

Geologic Resources Inventory Scoping Summary Chattahoochee River National Recreation Area Georgia

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Geologic Resources Division
National Park Service
U.S. Department of the Interior



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

The Geologic Resources Division held a GRI scoping meeting for Chattahoochee River National Recreation Area on March 19, 2012, at the headquarters building in Sandy Springs, Georgia. Participants at the meeting included NPS staff from the national recreation area, Kennesaw Mountain National Battlefield Park, and the Geologic Resources Division; and cooperators from the University of West Georgia, Georgia Environmental Protection Division, and Colorado State University (see table 2, p. 21).

During the scoping meeting, Georgia Hybels (NPS Geologic Resources Division, GIS specialist) facilitated the group's assessment of map coverage and needs, and Bruce Heise (NPS Geologic Resources Division, GRI program coordinator) led the discussion of geologic features, processes, and issues. Jim Kennedy (Georgia Environmental Protection Division, state geologist) provided a geologic overview of Georgia, with specific information about the Chattahoochee River area. Randy Kath (University of West Georgia, professor of geology) presented information about the geology of the Chattahoochee Tunnel—a project that will relieve the existing wastewater sewer system in metropolitan Atlanta (Jones and Robison 2001). The 15-km- (9.4-mi-) long tunnel is approximately 5.5 m (18 ft) in diameter and between 27 and 107 m (90 and 350 ft) below ground. The alignment of the tunnel is close to the Chattahoochee River and crosses numerous surface drainages and the Brevard Zone—a structural feature of great significance for the Chattahoochee River (see “Brevard Zone” section). The tunneling project provided the opportunity to map the subsurface geology in the vicinity of Chattahoochee River National Recreation Area.

After the meeting on March 19, participants visited Island Ford Shoals near the park headquarters. The site visit continued on March 20 with stops at Vickery Creek, Sope Creek, and Devils Race Course Shoals.

Park Setting

Chattahoochee River National Recreation Area is a “river park.” As the name indicates, the Chattahoochee River is the national recreation area's most significant feature and the primary reason for its inclusion in the National Park System. Chattahoochee River National Recreation Area includes the 77-km (48-mi) stretch of the Chattahoochee River between Buford Dam at Lake Sidney Lanier, and Peachtree Creek, which flows through the city of Atlanta east of the national

recreation area (fig. 1). Chattahoochee River National Recreation Area is composed of 16 noncontiguous units that cover 2,630 ha (6,500 ac). The Bowmans Island unit is the northernmost unit; the Paces Mill unit is farthest south. Depending on future land acquisitions, the maximum potential area of Chattahoochee River National Recreation Area is approximately 4,450 ha (10,000 ac). An 18-ha (44-ac) tract of land near Rogers Bridge, around river mile 337, was the most recent land acquisition (in 2011).

The Chattahoochee River is vitally important to the greater Atlanta metropolitan area. It is the primary source of drinking water in the Atlanta metropolitan area (Atlanta Regional Commission 2012). Furthermore, the Chattahoochee River corridor provides 70% of public green space in the Atlanta area. Kennesaw Mountain National Battlefield Park provides most of the remainder (Kunkle and Vana-Miller 2000). More than 3 million people visit Chattahoochee River National Recreation Area annually, with approximately one third of these visitors engaging in river-based recreational activities. The segment of the Chattahoochee River within the national recreation area is the most intensely used segment in the state (Burkholder et al. 2010).

Chattahoochee River National Recreation Area is situated in the Piedmont physiographic province, which is characterized as a hilly plateau that slopes gradually eastward until it disappears under the Coastal Plain physiographic province to the south. The Blue Ridge physiographic province borders the Piedmont to the north. The Blue Ridge can be considered the backbone of the Appalachian region and is its principal drainage divide. The eastward-sloping Piedmont formed between 500 million and 450 million years ago, at which time the Piedmont and Blue Ridge were a stable carbonate margin similar to the present-day Bahamas. About 300 million years ago, the Coastal Plain, Piedmont, and Blue Ridge physiographic provinces were “squashed together” during the formation of a supercontinent, called “Pangaea,” that stretched from pole to pole (fig. 2). All of the landmasses that make up today’s major continents were part of Pangaea. The final assembly of Pangaea involved the collusion of proto-North America, called “Laurentia,” and “Gondwanaland,” composed of Africa and South America. The formation of Pangaea was responsible for enormous upheavals. In the eastern United States, the result was the Appalachian Mountains. In the western United States, the Ancestral Rocky Mountains formed at this time (320 million–290 million years ago).

A major feature cutting across the Piedmont physiographic province, and Chattahoochee River National Recreation Area, is the Brevard Zone. This structural feature or fault zone intersects the states of Alabama, Georgia, North Carolina, South Carolina, and Virginia. In the vicinity of Chattahoochee River National Recreation Area, the Brevard Zone runs from Habersham County to Douglas County on the west side of Atlanta. In a general way, the Brevard Zone serves as the boundary between the Piedmont and Blue Ridge physiographic provinces. The zone becomes truncated beneath the Coastal Plain physiographic province in Alabama. A primary significance of the Brevard Zone for the national recreation area is that it controls the location of the Chattahoochee River (see “Fluvial Features and Processes”).

