Chattooga River Watershed Coalition

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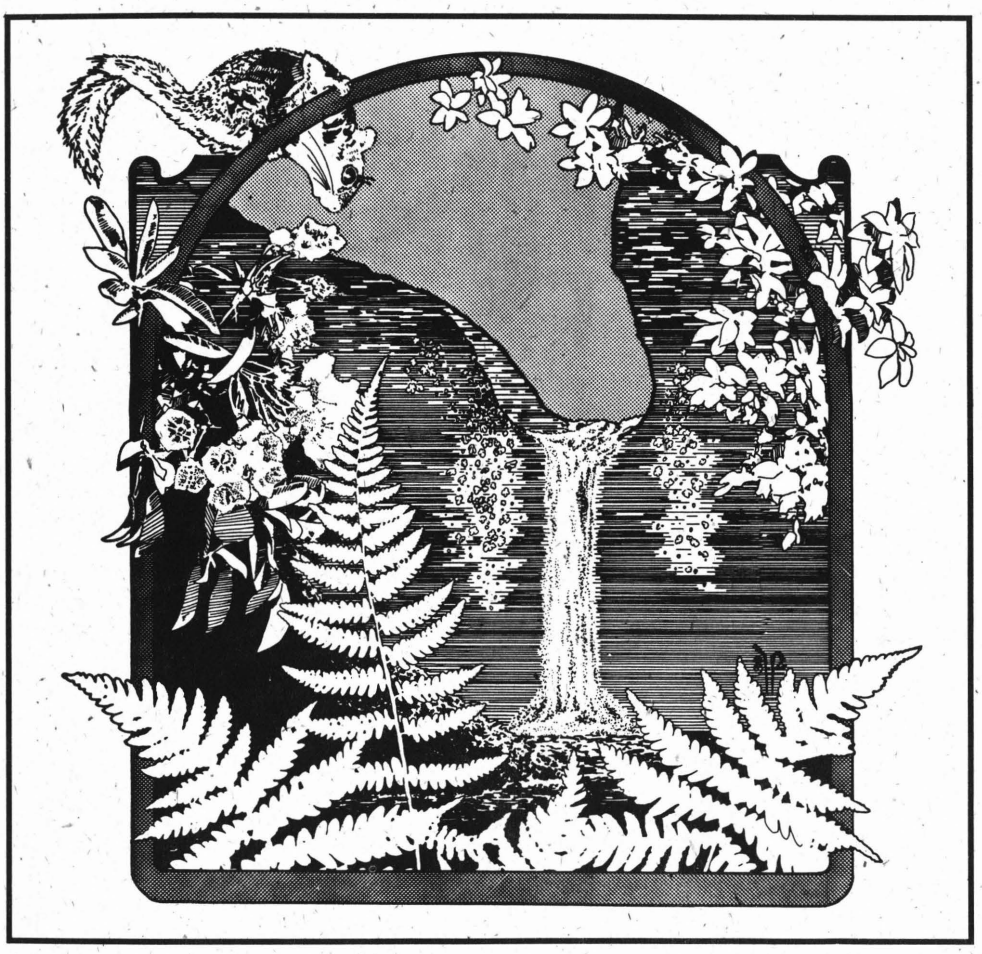
Biological Diversity: The Foundation of Life



God said, Let the water team with living creatures, and let birds fly above the Earth across the vault of the heavens.... Let the Earth bring forth living creatures, according to their various kinds.... And He saw it was good. Genesis 1 :20, 24, 25

Inside...

Director's Page

Buzz Williams, CRWC Executive Director

When it comes to protecting biological diversity, some "old-school" land managers just don't get it. For example: Consider the Buckeye Branch Timber Sale that currently is underway on our public lands in the Chattooga River watershed. This ill-conceived project was deemed necessary by the Tallulah District Ranger, of the Chattahoochee National Forest in Georgia. The intensive logging and road-building activity is occuring in the Sandy Ford area of the Chattooga River, beginning at exactly 1/4 mile from the river's banks. In fact, the blue paint-markers that mark the narrow National Wild and Scenic River boundary are the same markers used to delineate the timber sale boundary.

We opposed this timber sale when it was proposed, back in 1991. At that time, I assisted in a lawsuit to stop several illegal timber sales in the Chattahoochee National Forest. These sales had been erroneously authorized to proceed, without their mandatory Biological Evaluations (BE). In fact, as we investigated further, we were amazed to discover that none of the timber sales in Georgia had BE's -- as required by law. When the Federal Judge in Gainesville heard this case, which was based on exposing the Forest Service's blatant disregard for a very minimal conservation safeguard, he ruled to shut down all road-building and timber-cutting operations in the entire Tallulah Ranger District, until the required BE's were conducted. The Buckeye Branch Timber Sale near Sandy Ford was one of these sales. Unfortunately, even though this sale was halted, half of the trees there were already cut down. One stand of trees along Buckeye Branch (and right by the river) was harvested, which also severely degraded the streamside habitat of Buckeye Branch.

The newly appointed Forest Supervisor in Georgia claimed he wanted to work out these problems. Biological Evaluations were conducted, and two small areas of our forest were deleted from the timber sale. Remaining were about 70 acres of trees, which Forest Service officials were determined to cut. Two of these stands were prime 85-95 year old trees directly adjacent to the Chattooga River corridor. Further, access to the other stand of trees would require building a logging road across the historic Bartram Trail. In short, the Forest Service's new plan was just a token gesture of compromise. Now that they had complied with the minimal procedural requirements of law, we had little choice but to attempt to reason with the Forest Service on the discretionary issues. We were now entering the time of the 1996 "Timber Salvage Rider", which gave the Forest Service unprecedented authority to cut trees almost anywhere. Timber salvage operations were occuring all over the forest, to cut plantations of pine trees (also known as "monocultures") afflicted with and/or "susceptible" to the Southern Pine Beetle. What remained of the Buckeye Branch Sale was stalled temporarily. Finally by the fall of 1996, two stands of trees in the Buckeye Branch sale were felled: The stand located across the Bartram Trail, and the group of trees adjacent to the river corridor. The area next to the Chattooga River, called a "seed tree" cut, also was burned in preparation for the regeneration of pine trees. Then this spring, right as the migratory birds began to arrive in our forests, the last stand of trees was entered via a steep logging road across Rock Creek, and logged.

Concerning the Forest Service and biodiversity, consider this. First, take biological implications. The Chattooga Wild & Scenic River Corridor is only 1/4 mile wide. This protected corridor needs to be widened to 1/2 mile at a minimum, to provide adequate protection for wildlife and a suitable corridor for their travel. Timber harvesting and road-building within 1/2 mile of the river should not be permitted at all, and certainly not "intensive" timber management such the "seed tree" cuts implemented in the Buckeye Branch timber sale.

The Buckeye Branch timber sale also was a great economic loss to taxpayers. The Forest Service gave the timber purchaser a $24,000 "credit" for building new roads into the harvest area. They tallied these roads as a benefit, instead of a cost. The most recent road for this project was built in the midst of a series of springtime thunderstorms, which required much work for erosion control and at least four truckloads of hay to prevent it from washing away, because the area is steep with highly erodible soils. After the area was logged, it was burned by "heli-torch" (a helicopter with a flame-thrower) which killed the trees that were left to re-seed the area, resulting in a burned-out clearcut. Then, another helicopter seeded the area with non-native grass.

All of this activity consumed many hours on the Federal payroll, for planning and generating reams of paperwork. Employed were: foresters, a District Ranger, a timber sales administrator, fire specialists and support crews, road-builders, bulldozers, a fire engine, a helicopter, various trucks, seed, etc. All this was in the name of intensive timber management, in exactly the worst place for such operations. The fact that this whole operation also was far below it's cost to the owners of the forest — the taxpayers — makes the timber sale an outrage.

One would naturally ask WHY should the Forest Service build roads and conduct a timber sale that sacrifices wildlife, recreation opportunities and loses money for the taxpayer? The answer is: Congressionally mandated timber targets, and old-school public land managers who need to be replaced. Looking back, there exists only one bit of truth in the entire fiasco. In the prescribed burn plan for the sale, one section of the form addressed "objectives met". The hand-written answer was "excellent burn". I totally agree.

(Note: See also page 6.)

Biodiversity: *Facts on the Foundations of Life*

Reprinted with permission from the Biodiversity Support Program; March 1996.

What is Biodiversity?

Biological diversity, or biodiversity, is the variety of all forms of life on Earth. Its complexity is measured in terms of variations at genetic, species, and ecosystem levels. Ever-responding to natural forces and human activities the Earth's biodiversity is in a constant state of flux. As we'll see below, biodiversity plays a critical role in meeting human needs directly while maintaining the ecological processes upon which our survival depends.

Why Should We Care About Biodiversity?

BIODIVERSITY IS A NECESSITY, NOT A LUXURY.

In recent years, the loss of entire species and natural areas, caused almost entirely by human activity, has been occurring at unprecedented rates. The extinction of each additional species brings the irreversible loss of unique genetic codes, which are often linked to development of medicines, foods, and jobs.

The future well being of all humanity depends on our stewardship of the Earth.

Biodiversity not only provides direct benefits like food, medicine, and energy; it also affords us a "life support system". Biodiversity is required for the recycling of essential elements, such as carbon, oxygen and nitrogen. It is also responsible for mitigating pollution, protecting watersheds, and combating soil erosion. Because biodiversity acts as a buffer against excessive variations in weather and climate, it protects us from catastrophic events beyond human control.

The importance of biodiversity to a healthy environment has become increasingly clear. We have learned that the future well being of all humanity depends on our stewardship of the Earth. When we exploit living resources, we threaten our own survival.

Biodiversity is Important to the Global Economy

The economic value of biodiversity is a well-established fact. Modern agriculture, which depends on new genetic stock from natural ecological systems, is now a three trillion dollar global business; nature tourism generates some twelve billion dollars worldwide in annual revenues. In the United States, the economic benefits from wild plants and animals comprise approximately 4.5% of the Gross Domestic Product.

In 1988, worldwide commercial trade in wild plant (excluding timber) and animals was valued at $5 billion. That same year the twenty best selling drugs in the US, with combined revenues of about $6 billion worldwide, all relied on plants, microbes and animals for their development. Each wild plant that provides the chemical basis for developing new drugs is projected to generate at least $290 million annually.

Biodiversity is Essential for Ensuring Food Security

All of the world's major food crops, including corn, wheat and soybeans, depend on new genetic material from the wild to remain productive and healthy. Breeders and farmers rely on the genetic diversity of crops and livestock to increase yields, and to respond to changes in environmental conditions. Plant breeding, using wild genetic stock and other sources, was responsible for half the gains in agricultural yields in the United States from 1930 to 1980.

The Earth's oceans, lakes, and rivers contain an abundance of food resources. At present, food production from wild stocks of fish is the single largest source of animal protein for the world's expanding population. In 1994, more than 10 billion pounds of fish, valued at about $4 billion, were caught and sold in the United States alone.

Teosinte, a wild relative of corn discovered in Mexico during the 1960's, is resistant to four of the eight major diseases that kill corn in the United States. Had it been available to US farmers in the 1970's, losses of $1

Biodiversity *continued*

billion could have been avoided, when disease wiped out uniformly susceptible varieties. Corn is the essential ingredient in a range of products — from animal feed to corn syrup. Thanks to Teosinte, prices for grain-fed meats, soft drinks and other correlated foods have been kept low. This example shows that genetic biodiversity protects American farmers and consumers alike.

Threats to Biodiversity

Although it is clear that biodiversity conservation is vital to human survival, living resources are increasingly threatened around the world. Some of the most direct threats and illustrative examples include:

Habitat Destruction: Burning or felling of old growth forests, and destruction of other natural areas.

Over-Exploitation: Over-hunting of, for example, elephants, rhinos and other living creatures.

Pollution: Industrial emissions that cause acid rain, and other toxins which poison drinking water.

Global Climate Change: The destruction of the Earth's ozone layer, causing the greenhouse effect.

Invasion by Introduced Species: For example, displacement of native songbirds in the US by European starlings.

These direct threats are often driven by underlying social conditions, including increased per-capita consumption, poverty, rapid population growth, and unsound economic and social policies.

Biodiversity Safeguards Human Health

Of the top-selling 150 prescription drugs in the United States, 79% have their origins in nature. Many synthetic drugs, including aspirin, were first discovered in wild plants and animals. Roughly 119 pure chemical substances extracted from some 90 species of higher plants are used in pharmaceuticals around the world.

Traditional medicine, which relies on species of wild and cultivated plants, forms the basis of primary health care for about 80% of all people living in developing countries. In the United States, traditional medicine and other alternative health systems are gaining in acceptance. Each year, the US imports more than $20 million of rain forest plants valued for their medicinal properties.

Despite such widespread popularity, only 2% of the 250,000 described species of vascular plants have been screened for their chemical compounds. Of those that have been screened, some show dramatic promise. For example, Taxol, a new drug developed from the Pacific Yew tree, is being used to treat ovarian cancer.

In 1960, a child with leukemia had a 1 in 5 chance of remission. Now, thanks to anti-cancer drugs developed from a compound discovered in wild periwinkle plants, the same child's chance of survival has increased to 80%.

