

"erosion"-related preferences of mountain bikers. This is not to say that allowing erosion is correct management, or even desired from an environmental standpoint.

A more logical solution to this paradox is to locate and design mountain bike trails in areas that are resistant to trail erosion but which still provide the trail factors preferred by the majority of bikers. If, within a resource area, there are several soil types and textures, a resource manager might direct trail location to areas with textures that are more sandy and soil types that are shallow. This type of design would reduce erosion and pollution of the environment because of a more durable soil texture, and a shallow soil would create less potential for a large amount of soil loss than on a thicker soil. Shallow soils would also provide experience-enhancing obstacles, such as rocks, after a relatively small amount of soil erosion, compared with a large amount of soil having to erode on a deeper soil for unconsolidated rock material (saprolite) to be exposed.

The mountain biker is a relatively recent addition to the recreation spectrum and future research needs to allocate as much study to this user group as it does to other recreational use types. It is still unclear how some recreation resource environments should ideally be managed for mountain bike use. A balanced information base will aid resource managers and allow them to make more informed decisions in our wildland areas concerning appropriate carrying capacities and levels of acceptable change.

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Inventory and Monitoring Program Along the Appalachian Trail

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Objectives

The Appalachian Trail (AT) provides an example of an inventory and monitoring program along a lengthy, linear land corridor through multiple jurisdictions utilizing minimal staff. In 1988 the AT became the first national trail to establish an inventory and monitoring program, and it may still be the only trail to have such a program. The primary purpose of conducting AT natural heritage inventories in the 14 states through which the trail passes is to identify and record occurrences of rare, threatened, and endangered plant and animal species and exemplary natural communities found along the trail corridor. After completing each inventory, a monitoring program can be established. The AT inventory and monitoring program is also designed to guide future land management decisions and to educate the trail community about the ecological significance of trail lands (Figure 1).

History of the AT

At approximately 2,150 miles, the AT is the longest unit within the National Park System. The trail passes through 14 states, 6 National Park Service (NPS) areas, 7 national forests, and many state parks and forests. In total, it passes through more than 75 jurisdictions. As originally envisioned by forester Benton MacKaye in 1921, the AT connects the scenic high ridges of the Eastern Seaboard in one continuous public footpath from Springer Mountain, Georgia, to Mount Katahdin, Maine. Work on the AT commenced in 1922 and was completed in 1937.

In 1968 the AT became one of the original trails included under the National Trails System Act. Unlike most of the other 19 national scenic and historic trails, considerable land has been purchased to protect the AT corridor. Since 1978 the NPS has purchased approximately 105,000 acres to protect the AT. This land is in addition to the 165,000 acres of the AT corridor that were present in 1978, most of it in existing national and state parks and forests. The trail corridor is generally 1,000 feet in width, though in some locations it extends over one mile in width. Currently, about 99% of the trail corridor is public land, and the remaining 1% is to be purchased by 2000.

Ecological Significance

Although the AT was created to provide recreational and scenic opportunities for hikers, the trail is becoming known as an important habitat for significant and rare natural resources. The AT corridor protects many rare, threatened, and endangered plant and animal species and natural communities found only in the higher elevations of the eastern United States. Many of these species are endemic to the Appalachian Mountains. With over 1,600 rare plant and animal occurrences identified to date, it is possible that the AT corridor contains among the most occurrences of threatened, endangered, and rare species within any unit of the National Park System.

The southern and central Appalachians are among the most biologically diverse areas within the United States. On maps produced by the World Wildlife Fund (1997), the Appalachian-Blue Ridge ecoregion, which includes the southern and central Appalachians, is in the second highest category (out of 10) in the number of vascular plant and animal (mostly vertebrate) species found within the continental United States. With regard to species endemism, the Appalachian-Blue Ridge ecoregion is also in the second highest category (out of 11) in number of species.

