National Park Service
Department of the Interior

Appalachian Highlands Science Journal

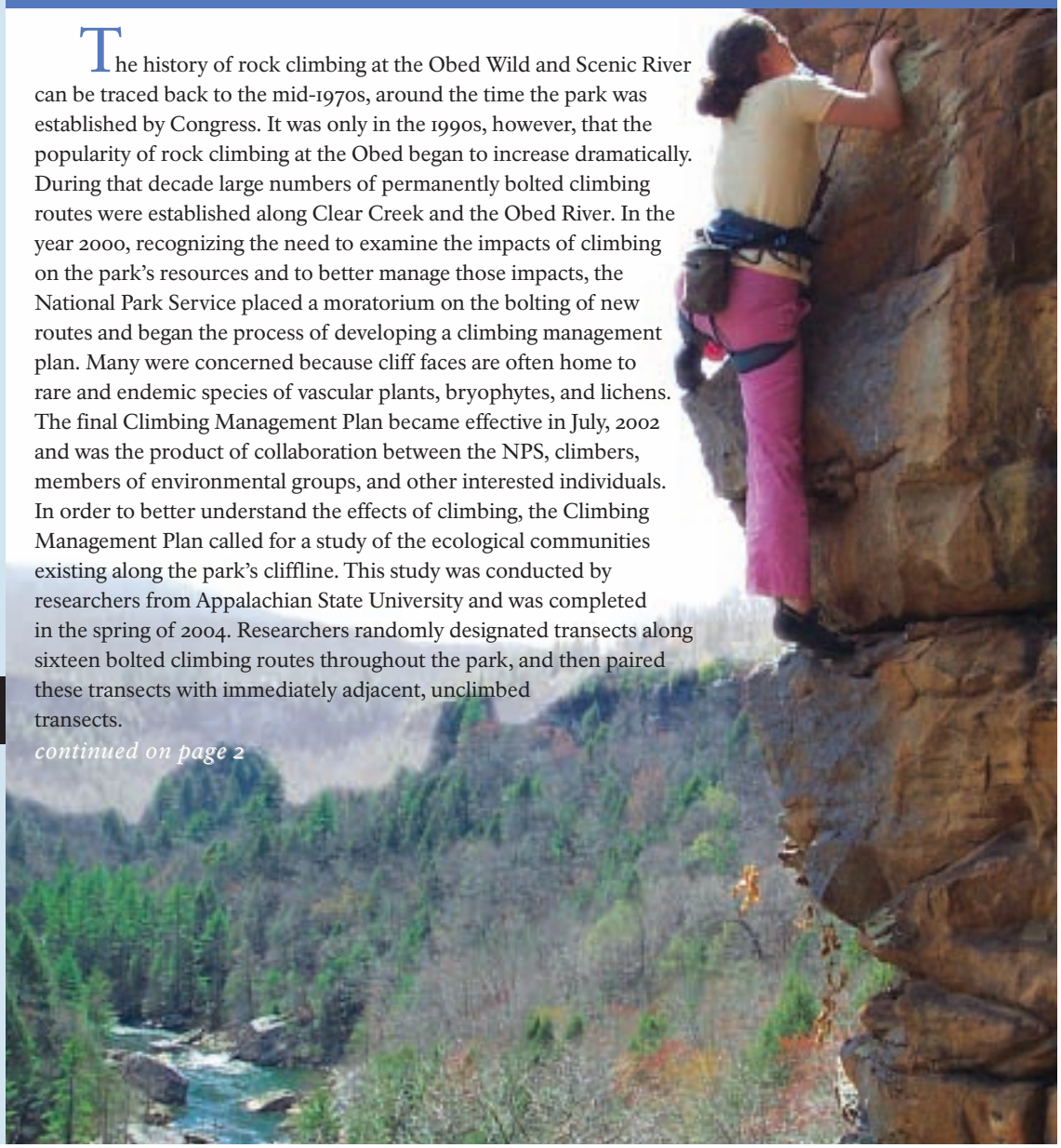
Welcome to the first issue of the Appalachian Highlands Science Journal. This magazine is a compilation of articles about natural and cultural research occurring in the parks of the Appalachian Highlands Monitoring Network. It is produced in collaboration by the staffs of the Appalachian Highlands Science Learning Center, the Appalachian Highlands Inventory and Monitoring Network, the Southeast Exotic Plant Management Team and the Southern Appalachian Cooperative Ecosystems Study Unit. These articles represent just a small sampling of research, management, and inventory and monitoring projects occurring as a result of the Natural Resource Challenge, an NPS initiative to improve science-based management at our national parks. We hope you enjoy this collection of articles.

Susan Sachs, Education Coordinator, Appalachian Highlands Science Learning Center

In this issue

The Impact of Rock Climbing at Obed Wild and Scenic River

Matt Hudson



The history of rock climbing at the Obed Wild and Scenic River can be traced back to the mid-1970s, around the time the park was established by Congress. It was only in the 1990s, however, that the popularity of rock climbing at the Obed began to increase dramatically. During that decade large numbers of permanently bolted climbing routes were established along Clear Creek and the Obed River. In the year 2000, recognizing the need to examine the impacts of climbing on the park's resources and to better manage those impacts, the National Park Service placed a moratorium on the bolting of new routes and began the process of developing a climbing management plan. Many were concerned because cliff faces are often home to rare and endemic species of vascular plants, bryophytes, and lichens. The final Climbing Management Plan became effective in July, 2002 and was the product of collaboration between the NPS, climbers, members of environmental groups, and other interested individuals. In order to better understand the effects of climbing, the Climbing Management Plan called for a study of the ecological communities existing along the park's cliffline. This study was conducted by researchers from Appalachian State University and was completed in the spring of 2004. Researchers randomly designated transects along sixteen bolted climbing routes throughout the park, and then paired these transects with immediately adjacent, unclimbed transects.