Biodiversity Provides Recreational Opportunities

In addition to protecting our future food supply, health and environment, biodiversity provides an array of recreational opportunities and aesthetic values. In 1991, recreation associated with wild birds alone generated nearly $20 million in economic activity and 250,000 jobs in the United States, exceeding many Fortune 500 companies. Saltwater recreational fishing in the US generates more than $15 billion annually in economic activity, and provides over 200,000 full-time jobs.

National Parks in the US brought in $3.2 billion from visitors in 1986. That same year, tourism in Kenya amounted to $400 million. In that country, the economic value of viewing elephants alone totaled $25 million in 1989. These large economic revenues reflect the high value that people place on recreation involving biodiversity.

Biodiversity and the Issues That it Affects Cross All National Borders

Air and water pollution do not respect national borders. Acid rain, which results when air pollutants mix with falling rain, is a good example. In North America, industrial emissions from US factories have caused acid rain to damage sugar maples in Canada, threatening future maple syrup production.

Perhaps the most serious threat to life on Earth is global climate change. In December of 1995, the Intergovernmental Panel on Climate Change, composed of scientists and policy-makers from 120 nations, agreed in writing that human activities are affecting the global climate.

Biodiversity *continued*

Carbon released from such human-induced activities such as the burning of fossil fuels, forests and other natural habitats is a major contributor to climate. Tropical forest burning outside of the US has accounted for about 25% of all carbon released into the atmosphere over the past decade.

Rapid build-up of carbon dioxide and other green-house gases in the Earth's atmosphere, combined inextricably with ozone depletion, is causing our climate to change. The consequences for many species of wildlife and ecosystems, as well as for human populations, may be catastrophic. In the United States, warmer temperatures could result in the shifting of agricultural lands hundreds of miles north, and could also cause severe coastal flooding. Species would be forced to migrate to keep up with optimum conditions, but the rate of change could be too fast for many to adapt.

On a global scale, loss of biodiversity can even threaten national security. There are many national and international conflicts over water, land and other natural resources. Such environmental conflicts often lead to mass migrations of people which strains national budgets, public infrastructure, and international relations.

Rates of Species Extinctions are Unprecedented

Not since the disappearance of the dinosaurs has rate of species extinction, the most common measure of biodiversity loss, been higher. Virtually all of the loss is caused by human activities, mostly through habitat destruction and overhunting. In the contiguous United States, 98% of virgin forests have been destroyed, and 54% of wetlands have been lost. Over the past 500 years, 200 species of plants and 71 species and sub-species of vertebrates have become extinct in North America alone; another 750 species are officially listed as Endangered or Threatened. Unfortunately, scientists have described only 13% of the approximately 14 million species that inhabit the Earth. With increasing human pressure on biological resources, rates of extinction can only be expected to accelerate.

What is Being Done to Conserve Biodiversity?

Conserving biodiversity is important to many Americans. According to a 1993 public opinion poll, 89% of the public agrees that human beings have an ethical responsibility for protecting plant and animal species. 78% percent of Americans believe that greater protection should be given to fish and wildlife habitats on Federal forest lands, and a large majority of citizens support the Endangered Species Act.

Public concern over the protection of wild plant and animal species often benefits society indirectly. For example, in 1972 public outcry over the declining populations of the American Bald Eagle caused the US to ban the production and sale of the pesticide DDT; later this chemical was identified as a serious cancer-causing agent in humans.

Global concern over the unprecedented loss of living resources has brought governments together to draft the International Convention on Biodiversity. This comprehensive agreement recognizes, for the first time, that the conservation of biodiversity is a common concern of all the world's people. Already, more than 100 countries have ratified it. By adding its signature to the Convention, the United States would send the global community a strong message about its commitment to protecting biodiversity.

Public acknowledgement of the importance of biodiversity has begun to influence US foreign policy. Increasingly, through the United States Agency for International Development (USAID) and US based non-governmental organizations, the US is helping other countries link their economic and social development with the conservation and sustainable use of natural resources. Informed leadership, supported by a growing public awareness, is critical to meeting the social, economic, and environmental challenges the world now faces.

WHAT CAN WE DO?

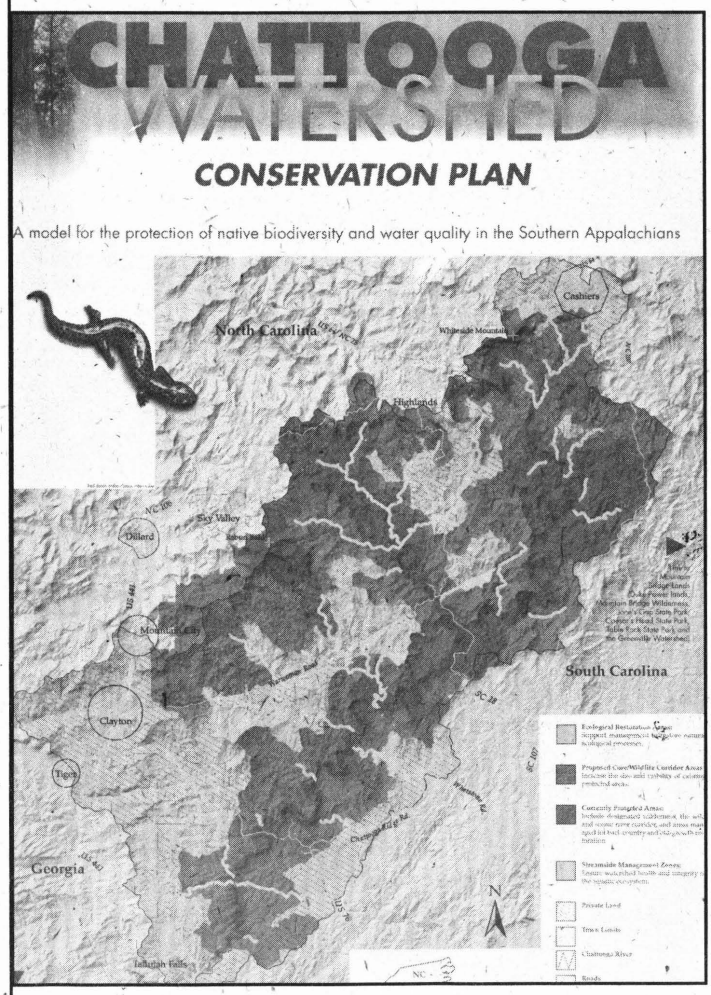
As individuals, we can help conserve biodiversity by:

1. Investing in and supporting environmentally sound businesses.
2. Supporting local, national, and international conservation efforts.
3. Minimizing our consumption of gasoline, electricity and material goods.
4. Becoming informed about legislation that affects the world's biodiversity.
5. Sharing our concerns with our elected representatives.

As a society, we can all move to curb our use of energy, eliminate our use and displacement of Threatened species, and support the transformation of national and international policies to those that are more sustainable and less harmful to biodiversity.

Applying the Concept of Conserving Biological Diversity vs. "Business as Usual"

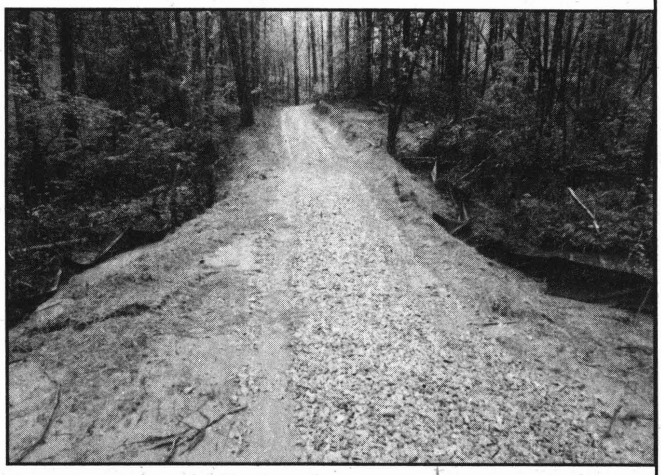
Outdated National Forest Management Plans based on "intensive timber management" allow for excessive logging and road-building throughout our public lands, and directly adjacent to the National Wild & Scenic Chattooga River. The Forest Service is now revising these Forest Management Plans, as required by law. Please take the time to write to the US Forest Service at the addresses below, and express your endorsement for the Chattooga Conservation Plan. ***Changes will occur only through the active involvement of citizens — the owners of our national forests.*** Copies of the written text of the Chattooga Conservation Plan, as well as the full-size color poster shown below, are available at the CRWC office.



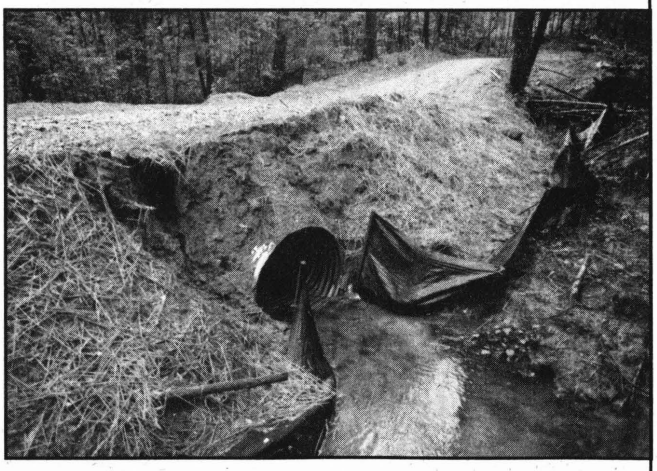
You can register your support for implementation of the Chattooga Conservation Plan. Write to:

USDA Forest Service
Francis Marion & Sumter NF
Attn: David Wilson
4931 Broad River Road
Columbia, SC 29210

USDA Forest Service
Chattahoochee NF
Attn: George Martin
1755 Cleveland Hwy
Gainsville, GA 30501



Your tax dollars recently were applied to build this road into the undisturbed, interior forest near the Sandy Ford area of the Chattooga River.



Where the road crosses Rock Creek, silt fences bulge after a springtime thunderstorm.

Scorched earth and dead "leave" trees in a "seed-tree" harvest area, right next to the Chattooga River corridor.

Carolina Hemlock &Table Mountain Pine: *Mountain Locals of the Woody Kind*

Chas Zartman

"The boy noticed that the cones on these pines were unlike anything he'd ever seen before; clustered in large masses around the branches and each covered with stout, recurved spines. He handed a cone to the other Samuel in the party, a horticulturist by profession, and asked what it was. Samuel Kelsey replied that this was a rare species in these southern mountains, known as Table Mountain Pine, and that this knoll [on Wildcat Ridge near Whitesides Mountain] supported the best specimens he knew of. He also pointed out to young Prioleau that the hemlock trees growing on this ridge were, as well, the best examples of the rare Carolina Hemlock that he knew of. These tall, stately hemlocks with their slender spires pointing to the sky were in sharp contrast to the squat crooked pines. All of the party agreed that the forest community on this knoll was unique and beautiful in its own special way."

—excerpt from The Mountain at The End of the Trail, by Dr. Robert Zahner.

Cone of the Carolina Hemlock, which averages 1.5 inches in length. The cone's scales spread distinctly outward.

The Appalachian Mountains from West Virginia through northern Georgia harbor more than a dozen tree species which are not known to occur anywhere else in the world. In fact, as Dr. Zahner makes clear in his historical account, both of the trees that Samuel Kelsey identifies for the scouting party are distinctly Southern Appalachian species, and both are well represented in the Chattooga River watershed area.

The Wildcat Knoll site that Dr. Zahner describes is located in western North Carolina, on the ridge dividing the Cullasaja and Chattooga watersheds. This site is especially unique in the sense that it supports two uncommon trees not usually associated with one another. Although Carolina Hemlock and Table Mountain Pine are found mostly in the exposed and harsh environments of ridgetops, rocky bluffs and cliff faces, they are infrequently seen together. One reason why Table Mountain Pines and Carolina Hemlocks rarely occur together may be due to their differing abilities to tolerate soil moisture. A voyage through some different areas within the Chattooga River watershed will illustrate these distinctions.

As summer heats up and the urge to swim in the cool holes of Bull Sluice rapid increases, make sure to look closely at the hemlock trees lining the boulders just below the falls on the South Carolina side. An inspection of these aged sentinels of the "Bull" will reveal massive root systems which embrace several large boulders along the river bank. These trees look decidedly different from the more common and widespread Eastern Hemlock (*Tsuga canadensis*) in both the positioning of their needles and the size of their cones. Unlike the Eastern Hemlock, the Carolina Hemlock's needles are splayed out at all angles encircling the twig, giving the tree a fuller appearance, and the cones tend to be larger than those of the Eastern Hemlock, averaging 1.5 inches length, with the cone's scales spreading distinctly outward. This Carolina Hemlock population at Bull Sluice is significant in several ways. Not only is it one of the few known South Carolina sites for this tree, but it is also one of the most southern and lowest elevational occurrences for this tree. (The isolated Tallulah River Gorge population from the Chattooga's neighboring watershed marks the southernmost locality for this species.) Furthermore, the Bull Sluice colony illustrates this species' preference for moist, cool, rocky sites. The success of these trees at such a low elevation possibly is because their roots have been consistently bathed by "the Bull's" whitewater spray.

