Interesting Inventory Finds Throughout the Network

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owls were documented wintering at BISO (it had been two years since the last one was seen there, and there are very few total records in the region).

For the Blue Ridge Parkway: Breeding pairs of vesper sparrows, alder flycatchers, black-billed cuckoos, horned larks, cerulean warblers (twelve breeding sites, including one of the two largest populations in North Carolina), southern Appalachian yellow-bellied sapsuckers (the largest and densest breeding population known for this subspecies is on BLRI) and nesting peregrine falcons were documented—all Partners in Flight species of conservation concern, or species under consideration for Federal Threatened and Endangered species listing.

Top: BISO fish seining
Photo Credit: Patrick Flaherty
Bottom: Duskytail darter
Photo Credit: Conservation Fisheries, Inc.

For the Obed Wild and Scenic River: Peregrine falcons were documented for the first time during migration.

Fish Inventory*

	BLRI	OBED	BISO	GRSM
Total Fish Species Before Inventory	35	45	64	71
Total Fish Species to Date	93	52	91	71
SIGNIFICANT FINDS				
Federally listed – Endangered				
blackside dace (*Phoxinus cumberlandensis*)			+	
duskytail darter (*Etheostoma percnurum*)			*	*
Federally listed – Threatened				
spotfin chub (*Cyprinella monacha*)[1]		*		
G2-G3 Species				
ashy darter (*Etheostoma cinereum*)			*	
Others				
pallid shiner (*Hybopsis amnis*)[2]			*	
Johnny darter (*Etheostoma nigrum nigrum*)[3]			+	
redtail chub (*Nocomis effusus*)			*	
pumpkinseed (*Lepomis gibbosus*)[4]	+			

[1] filmed spawning at OBRI with underwater videography
[2] not collected in Kentucky for 60 years
[3] first record for the middle Cumberland River system
[4] first record in the French Broad River drainage and in western North Carolina

* species present or probably present in parks
+ new for the park

Southern Appalachian Cooperative Ecosystems Studies Unit News

Ray Albright, NPS Coordinator for the Southern Appalachian and the Piedmont-South Atlantic Cooperative Ecosystems Study Units (CESU)

The Southern Appalachian Cooperative Ecosystems Studies Unit (SA-CESU) is into its eighth year of service as a partnership between six federal agencies, nine universities and three research organizations and a conservation association. The mission of the SA-CESU is to provide usable knowledge in the form of research, technical assistance and education for the management needs of the federal partners. In the federal fiscal year 2007, the SA-CESU facilitated a record number of 45 projects for a total of $2.4 million. Dr. Keith Belli has recently become the CESU representative for the host university, the University of Tennessee. The SA-CESU and the Southern Appalachian Man and the Biosphere (SAMAB) cooperative will jointly deliver an emerging issues workshop in the spring or summer of 2008.

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Edited by **Steve Kemp & Susan Sachs**

National Park Service
Department of the Interior

Appalachian Highlands Science Journal

Welcome to the second 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 (Big South Fork NRRA, Blue Ridge Parkway, Great Smoky Mountains National Park, Obed Wild and Scenic River). 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 CESU (Cooperative Ecosystems Study Unit). Several of the articles in this issue focus on the exciting new finds from park inventories that are part of the Natural Resource Challenge, a National Park Service initiative to increase the amount and effectiveness of science in our national parks. We hope you enjoy this collection of articles.

Susan Sachs, Education Coordinator, Appalachian Highlands Science Learning Center

In this issue

Using GIS to Predict the Location of Rare Plants at Big South Fork NRRA

Angel Falls Overlook
Photo Credit: BISO Park files

Ron Cornelius, GIS Specialist and Bryan Wender, Botanist, Big South Fork National River and Recreation Area and Robert Emmott, Coordinator and Nora Murdock, Ecologist, Appalachian Highlands Inventory and Monitoring Network

While working on Big South Fork National River and Recreation Area (KY and TN), Appalachian Highlands Network inventory crews found a small population of the globally imperiled white fringeless orchid (*Platanthera integrilabia*), a candidate for the Federal Threatened & Endangered species list, which had never before been found at Big South Fork (BISO). Over 40% of this rare orchid's populations have been extirpated, and it has been entirely eliminated from two of the eight states that were within its historic range. Most of the remaining 53 populations contain fewer than 100 individuals. The stream-head bog habitat of this species is uncommon, especially in pristine condition, and it often supports other rare species.

This discovery was well-timed for BISO, where a newly-released General Management Plan called for construction of 35 miles of new recreational trails in a remote 8,000 acre area of the park that had not been systematically surveyed for significant biological resources. The task of thoroughly inventorying such a large and remote area in a relatively short period of time was an understandably

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NSF Grant Makes Possible an Inventory of Eumycetozoa across the National Park Service

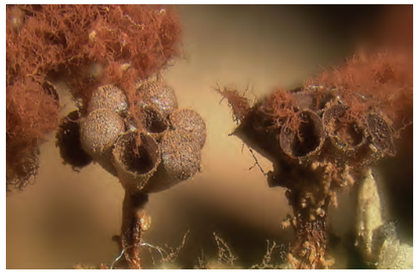
Paul Super, Science Coordinator, Appalachian Highlands Science Learning Center

Eumycetozoa, a fascinating group of organisms with the unfortunate common name of "slime molds," include species that are helping with the study of Alzheimer's disease, are major links in the food web between bacteria and invertebrates, can easily be used in the classroom to help students learn culturing techniques and study cell organization, and may help us monitor the health of soil communities and other parts of the ecosystem.