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The All Taxa Biodiversity Inventory in Great Smoky Mountains National Park

In 1998, Great Smoky Mountains National Park and its partners in the scientific community launched an ambitious effort to document every species of plant, animal, and fungus within the park. Called the All Taxa Biodiversity Inventory (ATBI), this 15- to 20-year effort aimed to produce checklists, distribution and abundance maps, databases, voucher specimens, and natural history web pages for each of the estimated 100,000 species in the park. This end product will help park managers proactively manage the natural resources in anticipation of changing climate and other threats.

As of December 2006, 829 undescribed species have been found, as well as an additional 4,740 species never before recorded within the park. Over 430 species web pages have been posted on the web site of partner Discover Life in America (DLIA) as well as annotated checklists for hundreds of other species. Besides species endemic to the park, many invasive exotic species have also been discovered, including the yellow fever mosquito (*Aedes aegypti*), fire ants (*Solenopsis invicta*), and several species of Asian worms in the genus *Amynthas* that can completely remove the important leaf litter layer on the forest floor, threatening wildflowers, salamanders, and other native species.

Hundreds of scientists, volunteers, and school children have contributed to this project, and work is being conducted on bacteria, archaea, and even viruses. This project has highlighted the serious lack of scientific expertise in some groups, as for decades no students replaced retiring specialists. The protocols and lessons learned in the Smokies are already being applied in park sites throughout the U.S. and abroad, including Point Reyes National Seashore, Adirondack Park, and Nantucket Island.

velvet leaf blueberry, the 5,000th discovery for the ATBI
Photo credit: Heather MacCulloch

The Impact of Rock Climbing at Obed Wild and Scenic River

On either side of the center line of each of the 32 transects, researchers sampled quadrants which were one meter square and at three meter intervals along the face of the cliff. For each transect, quadrants were also sampled at specified intervals both on the horizontal surface above the top of the cliff and along the slope beneath the base of the cliff. Within these quadrants, researchers documented each species present and the amount of surface area covered by each species. Researchers also made note of other environmental data relative to each transect, including aspect, slope, surface heterogeneity of the rock face, presence or absence of temporary or perennial seeps, presence or absence of overhanging roofs, and relative amount of visible human disturbance. Statistical analysis was then used to identify patterns in the data sets and to help distinguish the impacts of climbing from variations that are more highly attributable to other factors.

Based on the results of this analysis, the study makes several management recommendations regarding climbing in the park. On cliff-faces beneath overhanging roofs, for example, researchers found a dramatic decrease in the presence of all types of vegetation—a decrease which they suggest is attributable to the scarcity of direct sunlight and moisture. These areas are common throughout the park and are considered among the most desirable by many climbers. At least in terms of the impact on plant life, the study suggests that climbing in these areas should present no serious concerns. In most areas sampled, researchers found disturbance along the base of the cliff, and attributed this trampling to both climbers and hikers. The study indicates that it would be beneficial to conduct more extensive research in which undisturbed areas at the base of the cliff would be compared with the more heavily visited sites. The horizontal surface at the top of the cliff was found simultaneously to have the greatest diversity of plant species and to be the most sensitive to human disturbance. However, the fact that the top anchors for most bolted routes are located below the upper edge of the cliff is proving effective in protecting this fragile environment.

In weighing the relative importance of climbing in the composition of cliffline vegetation, researchers found that other factors such as site, aspect, and presence or absence of roofs were far more significant than climbing, and at most locations in the park researchers found no clearly identifiable pattern suggestive of climbing-related impacts on cliff-dwelling plant communities. In some areas (at Lilly Bluff, for example), the study states categorically that there is no effect of climbing on cliff-face vegetation. Because the vegetation varies so significantly from site to site, however, researchers were unable to completely eliminate the possibility of a negative impact for climbing at some locations. The study suggests that the effects of climbing may be specific to a given site, and that sampling a larger number of transects would allow researchers to better distinguish between variations which are attributable to climbing from those which are linked to the site itself. Based on the large amount of variation from area to area, the study concludes that site-specific management may be appropriate. The study may be viewed in its entirety at:

http://www.nps.gov/obed/parkmgmt/index.htm

Matt Hudson is a Law Enforcement Park Ranger at the Obed Wild and Scenic River. He is also an avid rock climber. Photo credit from front page Matt Hudson.

Crayfish communities in the Obed Wild and Scenic River National Park

Roger Thoma

In 2005 and 2006, seed grants from the Appalachian Highlands Science Learning Center supported an inventory of crayfish at Obed Wild and Scenic River National Park. The work was conducted by Roger Thoma. The study revealed a startling amount of species diversity in the park's watersheds.