Mountain Locals *continued*

For the other extreme, a walk along Dan and Big Ridges off the southeastern flank of Rabun Bald (in Georgia) presents quite a different experience. This exceptionally parched habitat is dominated by pines and heaths. At a glance the pine diversity of these sites may seem low, but four species of pines, Table Mountain Pine (*Pinus pungens*), Shortleaf Pine (*Pinus echinata*), Virginia Pine (*Pinus virginiana*) and Pitch Pine (*Pinus rigida*) are present here. One of the easiest ways to identify the Table Mountain Pine sites on these ridges is to keep your eyes on the ground. When you come across a pine cone that easily could be mistaken for a lethal weapon, you've hit your mark! Table Mountain Pine cones are robust and relatively heavy, and the cone's scales are armed with large, sharp spines. A look into the canopy should reveal mid-sized, gnarled trees with distinct clusters of cones along the length of some branches. Table Mountain Pine cones are persistent on the branches, and counting the rings of cones along any given branch will provide an estimate of the number of years that tree has been reproducing.

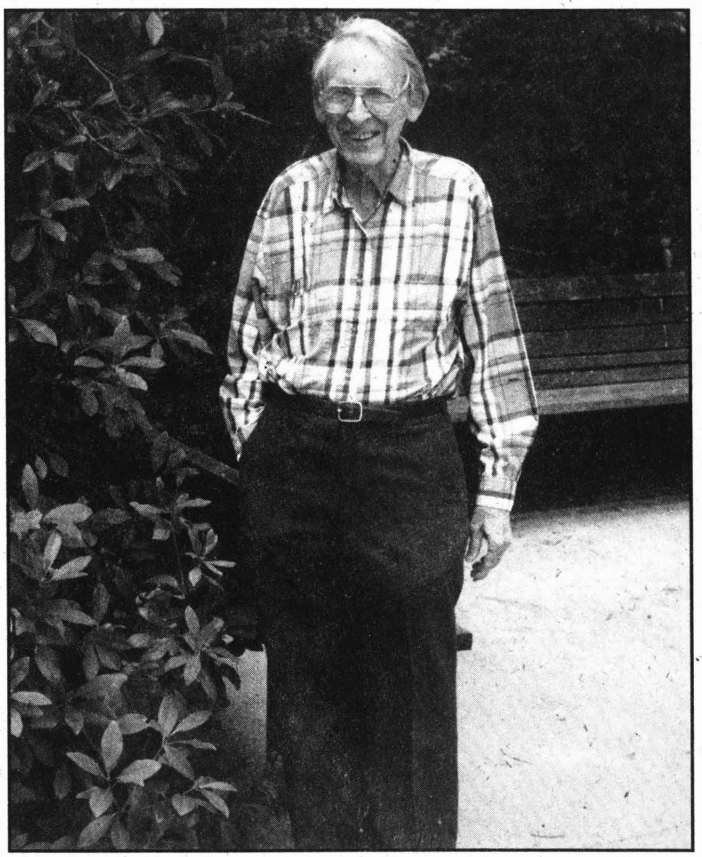
Table Mountain Pines are known notoriously for inhabiting the driest and most infertile ridgetops in the mountains, and it is considered to be a species dependent on fire for completing its reproductive cycle. The "sclerotinous" (heat dependent) cones rely, in part, on the searing temperatures of fire to open the scales, and to release and disperse the seeds. (The plumes of smoke coming from Rabun Bald last month were from a Forest Service-initiated fire, for the purpose of facilitating seed release on these sites).

Cone of the Table Mountain Pine: The cone's scales are armed with large, sharp spines. These cones rely, in part, on the searing temperatures of fire to open the scales, and to release and disperse the seeds.

These trees provide an excellent illustration of the wide spectrum of habitats that are exploited by local mountain conifers. Their convergence on Wildcat Ridge is just further evidence of the unpredictability of nature, but that's what makes exploration exciting. Who knows what will be around the next bend in the trail...?

Interview with Dr. Eugene Odum

Nearly forty-five years ago the publication of Dr. Eugene Odum's textbook, Fundamentals of Ecology, marked the pioneering effort to describe and summarize the various concepts which make up the basis of the science of ecology. Although a German biologist has been credited with coining the term "ecology" (rooted in "oikos", meaning household or home in Greek), Dr. Odum, Professor and Director Emeritus of the Institute of Ecology at the University of Georgia, can be credited both with revitalizing the science of ecology in academic and popular circles, and with granting the science of ecology autonomy from the rest of the life sciences. The study of ecology, as Dr. Odum states, is the study of our households -- our natural environment. Dr. Odum has contributed immeasurably to our present understanding of the interdependency and complexity of how the physical (non-living) and biological (living) worlds interact on our planet. In recent years, he has furthered his passion for the study of our household by seriously addressing how human society has altered our natural ecological systems and, more importantly, by promoting actions that humans can take to mitigate and lighten our impacts. In the following interview Dr. Odum addresses, among other things, his desire to preserve a functioning world, and he also offers an answer to one of the most difficult questions facing all of us today: How can we all help reduce our impact on native ecosystems to ensure that they will remain viable for future generations?



Dr. Eugene Odum
April 1997

Dr. Odum's two most recent books (published by Sinauer Associates) are Ecology and our Endangered Life Support Systems (1993) and Ecology: A Bridge between Science and Society (1997).

The following interview was conducted by Chas Zartman (CZ) on April 10, 1997, at Dr. Odum's (EO) office at the University of Georgia's Athens campus.

CZ: What do you consider to be your most significant contribution to the field of ecology?

EO: There's no question: My textbooks. They're all over the world and, at last count, translated in 15 different languages. The last copy I got was in Malaysian; it was interesting to see what my book looked like in Malaysian. Also, I've contributed the concept of a top-down approach to the study of ecology. The idea of looking at the big thing first, and the pieces last. This is opposite from the nature of most science. Most science wants to start with the fundamental pieces, like at the level of genes. If you start from the top and work down you have to ask: What are the good pieces here? What pieces don't I know about? What pieces do I need to study? Do I need more hydrology work here to understand the river? How can I preserve the riparian zone beyond what is national forest land?

CZ: Can you recall any specific experiences in your childhood which sparked your interest in the natural world and ultimately, in the life sciences?

EO: Through grade school I lived in Chapel Hill, North Carolina, and at that time the town and the University were just stuck in the woods. You could walk out of your back door and be in the woods. So as a kid, I became interested in birds. I had a cousin named George Mayfield, a good amateur birder, who was a professor at Vanderbilt University. I went up there one summer to his summer camp, and he helped to nurture my interest in bird life. Ever since I can remember, I've gone out into the woods looking for birds. When I was a junior in high school I wrote a little nature column for several years with a friend of mine, Coit Coker, in the local paper. Floyd's father, R. E. Coker, was a limnologist and professor at Chapel Hill. Coit and I took a couple of trips out west in a little old Ford Roadster, and we went all around the west. So my interest was nurtured by a combination of professors at Chapel Hill, and my friend Coit Coker. If you live in the city, you can't just step out

Odum *continued*

the door and be in nature. I think E. O. Wilson has said that he doesn't think that there are going to be any more naturalists, because the majority of people live in cities now. He and I both grew up in small southern towns, and it was almost inevitable that you'd be interested in nature, although maybe not in the depth that we approached it with. I went from being interested in not just birds, but how birds operate. So, this developed into an interest in biology.

CZ: How did you progress from your specific interest in birds to interests in community and ecosystem dynamics?

EO: It was a gradual evolution, I guess. The fact that my father was a professor initially deterred my interest in becoming a professor. I think all children revolt for awhile. I once thought I wanted to be a plumber -- I used to disappear underneath the house and look at how all the pipes were arranged. Essentially, I've always been into function, and after a while I felt it was important to know how birds function. So my next step was to become a physiological ecologist. My doctoral thesis was designing a crystal device for putting under bird nests to record their heart rates. I was more interested in function -- not necessarily in structure -- but rather, in how things work within the landscape. Next, I progressed to learning how populations function, and then onto the next logical step, how communities function. When I first came back (to the University) right after the war in 1945, we had a meeting to decide what every major in biology should take -- a core curriculum we call it -- and I suggested that maybe ecology ought to be a part of the core. Ecology wasn't one of the basic things in those days. Basic classes were physiology, pre-med. subjects and so on. They didn't know the difference between ecology and natural history. Natural history was describing -- more or less -- life in detail, taxonomy and the like. Ecology, of course, was studying the environment as a whole. So my contemporaries said, "We don't mean to hurt your feelings, but just what is this field?" It was then that I realized that there had never been a textbook written on general ecology. This convinced me to write a textbook.

Ecology now is the integration of the physical environment -- organisms and humans. It's not just organisms; it's not just a biological subject.... Ecology is the study of houses -- the place in which we live.

Ecology now is the integration of the physical environment -- organisms and humans. It's not just organisms; it's not just a biological subject. Other terms like zoology, the study of animals; botany, the study of plants; and ornithology, the study of birds, focus on specific entities. Ecology is the study of houses -- the place in which we live. This field had always been a sub-division in the field of biology, by some kind of precedent. That's why we now have the Institute of Ecology -- to study our home above the molecular and organism level. So the field of ecology is no longer of the minor interest that it once was in 1945. In the case of my own evolution, it is simply a natural chronology that one goes through. You start becoming interested in the parts and then become interested in the whole. Some people are just satisfied to stay interested in the pieces. After all, there's only so much you can learn about birds by just going out and looking at them. Some people travel the world around finding new birds, adding to their so-called life lists. Actually, you can spend your life studying different groups of organisms, especially in the case of insects. E. O. Wilson did both. He's an expert on ant systematics and in ant ecology as well. He told me once that if his eyesight hadn't been bad he would have probably studied birds, but his eyesight just wasn't that good, so he began studying ants with microscopes and magnifying glasses. He always carries a magnifying glass (laughter).

CZ: You mentioned the decline of naturalists, a trend represented by the fact that fewer people have direct experiences in the natural world.

EO: Yes, that's because most people used to live on farms, or they grew up on a farm in a rural area. Now, one of the things we worry about is the increasing urbanization of America; actually, of the entire world. One of my vignettes is that all technology has mixed benefits. Agricultural technology is a good example. Industrialized agriculture, which has now swept through the world, is characterized by heavy machinery and chemical use. It's put the little farmer out of business. My grandfather, who lived in Georgia, used to have a good life on 150 acres. You can't do that anymore; you can't make ends meet on anything less than 5,000 or 10,000 acres. And so the world over, wealthy

Odum *continued*

individuals buy up all the land and set up industrialized agriculture, that is, raising commodities, rather than food. For example, I was in Guatemala recently, and instead of raising their wonderful crops with a lot of variety, they now want to cut down all their trees and just raise broccoli and coffee in monocultures. That's what sells. It's the market economy that's killing the environment, and that's the bad side of agricultural technology. Urbanization is one of the things that worries me the most. Sao Paolo, Brazil, will soon have 25 to 30 million people. New York and Los Angeles are already too big to handle extensive further growth. This not only means sprawl, but it also means that people in the city, unless we get educated early in life -- that is, get kids into the country -- we won't have anyone appreciating nature. We can't just wait around for people to become naturalists. We're going to have to create them. Maybe that's something that the Chattooga River Watershed Coalition might want to do: Bring more people out to experience the woods.

CZ: Maybe experiential education at a young age?

EO: Yes, and like anything else, if you want to be prolific at something you need to start at a young age. You can't just take a single course in ornithology and expect to identify birds by their calls. You have to grow up on it. You can't just learn something by taking a course, without having some depth and experience in it already. Many of the ecology students we have now have had this experience. As kids, they had snakes, alligators, fish or some contact with nature. But there's going to be less and less of that, unless schools set aside schoolyard nature preserves for exploration and ecological experimentation. Environmental education has to be re-thought, and related to schools situated in an urban environment.

CZ: In your recent textbook you mentioned the anthropologist, Brock Bernstein, who observed in his work that human cultures surviving on resources extracted from their immediate surroundings were more likely to manage their lands sustainably. Can you comment on this?

EO: People in the city have no idea of their dependency on the life support of nature, whereas traditional cultures understood their dependency on forests. They could see the limits. People in the city have trouble visualizing these limits.

CZ: What event or series of events illustrated to you that the alteration of our natural ecosystems is a significant problem?...that we were pushing the limits?

EO: I don't think that I woke up one day and became enlightened. No, it doesn't happen that way. It's a gradual process. Some people have visions, and some people wake up thinking God told them to do this and that. But it was nothing like that; it was a gradual process. There was no point where I said, "Hey, the world is in trouble". I'm an "opto-pessimist", though. I think we have terrible problems to face, but I remain optimistic that we can address them. If I didn't feel positively about our potential, I wouldn't keep on teaching and writing. If people can move others up to a more holistic view, benefits will follow. Of course, one of the turning points was in the late 1960's when the astronauts first took pictures of our Earth. That's the first time we saw the Earth as a whole, you see. And so that started Earth Day, and the whole awareness movement and so on. In the last couple of decades, economic and social issues have put the environment on the back page. Yet I'm sure that by the next presidential election, the environment will become a major issue. My father was a sociologist, and he used to claim that it's in human nature to wait until things get really bad before there's a great rush to try and correct it. We're beginning to see that great rush now.

