRI report writer will obtain a copy of a map by Szabo et al. (1988).
3. GRI report writer will obtain a copy of Thomas and Bayona (2005).
4. GRI report writer will use Rinehart's thesis on Little River (Watershed Condition Assessment) for use in preparing the final GRI geologic report.

References

Szabo, M. W., W. E. Osborne, C. W. Copeland, Jr., and T. L. Neatherly. 1988. Geologic map of Alabama (1:250,000). Special Map 220. Tuscaloosa, AL: Geological Survey of Alabama.

Thomas, W. A., and G. Bayona. 2005. The Appalachian thrust belt in Alabama and Georgia: thrust-belt structure, basement structure, and palinspastic reconstruction. Monograph 16. Tuscaloosa, AL: Geological Survey of Alabama.

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Table 2. Scoping Meeting Participants

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