The crayfish of the Obed and Emory river systems are the end result of the watershed's evolutionary history. It is generally accepted that the geologic event that built the Appalachian Mountains began approximately 360-250 million years ago (mya) and that by 160-65 mya the existing stream patterns observed in the region today were in place. During this period of geologic activity a population of saltwater crustaceans entered the Earth's freshwater systems (approx. 280-265 mya), evolved into freshwater crayfish, and consequently have given rise to the crayfish we see today.

The Obed River has its origins on the Cumberland Plateau and drains eastward to the Tennessee River in the Ridge and Valley region. A dramatic drop in elevation occurs between the headwaters and the system's mouth. The broad range of elevations and resulting stream development has created a wide range of aquatic habitat types, all of which are being exploited by crayfish. As one might expect, the diversity of crayfish species occupying the basin is high. There are presently 11 species of crayfish found in the watershed, ten of which are native and one that was recently introduced, possibly from the Cumberland River system. All ten native species are from the genus Cambarus, a species group that is believed to have begun its evolutionary history in the southeastern Appalachians.

Habitat types in the basin can be divided into six basic types: high gradient large rivers, low gradient large rivers, high gradient small tributaries, low gradient small tributaries, springs/seeps, and lowland wetlands. Unlike fish communities, the Obed crayfish community is least diverse in the larger water bodies and most diverse in the smaller water habitats.

The broad range of elevations and resulting stream development has created a wide range of aquatic habitat types, all of which are being exploited by crayfish.

The bigclaw crayfish (*Orconectes placidus*) is not native to the Obed basin. In the Obed, it is currently known only from two larger mainstream areas. Collections made in 1974 at these two sites yielded only members of the genus *Cambarus*. Collecting in 2005 showed all mainstream species gone and replaced by bigclaw crayfish. Species that burrow into banks were still found in 2005, but the resident open water species was missing. It is likely that bigclaw crayfish will continue to expand their range in the basin, eliminating other species populations in the process.

The expansion of the bigclaw crayfish is of concern because of a group of highly endemic, geographically restricted species found only in this watershed. There are currently two known described species, including the hairy-legged crayfish (*Cambarus crinipes*) and two putative undescribed species in this complex. It is likely that the species complex is an ancient group that inhabited the early Cumberland Plateau. As the drainage of the Mesozoic Era (250-65 mya) Cumberland Plateau developed, the ancestors of the different species became isolated in separate parts of the two basins and consequently evolved into separate species.

Roger Thoma is from the Midwest Biodiversity Institute and The Ohio State University, Dept. Evolution, Ecology, and Organismal Biology

The native hairylegged crayfish (*Cambarus crinipes*) from Clear Creek.
Photo credit: Roger Thoma

Larvae makes discovery for ATBI

Research in one field can often produce findings for another. Dan Dourson, studying land snail diversity with a seed grant from the Appalachian Highlands Science Learning Center, found an unusual insect on a tree in Great Smoky Mountains National Park. The common green lacewing larva from the family Chrysopidae was dubbed the "junkyard bug" as it was carrying shells of six species of snail attached to its back as camouflage. One snail, *Punctum vitreum*, was a new record for the state of North Carolina. Other species attached to its back included *P. minutissimum, P. blandianum, Gastropocta pentadon, G. contracta, and Carychium clappi.* One species, the *G. pentadon*, was actually still alive.

The menagerie of camouflage items on the lacewing larva included a new snail record for North Carolina and several insect heads.
Photo credit: Dan Dourson

Dr. Catherine Tauber of the University of California at Davis determined that the larvae is probably a species whose larval stage is not well known. Other species in this genus cover themselves with lichens, plant debris, or insect remains, but it is not known whether this species commonly uses snail shells or if this individual was starting a fashion trend. Volunteers have been searching for more larvae to rear into adults to confirm the identification and, possibly, the preference for snails.

> *"Other species in this genus cover themselves with lichens, plant debris, or insect remains, but it is not known whether this species commonly uses snail shells or if this individual was starting a fashion trend."*
>
> *– Paul Super*

Junkyard bug covered in snails
Photo credit: Dan Dourson

Naked "junkyard bug"
Photo credit: Dan Dourson

Cartoon by Lisa Horstman

THE REAL JUNKYARD BUG.

The Natural Resource Challenge: Parks for Science, *Science for Parks*

National Parks are charged with preserving natural resources for the future. For many years, the idea that natural resources would take care of themselves if left alone prevailed. In today's world, this is no longer true. Park natural resources are threatened by issues such as exotic species, air and water pollution, and fragmented habitats. Good science is needed for managers to make appropriate decisions about the complex biological situations occurring in their parks. This need for information led the National Park Service to develop a strategy to attract the scientific community to parks, offering some of the most unusual scientific labs in the world, so parks can obtain information to make the most informed decisions.

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This strategy, called the Natural Resource Challenge, divided the country into 32 biological monitoring networks; providing direction and funding to each network to assist in obtaining and using the best scientific information. In the Appalachian Highlands Monitoring Network, which serves the Appalachian Trail, Big South Fork National River and Recreation Area, Blue Ridge Parkway, Great Smoky Mountains National Park, and Obed Wild and Scenic River, four special programs have been established. They are as follows:

Cooperative Ecosystem Study Units (CESU) – The Southern Appalachian CESU serves more than just the Appalachian Highlands Monitoring Network. Its mission is to provide research, technical assistance, and education to park managers. Each CESU is structured as a working collaboration among federal agencies and universities, providing agreements allowing each of the partners to efficiently transfer funds and employees.