Chattahoochee River National Recreation Area

- National Recreation Area (includes 48 miles of the Chattahoochee River)
- Private land within authorized boundary
- Other public area

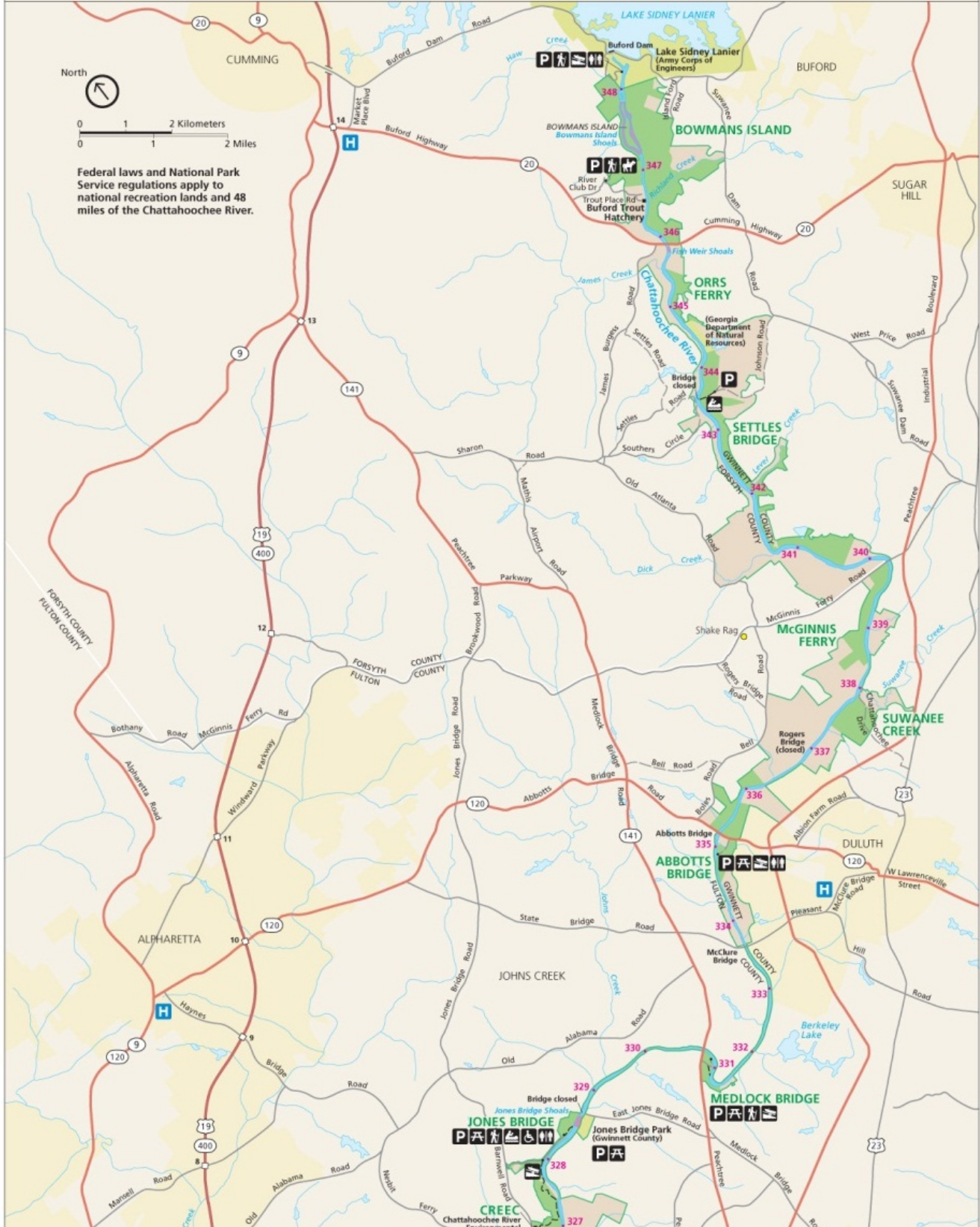
- River milepost
- Hiking trail
- Unpaved road
- Shoal area
- Exit number

- Hospital
- Parking
- Ranger station
- Boat, canoe, and raft launch
- Canoe and raft launch
- Picnic area
- Restrooms
- Horseback riding trail
- Bicycle trail
- Hiking trail
- Wheelchair-accessible trail



0 1 2 Kilometers
0 1 2 Miles

Federal laws and National Park Service regulations apply to national recreation lands and 48 miles of the Chattahoochee River.