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CZ: How do you feel ecosystem management should fit

Odum *continued*

into this movement?

EO: An ecosystem is a functional unit. It's not simply a piece of land. When applying ecosystem management, you need to think not only about what's inside the boundary, but what's going in and what's coming out. In other words, an ecosystem is an open-ended functional unit. People want to close it. You have to give equal consideration to what's coming in and what's going out. I'm supposed to give a keynote address to a soil conservation group that's meeting here a couple of weeks from now, and I just finished the abstract today. My main goal is to straighten out the notion that an ecosystem is not just a geographical unit.

When people are numerous, they chop up the landscape into strips and patches, so we need to go from ecosystem to landscape scale management. Then you concentrate on how the various patches interact. The watershed is a good unit for management and study, because a watershed is both a geographic and a functional unit that includes all of the patches.

CZ: So it's a biological unit?

EO: No, it's not a biological unit. It's a physical unit. In the hierarchy ranging from cells to ecospheres, the ecosystem is the first level that is complete. That's why we focus on it. A population can't live by itself. An organism can't live by itself. But the ecosystem theoretically is a sustainable unit. It has all the parts including not only the organisms, but also the input and outputs of physical energy: The energy flow. If you do not consider the physical components of an ecosystem, you're not taking into consideration the full unit.

CZ: So accepting this pure definition of an ecosystem would be troublesome to land managers, because you can't theoretically draw lines around an ecosystem. Right?

EO: Right. You can't completely isolate and protect an ecosystem, because there is no such thing as a closed system in the natural world. When you set aside something for protection, you also have to know and be able to control what's coming downstream and what's coming into the watershed. You'll fail in your management if you don't consider what's coming in and what's going out. The Chattooga River is not going to stay unpolluted unless the headwaters and the watershed slopes remain in good shape. So the top-down approach is to start by looking at how productivity is effected by surrounding ecosystems. What's coming in and going out. Only then can you be sure that what's inside remains sustainable. The Nature Conservancy's philosophy is to preserve islands within the landscape because of the biological character that is inside of them. But this isn't necessarily a viable approach to conservation in the long run especially if the island is small and if the input from the surrounding environment does not remain good. It's expanding your vision — that's all ecosystem management is. Expanding your vision to a larger, more holistic level.

Survival depends not just on localized preservation. Chances are if you have a rare species in a small reservation, it will inevitably go extinct -- unless you have corridors and places for the species to replenish themselves.

CZ: So you don't think that the Nature Conservancy's interest in preserving small, threatened tracts of land is a worthy cause?

EO: Sure, it is as a start — but don't kid yourself that it will remain pristine if eroding soil and toxic wastes come in. The species inhabiting the preserves may not survive unless the energy, water and food are going to be there. Survival depends not just on localized preservation. Chances are if you have a rare species in a small reservation, it will inevitably go extinct — unless you have corridors and places for the species to replenish themselves. Otherwise there's a greater chance that some disease or natural catastrophe will wipe out the species. Take St. Matthew's island, for instance. They put caribou on there and left them alone, and their population exploded to over 6,000. Then they all died off after grazing all of the vegetation. Nobody had bothered them. Nobody shot them, either. They all died because the island wasn't large enough to support them, and there were no predators or other restraints to reproduction. In essence, the input and output didn't balance with the population size. The island had a cap on its resources. So the ecosystem concept is the realization that everything is open. It's all right to preserve these areas — especially larger ones, which are more able to sustain populations because they are less dependent on input and output.

Odum *continued*

CZ: What implications does the open-ended ecosystem concept have on land management issues?

EO: Just that. If you're going to manage land like a lot or a geographic unit, that's not ecosystem management — unless you're able to control your neighbor's dogs and cats and things that come in there. All systems are thermodynamically far from equilibrium. They're kept going by the inflow of high quality energy from the sun or fossil fuels. The city directly maintains its energy through fossil fuel consumption. Nature maintains its energy flow through the sun, wind, rain and all the other forces which are part of solar energy. Solar energy is the earth's primary input, but ironically solar energy is considered a nuisance in cities. We ought to have rooftop voltaics, rooftop agriculture. Of course, someday we will. Already in many countries they have urban agriculture with greenhouses and plastic sheds everywhere, where food is produced right there. That saves a lot of fossil fuel waste through transportation. In our food markets, everything comes from a long way off. All your grapes come from Chile, all your broccoli comes from Guatemala; your oranges, of course, come from Florida and California. It's all shipped. As long as fossil fuels are so utterly and stupidly cheap, we'll get away with hauling things such long distances. As soon as the gas prices go up to three or four dollars, we're not going to be able to do that. We're going to have to grow vegetables in close proximity to big cities. Atlanta will have to have a ring of gardens around it. We will get back to where one man can make a living on 10 acres, if he grows high quality produce. He'll have to grow all year round, therefore requiring small greenhouses to grow beans and tomatoes. You can't get the business of the supermarkets unless you can promise to deliver fresh vegetables every day.

The subject matter in so many environmental books focuses too much on a doomsday mentality, and in pointing out the obvious. There are long range solutions such as land use planning on a landscape scale.

CZ: So what percentage or proportion of a landscape do you feel needs to be preserved in its native form, in order to ensure a functional ecosystem?

EO: As far as life support is concerned, for a long time we said that in Georgia, we ought to strive for 20% natural areas for supporting air, water and native species. One interesting aside: There's a group called the "Technological Optimists", and they've been writing articles under the headline "The Liberation of the Environment". They say if we adopt three technologies, we can leave half of the earth in a natural state. Right now, a lot of the environment is used for waste management. If we strive for wasteless industry and landless agriculture by growing food on rooftops and in greenhouses, we won't need all of that farmland. We'll just let this farmland go back to nature, like it is in Georgia anyway. Ninety percent of Georgia's farmland is back to forests. We have more trees, more deer and more animals than we ever have had before. People always think about these little, odd endangered species when what we really ought to think about are endangered ecosystems. Species come and go, so to put all of our conservation efforts only on endangered species is putting our energies in the wrong level of organization.

CZ: Don't you think that certain species, based on their life history characteristics, can be used as a monitor for broad scale changes in the ecosystems? Look at eastern songbirds — the fact that certain interior forest birds are declining would indicate that forest fragmentation affects whole ecosystems.

EO: Sure, but that's a fact of life. The big question is what are you going to do about it?

CZ: Well, at least it shows you where the problem is.

EO: The subject matter in so many environmental books focuses too much on a doomsday mentality, and in pointing out the obvious. There are long range solutions such as land use planning on a landscape scale.

CZ: Both the politicizing and the specialization in the sciences have, in some respects, altered the reputation of ecological research in the eyes of the public. One quote of yours that seems to address this issue is as follows: "Ecology must combine holism with reductionism, if applications are to benefit society". Would you comment on the idea of more socially conscious research?

Odum *continued*

EO: Ecologists depend on both the top-down and bottom-up approaches for studying nature. We need both. The teaching of life science usually starts down at the bottom, with molecules, cells and genes and so on -- with only lip service being paid towards the whole biosphere. My book was the first top-down approach. The first chapter starts with ecosystems. The first chapters of most other ecology books focus on the organisms. If you're taking biology and you want to study a frog, it would be ridiculous to bring the leg in and study that, bring the heart in and study that: You'd be best off bringing in the whole damn frog to start, then study the organs.

Top-down. Ninety percent of other ecologists don't agree with that. All the other ecology books start with the pieces, and the focus on ecosystems is the last chapter, instead of the first. If you start at the top, then you're looking at the whole. In my abstract I mention that the reason we haven't done ecosystem management until recently is because the piecemeal, or what I call "quick fix", management often works so well in the short term. Timber managers have increased the short-term timber yield. Big game managers increase deer populations, but nobody thought about what the deer would do if you got too many of them around. They're eating up all of the seedlings! No one thinks about what the forests are doing as a whole. This is evidence that we must move up to more holistic forms of management, in order to avoid the tyranny of small technology and micro-management. Since the ecosystem is the first complete unit, that is -- it has all biological and physical components, it is a logical level to organize management around.

In my new texts, I talk about bringing together the three E's: Economics, ecology and ethics. And if you want to get anything done in the real world, you also have to have the two C's: Consensus, and a coalition. You have a Coalition on the Chattooga, but do we have a consensus on what is to be done?

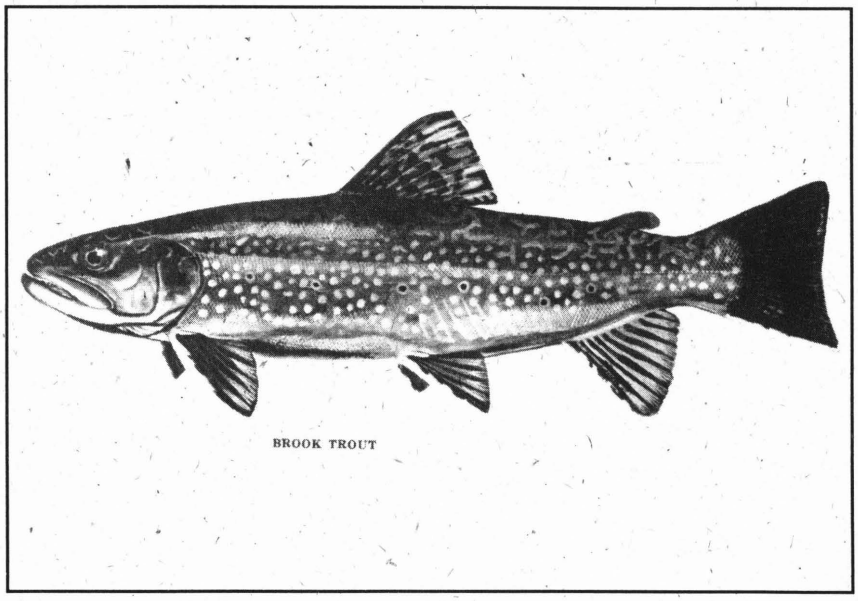
CZ: From your experience, what is the most effective way to convince people who have limited, direct experience in the natural world of the non-market value of the natural landscape?

EO: Talk about air and water. Point out that the three things you need to survive that are not in the market are clean air, clean water and food. Food's in the market partly, but it's the work of nature that builds up the soil. Air is the best example. We require a certain amount of forests in nature, and green stuff and functional oceans to clean our air every day. We don't pay a dollar for that. And then talk about water. A third of the daily solar energy input goes to purifying water for us. The energy draws it up out of the sea, desalinates it and transports it many miles, and releases it as rain -- giving us both water and hydroelectric power. This process would make for a heavy cost, if you had to do it artificially. We don't pay nature for producing that energy for us, we just tap it. That's why hydroelectric power is so cheap. You can also point out that money is not a very good measure of wealth. There are so many other things that will make you wealthy. Things that are not bought or sold: Your health, love, aesthetic value for the arts, music and drama. Of course people do make money selling these things sometimes, but appreciating the beauty of nature is wealth, and it's non-market. But market economists are telling people they should only give value and deal in human-made objects. That's what the free market system is good at. It's good at allocating human-made goods and services, but it isn't worth a damn at allocating nature's goods and services which are mostly external to the market. When people think about that, they may better understand the worth of natural systems and find ways to incorporate them in economics. In my new texts, I talk about bringing together the three E's: Economics, ecology and ethics. And if you want to get anything done in the real world, you also have to have the two C's: Consensus, and a coalition. You have a Coalition on the Chattooga, but do we have a consensus on what is to be done?

Brook Trout in the Chattooga Watershed

Dr. William McLarney

The Brook Trout (*Salvelinus fontinalis*) is the most widely distributed native salmonid fish in North America east of the Mississippi River, and one of the most conspicuous natural components of small coldwater stream ecosystems over much of its range. That range was largely confined to North America, east of the Mississippi, south of northern Hudson Bay to the upper limits of the Great Lakes watersheds. However, at higher altitudes along the spine of the Appalachian Mountain Range, the natural range *S. fontinalis* is considered to extend from Pennsylvania as far south as the vicinity of Athens, Georgia. Today the extreme southern limit of Brook Trout distribution may be considered to occur in Georgia, where brook trout still occur in portions of the Atlantic Coast, and the Mississippi/Ohio and Gulf of Mexico drainages. While the distinction of southernmost Brook Trout on the continent must be attributed to fish in streams of the Toccoa or Chattahoochee drainages, the southernmost populations on the Atlantic slope are found in the Chattooga and Tallulah watershed of the Savannah River system.



Brook Trout, Salvelinus fontinalis, are among the most intolerant of fishes with respect to most chemical pollutants.

The present range of *S. fontinalis* differs considerably from its native distribution. On the one hand, it has been hatchery propagated and widely distributed outside its native range. While many of these "introductions" serve only to sustain "put and take" recreational fisheries, *S. fontinalis* has become widely established outside its native range, especially in the Rocky Mountains of the western United States and Canada.