Inventory and Monitoring Networks – The role of the I&M network is to assist parks in developing basic biological inventories and monitoring vital signs, the key indicators of change in network parks. Information is being collected in 12 basic data sets, including air and water quality, base cartography (GIS), weather data, geology, soil and vegetation maps for each park, as well as information about the distribution and relative abundance of vertebrates and vascular plant species.

Exotic Plant Management Teams (EPMT) – Like the CESU, this team covers more area than the one biological monitoring network. The Southeast Regional EPMT travels to parks within the monitoring network to locate, control and eliminate invasive species of non-native plants.

Research Learning Centers – The Appalachian Highlands Science Learning Center, located in Great Smoky Mountains National Park, provides lodging, lab space and support for research in its host park. Additionally, staff facilitates research in network parks and provides opportunities for learners to collaborate directly with researchers or otherwise interact with research results.

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Appalachian Highlands Science Learning Center at Purchase Knob

A Plundered Rock Shelter

Tom Des Jean and Ray Albright

The two men dug steadily, pausing only to place a spear point or flake tool carefully to the side of their hole. They were illegally digging up a prehistoric fire pit at the base of a rockshelter in Big South Fork NRRA. Each artifact they uncovered meant a little more money in their pockets as they busily looted the site. But they were not alone. Not far from the two robbers was NPS Ranger Barry Melloan with a video camera. When Barry stepped forward to apprehend the two looters, he had all the evidence needed for a conviction. It was August 22, 2005.

The artifacts in the looted fire pit had to be professionally analyzed so that the information could be used by Bill Cohen, the Assistant US Attorney, in court. To accomplish this as quickly as possible, the park Archeologist, Tom Des Jean, utilized the Southern Appalachian Cooperative Ecosystem Studies Unit (SA-CESU) to partner with the University of Tennessee's Archeological Research Laboratory to perform an emergency archeological analysis.

The analysis revealed that the wood charcoal in the fire pit was about 2,260 years old. The fire pit contents included charred hickory, acorn, and beech nut hulls, and burned pine wood. This information together with the analysis of the spear points and flake tools taken from the looters showed that the Late Archaic "Adena" people of 3,000-1,200 years ago were using this area, probably in the fall. The analysis gave a fascinating glimpse into what the forest of 2,000 years ago was like and what the prehistoric Native Peoples were burning, using, and eating.

The two looters were not so fascinated by the analysis. They were charged with an Archeological Resources Protection Act violation, given a year of probation and fined $1,300 each. As Tom Des Jean later noted, "It was a whole lot of grief and destruction for only $97 worth of artifacts."

Ray Albright is the NPS CESU Coordinator for the Southern Appalachian and the Piedmont-South Atlantic Cooperative Ecosystems Study Units. Tom Des Jean is the Archeologist for the Big South Fork NRRA.

Reptile and Amphibian Inventories of the Network Parks

Nora Murdock

The southern Appalachian Mountains are one of the most species-rich temperate regions on Earth and are particularly well known for their amphibian diversity. This region is the global center of evolutionary divergence for the lungless salamanders (*Plethodontidae*), a family which includes 67% of all the world's salamander species.

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Inventories for reptiles and amphibians have been completed in all but one of the network parks; Big South Fork National River and Recreation Area surveys will be completed in late 2006. The most significant finds to date include, among others, a substantial breeding population of green salamanders (*Aneides aeneus*) (a G3/G4 species) found at Obed Wild and Scenic River, and two new species for Big South Fork – the cave salamander (*Eurycea lucifuga)* and spadefoot toad (*Scaphiopus holbrookii*). The finding of the cave salamander at Big South Fork was significant, indicating that this species thrives there in habitats other than caves – in this case, rock shelters or overhanging cliffs. At the Blue Ridge Parkway, the pygmy salamander *(Desmognathus wrighti*) – a G3/G4 species, was documented from several locations, along with first park records of northern cricket frogs (*Acris crepitans)*, southern gray-cheeked salamander *(Plethodon metcalfi*), and red-bellied turtles (*Pseudemys rubiventris)*. The red-bellied turtles were found in the mountains of Virginia, which represented a range extension for the species of approximately 100 miles. Collecting methods included a combination of structured surveys in randomly-placed plots which were selected to represent all the major habitat types in each park and to provide standardized results for defined habitat areas. In addition, unstructured surveys of other areas were conducted by multiple methods. Survey methods included carefully turning and replacing ground cover (rocks and logs), turtle traps, minnow traps, snake traps, nocturnal audio surveys for breeding frogs, coverboards (pieces of plywood and tin placed in open areas to serve as cover), seining of streams and small ponds, snorkeling, nocturnal spotlight surveys of aquatic habitats, and use of drift fences with pitfall traps and/or funnel-type live traps. The surveys of the Blue Ridge Parkway were particularly arduous, involving placement of over 200 coverboards, establishment of 219 inventory sites (each of which was visited six times), and 12 complete surveys of the entire road (six diurnal and six nocturnal) – 5,628 miles.

As part of the final reports and analyses of the reptile and amphibian inventories, cooperators identified habitats of greatest significance within each park, offered management recommendations, and described species distribution and abundance by habitat type.

Nora Murdock is the Ecologist for the Appalachian Highlands Inventory and Monitoring Network.

RESULTS OF REPTILE AND AMPHIBIAN INVENTORIES IN APPALACHIAN HIGHLANDS NETWORK PARKS

(Numbers include species that have been found in the parks, or immediately adjacent areas, during network-funded inventories or during previous studies.