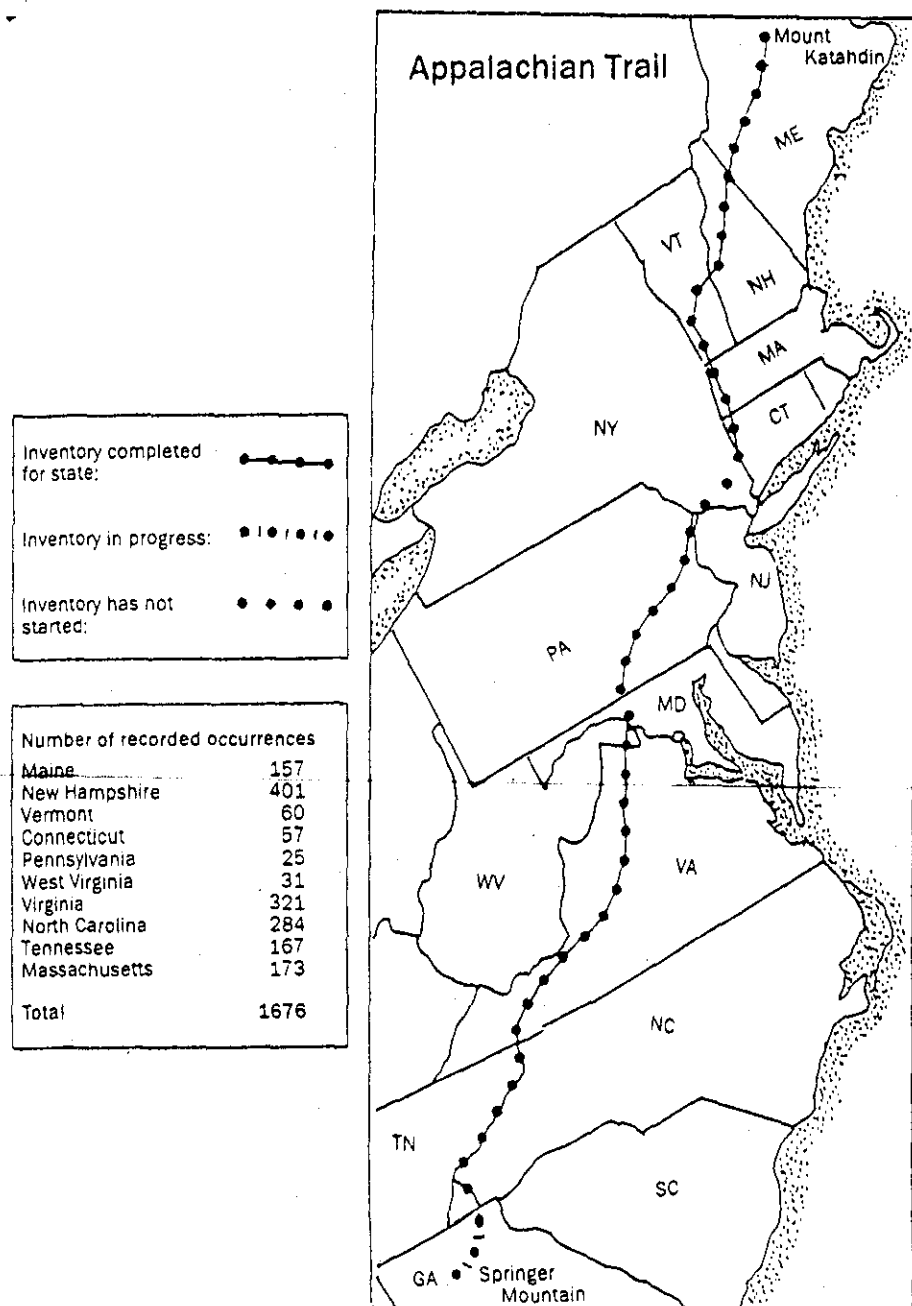


Figure 1. Current status of Appalachian Trail natural heritage inventories
 Proceedings of the 10th Conference on Research and Resource Management

Partnerships and Cooperative Agreements

Management of the AT is accomplished via a system of agreements between the Appalachian Trail Conference (ATC), its trail clubs, NPS, the U.S. Forest Service (USFS), and state land management agencies. The ATC is a private, non-profit organization to which the NPS has delegated the responsibility of maintaining and managing the AT corridor. The NPS retains ultimate responsibility for the administration and protection of the trail, including environmental compliance, threatened and endangered species, law enforcement, and the authority to acquire lands through which the trail passes.