On the other hand, Brook Trout have been eliminated from much of their native range, especially at low elevations. A comparison of the original and present distributions of Brook Trout in the Southern Appalachians would show the range boundaries as somewhat narrower but largely intact. Within these boundaries, however, distribution would be seen to be much spottier. In most Southern Appalachians watersheds, Brook Trout occur occasionally at altitudes below 3,000 feet. The factors which have contributed to the loss or decline of Brook Trout may be divided into three categories:

1) Environmental Disturbance

Brook Trout are among the most intolerant of fishes with respect to most chemical pollutants. Thus, *S. fontinalis* serves as an "indicator" species in this respect. Nutrient enrichment, as from livestock, sewage or agricultural runoff may not always be directly harmful to brook trout, but it can benefit competitor species. Certainly Brook Trout are rarely associated with highly fertile, nutrient-enriched waters.

In terms of temperature, Brook Trout probably are the most demanding of our "cold water" fishes. While they can survive short exposures to temperatures as high as 75F, they will not long endure temperatures above 68F. In practical terms this means that early logging and development for agriculture, leading to elimination of natural shade from permanent and temporary streams and springs, wiped out many populations. The extent of suitable Brook Trout water continues to be limited by this factor.

Brook Trout are moderately tolerant of sedimentation. However, the heavy sediment loads characteristic of many streams in developed areas are lethal to the species.

As compared to other salmonids, Brook Trout are relatively tolerant of low pH. They often are the only fish species in streams associated with mountain bogs, even where other species may have been introduced into the watershed. Paradoxically, in some areas severely affected by acid precipitation (notable the Shenandoah National Park in Virginia), the Brook Trout is extending its range for the first time since Caucasian settlement. However, Brook Trout do have a lower pH limit for survival and reproduction, as do their food species, so this can scarcely

Brook Trout *continued*

be seen as a positive development. In fact, Brook Trout have been eliminated from some waters in Ontario and New York by acidification.

2) Over-fishing

Brook trout are uniquely susceptible to depletion and even local extinction through over-fishing for three reasons: As compared to other salmonids, they are relatively easy to catch. They are a true gourmet item — a superior fish for dining. Also, they often are found in very small streams, where there is no difference between what might be termed "fishery extinction" (fish populations so reduced that angling becomes too inefficient to be attractive) and biological extinction.

3) Introduction of Exotic Species

Partly in response to reduction in Brook Trout populations due to the factors mentioned above, it became customary in the 19th century to stock exotic salmonids (Rainbow Trout, *Oncorhynchys mykiss*, from the Pacific slope of North America, and Brown Trout, *Salmo trutta*, from Europe) in Eastern streams, in order to sustain sport fisheries. This practice continues to this day. Insofar as the introduced species "stayed put," this policy had its merits. However, both of these exotic trouts typically extend their ranges upstream. As larger, more aggressive and more omnivorous animals, they tend to out-compete the Brook Trout. In those few relatively large streams, which still have water quality suitable for Brook Trout, there may be adequate niche separation to accommodate two, or even all three, species. But in the small streams that constitute the majority of Brook Trout habitat today, elimination of Brook Trout is the rule.

In general, Brook Trout compete poorly with other fish species. Typically, if a Southern Appalachian stream has Brook Trout, it will be the only fish species present. Occasionally Brook Trout will be found associated with non-insectivorous species such as the Blacknose Dace (*Rhinichthys stratulus*). The Brook Trout's lack of ability to compete with other fishes is the reason surveys for this species often begin with a search for barriers to upstream movement of fish.

It should be acknowledged that expansion of Brook Trout distribution has also occurred within its native range in the Southern Appalachians. On both public and private lands, authorized and unauthorized stocking of Brook Trout in previously fishless streams, above barrier falls, has been carried out for a myriad of reasons involving sport fishing, aesthetics, and desire to conserve the species. Today, the mere presence of Brook Trout in a headwater stream does not necessarily indicate that the fish is native there. However, in most cases we would need far better historical records and knowledge of geologic events, in order to determine whether a population is natural or introduced.

At least in North Carolina and Georgia, local "old timers" stoutly maintain that the native fish here are different from Brook Trout of hatchery origin (and therefore, ultimately, of Northern origin), and refer to the native fish as "Speckled Trout".

Genetics

Even before the white man began to grossly modify the North American landscape, the Brook Trout was a species with a strong tendency to become isolated in the headwater reaches of watersheds. This would lead one to suspect that evolutionary processes leading to speciation [the process of developing new species through evolution] would occur. However, until quite recently very little attention has been paid to Brook Trout genetics.

The Silver Trout (*Salvelinus agassizi*), known only from Dublin Pond, New Hampshire, and presumed extinct since 1930 (Jenkins, 1980; Warfel, 1939), is generally considered a separate species. Various investigators have argued for its affinity with Brook Trout (Behnke, 1972) or the Arctic Char (*Salvelinus alpinus*) (Willers, 1991). Since its disappearance followed the introduction of hatchery strains of Brook Trout, either genetic swamping or interspecific competition could be the cause of its demise. To make matters more confusing, a native strain of Brook Trout originally cohabited with the Silver Trout in Dublin Pond.

Visual inspection of the *S. fontinalis* range map, with its Southern Appalachian "tail" would incline one to suspect genetic differentiation in the southern portion of the range. At least in North Carolina and Georgia, local "old timers" stoutly maintain that the native fish here are different from Brook Trout of hatchery origin (and

Brook Trout *continued*

therefore, ultimately, of northern origin), and refer to the native fish as "Speckled Trout". This also is the prevailing common name for brook trout in Canada. However, it was not until the late 1960's that the scientific community took note (Lennon, 1967) and was the first to suggest that various subspecies, or even species, might be included in what was referred to as Brook Trout and Speckled Trout populations in the Southern Appalachians.

With the development of electro-phoresis [the migration of charged colloidal particles or of molecules through a fluid or gel subjected to an electric field] as a genetic tool, interest in local fish stocks grew. There is now a successful research establishment involved in Southern Appalachian Brook Trout genetics (Harris et.al. 1978; Stoneking et al. 1981; McCracken et al., 1993). Possible eventual outcomes include recognition of one or more genetically distinguishable strains, subspecies or even new species.

The Brook Trout occupies a position at the top of the food chain in small streams. It is in this respect analogous to the bear, the wolf and the cougar in the forests. Its presence argues for the persistence of a fully functioning ecosystem, and lends weight to conservation proposals.

For now, opinion is diverse. Conservation authors like Willers (1991) hold to the traditional view that "Brook Trout exhibit a high degree of uniformity throughout their range. There seems to be no suitable, widely held hypothesis to explain this high degree of evolutionary stability". Others believe that Brook Trout may eventually be shown to be as genetically diverse as the Cutthroat Trout (*Oncorhynchus clarki*), for which fifteen subspecies are recognized (Behnke, 1979). What is certain is that some Southern Appalachian Brook Trout streams have been stocked, once or repeatedly, with Brook Trout of Northern origin. In others, the Brook Trout are the pure descendants of fish which swam there 300 years ago.

Of twenty-nine streams in the Chattooga watershed which so far have been found to contain naturally reproducing Brook Trout, genetic profiles are available for only two of them. Both populations suggest Southern stock identity, but some contamination by Northern strains cannot be ruled out.

Conservation Biology and Activism

The Brook Trout complex is important to conservation biologists and environmental activists for a variety of reasons. In general terms, *S. fontinalis* is an "intolerant" species. Its mere presence indicates high water quality and the absence of significant pollution, thus supporting arguments for water quality classification upgrades, wilderness designations, and so forth.

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The Brook Trout is, for various reasons, a charismatic species. It is part of our European heritage to place a high value on trout and salmon in general, and our forefathers were quick to extend that status to the native salmonids of North America. The great beauty and perceived rareness of the Brook Trout enhance its prestige. It is easier to sell a conservation proposal based on Brook Trout than one based on, for example, an obscure, dull-colored salamander.

The Brook Trout traditionally is considered a sport fish. While this has led to some resistance to Threatened or Endangered Species designations in some places, it also creates a constituency of concerned people, over and above those who generally worry about sensitive species. Organized anglers will usually support trout conservation measures, even in streams too small to afford or sustain a fishery.

Ongoing research in brook trout genetics strengthens the conservation case. If distinct strains, subspecies or species are recognized, it raises the possibility of a "listed" status. There is precedent here in the treatment of local stocks of the Pacific Salmons, under the

Brook Trout *continued*

Endangered Species Act. While anything depending on Endangered Species legislation is moot at this point, conservation appeals based on local uniqueness can effectively be made, even absent strong legislation.

It should be recognized that the Brook Trout, like most species, could also be "part of the problem". Northern stocks have in some instances mongrelized Southern stocks out of existence, and introduced Brook Trout have been implicated in the extinction of other salmonids in the Western United States and Canada. A case could also be made that where Brook Trout are successfully introduced to previously fishless streams, native populations of amphibians or invertebrates may be endangered. In such situations, eradication of Brook Trout could be justified (Rainbow and Brown Trout are being eradicated in the Great Smoky Mountains National Park, in favor of the native Brook Trout). However, given the present status of Brook Trout in the Southern Appalachians and our present state of knowledge, all Brook Trout populations probably should be considered worthy of conservation efforts.

Editor's Note:

Between May and October of 1996, field investigations were conducted by Dr. McLarney and the Chattooga River Watershed Coalition to determine the presence or absense of *Salvelinus fontinalis* in the Chattooga River watershed. Streams were sampled where conditions were favorable for their presence. We discovered a number of previously undocumented Brook Trout populations, to add to the list of populations already identified by the Forest Service and state agencies.

The Chattooga River Watershed Coalition (CRWC) has outlined a program for the preservation and recovery of the Brook Trout, based on Dr. McLarney's work in 1996. We have chosen the Brook Trout as a keystone species for restoration, in conjunction with the larger goal of restoring the natural ecological integrity of the Chattooga River Watershed as a whole. Our efforts are concentrated in the following areas:

Education

The Brook Trout is a species which has been recognized locally as an important native fish, and is prized for its beauty as well as its status as a game fish. We are working to inform and educate citizens about the importance of this species from the standpoint of restoring unique, native biological diversity. Information concerning erosion control measures also will be an important component of this program. The threat of contamination of Brook Trout streams from the stocking of non-native fishes is another component of educational outreach to local landowners.

Protection

There exists the distinct possiblity that the Southern strain of Brook Trout, if it exists, is in dire need of protection. This Southern strain of Brook Trout certainly would merit some type of Threatened status, should scientific research recognize it as a unique taxon.

The CRWC intends to work with both state and Federal agencies to prioritize appropriate streams for protection and restoration of the species. Emphasis shall be placed on conscientious enforcement of erosion and sedimentation regulations and guidelines. In certain cases, the CRWC will advocate a reasonable upgrade of water quality classification. Also, we shall support polices which discourage the stocking of non-native fish into existing Brook Trout streams.

Further Study

In the future, the CRWC will be working to form partnerships with Federal and state agencies, as well as academia at large, to study the genetic aspects of the Brook Trout. Our goal is to contribute to the resolution of the unanswered question of the existence of a unique, "Southern strain" of Brook Trout.

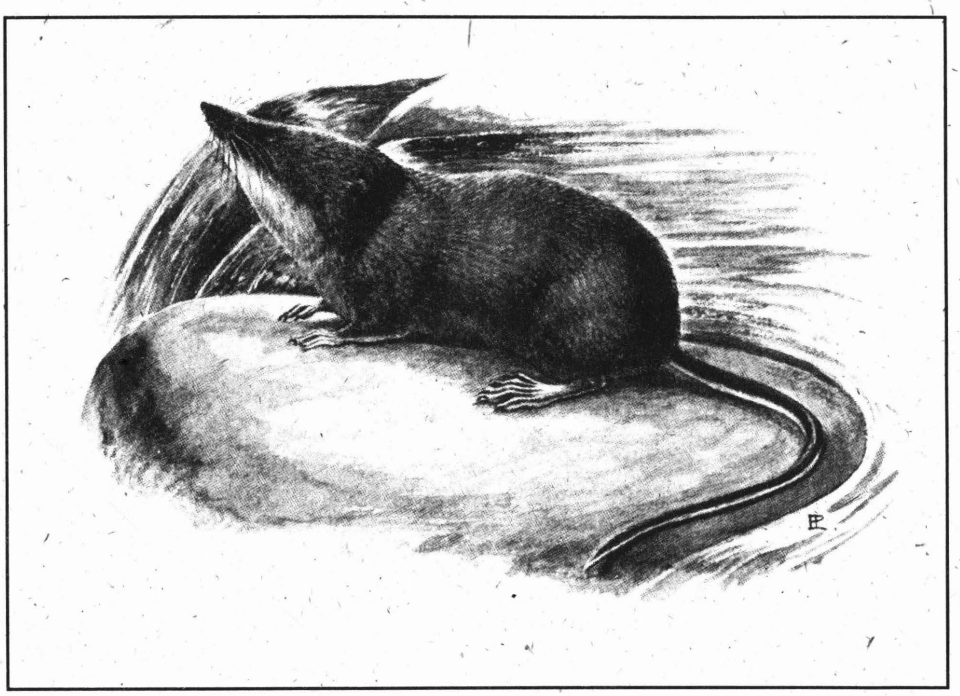
Finally, we will advocate stringent protection for those streams where Brook Trout currently are present. For example, the Rock Gorge area in Georgia and the Persimmon Mountain Roadless Area in South Carolina certainly need to have increased protection as outlined in the Chattooga Conservation Plan, as "core /ecological restoration areas", or even the Forest Service's wilderness designation.