PARK	Salamanders	Frogs & Toads	Snakes	Lizards	Turtles	Totals
BISO*	19	13	18	7	8	65
BLRI	34	11	17	5	8	75
GRSM	31	14	21	9	8	83
OBRI	18	13	21	6	7	65

(*BISO inventories are still in progress)

Red-bellied turtle (*Pseudemys rubiventris*)- a new species for the Blue Ridge Parkway, and a 100 mile range extension for the species. Photo credit: Acciputer Biological Consultants

Green salamander (*Aneides aeneus*), a large breeding population of this rare salamander was found at OBRI during network inventories.

Photo credit: Les Meade, Third Rock Consultants

Spadefoot toad *(Scaphiopus holbrookii)*

Photo credit: R.W. Van Devender

Pygmy salamander *(Desmognathus wrighti)*

Photo credit: David M. Dennis

Tin cover boards used in herpetological inventories. Sometimes park visitors call rangers to report these as airplane crash sites. Photo Credit: Leslie Morgan-Smith

Cave salamander *(Eurycea lucifuga)*

Photo credit: David M. Dennis

Snake trap with drift fences in powerline corridor at OBRI

JUST WHAT IS A G3/G4 SPECIES?

The G ranks were originally conceived by The Nature Conservancy as measures of a species' global status. NatureServe, once the science arm of The Nature Conservancy, but now an independent organization, updates the G ranks. It's a quick way of checking how rare or threatened a species is throughout its entire range. Here they are, in brief:

G1 - Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. (Usually five populations or less remaining).

G2 - Imperiled globally because of rarity or because of other factor(s) (usually six-20 populations left).

G3 - Either very rare and local throughout its range or found locally in a restricted range, or because of other factors making it vulnerable to extinction throughout its range. (21-100 populations).

G4 - Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery (100 - 1,000 populations).

G5 - Demonstrably secure globally (1,000+ populations).

There are also ratings of GX - extinction and GH - historically-reported species.

Species with a split rank, like G3/G4, are on the line between the two designations.

All the states maintain lists of corresponding "S ranks" that indicate a species' status within that particular state. Some parks, like Great Smoky Mountains, even keep lists of "P Ranks" that reflect the status of the species within that particular park, so a species that has only 1 or 2 populations in the park might warrant more protection than its G Rank would indicate.

The significance to the NPS is the mandate to protect the parks' resources from impairment, with already-vulnerable species being an obvious target for protection.

The Story of the Clifflines in Prehistory

Ray Albright and Tom Des Jean

Two thousand years ago, before the history of the Americas was being written down, in a valley of what we now call the Cumberland Plateau, a solitary Native American hunter crouched beside a small cook fire. He was tucked into a shallow overhang at the base of a large rock cliff, warm and protected from the weather. As his food cooked, he pulled out a flint rock from his hunting pack and began to chip off flakes to create a stone spear point. Flakes of flint fell silent and unnoticed to the sandy floor. Today, the shallow overhang can still be found, but all the signs of the solitary hunter are gone. Or are they?

Big South Fork National River and Recreation Area is a part of the National Park System, with gorges deeply carved into the elevated land of the Cumberland Plateau. The park boasts more natural arches than any other place in the eastern United States. The gorges are dramatically lined with over 450 miles of sandstone rock cliffs, many hidden from view by a blanket of forest vegetation. Some of the cliffs are small, barely higher than a person, and some are huge, presenting towering rock bluffs that stretch hundreds of yards along the side of a gorge. The early Native Americans recognized that the openings and overhangs at the base of the cliffs as safe places to lodge and linger. We call those areas rock shelters today.

The Park Service knows of about 800 rock shelter sites which ancient peoples once inhabited. The Park Service also knows that there are many other sites, possibly as many as 2,000, along the cliff lines that have not been officially recorded.

The park's Archeologist, Tom Des Jean, began a project in 1996 to survey the hundreds of miles of cliff lines within the park for archeological information. "It is hard to develop a patrol strategy without knowing where the cliff line sites are," Tom reasoned. He knew it would take a long time, but he also knew it would go faster if he had help. Tom found help at the Middle Tennessee State University (MTSU). He established an agreement with Dr. Kevin Smith of MTSU for archeological students to help survey cliff lines in the summer. When MTSU joined the Southern Appalachian Cooperative Ecosystem Studies Unit (SA-CESU) in 2003, Tom began to use the SA-CESU agreement for his student survey teams.

The 2-3 member student teams are given the task of walking specified sections of cliff lines and

Today, the shallow overhang can still be found, but all the signs of the solitary hunter are gone. Or are they?

Image of part of the 450 miles of sandstone cliffs that line the gorges of the Cumberland Plateau.
Photo Credit: Paige and Jason Silcox

Indians used the cliffs and bluffs as safe places to lodge and linger. Many artifacts of their lives can be found here.
Photo Credit: NPS

locating previously unknown historic and prehistoric rock shelter archeological sites. The park outfits the students with radios, cameras, backpacks, tools, GPS units, and other field equipment. They are not looking for old ruins or even earthworks. To the untrained eye, what they consider an ancient site usually looks like a dank, uninviting rock overhang. Sometimes there is enough of a sandy floor to visualize where someone might have slept or crouched by a fire. The student archeologists ignore what the surface looks like today.