The Appalachian Highlands Science Learning Center (AHSLC) is coordinating an effort to use the National Park Service system of parks and other protected places to conduct a nationwide inventory of eumycetozoa. We are working in collaboration with Dr. Steve Stephenson at the University of Arkansas and his colleagues, who in 2003 received a five-year Planetary Biodiversity Inventory Grant from the National Science Foundation to inventory eumycetozoa worldwide. In June 2005, through an additional grant from the Environmental Protection Agency's Office of Environmental Education, the AHSLC was able to bring in 25 partners and volunteers from national parks across the United States to train in the collection and identification of slime molds.

As of May 2006, over 30 Park Service sites have provided specimens for this study or are committed to, ranging from the tundra of Denali to the grasslands of Tallgrass Prairie National Preserve and the deserts of Zion and Saguaro national parks. Many of the other research learning centers are assisting with this project. For more information about these organisms and their study, visit the University of Arkansas's web site http://slimemold.uark.edu/. In addition to learning about slime molds, we hope to learn how to conduct a similar inventory across numerous parks for other groups, such as native bees.

Metatrichia vesparium is found in Great Smoky Mountains National Park.
Photo credit: UARK



Metatrichia vesparium after the spores are released
Photo credit: UARK

Using GIS to Predict the Location of Rare Plants at Big South Fork NRRA

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White fringeless orchid (Platanthera integrilabia)—a candidate for Federal Threatened and Endangered (T&E) listing, was discovered for the first time at BISO during Network inventories. This population is one of the largest remaining in existence for this species, which has disappeared from almost half of the historically-known sites. Photo credit: Bryan Wender

daunting task for the park, but a necessary and critical first step in recreational development plans and protection of park resources.

Using the habitat characteristics of the newly-discovered orchid sites, the park's Geographic Information System (GIS) specialist Ron Cornelius and botanist Bryan Wender developed a predictive habitat model to target searches of the proposed development area.

Network inventory crews collaborated with park staff and volunteers to survey the area, making several significant discoveries for the park.

- **White fringeless orchid—discovery of what may be the largest remaining population in existence**
- **12 new species for the park, including three other rare plants**
- **Diana fritillary—rare butterfly being considered for Federal T&E listing**

The information obtained from these more efficient, focused inventories should make it possible for the park to protect rare and sensitive habitats by routing trails through less sensitive areas, controlling runoff and siltation from existing trails, and by preventing or controlling exotic plant invasions—major threats to pristine, streamhead wetlands on the Cumberland Plateau.

Interesting Inventory Finds Throughout the Network

Nora Murdock, Ecologist, Appalachian Highlands Inventory and Monitoring Network, National Park Service; Robert Emmott, Coordinator, Appalachian Highlands Inventory and Monitoring Network, National Park Service

Network inventories of vascular plants and vertebrates have been completed at Big South Fork National River and Recreation Area (BISO) , Blue Ridge Parkway (BLRI), and Obed Wild and Scenic River (OBRI). To date, 720 species new to these parks have been found, including previously unknown populations of Federally-listed Threatened and Endangered Species, state-listed species, and G1-G3 species (species ranked globally as critically imperiled, imperiled, or very rare and restricted throughout their range). Some of the new species found were exotics that have recently invaded the parks. Other new species of interest included plants and animals that are indicative of fire-adapted communities, which have declined due to fire suppression. Data for Great Smoky Mountains National Park (GRSM) has been greatly augmented by the All Taxa Biodiversity Inventory (ATBI), an effort to document all species living within the park.

Vascular Plant Inventory**

	BLRI	OBED	BISO	GRSM
Total Vascular Plants Before Inventory	1,228	637	975	1,598
Total Vascular Plants to Date	1,614	759	1,100	1,638

** species present or probably present in parks

Mammal Inventory*

	BLRI	OBED	BISO	GRSM
Total Mammal Species Before Inventory	62	38	50	65
Total Mammal Species to Date	67	50	57	66
SIGNIFICANT FINDS				
Federally listed				
Gray bat (*Myotis grisenscens*)		+	+	
Virginia big-eared bat (*Corynorhinus townsendii virginianus*)			*	
State listed				
eastern small-footed bat (*Myotis leibii*)			*	*
eastern big-eared bat (*Corynorhinus rafinesquii*)			*	*
Allegheny woodrats (*Neotoma magister*)	*	*	*	*
water shrew (*Sorex palustris puntulatus*)	*			*
southern rock vole (*Microtus chrotorrhinus*)	*			*

* species present or probably present in parks
+ new for the park

Small-whorled pogonia
Photo Credit: Tom Govus

Vascular plant inventories: To date, 569 species of previously undocumented vascular plants have been added to park species lists for BISO, BLRI, and OBRI. This represents a significant accomplishment in parks that have each had extensive botanical surveys done in the past.