The Brook Trout is a species we can all help to protect. It is a key, charismatic species in the Chattooga River watershed ecosystem. Much is yet to be learned about this beautiful native fish. The Brook Trout easily could be one of the rarest salmonids in North America. This is a legacy that we could all strive to restore, enjoy and protect for posterity. Please write to the Forest Service and support the implementation of the Chattooga River Conservation Plan, as well as advocate increased protection of the Rock Gorge, Persimmon Mountain and Rabun Bald Roadless Areas.

Small Mammals of the Chattooga River Watershed

Buzz Williams

Small mammals exhibit a wide array of adaptive characteristics that are exemplary of the amazing diversity of life. Some of these fascinating little creatures which live in various habitats in the Chattooga River watershed are bats, moles, shrews, voles, pack rats and lemmings. Like all mammals, these animals have hair on their bodies and produce milk for their young. For the most part they are nocturnal, although some of the shrews are active throughout the night and day. It seems to be the small mammals' size, which allows these creatures access to the dark recesses of hollow trees and logs as well as under thick vegetation and leaf litter, that is the genesis of many interesting evolutionary adaptations. Many species of small mammals also are very prolific and prone to cyclic population explosions; thus, they also influence a number of other animals which are both higher and lower on the food chain.



The Water Shrew, Solex palustis , dives into swift moving mountain streams to capture aquatic insects.

Due in part to the wide range of elevations here, the Chattooga River watershed is home to many different small mammals. Some of the more interesting ones occur in the higher elevations of the Highlands Plateau in North Carolina, where several boreal species exist at the extreme southern tip of their range. These include the Water Shrew, Rock Shrew, Pigmy Shrew, Southern Bog Lemming, Red Squirrel and Red Backed Vole. Other species occupy the deep woods, in remote tracts of our national forest land which have not yet been disturbed and fragmented by road building and logging. Isolated mountain bogs and numerous streams provide additional, diverse habitats for many other small mammals in the watershed.

The shrews are grouped taxonomically with the moles as *Insectivora*, or insect-eaters. Shrews also eat earthworms, some vegetative matter, and in some cases they are carnivorous. They have a very high metabolism, and can consume quantities of food equal to their own body weight in just one hour. Shrews have a narrow, sensitive snout, very small eyes and ears, and sharp chestnut-colored teeth. Shrews also posses well developed scent glands which give off a foul odor, especially during their mating season in early spring and summer. Active during both the night and day, shrews are preyed upon by owls, snakes, weasels, hawks, bobcats and foxes.

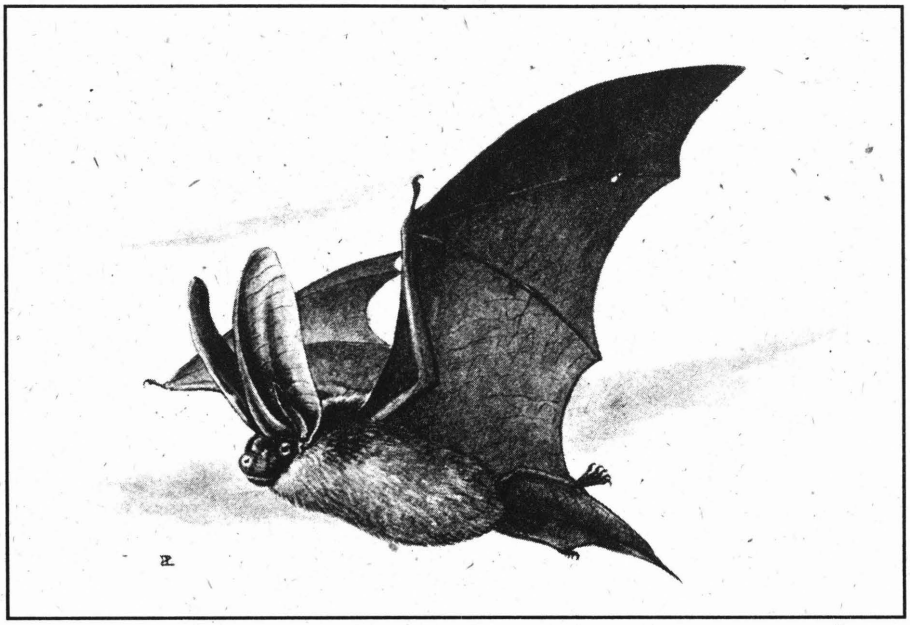
The Rock Shrew, *Sorex dispar*, lives on the rocky, high slopes of Georgia's Rabun Bald. Here, it searches for centipedes, spiders and other insects in rock crevices and around moss-covered logs, which lie on the forest floor near streams flowing through the cool, moist, high elevation hardwood forest. The Rock Shrew is a medium sized shrew, about five inches long including its tail. Its body is slate gray on top and somewhat paler underneath.

The Pygmy Shrew, *Microsorex hoyi*, has the distinction of being the smallest mammal in the world, tipping the scales at around the weight of a dime (1/10th ounce). An adult Pygmy Shrew is 2 to 2 1/2 inches long, with a tail that's around 1 inch long. The Pygmy Shrew's fur is a reddish-brown to grayish-brown, and smoky-gray on the animal's underside. Incredibly, their size is such that two Pygmy Shrew babies could fit on the eraser of a pencil. These tiny shrews are said to be able to fit into earthworm tunnels.

The Northern Short Tailed Shrew, *Blarina brevicuda*, is one of the larger-sized shrews, at about 6 inches long. Though rarely seen, this shrew is widely distributed. It is often found in the leaf litter of moist,

Small Mammals *continued*

mature forests along streams. In the mountains, these shrews are of a darker, slate black color than their grayish brown relatives found in the lower elevations. As the name implies, its tail is only about 1/3rd the length of the animal's head and body. It is noteworthy that the Northern Short Tailed Shrew is the only mammal in North America with poisonous glands. This poison is secreted from submaxillary glands into the shrew's saliva, which then is used to anesthetize its prey.



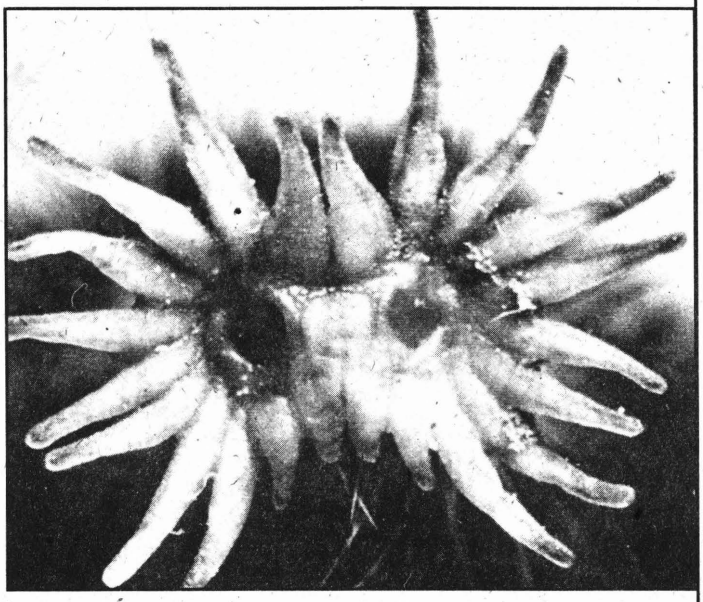
Rafinesque's Big-Eared Bat, Plecotus rafinesquii

Solex palustis, the Water Shrew, is another Northern species that is found in the higher elevations of the Chattooga River watershed. The Water Shrew is nearly as large as the Northern Short Tailed Shrew, with similar coloration, but it has a longer tail. This shrew has some very unique features which allow it to dive beneath the surface of swift-flowing mountain streams where it catches aquatic insects. Stiff hairs along the margins of its enlarged hind feet, and partial webbing between the third and fourth toes allow the shrew to dive beneath the water's surface while ruddering and sculling along with its tail. However, this shrew has to work hard to stay below the water's surface due to the air bubbles which get trapped in its thick fur. The Water Shrew also is reported to use its relatively large feet to literally run across water, held aloft by the surface tension.

Moles, the other *Insectivores,* differ from the shrews in that they posses well developed, claw-like front feet, which they use to tunnel beneath the surface of the soil in search of insects and earthworms. Also, they are nearly blind and have very small ears. Their fur usually is gray to black, and the mole's body has been described to be shaped like an Irish potato. Their tail is relatively short in comparison to the shrews'. One curious thing about these creatures is that they are adept at traveling in reverse, where they are aided by a sensitive tail as well as hair that grows straight up, which will brush easily in either direction. Moles spend most of their lives in darkness, underground.

One interesting little mole which our staff biologist found in a bog in the Chattooga River watershed is the Star-Nosed Mole, *Condylura cristata*. This mole is comfortable around water, and is fond of muddy, slow-moving streams. Here, it uses twenty-two little tentacles which radiate from the tip of its nose (hence the name "star-nose") to locate aquatic insects in the mud. One theory holds that this mole employs its star-nose to detect the low-level electrical impulses of its prey.

Rafinesque's Big-Eared Bat (*Plecotus rafinesquii)* also has several special features: This small mammal can fly! Not only can this mammal become airborne, it can fly in complete darkness by using sonar. Though all bats can fly and use supersonic emissions to avoid objects and to locate prey, Rafinesque's Big-Eared Bat is especially highly developed. Bats produce



Nose of the Star-Nosed Mole, Condylura cristata. The twenty-two tentacles are used to help locate prey.

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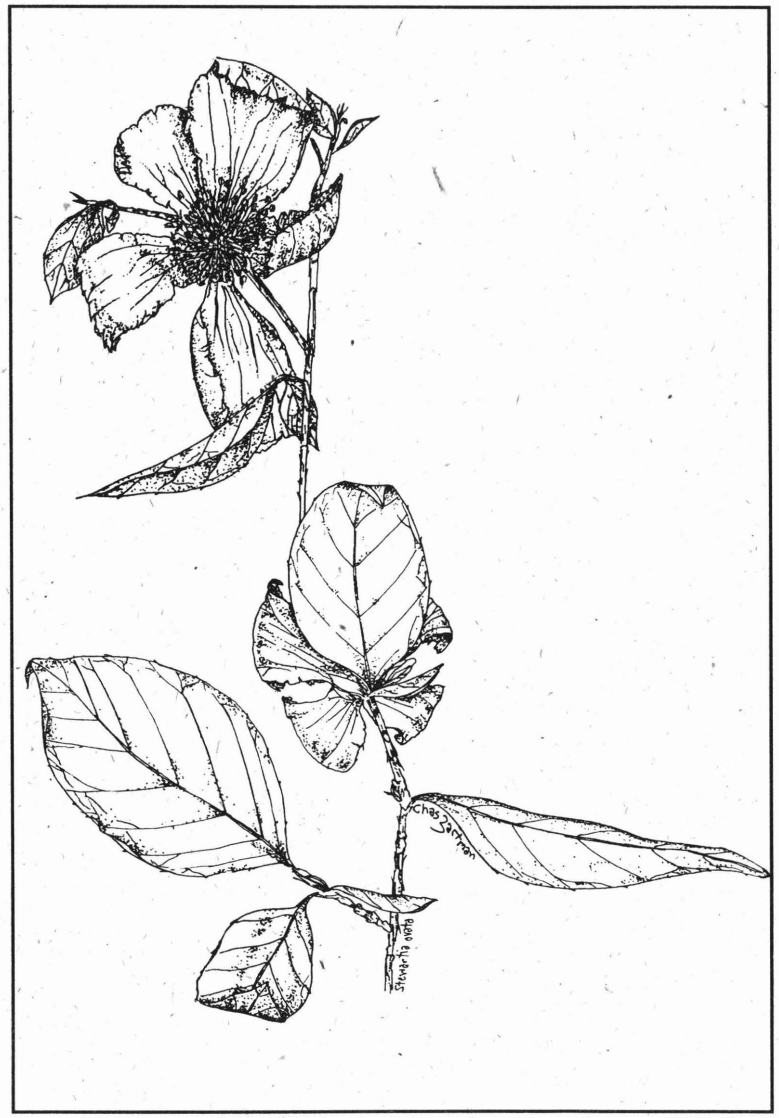
When Continents Collide: *Patterns in Plant Diversity*

Chas Zartman

Assuming that the aim of scientific research is to describe and explain nature, one can safely say that certain discoveries of the twentieth century have attained this goal with flying colors. Early in this century, Albert Einstein's concepts of space and time as expressed in his Theory of Relativity immediately became the foundation of modern physics. Edwin Hubble's discovery in the 1920's that individual galaxies are moving away from one another at calculable rates reshaped modern cosmological thought by verifying that the universe is expanding constantly outward. Francis Crick and James Watson's half-century-old discovery of the structure of DNA, the molecule which carries the genetic material of all living creatures, liberated nearly overnight the field of molecular genetic research. Although these celebrated highlights of science have led to profound and sometimes questionable changes in our society, one major scientific realization of the twentieth century was ignored, even ridiculed, for nearly forty years following its conception.