They know time has changed the site, in places covering it with new soil, in other places washing the soil away. It is the pieces of flint, shards of pottery, and odd shaped rocks that catch their attention. These are the signs of a bygone people, even of a solitary hunter many, many years ago. Each cliff line site is located by its GPS coordinates, measured in size, field sketched and photographed, then identified with a metal tag shot into the cliff wall. Diagnostic material (meaning items used within a known time period) are mapped and collected. While the students are stopped, the site is scouted for Threatened and Endangered (T&E) plants or animals. Tom has developed flash cards to aid the archeological students in identifying key T&E species. All unusual natural features like arches, stone pillars, or "chimneys" as these are know locally, and fossils are also noted or collected by these researchers. The rare occurrence of identifiable fragments of human remains are field sketched, photographed, and covered in soil according to National Park Service agreements with Native American tribes. Back in the office, the students washed and cataloged newly collected artifacts. They also logged new sites into the NPS Archeological Sites Management Information System (ASMIS) database.

Since 1996, when the cliff line surveys started, about 108 miles have been surveyed by about 25 different student archeologists. They have logged in 308 rock shelter sites, almost all of these new finds. This is about three sites per mile. It has taken 10 years to survey roughly one quarter of the cliff lines in the park.

Sadly, about 30% of the sites have already been looted by people looking to profit from the sale of ancient relics. Many times all the students found were a few artifacts that the looters had left behind. It is the park's intention to keep these damaged sites from being looted again. Tom Des Jean noted that, "while looting can destroy a site, there is always some information that can be squeezed out."

The rock shelters within the Big South Fork NRRA represent an irreplaceable part of the American story. They tell of the ways of people and a time we can never go back to.

There have been some unexpected finds. One rock shelter had a petroglyph of a Wild Turkey, which is extremely uncommon. Animal bone awls, used for punching holes in skins, were found in a few sites. Other sites had pieces of soapstone bowls. The oddity being that soapstone is not found naturally on the Cumberland Plateau. Some sites had evidence of niter mining. Niter is a key ingredient in gunpowder and niter mining in Big South Fork NRRA became a popular and profitable cottage industry for a period after the War of 1812 and again during the Civil War. More spectacular finds may have been discovered if the student archeologists had been instructed to dig rather than glean artifacts off the ground surfaces.

Tom Des Jean is not sure the student internships will continue. Funding has shifted to focus on other archeological needs. MTSU was able to find its own means to provide a single student last summer. This has been a tremendous learning opportunity for MTSU students, immeasurable in its long term benefits. With such great interest from both the park and MTSU, Tom is confident that the program will continue, most likely at a slower pace. The ongoing preservation efforts of the National Park Service will insure that the archeological sites, needed to answer the many more questions that we have about the lifestyle, behavior, and culture of our prehistoric ancestors, are going to be there.

The Big South Fork NRRA has more archeological sites than any other park in the eastern US, almost three times more sites than Great Smoky Mountains National Park, which has five times more land than the Big South Fork. The rock shelters within the Big South Fork NRRA represent an irreplaceable part of the American story. They tell of the ways of people and a time we can never go back to. They tell of a solitary hunter crouched by a fire.

Ray Albright is the NPS CESU Coordinator for the Southern Appalachian and the Piedmont-South Atlantic Cooperative Ecosystems Study Units. Tom Des Jean is the Archeologist for the Big South Fork NRRA.

A student sketches a cliffline in Big South Fork NRRA. Photo Credit: Paige and Jason Silcox

Detailed Vegetation Mapping Underway in Network Parks

Nora Murdock

Network park managers will soon have detailed vegetation maps at their disposal, thanks to an Appalachian Highlands Network-funded project with NatureServe and the University of Georgia Center for Remote Sensing and Mapping Science. Rectified digital ortho-photographs (geographically corrected photographs that can be used as a base layer in combination with other GIS layers) are being created from color-infrared aerial photos. The final maps will include a dichotomous key to the vegetation types of each park, along with detailed descriptions of each community, its associated structure and species composition. Fuels assessment is included as part of this project, to assist with fuel reduction and wildfire control efforts.

Plant inventory contractors are working with the vegetation mappers to complete a vegetation classification for the parks according to the standards of the National Vegetation Classification System.

The aerial photographs created for this project have already proven useful. Extra sets of prints were produced and provided to the parks, which are using them for other projects such as General Management Planning at the Blue Ridge Parkway, inventories of impoundments and watershed assessments at Obed Wild and Scenic River, and locating and assessing the extent of forest disease and insect damage.

Map credit: University of Georgia Center for Remote Sensing and Mapping Science

Help Preserve Your Parks and Natural Areas: Garden Smart and Be Plantwise

In 2005 the National Park Service, Lady Bird Johnson Wildflower Center, The Garden Club of America, and the Student Conservation Association entered into a partnership called Be PlantWise. The mission is to educate the public and communities about best management practices to prevent harmful invasive plants from invading parklands and natural areas. Some of the recommended guidelines follow.

• Plant non-invasive plants. Select plants that are not listed on the Federal noxious weed list for your state (http://plants.usda.gov/java/noxiousDriver); find out which plants are causing problems in parks or natural areas in your region and avoid planting these.

• Watch out for invasive plant hitchhikers. Check items such as clothes, shoes, mountain bikes, and vehicles for seeds and pieces of plants.