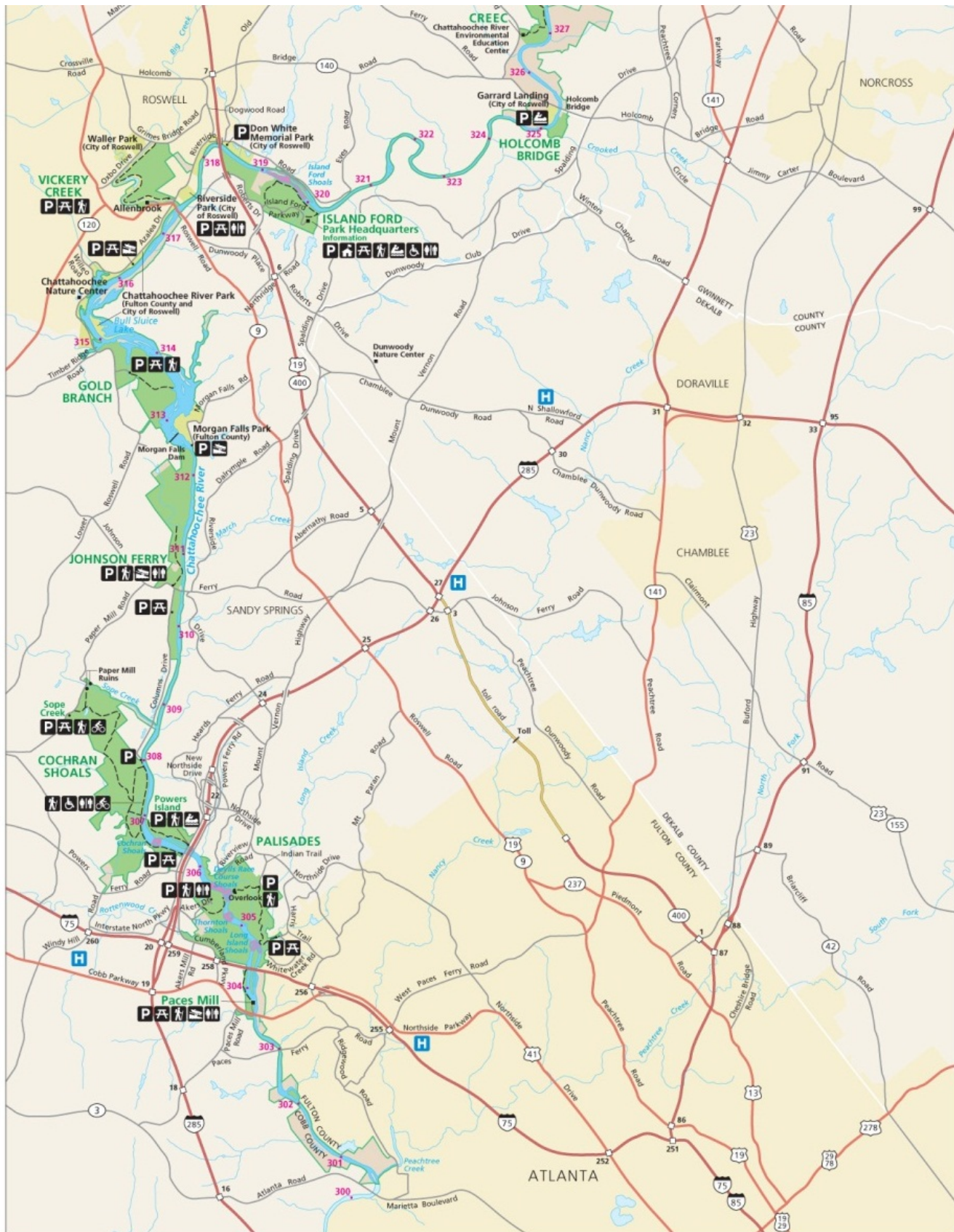


Figure 1. Map of Chattahoochee River National Recreation Area. The national recreation area is composed of 16 noncontiguous units along the Chattahoochee River. The northernmost unit is Bowmans Island. The southernmost is Palisades. During GRI scoping, participants visited the Island Ford, Vickery Creek, Cochran Shoals, and Palisades units. National Park Service graphic.

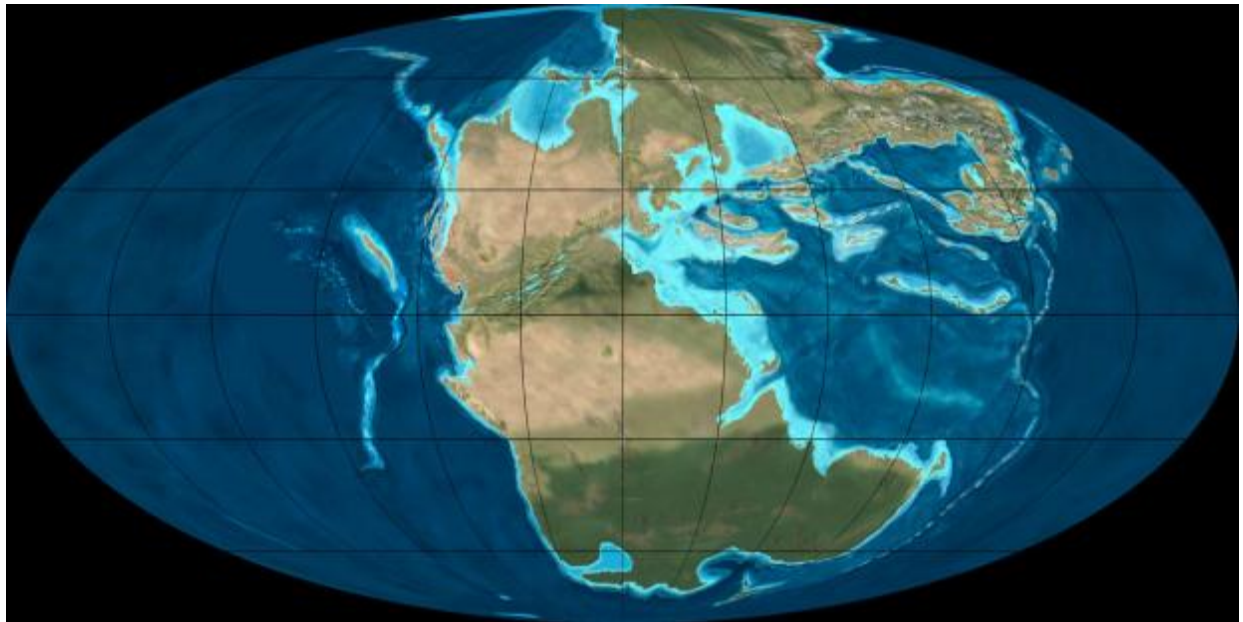


Figure 2. Pangaea. North America was once part of the supercontinent Pangaea. The C-shaped landmass stretched from pole to pole, and cupped the Tethys Ocean. The spine of the “C” was adjacent to a long subduction zone (a convergent plate boundary where one plate slides deeply beneath another). Much of Earth’s surface was covered by a large ocean called Panthalassa. Base paleogeographic image by Ron Blakey (Northern Arizona University), available at <http://jan.ucc.nau.edu/~rcb7/index.html> (accessed 26 October 2011).

Geologic Mapping for Chattahoochee River National Recreation Area

During the scoping meeting, Georgia Hybels (NPS Geologic Resources Division) showed some of the main features of the GRI Program’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 (see <http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm>) 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, Federal Geographic Data Committee (FGDC)–compliant metadata, a PDF that captures ancillary map data, and a document that displays the map.

The process of selecting maps for inclusion in the GRI data set began with the identification of existing geologic maps (table 1). During the scoping meeting, participants evaluated, discussed, and selected source maps that would be useful for resource management. 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 parklands (fig. 3). Maps of this scale (and larger) are useful for resource management because they capture most geologic features of interest and are spatially (horizontally) accurate within 12 m (40 ft).

Chattahoochee River National Recreation Area has nine quadrangles of interest (fig. 3). Three published geologic maps cover parts of this area (table 1), though none at a scale of 1:24,000. Dicken et al. (2005) provided 1:500,000-scale bedrock data for five quadrangles of interest (Buford

Dam, Mountain Park, Roswell, Duluth, and Suwanee) in the northern part of the national recreation area. Higgins et al. (2003) provided 1:100,000-scale geologic mapping for four quadrangles of interest (Sandy Springs, Chamblee, Norcross, and Northwest Atlanta) in the southern part of the national recreation area. The map by McConnell and Abrams (1984) was deemed unsuitable for resource management because it was never field checked.