The inventory and monitoring program for the AT was established in 1988 by Paul Brewster, a USFS resource specialist assigned to the NPS's Appalachian Trail Park Office (ATPO), and was further developed by Don Owen of the NPS. The program is administered jointly by the ATPO and the ATC. The ATPO has a staff of seven, including one natural resource specialist who manages the inventory and monitoring program. The ATC has regional offices along the trail, three of which have a staff person assigned to use a small portion of their time to help coordinate natural heritage inventories and monitoring in their regions. Other partners in the AT inventory and monitoring program are the federal or state land-owners through which the trail passes, the local AT clubs, and the state natural heritage programs, which often conduct the actual inventories. A cooperative agreement or a contract defines each party's role.

Conducting the Inventories

At the time the inventory and monitoring program for the AT was being established, it was felt that inventorying rare, threatened, and endangered species was the most immediate need. Due to the trail's length, it was also thought that the most manageable way to proceed would be to conduct the inventory state-by-state. In addition to breaking the inventory into more manageable segments, each state has its own natural heritage program that is a repository for information on all recorded species in the state, including distribution, habitat, present status, and land ownership. Though each state has its own natural heritage program, there is consistency among the states, since they all use a standardized system of field survey methods and data storage that were developed by The Nature Conservancy in the 1970s.

In most of the AT states, the state natural heritage office has agreed to conduct the state AT inventories utilizing their own staff, with funding provided by AT partners. Some natural heritage offices have supplemented their own staff by hiring contract botanists and zoologists to complete specific parts of an inventory. In a few states where the state natural heritage office was unable to conduct an AT inventory, the ATC has contracted directly with independent scientists.

Due to time and fiscal limitations, not all groups of plants and animals have been included in the state AT inventories. In each state, all rare vascular plants have been inventoried, and in a few, some groups of rare non-vascular plants were identified. The recommendations of the state natural heritage offices have been important in deciding which animal groups to inventory. The animal groups most frequently inventoried have been birds, reptiles, and amphibians.

inventory. All endangered and threatened species; USFS PETS (proposed, endangered, threatened, and sensitive) species; and watch list species are included in the AT inventories.

Preparing a landscape analysis and work plan is the first step in conducting an AT natural heritage inventory. The landscape analysis identifies which locations are most likely to contain extant populations of previously recorded or new occurrences of rare, threatened, and endangered species and exemplary natural communities. In addition to doing an element search of the natural heritage database, information is gathered from historical records, such as surveyor notes and fire records; scientific literature; aerial photographs; satellite imagery; herbarium and museum specimen collec-

tions; consultations with experts on the flora and fauna of the region; and interviews with people familiar with the area. The work plan is developed from the landscape analysis, and it usually consists of a map-based summary of high- and low-probability sites slated for field survey, a list of the existing and potential species of concern to be surveyed for, and a brief summary of the procedures to be followed in the field.

In the field survey phase of each state AT natural heritage inventory, the research team attempts to verify existing records of element occurrences on the ground, while searching for previously unrecorded occurrences. Populations of rare species are described and habitat characteristics are noted. The boundary of each rare species occurrence is mapped, as is the boundary of each natural heritage site. (A site includes all rare species occurrences at a single location.) The large majority of the trail length is surveyed at least once in the field season, and in many cases on several occasions, to increase the probability of locating ephemeral species. The state AT natural heritage inventories have taken 1-3 field seasons to complete, depending primarily on the length of the AT in each state.