During Network inventories at BLRI, a previously unknown population of small-whorled pogonia, a Federally-listed Threatened orchid, was discovered. This is only the second population ever to be found in the park, and the first record of the species from the mountains of Virginia.

Mammal inventories: Fieldwork has been completed for all parks, with 765 individual animals captured, representing 54 different species for the BISO, BLRI, and OBRI. Species were detected by means of livetraps, pitfalls, motion-activated cameras, mistnets and acoustic monitoring (for bats), and nocturnal spotlighting. Investigators logged over 13,000 trapnights, 51 nights mist-netting, acoustic monitoring at 50 stationary sites and along nine mobile transects, and canoed over 8 km of river in search of mammalian diversity.

Fish inventories: Ninety-two new species of fish were added to park lists by the inventories. Fish diversity was documented by means of backpack shocking (small tributaries), boat shocking (large river sites and lakes), and by snorkeling and underwater videography in areas where extremely rare and sensitive species were believed to occur.

Bird inventories: Eleven new species were added to park lists during the inventories. For the Big South Fork: The Cumberland Plateau's first breeding record for red-breasted nuthatches; additional first records for the park included breeding Cooper's hawks, prothonotary warblers, and Chuck-will's-widows (probably breeding). The BISO cerulean warbler population has declined from 10-15 singing males 10 years ago to a single bird in 2004 (this species is state-listed); saw-whet

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Little brown bat
Photo Credit: Nora Murdock, NPS

Gems of a Cumberland Prairie

Rebecca Schapansky, Chief of Resource Management, Obed Wild and Scenic River

Although not identified as a prairie state, Tennessee has its own brand of prairie to boast about. Referred to as "riverside scour prairies," these communities show some similarity to the grasslands of the Great Plains but water, not fire, is the primary force that maintains the community. Native warm season grasses such as big bluestem, switchgrass, and Indian grass grow in the scoured paths of floodwaters that overtop gravel or cobble bars alongside dynamic river courses of the Cumberland Plateau.

Cumberland rosemary
Photo Credit: Nora Murdock, NPS

This southern section of the Appalachian Plateau physiographic province lies northeast to southwest between Tennessee's Eastern Highland Rim and Valley and Ridge regions. Roughly 60 to 100 kilometers wide, the plateau covers portions of four southeastern states from Alabama to northwest Georgia and into Kentucky. Down-cut streams and impressive gorges typify this sandstone region and the floodplains are narrowly confined due to steep terrain. Even Congress felt compelled to protect this region when in 1976 it established the Obed Wild and Scenic River park, making segments of the Obed and Emory Rivers, Clear Creek and Daddy's Creek part of the National Wild and Scenic River System. This biologically rich area was found to possess remarkable scenic, recreational, geologic and fish and wildlife values, the impetus behind the federal designation.

The park is located in Cumberland and Morgan counties and is home to many rare plant species, several of which favor the open conditions found in riverside scour prairies. Unlike big bluestem, switchgrass and Indian grass, species also found in the tallgrass prairies of the western United States, Cumberland rosemary is endemic to the Cumberland Plateau and known from only six counties, five in Tennessee and one in Kentucky.

This member of the mint family thrives in flood-deposited sands of cobble and gravel bars where periodic flooding uproots woody vegetation that could out-compete and overshadow this sun-loving plant. Cumberland rosemary is protected under the Endangered Species Act of 1973 and is classified as a federally Threatened plant. This perennial shrub can be found growing with other state or federally protected plants such as Cumberland sandgrass, Virginia spiraea and large-flowered Barbara's buttons.

Because they flourish in early successional habitats, changes to water levels or alterations to flood regimes could put a population of these imperiled plants at risk. Given their limited range, plants could be extirpated or propelled toward extinction with the construction of large reservoirs or impoundments. Another very real threat is the spread of invasive plants. Botanical surveys conducted along Clear Creek since 2000 have documented at least ten non-native species at the Obed Wild and Scenic River. Multi-flora rose and Japanese stiltgrass dominated the most recent survey.

To date, roughly 17 miles of riverbank have been surveyed for exotics and plans are underway to cover an additional four-mile stretch. Instrumental in the Obed's fight to control exotics has been the Park Service's Southeast Exotic Plant Management Team, a group of dedicated specialists that assists parks in the region with control and eradication of non-native plants.

Water Quality and Legacy Data Collection Demonstrate Recovery of Aquatic Ecosystems at Big South Fork NRRA

Nora Murdock, Ecologist, Appalachian Highlands Inventory and Monitoring Network, National Park Service

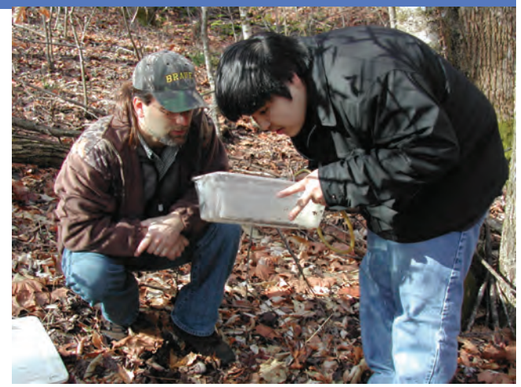
In collaboration with the United States Geological Service (USGS), the Appalachian Highlands Inventory and Monitoring Network has identified and mapped all watersheds that could influence or be influenced by surface waters in the Appalachian Highlands Network parks. All available water quality data has been compiled from historic and ongoing monitoring activities inside and adjacent to the parks, and USGS has conducted trend analyses as part of the network's long-term water quality monitoring protocol design. The trend analyses have shown improvement in water quality in some streams that were heavily impacted by historic coal mining activity and municipal pollution at Big South Fork National River and Recreation Area. These encouraging positive trends were mirrored by significant increases in fish species diversity found by network inventory crews in the same streams, compared with inventories at the same sites 23 years ago.