Table 1. Potential source maps for Chattahoochee River National Recreation Area GRI data set

Covered Quadrangles	GMAP ¹	Source	Scale	Format	Assessment	GRI Action
Sandy Springs, Chamblee, Norcross, and Northwest Atlanta	68679	Higgins et al. (2003)	1:100,000	paper	Covers lower quadrangles of interest. Best scale and most recent data for what is available.	Crop to quadrangles of interest and digitize this map.
Buford Dam, Mountain Park, Roswell, Duluth, and Suwanee	74109	Dicken et al. (2005)	1:500,000	digital	Covers top quadrangles of interest. Try to edge match with Higgins et al. (2003).	Crop to quadrangles of interest and convert this map data.
All quadrangle of interest	74132	McConnell and Abrams (1984)	1:100,000	paper	Kath and Crawford said this was never ground checked and should not be used.	None

¹GMAP numbers are unique identification codes used in the GRI database.

GRI staff put “cropped out” quadrangles of interest from Dicken et al. (2005) and Higgins et al. (2003) into a GIS format (GRI 2.1 geodatabase data model) that is available in ESRI 9.3 personal geodatabase and shapefile formats. Because of the difference in scales between Dicken et al. (2005; scale 1:500,000) and Higgins et al. (2003; scale 1:100,000), no attempt was made to “edge match” these maps, and they occur as separate files. The five quadrangles of interest of Dicken et al. (2005) are at <https://irma.nps.gov/App/Reference/Profile/2188723>. The four quadrangles of interest of Higgins et al. (2003) are at <https://irma.nps.gov/App/Reference/Profile/2188724>. The project record for these data is <https://irma.nps.gov/App/Reference/Profile/2188660>. These maps are also available in KMZ/KML format for use in Google Earth. Google Earth software is available for free at <http://www.google.com/earth/index.html>.

Because the scale for the northern section of the national recreation area (i.e., Dicken et al. 2005) is very coarse, scoping participants suggested that bedrock mapping of the Chattahoochee Tunnel by Randy Kath and Tom Crawford (University of West Georgia, professors of geology) would provide detailed geologic information that is lacking at scale 1:500,000. Chattahoochee Tunnel mapping could be projected into Chattahoochee River National Recreation Area. If funding is available in 2013, the GRI Program could support one or two Geoscientists-in-the-Parks (GIP) participants to complete such a project, possibly under the guidance of Randy Kath. The GIP Program is administered by the NPS Geologic Resources Division (see <http://nature.nps.gov/geology/gip/index.cfm>).

Additionally, the shoals in the Chattahoochee River were recently identified as a value of special significance for Chattahoochee River National Recreation Area (National Park Service 2012). Given this significance, and their significance as a distinctive geologic resource (see “Shoals” section), GRI staff would be willing to include the locations of shoals as a GIS layer in the GRI data

set. However, the locations of the shoals have not been mapped on a topographic base (Rick Slade, Chattahoochee River National Recreation Area, chief of planning and resource management, e-mail communication, 6 September 2012). A map showing the shoals is available as an Adobe Illustrator file (see <http://hfc.nps.gov/cfm/cartto.cfm>), which was used to create the park map (Tom Patterson, Harpers Ferry Center, cartographer, e-mail communication to Georgia Hybels, NPS Geologic Resources Division, GIS specialist, 26 September 2012). However, this file lacks necessary geospatial coordinates for inclusion in GIS. Thus mapping of the shoals is another potential project for a GIP participant.



Figure 3. Quadrangles of interest for Chattahoochee River National Recreation Area. The 7.5-minute quadrangles of interest are labeled in red. Names in orange indicate 30-minute x 60-minute sheets. The green outline indicates the NPS boundary of Chattahoochee River National Recreation Area. Graphic compiled by Georgia Hybels (NPS Geologic Resources Division).

Geologic Features, Processes, and Issues

The GRI scoping meeting for Chattahoochee River National Recreation Area provided an opportunity to discuss distinctive geologic features and processes at the national recreation area, some of which have associated issues of management concern.

Brevard Zone

The Brevard Zone is a major structural feature that extends for 600 km (965 mi) across the southern Appalachians (Bobyarchick et al. 1988). Chattahoochee River National Recreation Area is an outcome of the Brevard Zone in both large ways, such as topography and landforms, and small ways, such as grain size and shape in rocks. The Chattahoochee River in the Atlanta area flows along the Brevard Zone. “Locked” in place along the Brevard Zone, the river is one of the oldest and most stable river channels within the United States (O’Grady and Poe 1980). As a result of the Brevard Zone’s influence, the overall character of the Chattahoochee River watershed is long and linear, as are many of the river’s reaches, such from Morgan Falls Dam downstream to just north of Interstate 285, and the reach north of Gainesville, Georgia, used for the 1996 Summer Olympics rowing and flat-water canoe venues. The influence of the Brevard Zone on the landscape of Chattahoochee River National Recreation Area and northern Georgia is revealed on digital elevation models or shaded-relief maps. Many segments of the Brevard Zone show rhythmically spaced parallel ridges that are oriented northeast–southwest, along the zone’s northeast strike. These ridges are responsible for the Chattahoochee River’s northeast-to-southwest course through northern Georgia. Furthermore, the Brevard Zone is responsible for the interception of drainage that would otherwise flow southeast toward the Atlantic Ocean. Instead, the Brevard Zone diverts surface water flow southwest into the Gulf of Mexico.