While conducting the field surveys, researchers note any natural or unnatural disturbances or threats that may endanger the survival of rare species populations. Among the most common threats recorded during the AT natural heritage inventories are: competition from invasive exotic plants, competition from other native plants, trampling by hikers and trail maintenance crews, and defoliation of canopy tree species by gypsy moth and hemlock woolly adelgid infestations.

Also while in the field, researchers begin assessing the options for managing the threats that have been identified. Common recommendations for dealing with threats to rare species have included: monitoring for presence and health, conducting additional survey work, control of exotic species, acquiring additional lands or interest in lands, relocating the trail, consultation with the state natural heritage program and the ATPO prior to any relocation of the trail, educating trail maintenance crews to exercise caution around occurrences, and using signs to educate trail users. Some of these recommendations require actions by land managing agencies, but many, such as monitoring and careful trail maintenance, can be performed by local trail clubs. A few recommended actions, particularly relocations of the trail, take place during the time of the inventory fieldwork, in order to immediately eliminate continued impacts to a rare species occurrence.

Written documentation of the AT natural heritage inventories in each state has included an interim draft, a final draft, and a final report delivered to the ATPO, the ATC, and to other federal and state land-owners along the trail in that state. The state AT inventory reports have varied from about 100 pages to 600 pages. After discussing methodology, the final inventory report contains individual site reports, which consist of: 1) a table of exemplary natural communities and element occurrences, with their global and state rarity and legal status (Figure 2); 2) site descriptions, including rare species, common species, and habitat; 3) threats to the rare species and communities; 4) recommended management actions; and 5) a series of topographic maps which identify the natural heritage site boundary and the boundaries of the individual rare element occurrences and exemplary natural communities.

Results

The first statewide AT natural heritage inventory to be completed was that of Pennsylvania in 1990. Other states—about one per year—followed, and at the present time, inventories have been completed for 10 of the 14 AT states. One inventory (Georgia) will be completed in 1999, and the remaining three (New York, New Jersey, and Maryland) should be completed in 2000 (Table 1).

Inventory results have shown that trail lands provide much critical habitat for sensitive species. Thus far, 429 natural heritage sites, containing 1,676 occurrences of rare, threatened, or endangered plant or animal species or exemplary natural communities, have been identified. The total number of natural heritage sites has varied

PINK MOUNTAIN

SIZE: ca. 1,586

BIODIVERSITY RANK: B4

NATURAL HERITAGE RESOURCE SUMMARY TABLE

SCIENTIFIC NAME	COMMON NAME	GLOBAL RARITY RANK	STATE RARITY RANK	USFWS STATUS	VA LEGAL STATUS	ELEMENT OCCURRENCE RANK
Plants:						
CINNA LATIFOLIA	SLENDER WOOD REEDGRASS	G5	S2	--	--	D
DIPHYLLEIA CYMOSA (1)	UMBRELLA-LEAF	G4	S2S3	--	--	D
DIPHYLLEIA CYMOSA (2)	UMBRELLA-LEAF	G4	S2S3	--	--	C
DIPHYLLEIA CYMOSA (3)	UMBRELLA-LEAF	G4	S2S3	--	--	C
HYPERICUM MITCHELLIANUM	BLUE RIDGE ST. JOHN'S-WORT	G3	S1S2	--	--	D
ILEX COLLINA	LONG-STALKED HOLLY	G3	S2	3C	LE	E
PRENANTHES ROANENSIS	MOUNTAIN RATTLE-SNAKE ROOT	G3	S2	3C	--	C
Animal:						
GLAUCOMYS SABRINUS FUSCUS	VIRGINIA NORTHERN FLYING SQUIRREL	G5T2	S1	LE	LE	D
Community:						
SUBMESOTROPHIC FOREST						B

Figure 2. An example of a resource summary table for rare plants and animals and exemplary natural communities found within a natural heritage site report. "G1" and "S1" species are rarest (five occurrences or fewer globally or statewide), "G3" and "S3" species are moderately rare, and "G5" and "S5" species are very common. "LE" refers to a listed endangered species.

from 8 in West Virginia to 74 in Virginia, and the total number of occurrences has varied from 25 in Pennsylvania to 401 in New Hampshire. Virginia and North Carolina also have a large number of rare species occurrences, partly due to greater habitat diversity across a wider range in elevation found in these states. One plant, the federally endangered small whorled pogonia, is found at several locations along the AT, including the only population of the orchid in Connecticut. Among the rarest animals found along the trail are several species of Shenandoah salamanders.