Amazing Grace: High School Students Rediscover a Lost Species

Susan Sachs, Education Coordinator, Appalachian Highlands Science Learning Center; Kelly Felderhoff, Graduate Student, University of Tennessee, Knoxville

It's a complicated story known to only a select few who study a small, wingless soil insect known as a springtail. In 1951, a researcher in New York found and described a new species of springtail he named *Pogonognathellus nigritus*. This particular springtail is rather large and conspicuously purple in color but it was never found anywhere else again. In 1964 it was invalidated as a species name.

In 2004, a group of Cherokee High School students, working under the direction of staff at the Appalachian Highlands Science Learning Center, were sampling for soil invertebrates as part of the All Taxa Biodiversity Inventory (ATBI) in Great Smoky Mountains National Park. A team of soil scientists working on a soil survey for the park had let staff know that there was a particularly nutrient rich area near Cherokee with a soil type that was very different than others in the park. That day, the students were collecting for Dr. Ernie Bernard of the University of Tennessee who studies apterygotes; primitive, wingless insects which include springtails. The approximately 50 springtails were forwarded to Dr. Bernard who, along with graduate student Kelly Felderhoff, began identifying the springtails. In an email written by Dr. Bernard he exclaimed, "These insects are amazing. They're purple with white rings on their antennae. Earlier this month, three of us went down there and sampled intensively in a search for more of them, but did not find any." They suspected they might have a new species to science, but would need another specimen, kept alive to preserve its true coloration, to be positive.



Emory Rhodes, forestry teacher at Cherokee High School, assists a student searching for springtails.
Photo credit: Susan Sachs, NPS

Several times over the next three years Kelly went back out to the same spot, searching for the elusive purple springtail with no success. This winter, Susan Sachs, Education Coordinator for the Appalachian Highlands Science Learning Center, suggested taking the current class of Cherokee High School students out in the field as assistants. On a cool February morning, after an hour of searching, the students went back to school leaving Kelly with at least one possible match. After hours at the microscope, Kelly determined that the students had located *Pogonognathellus nigritus*. The once-invalidated species from New York not only has been validated, but with a significant increase in its range. From here, we will go back to the soil map to determine if there might be other potential site locations… and we are definitely taking students from Cherokee High School to assist in the sampling.

This particular springtail is rather large and conspicuously purple in color. Photo credit: Kelly Felderhoff

Caring for the Story of the Park That Almost Never Was

Ray Albright, NPS Coordinator for the Southern Appalachian and the Piedmont-South Atlantic Cooperative Ecosystems Study Units (CESU); Tom Des Jean, Archeologist, Big South Fork National River and Recreation Area

The Big South Fork National River and Recreation Area, with its miles of scenic river and sandstone bluffs, almost never existed. In the 1960s, Congress told the US Army Corps of Engineers to create a reservoir by building a dam on the Big South Fork River in north-central Tennessee. The Corps surveyed the area, drew up lots of plans, made lots of maps, wrote lots of reports and took lots of pictures. They were ready to build it. Then, almost overnight, an amazing thing happened and the Corps of Engineers shifted their interest from building a dam to building a national park. Congress had just passed a new act: the Wild and Scenic Rivers Act of 1968 stating that Wild and Scenic Rivers, such as the Big South Fork, could not have dams. These rivers had to flow freely forever.

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Caring for the Story of the Park That Almost Never Was

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But, what happened to all those plans, maps, reports and photographs that the Corps had created for the dam? They did not throw them away, they just stored them away—along with all the blueprints, maps and photographs of the new park facilities that were built. As the years progressed, the park stored away newspapers, books, scrapbooks, slides, audio cassette tapes, and video tapes that helped tell the history of the park. All together, there are about 30,000 items randomly stored away! How could anybody find anything in that enormous collection?

Tom Des Jean, the Cultural Resource Specialist at Big South Fork NRRA, knew the 30,000 items had to be organized and cataloged so someone could easily search through the collection. To accomplish this goal, Tom utilized the Southern Appalachian Cooperative Ecosystem Studies Unit to partner with Lincoln Memorial University (LMU).

Painstakingly, LMU archivists took item by item from storage, removed any paper clips or staples and arranged them in acid-free folders or boxes. Some of the items were faded or fragile with age and had to be handled carefully. LMU did an admirable job of getting the 30,000 items preserved, into order, and cataloged following National Park Service guidelines.

While the task of sorting, protecting, and cataloging historical items seems mundane and unrewarding, its importance cannot be overstated. It is keeping the story safe of a park that almost never existed.