The Brevard Zone was first recognized by Keith (1905) as Brevard Schist, and its lithologic origins are still instructive today. Schist is a strongly foliated, crystalline rock formed by dynamic metamorphism; its minerals are platy and have a parallel arrangement. The Brevard Zone influences such micro-scale features in rocks. Interestingly, the zone is often called the “Brevard zone of cataclasis,” referring to severe mechanical stress applied during dynamic metamorphism, which results in the rotation and fragmentation of mineral grains. Every term used to describe deformation in geology can (and probably has) been used to describe the Brevard Zone: folding, faulting, jointing, shearing, crushing, and fracturing. The rocks in the Brevard Zone exemplify these “catastrophes” such as gneisses whose banding typifies deformation, mylonites whose extreme brecciation characterizes fracturing, and button schists whose orientation of grains highlights shearing (fig. 4).



Figure 4. Button schist. Button schist occurs in the vicinity of Chattahoochee River National Recreation Area and exemplifies the intense shearing that has taken place in the Brevard Zone. Photograph by Randy Kath (University of West Georgia).

The Brevard Zone has been interpreted as a variety of different kinds of faults or discontinuities (Bobyarchick 1999). One interpretation is that the Brevard Zone represents a “suture” where proto-Africa and North America joined to form Pangaea. Geologists continue to debate the Brevard Zone’s structure, significance, and the nature and direction of ancient movement within the fault zone. Bobyarchick et al. (1988) noted 31 interpretations between 1905 and 1987. Citations housed in the GeoRef database reveal the continuation of the debate to the present day.

Fluvial Features and Processes

The Chattahoochee River flows southwest through Georgia, beginning in the mountains at the Tennessee border. Brasstown Bald, the highest peak in Georgia at elevation 1,455 m (4,774 ft), is located near the headwaters. Chattahoochee River National Recreation Area includes the stretch of the Chattahoochee River between Buford Dam at Lake Sidney Lanier (a reservoir) and Peachtree Creek, which flows through the city of Atlanta to join the river. From the Peachtree Creek tributary, the Chattahoochee River continues flowing south-southwestward where it serves as the state line between Alabama and Georgia. The Chattahoochee River connects with the Flint River to form the Apalachicola River, which empties into the Gulf of Mexico (Byrd 2009).

The Chattahoochee River drains an area of about 1,077 km² (416 mi²) (Kunkle and Vana-Miller 2000). Fifteen major tributaries and many minor tributaries of the Chattahoochee River occur within Chattahoochee River National Recreation Area. The two largest tributaries are Big Creek and Suwanee Creek (National Park Service 2004). Many of the tributaries that join the Chattahoochee River run through steep, rugged terrain. For instance, Sope Creek drops almost 90 m (300 ft) along the 19-km (12-mi) length of its watercourse to the Chattahoochee River (Byrd 2009). The slope of the tributaries allowed for the development of hydroelectric power of the area.

Flooding

Before the Buford Dam was completed, major winter and early spring floods were common; large floods of more than 30,000 cfs (cubic feet per second) occurred once or twice during most decades (Kunkle and Vana-Miller 2000; Burkholder et al. 2010). Since 1957, the Buford Dam and releases from Lake Sidney Lanier have dominated the Chattahoochee River’s flows within Chattahoochee River National Recreation Area. The exception is during major storms when runoff has more strongly influenced the river’s hydrograph (U.S. Army Corps of Engineers 1998).

Lake Sidney Lanier—the impoundment/reservoir created by the Buford Dam—is large enough to hold the volume of a 500-year flood (U.S. Army Corps of Engineers 1998). Nevertheless, flooding poses some threat to park infrastructure such as rest rooms, parking lots, and trails within the floodplain. The historic steel-truss bridges may also be threatened during high runoff events. During flooding in September 2009, when 30 cm (12 in) of rain came in three days, the rest room and boardwalk at Paces Mill sustained damage as a result of flooding- and runoff-related erosion. The Vickery Creek area is known to experience big sediment slugs as a result of storm-water runoff. Impermeable surfaces such as roads, driveways, and parking lots have become a key factor in storm-related runoff and erosion. Scoping participants noted a sloped driveway at Sope Creek that becomes a spillway for storm-water runoff (fig. 5).



Figure 5. Sloped driveway at Sope Creek. During storms, this driveway near Sope Creek becomes a spillway for storm-water runoff. Photograph by Katie KellerLynn (Colorado State University).

Bank Erosion and Other Anthropogenic Effects

Two dams, the Buford Dam and the Morgan Falls Dam, have altered natural flows of surface water within Chattahoochee River National Recreation Area. Buford Dam and its impoundment, Lake Sidney Lanier, are the upstream boundary of the national recreation area at river mile 348.3. The U.S. Army Corps of Engineers has operated the dam since 1957, originally emphasizing hydroelectric power and flood control. Since 1989, additional emphasis has been on water supply. Recreational uses are also becoming an important emphasis (Burkholder et al. 2010). The much smaller second dam, Morgan Falls Dam, was constructed in 1903 at river mile 312.6. Today, this dam helps to regulate flow and soften pulses of sediment and water release from Buford Dam. Interestingly, Morgan Falls Dam provided hydroelectric power for the streetcars in Atlanta in the early 1900s. After more than 100 years, the impoundment of Morgan Falls Dam, called Bull Sluice Lake, is largely filled with sediment, which has significantly reduced water-storage capacity (Kunkle and Vana-Miller 2000). Today, Bull Sluice “Lake” may be rightly seen as Bull Sluice “Mudflats.” The mudflats and backwaters at Bull Sluice Lake support a thriving water-bird population.

Operation of these two dams, especially Buford Dam, is required to maintain a minimum flow of at least 750 cfs in the Chattahoochee River downstream from Atlanta’s water intake at river mile 299.6 (U.S. Army Corps of Engineers 1998). However, releases of water from the impoundments can be extremely variable. Scoping participants noted a range between 650 and 12,000 cfs. Kunkle and Vana-Miller (2000) documented typical river discharge below Buford Dam as less than 700 cfs (sometimes less than 500 cfs) to more than 5,000 cfs (Kunkle and Vana-Miller 2000). The outlet sluice at Buford Dam has a maximum capacity of 11,600 cfs, but the dam can release up to 22,600 cfs without use of the emergency spillway (U.S. Army Corps of Engineers 1998). Water levels attenuate downstream. Scoping participants noted the “bathtub ring” below “Jumping Rock” near Devils Race Course Shoals, which shows a change in water level of about 1.2 m (4 ft) (fig. 6).