Mountain Camellia, Stewartia ovata. The Mountain Camellia (of the Tea Family) inhabits riparian areas and streambanks in the Southern mountains. The genus Stewartia includes members native only to the Southeastern United States and Japan.

In 1910 (only five years after Einstein's publication of the Theory of Relativity), a German scientist named Albert Wegener became intrigued by the complementary shapes of the coasts of eastern South America and western Africa. In his eyes, they fit together almost like the pieces of a jig-saw puzzle. Despite the mounting evidence that Wegener gathered in support of his theory of "continental drift" — the idea that continents have migrated vast distances over geologic time — it was dismissed by most scientists of his time. Not until thirty years after Wegener froze to death during a botched expedition to Greenland did geologists, through sophisticated studies of the Mid-Atlantic Ridge, recognize the significance of Wegener's theory.

Although the implications of Wegener's theory are vast (the continental drift theory is considered a conceptual breakthrough for the geologic sciences as revolutionary as Charles Darwin's theory of evolution was for the life sciences), it was not accepted by his contemporaries. This surely wasn't due to a lack of supporting evidence: Wegener had definitively outlined the distributions of certain peculiar rock types, closely related ancient reptiles and long extinct ferns across the now widely separated continents of South America, Africa, Antarctica, India and Australia. It wasn't because someone else had a better answer — scientists mostly dismissed Wegener's evidence as either examples of freak migrations, parallel evolution or just plain coincidence. It could possibly have flopped because of an unwillingness in the scientific community to accept such a radical thought. Perhaps no self-respecting scientist of this time wanted to support the claim that "the earth is moving under our feet"!

Whatever reasoning might best explain the reluctant acceptance of the theory of continental drift, it has become a cornerstone of modern scientific thought. It is integral in our understanding of the slow yet inexorable topographic, climatic and biological changes which have occurred on our planet during the last four billion years. Not

Patterns in Plant Diversity *continued*

only does Wegener's theory help humans to better understand the quirky distributions of extinct organisms, it also helps us interpret the global patterns of closely related living organisms. Wegener's theory holds that in the relatively recent geologic past, all seven of the Earth's continents were crowded together in a huge land mass referred to as "Pangea". Here, North America was butted up against "Eurasia" to the east, Africa to the southeast and South America to the southwest. In short, many of the present day affiliations between plant and animal groups across the Earth's vast oceans originated when all present continents were fused together as one.

Stanley Cain, a renowned plant ecologist from the first half of this century, was one of the first to recognize some of these living connections between our Southern mountains and faraway places such as Southeast Asia. In his classic paper entitled The Tertiary Character of the Cove Hardwood Forests of the Great Smoky Mountains National Park Cain states, "Whatever the time of the transoceanic connections (whether by land bridges, as was undoubtedly the case in more recent times, or by continental displacement), two points are clear. In the first place, such connections across the north Pacific and the north Atlantic undoubtedly once existed; and second, climatic conditions were more favorable than now, because temperate plants can only migrate through regions of temperate climate.... It is thus reasonable to assume that certain types of modern areas could only have been attained in Cretaceous and early Tertiary time. This applies with conspicuous reasonableness to those genera [closely related plant groups, *i.e.* the oaks] which today have species only in eastern North America and in eastern Asia". Stanley Cain's language is illuminating in two senses. Overtly, Cain suggests that the eastern edge of both the North American and Asian continents harbor the world's most well developed examples of temperate forests, and each of these regions support floras of uncanny similarity. In the historical and more subtle sense, Cain's statement which included the words "continental" and "displacement" side by side, breached the conventional notion of his time that the theory of continental drift was a mere fallacy. The shock value of Cain suggesting that continental movement could explain similarities in Appalachian and southeast Asian plant distributions is heightened when one realizes that the publication date of his work, in 1943, preceded by nearly twenty years the indisputable evidence in support of the theory of continental drift!

Luckily enough for those of us living in the greater Chattooga River watershed area, there is ample opportunity to ponder and explore the patterns between the Asian and Southern Appalachian flora. The Chattooga River's East Fork trail at the Walhalla Fish Hatchery is a fantastic location to wander in search of East Asian-Southern Appalachian vicariads (*i.e.*, plant groups native to both of these regions). Here, the Chattooga explorer will stumble across the conspicuously large, double leaves of the Umbrella Leaf (*Diphylleia cymosa*), a plant which is restricted to mid and high elevation seeps and cove forests of the southern Appalachians. The genus *Diphylleia* includes only two other members (*Diphylleia grayi* and *D. sinensis*), both of which are native also to eastern Asia. Along the length of the East Fork trail, a connoisseur of Trilliums will likely see five species in this complex: the Large Flowering (*T. grandiflorum*), the Southern Wake Robin (*T. simile*), Painted (*T. undulatum*), Vasey's (*T. vaseyi*) and Catesby's (*T. catesbaei*) Trilliums. Although quite diverse in parts of Japan, China and eastern Siberia, Trilliums reach their greatest complexity in the Southern Appalachians. Towards the East Fork's confluence with Section Zero of the Chattooga River, on a mid-June jaunt one may be lucky enough to see the fist-sized, eye catching blooms of the rare shrub, the Mountain Camellia (*Stewartia ovata*). The Mountain Camellia (of the Tea Family) inhabits riparian areas and streambanks in the Southern mountains. Once again, the genus *Stewartia* includes members native only to the Southeastern United States and Japan!

Interestingly enough, this geographic trend extends beyond the plant world. In the southern Appalachians, organisms ranging from lichens to salamanders are closely allied with groups found in east Asia. The much celebrated hellbender salamander (*Cryptobranchus alleghaniensis*), a huge creature proported to inhabitant the Chattooga's Lake Tugalo, belongs to the Family *Cryptobranchidae*, which is only represented in the United States and the Orient. The extremely rare and restricted rock gnome lichen (which last October W.S. Lesan and the author located for the first time in the state of Georgia) is known only from the Southern Appalachians in perpetually moist, high elevation seeps. This Federally Endangered Species also belongs to a genus (*Gymnoderma*) represented in Japan and eastern Asian.

These patterns are not by any means restricted to the rarer or more obscure plants of our Southern mountains. Stanley Cain indicated that at least fifteen co-dominating woody plants of the Smoky Mountains' cove forests have range disjunctions (separations) from these mountains to the East Asian forests. Many of these tree groups, including Hemlock (*Tsuga*), Magnolia (*Magnolia*), Tulip tree (*Liriodendron*), Witch Hazel (*Hamamelis*), Sassafras (*Sassafras*) and Carolina Silverbell (*Halesia*) can be seen along the East Fork trail, and in other cove forests of the Chattooga River watershed. A 1983 investigation by Peter White, plant ecologist from University of North Carolina at Chapel Hill, concluded that 13% of the 1,211 plant species inhabiting the Great Smoky Mountains National Park had

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The Effects of Forest Fragmentation on Breeding Birds

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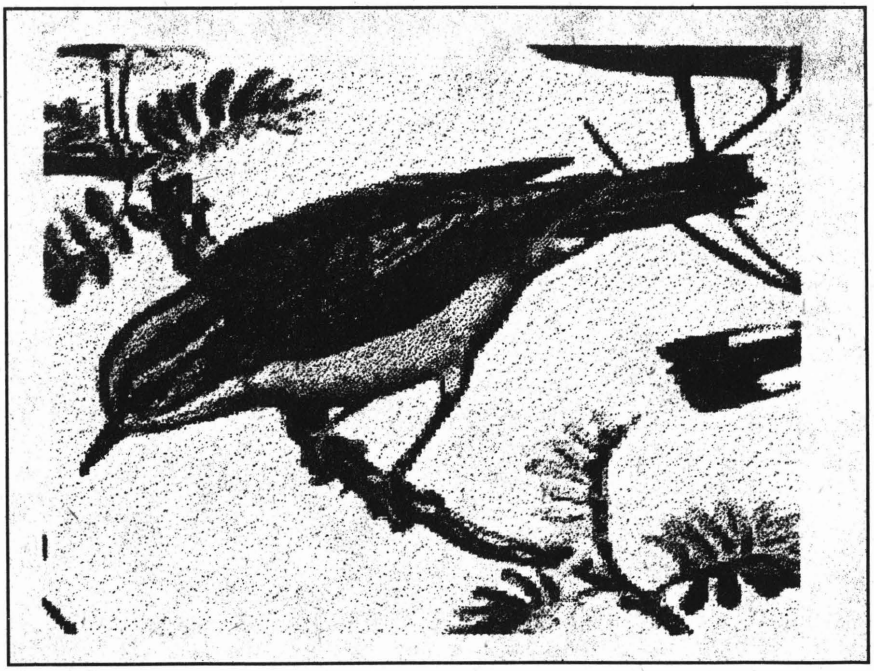
The notion that many species of migratory birds are declining in numbers became popularized with the publication of John Terborgh's 1989 book Where Have All the Birds Gone? which warned of a "silent spring" similar to the one envisioned by Rachael Carson twenty years earlier, albeit for different reasons. Just as Rachael Carson challenged us to stem the use of DDT and other pesticides, we are now challenged to stem the destruction and fragmentation of forests, which are important habitats for a variety of birds, particularly those that migrate between breeding grounds in temperate North America and wintering quarters in Central and South America and the Caribbean (called "Neotropical migrants"). There is widespread agreement among ornithologists that the loss and fragmentation of forested habitats is the ultimate cause of declining populations. However, to this day it is unclear exactly how populations are limited, and at which stage of the life cycle these limiting factors may be most important.



The Worm-eating Warbler, Helmitheros vermivorous, is a species whose population numbers decline in response to a reduction in forest patch size.

In the decade leading up to the publication of Terborgh's book, bird watchers and ornithologists alike hotly debated whether forest loss in the tropics or temperate zones was responsible for the observed declines. The debate has yet to be resolved, however most scientists now consider the relative importance of forest loss in wintering versus breeding ranges to be species-specific. That is, although all Neotropical migrants share the characteristic of long-distance migration, each species has independently evolved specializations and ranges of plasticity [resilience] that are unique to that species, and which may differentially affect vulnerability to habitat loss in one season relative to another. Despite differences in species-specific responses to fragmentation in wintering versus breeding areas, a growing body of evidence is showing that the fragmentation of breeding habitat can have broad, negative consequences for a wide variety of forest breeding birds.

The fragmentation of breeding habitats can affect birds both directly, by reducing the amount of habitat available, and indirectly through processes related to an increase in the amount of "edge" relative to interior habitat available. The indirect effects of fragmentation are complex, yet may be primarily related to birds nesting near edges or in small remnant forest patches suffering higher rates of both nest predation and nest parasitism (e.g. Robinson *et al.* 1995). The high rates of nest predation seen in small fragments or near edges are the result of high numbers of edge-adapted predatory species, including Blue Jays (*Cyanocitta cristata*), crows (*Corvus spp.*), grackles (*Quiscalus spp.*) and raccoons (*Procyon lotor*). Nest parasitism is primarily attributed to one species, the Brown-headed Cowbird (*Molarthus ater*) (although the Shiny Cowbird, *Molarthus bonariensis*, a South American brood parasite, has been seen with increasing frequency in the Southeastern United States in recent years). The Brown-headed Cowbird is believed to have originated on the short grass prairies of the central United States, making its living primarily by following the large herds of bison that were once common there. In keeping with this nomadic lifestyle, the species evolved a curious breeding strategy where the female lays her eggs in the nests of other species, freeing the cowbird parents of any parental duties. The clearing of Eastern forests and introduction of livestock by European settlers eventually opened up a variety of new habitats, and now its breeding distribution is virtually continent-wide. Many forest bird species, which had never before been subject to the pressures of nest parasitism, were subsequently left vulnerable. Although the ultimate effects of parasitism on the annual reproductive rates of some species of migrants is still largely unknown, many host

Breeding Birds *continued*

species end up raising cowbird young at the expense of their own.

As interior forest patch sizes decrease and reproductive rates decline, the return rates of adult birds to these patches often declines as well, resulting in local population extinctions and consequently, in lower species diversity in these remnant forest stands. Reduced diversity resulting from local extinctions can be exacerbated by reduced recolonization rates by adult birds from other areas, as habitat patches become increasingly isolated. This combination of local extinctions and reduced recolonization results in patterns of species distribution that are termed "area-sensitive." Thus, for many species, the probability of its occurrence in any given forest is a function of the forest's size. Another factor contributing to these "area effects" is that some species require specialized breeding "microhabitats" that are less likely to be found in small forests. Perhaps the most convincing evidence of area effects on Neotropical migrants is a study in Maryland by Robbins *et al.* (1989), which showed that many species may decline in response to a reduction in forest patch size. Many of these species are among the most common breeding birds in the eastern United States, including: Acadian Flycatcher (*Empidonax virescens*), Veery (*Catharus fuscescens*), Wood Thrush (*Hylocichla mustelina*), Scarlet Tanager (*Piranga olivacea*), Red-eyed Vireo (*Vireo olivaceus*), Black-and-White Warbler (*Mniotilta varia*), Worm-eating Warbler (*Helmitheros vermivorous*), Ovenbird (*Seiurus aurocapillus*), Northern Waterthrush (*Seiurus noveboracensis*) and Louisiana Waterthrush (*Seiurus motacilla*). Subsequent studies by other authors have confirmed these area effects for these and other species.