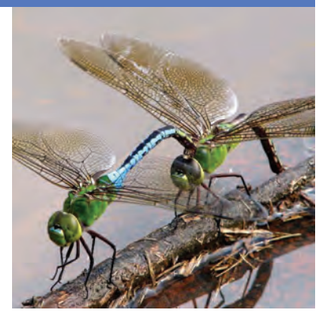
It is said that a picture is worth a thousand words, but those words are mute if the picture cannot be found in an enormous collection. Those words are forever silent if the picture fades away from age. While the task of sorting, protecting, and cataloging historical items seems mundane and unrewarding, its importance cannot be overstated. It is keeping the story safe of a park that almost never existed.

Top: Collections storage area after foldering, cataloging, and organizing the Big South Fork Collections under a cooperative agreement with Lincoln Memorial University.
Photo credit: Tom Des Jean
Top right: US Army COE archival photograph of the 1981 construction of highway 297 bridge over Big South Fork, one of hundreds cataloged under a cooperative agreement with Lincoln Memorial University.
Photo credit: US-Army COE

Left: Mylar sheets and diazotype (blue-line) maps and construction drawings stored in sub-standard conditions for over 25 years.
Right: One of numerous collapsed boxes of construction photos, reports and development documents stored in sub-standard conditions for over 25 years.
Photo credits: Myra Marcum

Polycentropus sp. is a new to science caddisfly found in BLRI.
Photo credit: Ernie Benard

Canada burnet
Photo credit: Conrad Mentjes



Green darners
Photo credit: Alvin Braswell

information to select sampling sites:

1) Lithology models developed by University of Virginia researcher Rick Webb, which analyzed and consolidated over 70 different geologic types into five classes based on sensitivity to acid deposition

2) Aquatic resource maps and databases for the parkway

3) Prior records of rare species (especially the 1992 surveys by Chuck Parker)

4) Plant community data, with special emphasis on boreal relict species associated with wet habitats. These relict species, now quite rare at this latitude, were left behind as the climate warmed after the end of the last ice age. The reason they have continued to survive this far south is because the colder microclimate they need has been maintained by a continuous supply of cold groundwater from springs. Their presence is indicative of great age in Southern wetlands—they, and the other species living with them in these unique sites, have remained in the same places, essentially unchanged, for thousands of years. We reasoned that there could be a high probability of finding unique species and significant aquatic invertebrate diversity at these sites.

We combined this information with GIS elevation models, and incorporated findings from air and water quality sampling conducted on adjacent U.S. Forest Service lands and the neighboring parks—Shenandoah and Great Smoky Mountains. Sites on acid-sensitive geologic strata were targeted, as well as sites on mafic (iron and magnesium-rich) geology. Mafic rock is rare in the southern Appalachians and often supports rare or unusual species of plants and animals.

Results so far: Some species identifications are still tentative, awaiting further analysis by taxonomic experts, but these are the most significant findings to date:

- **Over 50 rare species found (some are known from fewer than half a dozen sites worldwide)**
- **15 – 20 species new to science, including three completely new genera**
- **Several sites were found that had sparse fauna and high deformity rates (indicators of possible impacts of chronic low pH and/or heavy metal deposition)**
- **Unusual individuality of sites—apparently identical seeps and springs, even in close proximity, had significantly different species assemblages living in them**

This investigation of a small fraction of the parkway's wetlands and streams demonstrates that the Blue Ridge Parkway harbors even more significant aquatic species than were previously known, many of national or global importance. This study also emphasizes the importance of small wetlands and seeps to overall biodiversity, and reinforces the fact that effective protection of the park's fauna will require more than preserving just a few "representative sites." These results indicate the importance of conducting additional systematic inventories, to provide managers with the information they need to preserve the significant aquatic resources of the park, unimpaired, for future generations.

COMPREHENSIVE ASSESSMENT OF 18 SOUTHEASTERN PARKS AS RESERVES FOR CONSERVATION OF AQUATIC INSECT SPECIES

In 2005, the U.S. Geological Survey and the National Park Service jointly funded a comprehensive baseline inventory of aquatic macroinvertebrates (the four main orders—mayflies, stoneflies, caddisflies and dragonflies/damselflies) in the 18 parks of the Appalachian Highlands and Cumberland Piedmont I&M Networks (C. R. Parker, USGS, Principal Investigator). Spatial analysis of the results of this three-year inventory will be used to assess the importance of each park as a potential reserve for aquatic resources, based on the distribution of endemic, unique, and rare species. Comprehensive species lists and distribution maps will be produced for each park, as well as photographs, illustrations and descriptions of each species, which will be posted on websites. Completion of this project will contribute essential data to the work of the Inventory and Monitoring Programs in the Appalachian Highlands and Cumberland Piedmont Networks, and, most importantly, provide park managers with much-needed information to help them prioritize and protect the significant aquatic resources of the parks.