The cycle of dam releases typically follows a schedule, with weekday releases once per day at approximately 3:30 pm, corresponding to peak energy usage. More generally, Kunkle and Vana-Miller (2000) noted a weekly schedule, with five weekdays of short release periods followed by

little or no water released on weekends. The recent, extended drought in the region has caused increased interest and conflict over releases among various downstream parties.



Figure 6. Palisades unit. The Palisades unit at Chattahoochee River National Recreation Area exhibits shoals (see fig. 12) and cliffs. One cliff is the popular “Jumping Rock” below Devils Race Course Shoals. This cliff juts out over the river (arrow). Note the “bathtub ring” (light-colored rock) at the base of the cliff. Photograph by Katie KellerLynn (Colorado State University).

The surges of release from the dam adversely affect the river for about 32 km (20 mi) downstream. Surges of water cause tree fall and severe bank erosion (Kunkle and Vana-Miller 2000). Rapid changes in water levels cause exacerbated scouring and undercutting of the river banks, and increased amounts of suspended sediment. Significant bank erosion is impacting park structures, as well as private property. Erosion is notable around steps (river access points) built into banks. These rock steps are losing support as a result of fluvial erosion. During the site visit, scoping participants saw an example of this impact at the step-down ramp below Devils Race Course Shoals (fig. 7). More severe erosion occurs in other locations, such as at the step-down ramp at Settles Bridge.



Figure 7. Steps near Devils Race Course Shoals. The steps, which provide river access, are losing support as a result of fluvial erosion exacerbated by sudden water release from Burford Dam. Photograph by Katie KellerLynn (Colorado State University).

Another notable impact of fluctuating releases is that many tributaries have become deeply incised at their confluence with the Chattahoochee River due to water backing up into the tributaries during

peak releases. Park staff has observed incisions up to 5 m (15 ft) deep running as far as 45 m (150 ft) back into tributaries.

Crystalline Rocks

From Buford Dam to Peachtree Creek—the length of Chattahoochee River National Recreation Area—the Chattahoochee River flows through ancient crystalline rocks. With the exception of unconsolidated surficial material deposited during the last 2.6 million years (Quaternary Period), all of the rocks within the national recreation area are at least 250 million years old, with some as old as 1.6 billion years. These are some of the oldest rocks in the southeastern United States, and are some of the most complicated, with respect to their geology and structural history. Since their origins, these rocks have undergone repeated cycles of igneous intrusions and extrusions, metamorphism, folding, faulting, shearing, and silicification (Kath and Crawford 2001). They now lie fractured within the Brevard Zone. A notable feature of the Brevard Zone is the juxtaposition of many different rock types by numerous faults (see “Brevard Zone”). Since the late 1970s, Higgins and McConnell (1978), Abrams and McConnell (1984), McConnell and Abrams (1984), Higgins et al. (1988), Crawford et al. (1999), and Higgins et al. (2003) have provided various terminologies for the rocks in the Brevard Zone. Unit names in Higgins et al. (2003)—a data source for the digital geologic map of the national recreation area—will be used for writing the final GRI report. However, the final report may also refer to lithologic units mapped by Randy Kath and Tom Crawford (University of West Georgia) during the Chattahoochee Tunnel project (see “Mapping Plan for Chattahoochee National Recreation Area”).

The oldest rock unit over which the Chattahoochee River flows is the Long Island Creek Gneiss (fig. 8), which may be as old as the middle Proterozoic (1.6 billion to 1.0 billion years old) (Higgins et al. 2003). Interestingly, Long Island Creek, the feature from which this gneiss received its name, flows into Chattahoochee River National Recreation Area at the Palisades unit. The youngest crystalline rocks mapped by Higgins et al. (2003) within the national recreation area are button schist of possible Upper Ordovician to Permian age (460 million to 251 million years ago). Besides gneiss and schist, the rock types include metabasalt, granite, and granite gneiss. Quartzite is also present (fig. 9).

Boudinage and pegmatite are two other distinctive features of the crystalline rocks at Chattahoochee River National Recreation Area. “Boudinage” is a French word for sausages. Scoping participants observed boudinage, or “links” of quartz, in the crystalline rocks at Island Ford Shoals (fig. 10). Pegmatite is an exceptionally coarse-grained rock, usually igneous. In the western United States, finding veins of pegmatite thrilled prospectors, as pegmatite veins often concentrated precious minerals and gemstones. The pegmatite at Chattahoochee River National Recreation Area, however, is metamorphic. Under extremely high temperatures as a result of metamorphism, rock begins to “sweat,” precipitating large crystals of quartz, feldspar, and sometimes muscovite. Scoping participants saw examples of this type of pegmatite at Sope Creek.



Figure 8. Long Island Creek Gneiss. Gneiss is a common rock in Chattahoochee River National Recreation Area. The Long Island Creek Gneiss is the oldest rock unit in the national recreation area. Photograph by Randy Kath (University of West Georgia).



Figure 9. Quartzite. Quartzite is resistant to weathering and underlies many of the ridges in the area. Photograph by Randy Kath (University of West Georgia).



Figure 10. Boudinage. Strung together like sausages, a rock shelter at Island Ford Shoal exhibits boudinage—"links" of quartz. Photograph by Katie KellerLynn (Colorado State University).

Shoals

Described by scoping participants as islands of bedrock within the Chattahoochee River, shoals are a distinctive geologic feature within Chattahoochee River National Recreation Area. They are also a value of special significance (National Park Service 2012). The park map identifies eight shoals within the national recreation area; from north to south they are Bowmans Island Shoals, Fish Weir Shoals, Jones Bridge Shoals, Island Ford Shoals (fig. 11), Cochran Shoals, Devils Race Course Shoals (fig. 12), Thornton Shoals, and Long Island Shoals. By definition, a shoal is a relatively shallow place in a stream, lake, sea, or other body of water (Neuendorf et al. 2005). At Chattahoochee River National Recreation Area, bedrock that makes up the river channel "shallows" or "shoals" the waters to create these features. Shoals are indicative of areas where resistant crystalline bedrock has withstood weathering.