• Use only seed mixes that are invasive plant free. Some invasive plants were introduced because they were contaminants in wildflower and grass seed mixes. Check the ingredient lists of seed mixes to make sure that invasive plants are not included.

• Use weed-free soil and mulch mix. Some invasive plants are introduced because they were contaminants in landfill soil and mulch mixes. Try to purchase from manufacturers that guarantee the purity or weed-free content of their soil and mulch mixes. (Look for "Certified weed free" label)

• Be especially careful with aquatic plants. Don't just dump them! Invasive aquatic plants were often introduced from water gardens and aquariums.

• Keep an eye on new sprouts and volunteers. Invasive plants can come from anywhere and spread very quickly by producing lots of seedlings. Control your invasive garden plants by hand-pulling or mowing unwanted seedlings to prevent them from reaching maturity.

• Dispose of invasive plants carefully. When pruning or removing invasive plants consider whether there are any seeds, fruits or cuttings that could resprout. Try freezing seeds, fruits and cuttings or burning them if it is permitted in your area, to make them nonviable. Consider pruning or removal before fruit or seed production.

For more suggestions on how to Be PlantWise go to:

• http://www.wildflower2.org/NPIN/Plantwise/

• http://www.nps.gov/plants/alien/

Kudzu is a widely hated invasive plant. Photo Credit: NPS

Big South Fork NRRA Restores Endangered Freshwater Mussels

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The Big South Fork of the Cumberland River is one of the last and best remaining refuges for freshwater mussels in the Cumberland River watershed. It is an 18,000 square mile region which stretches from the western slope of the Appalachian Mountains nearly to the mouth of the Ohio River. Today, the Big South Fork provides habitat for 26 mussel species, but in the early part of the twentieth century more than double that number lived in the river.

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Historic collection records dating back to the early 1900s document at least 55 species that once resided in the Big South Fork, including four federally-listed endangered species which have since disappeared from the river system. This modern decline in mussel species diversity has been mirrored by steep declines throughout the southeastern U.S., where over 90% of North America's native mussel species occur. Impoundment of rivers, sedimentation from land disturbance, and water pollution from myriad sources have reduced available mussel habitat to a small fraction of what it once was.

Because the free-flowing section of river within the Big South Fork National River and Recreation Area remains relatively intact, it has become a resource of national significance for the conservation of native freshwater mussels. In an effort to recover at least some of the mussel diversity that has been lost, the National Park Service has teamed up with a group of federal, state, and university partners. Working with the Freshwater Mollusk Conservation Center at Virginia Tech, the group has developed a mussel restoration plan which calls for augmenting populations of the five federally-listed Endangered species currently found in the river, including the Cumberland elktoe *(Alasmidonta atropurpurea)*, Cumberlandian combshell *(Epioblasma brevidens)*, Cumberland bean *(Villosa trabalis)*, tan riffleshell *(Epioblasma f. walkeri)*, and littlewing pearly-mussel *(Pegias fabula)*; and eventually restoring species now extirpated from the park, potentially including the federally-listed Endangered clubshell *(Pleurobema clava)*, cracking pearly-mussel *(Hemistena lata)*, dromedary pearlymussel *(Dromus dromas)*, and orangefoot pimpleback *(Plethobasus cooperianus)*.

A preliminary research and feasibility study in 2002-2003 provided essential information on host fish requirements for the parasitic larvae (*glochidia*) of these species, and made it possible for juvenile mussels to be experimentally produced and cultured in recirculating culture systems at Virginia Tech.

The laboratory propagation process begins with the collection of gravid female mussels from the river. Larvae are removed without harm to the mussels and are induced to attach themselves to the gills of suitable host fish.

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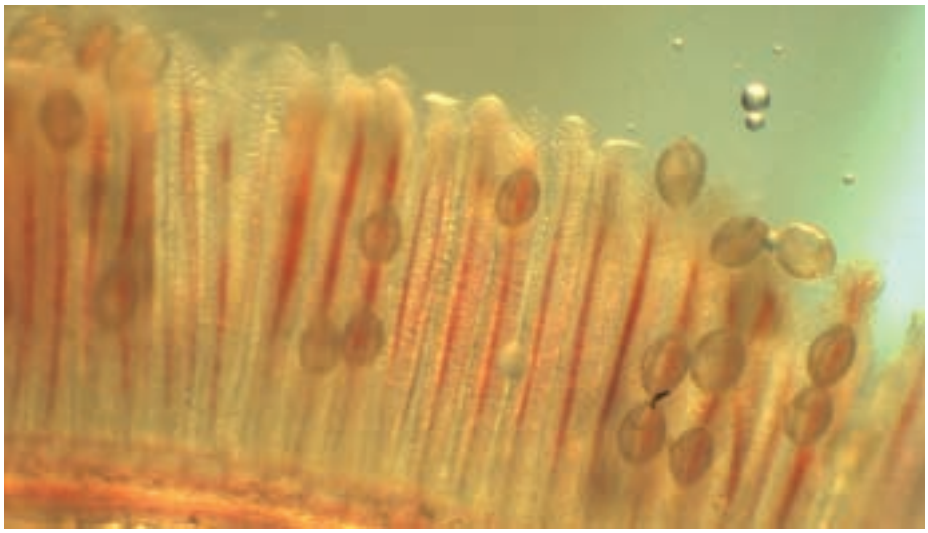
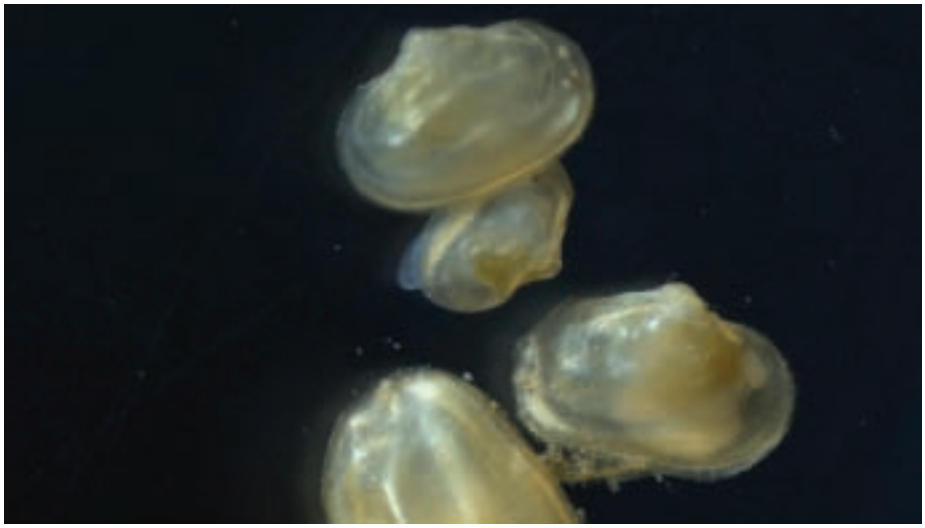