— Chuck Parker, USGS, Great Smoky Mountains National Park

An Environmental Mystery: Abnormal Morphologies of a Diatom in Great Smoky Mountains National Park

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acidic than normal due to acid precipitation, in combination with the presence of a complex geology and range of altitudes. In the summer of 2005, we explored high elevation springs and streams, such as those along the Appalachian Trail near Clingmans Dome, where we found a high abundance of the diatom species *Eunotia subarcuatoides*. To our surprise, morphological deformities were present in several of the diatoms. To further explore these unusual findings, we examined the external and internal diatom morphology and relative abundance more closely.

We found that the size and patterns on both the normal and deformed cells (i.e. holes in that silica-based case) were similar to those previously reported for this species (Fig. 1A, B, E).

However, the deformed cells often had small or large indentations or distortions along the bottom edge or variations in curvature patterns (Fig. 1C, D). Additionally we observed variations in the position of a special structure called the raphe which diatoms rely on for motility. In some cases, an additional raphe was present (Fig. 1F).

E. subarcuatoides was dominant at high elevation spring sites and decreased in relative abundance at stream sites as elevation decreased (Table 1). Abnormalities in morphology were most prevalent in the spring on the North Carolina side of the Double Spring Gap site (Table 1).

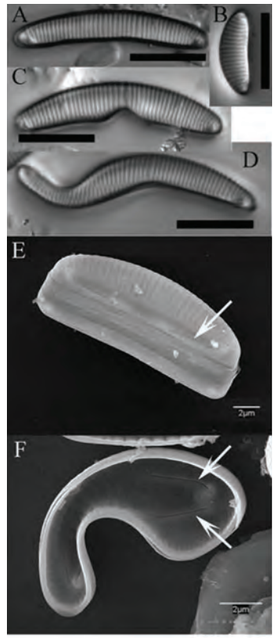


Figure 1. Light microscope (A to D) and scanning electron microscope (E, F) images of normal (A, B, E) and deformed (C, D, F) cells of the diatom *Eunotia subarcuatoides*. Light microscope micron bar = 10 µm. Arrows = raphe.

E. subarcuatoides is commonly reported from high elevation, electrolyte-poor springs and headwater streams with low pH (3.7-5.2), similar to the sites examined in this study. However, it was not clear from our study why cell deformities were present at some of our sites and absent from others—***an environmental mystery!***

There is some evidence from other scientific studies that metal contamination can result in abnormal diatom morphology. Several of the sites had water chemistry and metals (i.e. aluminum, copper) data previously collected by the National Park Service in 2002–2004, however, these values were low for all the sites. More recent water samples should be collected to help determine the current status of these high elevation sites.

Because high elevation spring water chemistry is determined directly from groundwater/aquifers and indirectly from atmospheric influences (i.e. such as from airborne contaminants), the diatom abnormalities observed in this study may be indicative of environmental change or even pollution.

Monitoring these high elevations may be critical to detecting some of the environmental influences that both shape and threaten the biodiversity in the park.

Table 1. Relative abundance of *Eunotia subarcuatoides* (normal and abnormal) and other diatoms.

Relative Abundance of *Eunotia subarcuatoides* and Other Diatoms

Location	Elevation	Relative Abundance: Total All E. sub.	E. sub. (normal)	E. sub. (abnormal)	Other *Eunotia*	Other diatoms
Silers Bald Shelter spring	1,663 m	97	96	1	0.5	2
Mt. Collins Shelter spring	1,767 m	99	93	6	1	0.5
Double Spring Gap (NC) spring	1,665 m	99	69	30	---	1
Double Spring Gap (TN) spring	1,675 m	63	63	---	14	23
Clingmans Creek	1,562 m	58	58	0.2	40	2
Spence Field Shelter spring	1,469 m	29	29	0.4	27	44
Russell Field Shelter spring	1,291 m	4	4	---	68	28
Stream along Appalachian Trail	---	4	4	---	5	91
Anthony Fork	891 m	---	---	---	6	94
Beech Flats Prong	1,227 m	2	2	---	4	94
Beech Flats Prong	1,432 m	3	---	---	7	90

Data Management Overview

Patrick Flaherty, Data Manager, Appalachian Highlands Inventory and Monitoring Network

One of the informal goals of the National Park Service's Natural Resource Challenge is to pull data out of filing cabinets and make it accessible to park managers, researchers, and educators. To assist with this, Data Managers have been hired at each of the 32 biological monitoring networks. Their job is to make data useable in a variety of different databases, both nationally and in parks. This has to be accomplished in a way that can lead to scientifically-informed staff while safeguarding sensitive information such as the locations of endangered, threatened or sensitive species.

Geographic Information System (GIS) layers serve as one of the more useful products. Vegetation GIS maps with polygon areas of species composition have already proved quite helpful for targeting an inventory that discovered new populations of rare orchids at Big South Fork. *(see article on cover page)*