Figure 11. Island Ford Shoals. Photograph by Katie KellerLynn (Colorado State University).



Figure 12. Devils Race Course Shoals. Photograph by Georgia Hybels (NPS Geologic Resources Division).



Figure 13. Devils Race Course Shoals. The downstream edge Devils Race Course Shoals shows the shallowing nature of this geologic feature. Photograph by Georgia Hybels (NPS Geologic Resources Division).

Although the rates of weathering depend on many factors, mineralogy seems particularly significant for the rocks along the Chattahoochee River, and thus the location of shoals. As discussed during the scoping meeting and site visit, the ability of these rocks to resistant weathering depends to a large degree on their mineral makeup. Generally speaking, where the rocks are rich in quartz—such as quartzites, though not exclusively—there is greater resistance to weathering. Notably, the rocks that make up the ridges in the area are often quartz-rich. By contrast, if rocks are rich in feldspar, greater weathering is likely to occur. Furthermore, many of the rocks at the national recreation area contain muscovite or biotite mica; muscovite is more resistant to weathering than biotite. In general, the overall degree of weathering, from least to most weathered in the Chattahoochee River area, is quartzite, quartzose muscovite schist, muscovite schist, ultramafic rocks, amphibolite-hornblende gneiss, and biotite gneiss (Kath and Crawford 2001). Potential for weathering is depicted by Bowen’s reaction series, which shows the sequence in which minerals crystallize from magma (fig. 14). Bowen’s reaction series is a basic geologic tool that may be useful to resource managers in understanding why shoals, and other geologic features, exist where they do.

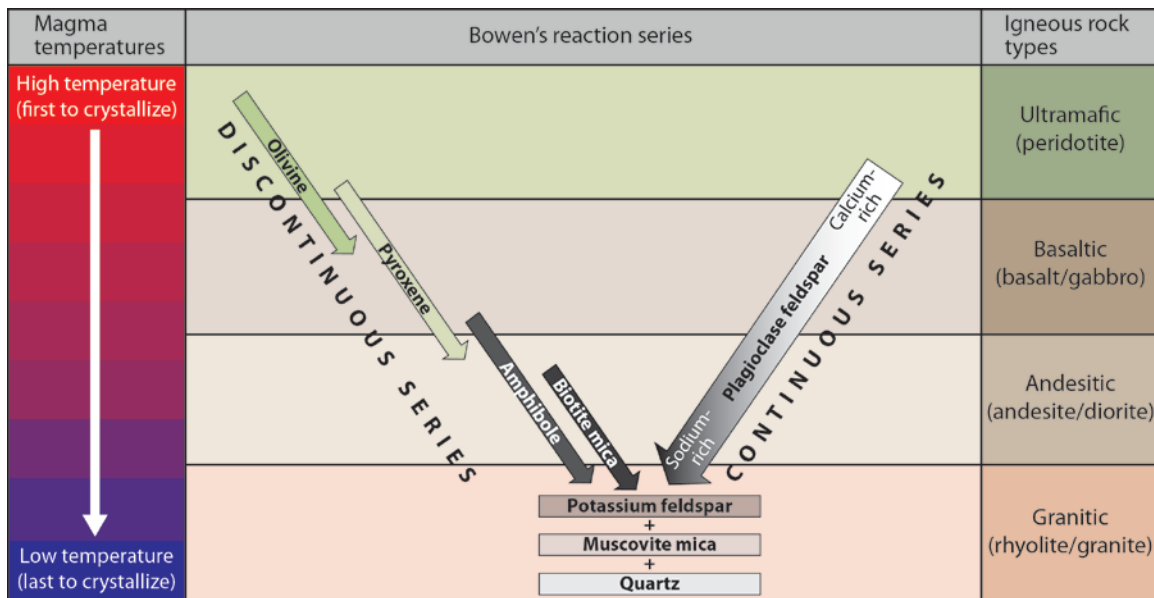


Figure 14. Bowen's reaction series. The diagram shows the sequence in which minerals crystallize from magma. It also indicates the potential for weathering. For example, quartz crystallizes last and is the most resistant to weathering. Graphic by Trista Thornberry-Ehrlich (Colorado State University).

Another feature of shoals is that large tributaries often enter the main channel of the Chattahoochee River at these locations. The abundance of shoals, and associated waterfalls on creeks feeding into the Chattahoochee River, allowed saw mills, paper mills, grist mills, and textile mills to proliferate in the region well before the Civil War (Byrd 2009). Local mills made the river the focus of industrial development in northern Georgia and a lucrative business location (Byrd 2009). Rugged terrain, underlain by resistant bedrock, set the stage for the growth of industry and harnessing water power, for example along Sope Creek (fig. 15). Today, the combination of resistant bedrock that forms shoals and cliffs through which large tributaries flow means enhanced water flow for recreation. From a recreationist's perspective: where there are shoals, there are rapids (fig. 16).



Figure 15. Mill at Sope Creek. The abundance of shoals and waterfalls on creeks feeding into the Chattahoochee River facilitated hydroelectric power and supported many mills such as the historic paper mill at Sope Creek. Photograph by Katie KellerLynn (Colorado State University).



Figure 16. Rapids on Vickery Creek. Shoals equate to rapids and recreational opportunities within Chattahoochee River National Recreation Area. Photograph by Katie KellerLynn (Colorado State University).

Rock Shelters

By and large, Chattahoochee River National Recreation Area is not known for its cave and karst resources. Such resources generally occur in sedimentary rocks such as limestone, which are lacking at the national recreation area. However, occasionally caves will occur in metamorphic rocks such as marble, for instance, at Oregon Caves National Monument in Oregon (see KellerLynn 2011). According to scoping participants, huge voids occur in the marble in the Brevard Zone, but none within Chattahoochee River National Recreation Area.