Funding

Support for the AT inventories has come from the NPS operating budget, the NPS challenge cost-share program, the USFS, the National Forest Foundation, the National Fish and Wildlife Foundation, state resource agencies, and private foundations and corporations. The total cost for the inventories conducted to date is \$247,250 on an acreage of 254,158 acres, or an average of only about \$1.00 per acre surveyed. Inventory cost has varied from \$4,000 for West Virginia to \$59,750 for Virginia, reflecting the amount of acreage surveyed and the year in which the inventory was conducted.

State	Acreage	Miles	# of sites	# of occurrences	Cost	Status of inventory
PA	30,000	229.8	15	25	\$13,500	Completed 1990
NH	23,000	157.7	59	401	\$9,900	Completed 1991
VT	22,500	145.5	33	60	\$8,400	Completed 1991
CT	6,000	46.7	27	57	\$4,500	Completed 1992
NC	27,500	234.0	66	284	\$27,000	Completed 1993
VA	60,000	543.2	74	321	\$59,750	Completed 1994
TN	10,800	73.2	58	167	\$17,000	Completed 1996
WV	2,100	29.4	8	31	\$4,000	Completed 1997
ME	40,300	274.6	46	157	\$44,100	Completed 1998
MA	12,500	89.0	43	173	\$19,500	Completed 1999
GA	7,166	75.6	In progress	In progress	\$19,600	Begun June 1998
NY	12,292	90.9	—	—	\$25,000	Begun May 1999
NJ	—	73.0	—	—	—	Begun May 1999
MD	—	40.0	—	—	—	Planned for 2000

Table 1. Summary of Appalachian Trail natural heritage inventory and monitoring program, by state

Site Monitoring

Once a statewide AT inventory is completed, a monitoring program for the trail in that state can begin. The primary goals of the natural heritage site monitoring program are to discern the size and health of the rare species and to identify any threats to them. Because of AT staff limitations, and because of the success of utilizing volunteers in other roles along the AT, a decision was made to accomplish the monitoring program through volunteers. Most natural heritage volunteers are selected from local trail clubs based on their interest in observing plants and animals, though some are also environmental professionals. Of the total 429 sites identified in 10 of the AT states, only about 100 of the highest priority sites have been identified for monitoring, based primarily on the rarity of the species and the threat to its presence. Approximately 100 volunteer natural heritage monitors have been trained and are active along the AT.

Workshops

At least one workshop is held in each state to train volunteers in identifying the species to be monitored and in procedures for monitoring. The ATPO and the ATC regional offices organize each workshop. The primary instructor is usually from the

state's natural heritage office or is the contracting biologist for the AT inventory. Also invited are natural resource managers from national parks and forests and state land agencies in the region. Over the course of the six-hour workshop, volunteers are introduced to the concepts of biodiversity and rare species protection, briefed on the AT natural heritage inventory program, shown identifying characteristics of the species or communities to be monitored (through slides and herbarium specimens), and instructed on how to complete monitoring forms. During the afternoon portion of the workshop, volunteers practice species identification and monitoring under the guidance of professionals.

A monitoring packet supplied to each volunteer consists of general information on the AT inventory and monitoring program, a specific site report from the inventory, drawings or photos of the species and community occurrences, topographic maps showing the location of the occurrence(s), and blank monitoring report forms. Volunteers are encouraged to take photos of their site and species. The monitoring reports are critical to determining if a natural heritage site needs more active management to preserve its rare elements.

A Look Ahead

Once the 14 state AT inventories are completed, the ATPO will devote more time to prioritizing and implementing additional management recommendations from the inventories, particularly on its own lands.

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