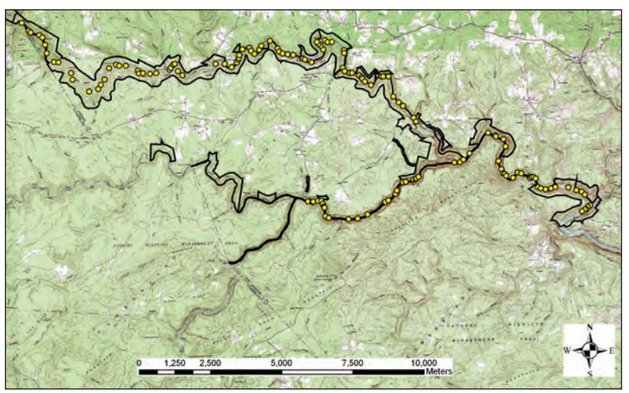
Digital elevation models, soil fertility, and moisture distribution maps have created models for targeting rich cove habitats special to the Blue Ridge Parkway. These rich coves contain significant plant diversity and will be closely monitored to document change over time as a park Vital Sign. ArcIMS software applications have been developed at the national level for easier GIS use by park managers to see specialized habitats and locations of threatened and endangered species. Other base layers such as boundaries, roads, and streams can be used for spatial analysis in satisfying answers for National Environmental Policy Act (NEPA) compliance.

Normalized databases with information that changes yearly for long-term ecological monitoring have been developed with quality assurance data entry forms. The data management documentation can lead to fewer data entry mistakes and better overall quality data. These standardized databases may be exported easily into GIS for more detailed spatial analysis.

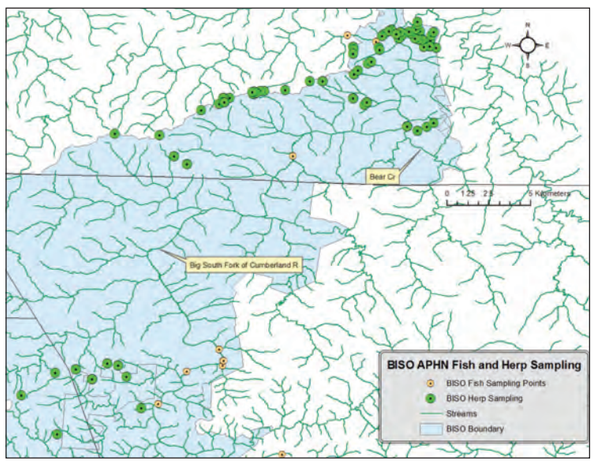
Certified species lists for park taxonomic groups are presently available for park interpreters and resource management staff to better serve the public. Science and education within the parks will be greatly enhanced by these digital on-line lists supported by linked documentation. These species lists have been reviewed in detail to provide a goal of 90% of species present in parks. Future inventories and monitoring will provide new discoveries for adding to park lists. In the past data management may have taken a back seat to more immediate park concerns; however, the Appalachian Highlands Network can be assured of quality data management for years to come.

Taking baseline data about cobble bar plant communities along Big South Fork.

Locations of 147 cobble bars at Obed Wild and Scenic River GPS'ed during 2007.



Herpetological and fish inventory locations for sampling conducted in the northern part of Big South Fork.



Managing the Complex Waters of the Blue Ridge Parkway

Nora Murdock, Ecologist, Appalachian Highlands Inventory and Monitoring Network, National Park Service; Dave Lenat and Skip Call, consultants, Southern Appalachian Man and The Biosphere

The southeastern United States has the highest biodiversity of aquatic insects known from this continent, with approximately 40 percent of all North American species occurring here. In addition to being significant resources in their own right, aquatic macroinvertebrates (such as dragonflies, mayflies, stoneflies and caddisflies) have long been used as valuable and sensitive sentinels in water quality monitoring programs throughout the country.

Aquatic resources exist in abundance on the Blue Ridge Parkway, but specific information about them is scarce. Also, even though many short-term water quality studies have been conducted on or near the parkway in the past, there is very little consistent, park-specific baseline data on water quality. To design a long-term aquatic monitoring program, the Appalachian Highlands I&M Network needed to conduct some characterization sampling, but in a park with many water-related resources and potential threats, it was difficult to know where to start first.

Macroinvertebrate collections from some of the parkway's wetlands and streams in 1992 had produced significant finds, including some extremely rare species and at least one species potentially new to science, emphasizing the importance of conducting more systematic inventories of these taxa and their unique and highly-threatened habitats.

In June of 2005, the Appalachian Highlands I&M Network, in collaboration with Chuck Parker (USGS, Great Smoky Mountains National Park) and principal investigators David Lenat and Skip Call (SAMAB), began water quality characterization sampling and aquatic macroinvertebrate inventories at 50 sites on the Blue Ridge Parkway.

Dave Lenat and Skip Call, consultants, Southern Appalachian Man and the Biospehre (SAMAB), collecting aquatic insects on the Blue Ridge Parkway.
Photo Credit: Nora Murdock

The Blue Ridge Parkway is a water-rich park, owing to its complex topography and the heavy precipitation common to the southern Appalachian Mountains (as much as 100 inches per year in some areas). Park boundaries encompass the headwaters of 150 streams, and contain portions of five major rivers, over 400 smaller streams and creeks, and numerous lakes and wetlands. The parkway protects over half of what remains of the globally imperiled southern Appalachian Mountain bog/fen habitat, and several rare aquatic species are known from the park, including two Federally-listed Threatened species.