The cave resources at Chattahoochee River National Recreation Area consist of rock shelters in overhanging bedrock near the river (fig. 17). They are a result of weathering of the crystalline bedrock. For example, the roof lines of the rock shelters at Island Ford Shoal follow the metamorphic foliation (banding) of the biotite gneiss in which the caves formed. Over time, weathering targeted bands of biotite mica (a “flaky” mineral within the gneiss), thus providing a means for cave development. In this way, the overall structure of a shelter is indicative of the rock in which it formed, with foliation in this case as the main controlling factor.

Rock shelters are a feature where geological and archeological resource concerns come together. Around the time Chattahoochee River National Recreation Area was established in 1978, investigators from the NPS Southeast Archeological Center completed archeological overviews of several of the larger shelters. Archeological evidence shows that the rock shelters along the Chattahoochee River were used by prehistoric peoples; those in the Sope Creek area were apparently used as temporary hunting camps (Byrd 2009). In addition to the preservation of these features as part of the cultural landscape, resource management issues related to rock shelters include vandalism and impacts such as climbing chalk on the rock surfaces.



Figure 17. Rock shelter. The rock shelter shown in the photograph occurs near the Chattahoochee River at Island Ford Shoals. It is the result of weathering of crystalline bedrock. Photograph by Georgia Hybels (NPS Geologic Resources Division).

Proliferation of Social Trails

During the site visit on March 20, 2012, scoping participants noted the proliferation of social trails as an issue in the Sope Creek area (figs. 18 and 19). Social trails are informal, unmaintained pathways created by repeated human use. Social trails disturb native vegetation and cause soil erosion, especially in steeply sloped areas (National Park Service 2008). The proliferation of social trails is an indicator of use, and perhaps “overuse,” at Chattahoochee River National Recreation Area.



Figure 18. Restoration effort at Sope Creek. The proliferation of social trails in the Sope Creek area has resulted in the need for restoration. Photograph by Katie KellerLynn (Colorado State University).



Figure 19. Homes near Sope Creek trailhead. The private lands immediately surrounding the Sope Creek area have experienced increasing development, which has led to heavy use of the trails in the Sope Creek area. The road in the photograph is Paper Mill Road. The photo was taken from a trail in the Sope Creek area. Photograph by Katie KellerLynn (Colorado State University).

The private lands immediately surrounding the Sope Creek area have experienced increasing development as a result of the expanding Atlanta metropolitan area. The counties surrounding Chattahoochee River National Recreation Area are among the fastest growing in the nation (National Park Service 2008). About 5.3 million people now reside in the Atlanta metropolitan area (Atlanta Regional Commission 2010), which is adding more than 100,000 new residents per year (Burkholder et al. 2010). With increasing population growth and development comes increasing use of the national recreation area.

Seismic Activity

Chattahoochee River National Recreation Area occurs along the Brevard Zone, which is a conspicuous swath of deformation that cuts across the entire state of Georgia (see “Brevard Zone” section). Many individual faults splay from or parallel the Brevard Zone. In the vicinity of Chattahoochee River National Recreation Area, Higgins et al. (2003) mapped the Oakdale, Long Island, Rivertown, and Ball Mill faults, to name a few. Kath and Crawford (2001) encountered the Frolona and Long Island faults during bedrock mapping of the Chattahoochee Tunnel.

The Brevard Zone transects portions of both the Piedmont and Blue Ridge physiographic provinces, which still experience some tectonic activity today. The U.S. Geological Survey (USGS) Earthquake Hazards Program posts online information about seismic activity in Georgia, including earthquake history, seismic hazard maps, notable earthquakes, recent earthquakes, and state and regional institutions where earthquake data are stored (<http://earthquake.usgs.gov/earthquakes/states/?regionID=10>; accessed May 22, 2012). This online information documented a magnitude 2.3 earthquake (on the Richter scale) at about the time of the scoping meeting (April 24, 2012). The largest historic quake in the state was a magnitude 4.5 on March 5, 1914. Professor Tim Long in the Earth & Atmospheric Sciences Department at Georgia Tech monitors earthquake activity in Georgia. According to scoping participants, earthquakes are occasionally felt in the national recreation area but are not sources of structural damage or hazards to people.

Paleontological Resources

Tweet et al. (2009) completed a baseline paleontological inventory for the Southeast Coast Network, including Chattahoochee River National Recreation Area. Quaternary river deposits are the only rock unit or unconsolidated deposit at Chattahoochee River National Recreation Area to potentially contain fossils such as algal cysts, pollen, leaves, and wood (Tweet et al. 2009). These types of fossils have been found in former marshy areas at Congaree National Park, another Southeast Coast Network park with active rivers. If present, such fossils could be useful for paleoclimatological and paleoecological studies (Tweet et al. 2009). Because the local, crystalline bedrock at Chattahoochee River National Recreation Area does not contain fossils, no reworked fossils from these units will occur in Quaternary deposits within the national recreation area.

Another potential area for fossil discoveries at Chattahoochee River National Recreation Area is in conjunction with archeological resources. Kenworthy and Santucci (2006) presented an overview and provided selected examples of National Park Service fossils found in cultural resource contexts. Remains of biota contemporaneous with archeological resources may also be of paleontological interest. As of 1982, 70 archeological sites were known within Chattahoochee River National Recreation Area; 47 of these pertain to prehistoric Indians, and 23 are historic. People have been

present in what is now Chattahoochee River National Recreation Area starting about 10,000 years ago (Bhernard 1982). Early inhabitants left behind evidence of their occupation in rock shelters, fish weirs, special-use areas, villages, and camps (Ehernhard 1982). Fossils have not yet been documented in association with cultural resources at Chattahoochee River National Recreation Area.

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Table 2. Scoping Meeting Participants

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Katie KellerLynn	Colorado State University	Geologist, Research Associate
Jim Kennedy	Georgia Environmental Protection Division	State Geologist
Allyson Read	Chattahoochee River National Recreation Area	Biologist
Rick Slade	Chattahoochee River National Recreation Area	Chief of Planning and Resource Management
Nancy Walther	Kennesaw Mountain National Battlefield Park	Superintendent
Anthony Winegar	Kennesaw Mountain National Battlefield Park	Chief Ranger