The song of the Wood Thrush (Hylocichla mustelina) is one of the most beautiful sounds in the forest. The Wood Thrush migrates thousands of miles, from points in the Eastern US to its winter home in Costa Rica, and back.

It is curious that population declines similar to those observed for migrants are not seen for resident birds (*i.e.* year-round residents) which are often just as susceptible to predation and parasitism as are the migrants. One reason that residents may be better equipped for dealing with predation and parasitism than migrants is that residents, in general, attempt more clutches per breeding season than do migrants. For example, a northern Cardinal (*Cardinalis cardinalis*) may attempt up to four clutches of four eggs per season, whereas an American Redstart (*Setophaga ruticilla*) will only attempt one clutch of four eggs. This is a direct result of the different lengths of the breeding season for each of these species. Thus, although both cardinals and redstarts will re-nest following nest depredation, the redstart is much more limited in the number of new clutches it can attempt due to the constraint of having a much shorter breeding season than cardinals. Whereas a cardinal may nest anytime from March to September, the redstart restricts its breeding activities primarily to just June and July. As mid-July approaches, the adult redstart must redirect its activities from breeding to accumulating fat reserves for the long journey back to the tropics.

Many species of Neotropical migrants are common breeding residents in the Southern Appalachians and the Chattooga River watershed, and include a number of the area-sensitive species mentioned above. Several of these are of special conservation concern, due either to evidence of long-term population declines or to their general rarity. Perhaps the most sought after of these species by bird watchers, the Swainson's Warbler (*Limnothlypis swainsonii*), is a conservation concern primarily due to the latter. In addition to (and at least in part, as a result of) its general rarity, its specialized microhabitat requirements make it a prime candidate for an area-sensitive species. Swainson's Warblers, which were once thought to breed only in the swamps and bottomland hardwood forests of the South Atlantic and Gulf Coastal Plains primarily where remnant dense patches of cane (*Arundinaria spp.*) occurred, were first discovered breeding in the southern Appalachians in the 1930's (Brown and Dickson 1994). The typical mountain habitat for these birds is rhododendron (*Rhododendron spp.*) or rhododendron-mountain laurel (*Kalmia latifolia*) thickets, and this species is certain to be absent from areas where such dense understory does not occur. Indeed, one of the best places to see this bird along the Southeastern Blue Ridge Escarpment is in the Chattooga River watershed (Simpson 1992), where this habitat is plentiful.

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Patterns *continued from page 22*

near relatives from East Asian forests.

One of Cain's most important points is that many cove forest species originated early in the development of flowering plants, and this antiquity stems from several factors. The formation of the Appalachian Mountains predates the evolution of flowering plants by more than 200 million years. Since the advent of flowering plants, the southern half of the Appalachians has not been scoured by glaciation, nor has it been inundated by fluctuating sea levels. Thus, the Southern Appalachian landscape has been uninterrupted by any regional catastrophic disturbances during the reign of flowering plants. This unique feature has, in part, allowed for flowering plants to survive and diversify essentially undisturbed since their most primitive forms evolved on the planet.

It is only within these cove forests that one can find the greatest number of these ancient plants in close affiliation with forests nearly half way around the earth. These forests, which are known for their outstanding tree and herb diversity, are present in many forms throughout the Chattooga River Basin. From the richer hardwood sites, such as found along Georgia Highway 76, where 43 woody plants have been observed by W.S Lesan and the author, to the more acidic Hemlock dominated stands, cove forests are prevalent throughout the Chattooga Basin. When referring to these cove forests, we should heed the age old axiom "show respect for your elders". These truly ancient forests always should be treated with respect and care.

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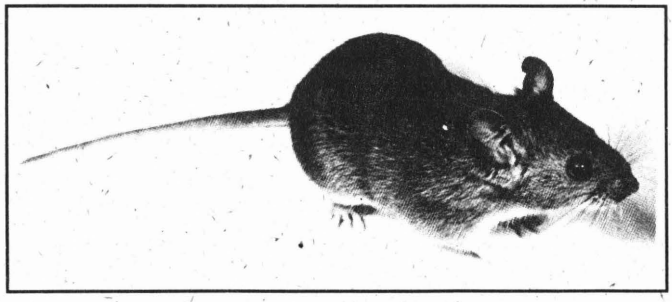
Small Mammals *continued from page 20*

supersonic emissions from modified skin flaps in their nostrils, and these emissions bounce off of objects and back towards this bat's very large ears. These ears are joined together in the middle of the animal's head, and contain additional sensitive skin flaps called *tragi*. This brown bat also has a wart-like lump on its nose, which along with its very large ears helps to distinguish it from other kinds of bats. Most Rafinesque's Big-Eared Bats live in hollow trees, rather than being strictly found in caves. The sounds emitted by these mammals range all the way from 30,000 to .02 frequencies per second. Some of these bats hibernate in areas where their body temperature can drop to near-freezing temperatures. When they sleep, their ears coil about their neck like a ram's horn.

Another curious small mammal which lives in the Chattooga River watershed is the Woodrat (*Neotoma floridana)*, also called the Pack Rat or Cave Rat. The Woodrat often is found living in caves or under overhangs, where it builds a huge nest out of sticks. The Woodrat is about 8 inches long with a 6-inch tail, and its fur is grayish-brown, with a white or grayish belly. It is distinguished by its hairy tail and soft, fine fur, and also has big ears and large, black and white whiskers. The Woodrat also possesses the unusual habit of collecting shiny objects for its nest. These trinkets include anything from cans and cooking utensils, to jewelry that may be found on a hiking trail. These animals eat seeds, nuts and fruits. Woodrats are said to be intelligent, and are even rumored to make good pets. (I wouldn't put them in charge of the silverware though!)

These small mammals which live with us in the Chattooga watershed are indeed fascinating creatures, who demonstrate the wonder and diversity of creation. Though small in size, they occupy a critical and significant place in the web of life on Earth. These animals are quite beneficial to the human community in that they eat tremendous amounts of insects, and in turn are an important food source for larger animals. The complexity of adaptations developed by small mammals is evidence enough that every creature has a purpose far greater than we can imagine. The next time you are in the forest or sitting quietly by a stream, look closely around: You may have a chance to observe one of these unique creatures.



Eastern Wood Rat, Neotoma floridana

Trends in Biodiversity

We have assembled here these statistics for consideration:

** The road density on our National Forests averages 1.5 miles per square mile, while on private land the average is less, at 1.1 miles per square mile. *Greenwire News*

** The *New York Times* reported on February 16, 1997, that the smuggling of living and dead wildlife nets between 10 to 20 *billion dollars* annually, second only to drug trafficking.

** 50% of the Dogwood trees in the Great Smoky Mountains are gone due to the disease Anthracnose.

** 80% of native Fraser Firs in the Great Smoky Mountains are gone due to air pollution and exotic insects.

** About one-half of the world's original forest cover is gone. *World Resources Institute*

** Feral cats (house cats) kill over *one billion* birds annually. *Greenwire News*

** 50% of all wetlands along the Northeast coastline of the United States have been destroyed between 1950 & 1970.

** From pre-European settlement times to 1990, the fire dependent communities of longleaf pines located in the Southeastern coastal plains *fell from 60% to 1.5%* of the landscape.

** The average American each week uses the equivalent of *300 shopping bags filled with natural resources* for food, shelter, energy and transportation. *World Resources Institute, via Greenwire News*

** Americans spend about *200 billion dollars per year* on the cleanup of resource extraction, pollution and waste. *Greenwire News*

** People in industrialized countries make up only a quarter of the Earth's population, but they use three-quarters of its resources. People in the US make up only 5% of the Earth's population, but generate at least a third of the planet's pollution. *World Wildlife Fund*

** 1.4 million species have been identified on Earth, but Dr. E. O. Wilson estimates that, in reality, the total is between 10 and 100 million species.

** One-fourth of all prescription drugs used today were originally derived from plants. Only 5% of all plants have been studied for medicinal use. *World Wildlife Fund*

Breeding Birds *continued from page 24*

Some common Neotropical migrants that breed in the Southern Appalachians that have shown long-term population declines include the Wood Thrush and American Redstart. The North American Breeding Bird Survey (BBS), a continent-wide network of roadside bird survey routes, is perhaps our best source of information concerning large-scale trends of bird populations. The BBS, which is coordinated by the U. S. Fish and Wildlife Service in Laurel, MD, is currently comprised of about 3,400 24.5 mile survey routes, where observers count the number of individuals of bird species seen or heard during 3 minutes at half-mile intervals. For the Wood Thrush, BBS data indicate a 2% annual decline since 1966 (Peterjohn *et al.*, 1995). This amounts to about a 50% total population decline in the past 30 years! Similarly, American Redstarts have also exhibited long-term declines (32% between 1970-72 and 1986-88; James *et al.* 1996). Both of these species are conspicuous members of Eastern forest bird communities, and their declining numbers are a serious concern, not just to bird watchers and scientists, but to all those interested in sustaining natural communities.

In an effort to stem this loss of migratory songbirds, an initiative began in 1989 with the goal of uniting various governmental and non-governmental organizations in monitoring, research, and conservation efforts. This initiative, "Partners in Flight," has since gained momentum and there are now various opportunities for anyone interested in bird conservation in North Carolina and elsewhere. For example, the North Carolina working group of Partners in Flight is offering a series of training workshops this spring where individuals can learn songbird identification and monitoring techniques. In addition, a "Backyard Wildlife Habitat Improvement" seminar will also be offered in May in cooperation with the North Carolina Wildlife Federation. Anyone interested in participating should contact Mark Johns, the North Carolina Partners in Flight Coordinator at (919) 362-9257.

ACKNOWLEDGEMENTS

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Western NC Alliance
SC Forest Watch
Sierra Club
The Wilderness Society
Association of Forest Service Employees for Environmental Ethics

Newsletter:

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Endorsing Organizations

Foothills Canoe Club
Atlanta Whitewater Club
Georgia Canoeing Association
Higgins Hardwood Gear
A.F. Clewell, Inc.
Atlanta Audubon Society
National Wildlife Federation
Action for a Clean Environment
Georgia Botanical Society
Columbia Audubon Society
The Georgia Conservancy
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Carolina Bird Club
Government Accountability Project
Dagger, Inc.

Membership

Join the Coalition and help protect the Chattooga Watershed!
Thank you for your contribution; it is greatly appreciated. It will be used to support the Coalition's work, and guarantee you delivery of the ***Chattooga Quarterly***. We're a non-profit organization, and all contributions are tax-deductible.

Renewal ☐

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Individual: $14.00 ☐ Group: $27.00 ☐

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Send to:
Chattooga River Watershed Coalition
P.O. Box 2006
Clayton, Georgia 30525

Chattooga River Watershed Coalition

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Clayton GA 30525
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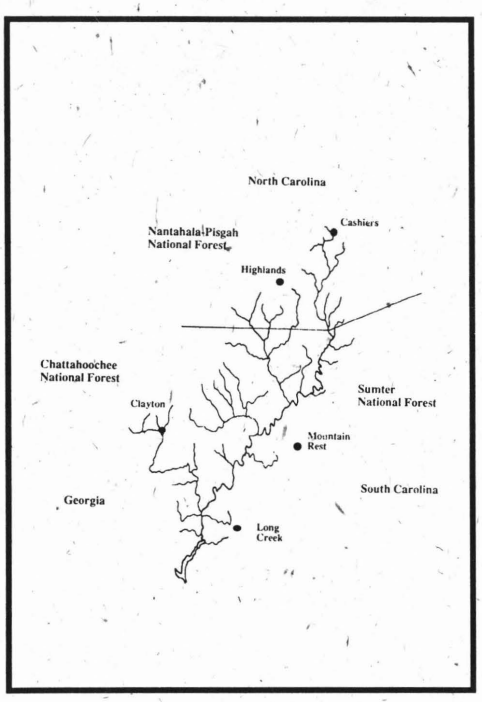
Purpose:

"To protect, promote and restore the natural ecological integrity of the Chattooga River watershed ecosystem; to ensure the viability of native species in harmony with the need for a healthy human environment; and, to educate and empower communities to practice good stewardship on public and private lands."

Our Work Made Possible By:
CRWC Members and Volunteers
Turner Foundation, Inc.
The Moriah Fund
Lyndhurst Foundation
Patagonia, Inc.
Town Creek Foundation
Merck Family Fund
JST Foundation



Goals:

Monitor the U.S. Forest Service's management of public forest lands in the watershed

Educate the public

Promote public choice based on credible scientific information

Promote public land acquisition by the Forest Service within the watershed

Protect remaining old growth and roadless areas

Work cooperatively with the Forest Service to develop a sound ecosystem initiative for the watershed

Chattooga River Watershed Coalition
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Non-Profit Organization
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