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SAMPLING GOALS

1) Identify specific sites and habitat types that support significant aquatic macroinvertebrate fauna (rare species or exceptionally rich diversity)

2) Identify at-risk aquatic habitats, based upon exposure to atmospheric pollutants or other sources of contaminants

3) Identify target sites for long-term monitoring of water quality and macroinvertebrates

Maintaining waters in an unimpaired state represents a considerable challenge for the 469-mile long Blue Ridge Parkway. Many of the streams crossing parkway lands are polluted by offsite sources. There are 149 industrial/municipal discharges, 40 drinking water intakes, and 78 impoundments that are affecting or are being affected by parkway waters. In addition, there are over 500 agricultural leases operated within the park's boundary. Atmospheric deposition is also related to water quality issues here, where some of the highest total nitrate and sulfate levels in the United States have been documented. The average pH of rainfall in nearby Great Smoky Mountains National Park in recent years has been 4.3 (on a scale from 1 to 10, with 7 being neutral). A single large storm at higher elevations can lower streamwater pH to less than 5.0 for several days after the storm has ended. Sustained pH levels of less than 5.0 can result in declines in benthic invertebrates and fish, and reproductive failure of acid-sensitive amphibians. Chronic and episodic acidification of streams can lead to elevated levels of toxic aluminum, which can further reduce survival and diversity of aquatic invertebrate and fish populations.

Based upon work conducted in Great Smoky Mountains and Shenandoah national parks, and on national forests adjacent to the parkway, the waters most affected by acidic deposition are those associated with first-order streams, at higher elevations, and in watersheds with low buffering (acid-neutralizing) capacity. This characterization describes much of the Blue Ridge Parkway. Therefore, with current high nitrate and sulfate deposition levels, streams at high elevations on the parkway are extremely susceptible to acidification. In watersheds where gypsy moths have defoliated the trees, problems with nitrate acidification are exacerbated.

For the aquatic macroinvertebrate survey, we used several sources of

Plant Physiology Study Hopes to Unlock Secrets of Exotic Invasive Species

Dr. Jennifer Nagel, Visiting Professor, Connecticut College

About one quarter of the plant species in Great Smoky Mountains National Park are not native to this area, or even to this continent. Most of these are limited to disturbed sites and do not out-compete native species in more intact natural areas. However, a handful of species do have the capacity to invade natural areas and completely overwhelm natural communities, requiring the park to spend tens of thousands of dollars each year to control them. Predicted changes in climate could further exacerbate this situation, potentially turning innocuous exotic plant species into efficient invaders. A lot of money and effort could be saved if park managers could predict which exotic species were likely to become invasive so that they could be controlled before they spread.

Dr. Jennifer Nagel received a National Parks Ecological Research Program Post-Doctoral Fellowship in 2004 to work in the Smokies. Her work in the park was conducted in collaboration with Dr. Jake Weltzin at the University of Tennessee's Old-Field Community Climate and Atmospheric Manipulation Project at Oak Ridge National Laboratory. Based on some of her earlier work in New York and Nevada, she hypothesized that species that use energy (from photosynthesis) most efficiently (for growth/production of biomass) would be the most productive within a given community. At Oak Ridge, she studied the responses of her test plants to a variety of controlled exposures to different levels of carbon dioxide, air temperature, and soil moisture. **In the field, she established test plots at two sites in the park:**

1) Cades Cove, where she looked at native and non-native grasses, as well as native goldenrod and non-native clover and plantain;

2) Purchase Knob, where she looked at non-native brown knapweed and several native forbs.

The analysis of this and related studies is ongoing, but thus far some interesting findings have assisted with the development of a model that illustrates the complexities of the system. First, by measuring photosynthetic activity throughout a 24-hour period, she determined that not all species achieved their highest levels of photosynthetic activity at solar noon, as had been previously assumed. *Lesson: when collecting the baseline data for exotic species and the communities into which they've been introduced, measurements must be made at several times during the day.*

Second, the predictor of the most successful species (measured by percent ground cover) changed during the season. Early in the season, successful species were those that were most efficient at energy gain, but this predictor was replaced later in the season by efficiency with which new biomass could be produced, and eventually, by the efficiency with which limiting nutrients such as nitrogen could be utilized. Certain nutrients may be in short supply by the end of the growing season; thus, more efficient plants can set and ripen more seed or otherwise position themselves to expand their population at the expense of other species. *Lesson: baseline data needs to be collected several times throughout the season.*

Dr. Nagel is proceeding on to work in Cape Cod National Seashore, looking at a system where an invasive exotic is a nitrogen fixer, and then on to Hawaii, where she will continue to develop this model.
Photo credit: Jennifer Nagel

An Environmental Mystery: Abnormal Morphologies of a Diatom in Great Smoky Mountains National Park

Paula Furey, Bowling Green State University

As part of the All Taxa Biodiversity Inventory (ATBI) taking place in Great Smoky Mountains National Park, the Algal Taxonomic Working Group has been sampling aquatic habits throughout the park. What is great about algae, especially diatoms (a group of algae that have a silica-based case…essentially a glass house), is that different species have different environmental tolerances and preferences and they are able to integrate and respond to the biotic and abiotic elements of the environment. This makes them ideal indicators of changes in the condition of aquatic ecosystems, such as those caused by acid pollution.

We have been focusing on the acid loving diatom genus *Eunotia Ehr.*, which can flourish in the park because of habitats that are more

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