Parasitic mussel larvae on host fish
Photo Credit: Rachel Mair, Virginia Tech



Free living juvenile mussels
Photo Credit: Rachel Mair, Virginia Tech

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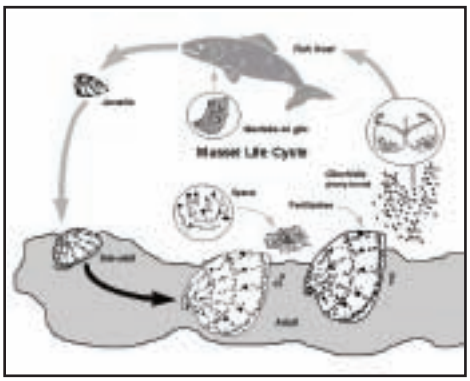

Figure 1. The life cycle of freshwater mussels, showing their development from parasitic larvae, called glochidia, on fish gills (often with particular mussel species dependent on specific fish hosts), to sedentary, filter-feeding adults.

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The female mussels are returned to the river unharmed, to reproduce in subsequent years. The infested host fish are held in tanks at controlled temperatures until the larvae transform from the parasitic larval stage to the free-living juvenile stage. These juveniles are then placed in water recirculating systems in a layer of fine sediment with daily additions of small unicellular algae as their main diet. Once juveniles grow large enough to avoid being consumed by most invertebrate predators, they are released back into the river, to fend for themselves and to grow to adulthood.

Remarkably, mussels attract fish hosts by mimicking their appearance and movements. These pictures show two such displays by the wavy-rayed lampmussel *(Lampsilis fasciola).*
Photo credit:
Rachel Mair, Virginia Tech

Although each gravid female may contain anywhere between 1,000 and 100,000 larvae, research suggests that, under natural conditions, less than 1% of the larval mussels are able to find a fish host and eventually transform into juvenile mussels. Hence, artificial propagation can dramatically increase the successful recruitment of juveniles into the wild populations. During this exploratory stage of the project, more than 42,000 juveniles (from two weeks to six months of age) of four of the Endangered species were released to an extensive shoals area of the river, to augment natural reproduction at this site.

In 2004, the project focused on two of the Endangered mussel species with previously-identified host fish. Experiments were conducted with juveniles of the Cumberlandian combshell and littlewing pearlymussel to test various culture conditions and improve survival within the recirculating aquaculture systems. Survival rates can differ greatly among broods, and the causes for this variability continue to be evaluated through the manipulation of culture conditions.

Upon completion of these culture experiments, approximately 12,000 more juveniles were released to the river. In 2005, host fish testing on the endangered Cumberland elktoe and the round pigtoe *(Pleurobema sintoxia)* were performed and previously unknown host fish were discovered.

The Cumberlandian combshell was also propagated in 2005 and 16,277 juveniles of this Endangered species were released into the Big South Fork.

Future plans include further release of Endangered juvenile mussels at sites selected by Park personnel. In future years, Propagation will be extended to additional mussel species, including those that are now extirpated from the Big South Fork.

As part of its Inventory and Monitoring Program, the National Park Service is currently designing a long-term plan to monitor the ecological health of the Big South Fork and to track the status of freshwater mussels over time, including those species that are part of the mussel restoration effort.

As part of its Inventory and Monitoring Program, the National Park Service is currently designing a long-term plan to monitor the ecological health of the Big South Fork and to track the status of freshwater mussels over time, including those species that are part of the mussel restoration effort. It will take several years before the results of the recovery project are known, but the documented success of such releases in other rivers engenders hope that these endangered mussel populations will someday flourish again in the Big South Fork.

The National Park Service teamed up with the Freshwater Mollusk Conservation Center
Photo credit: Jess Jones, USFWS

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