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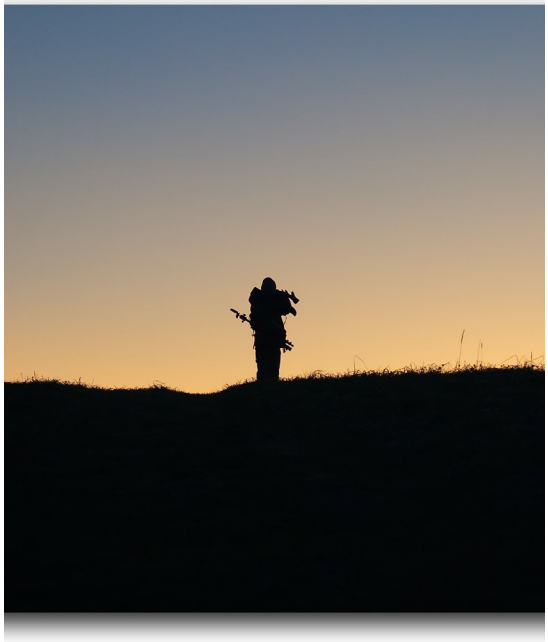
Appalachian National Scenic Trail Vital Signs Monitoring Plan

Report NPS/NETN/NRR—2011/2011/389



ON THE COVER

Clockwise from top left: Harpers Ferry AT sign - Adam Fagen photo; Vernon Valley , NJ - Nicholas T. photo; Hiker on trail - Frank Kehren photo; Roan Highlands, TN - Blueridgekitties photo.

Appalachian National Scenic Trail Vital Signs Monitoring Plan

Natural Resource Report NPS/NETN/NRR—2011/2011/389
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May 2011

U.S. Department of the Interior
National Park Service
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Vital Signs Monitoring Plan

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List of Acronyms

AMC – Appalachian Mountain Club

ANC – Acid Neutralizing Capacity

APHN – Appalachian Highlands Network

APPA – Appalachian National Scenic Trail

ARD – Air Resources Division, a National Park Service division

ATMT – Appalachian Trail MEGA-Transect

ATPO – Appalachian Trail Park Office

CASTNET - Clean Air Status and Trends Network

CUPN – Cumberland Piedmont Network

DEWA – Delaware Water Gap National Recreation Area

EBTJV – Eastern Brook Trout Joint Venture

EMP – Environmental Monitoring Program

EPMT – Exotic Plant Management Team

ERMN – Eastern Rivers and Mountains Network

FHM – Forest Health Monitoring

FIA – Forest Inventory Analysis, a U.S. Forest Service program

GPRA – Government Performance and Results Act

GRTS – Generalized Random Tessellation Stratified

HUC10 – Hydrologic Unit Code, 10-digit

I&M – Inventory and Monitoring, a National Park Service program

IMPROVE - Interagency Monitoring of Protected Visual Environments program

LCC – Landscape Conservation Cooperative

MIDN – Mid-Atlantic Network

NAAQS - National Ambient Air Quality Standards

NADP/NTN - National Atmospheric Deposition Program/National Trends Network

NASA – National Aeronautic and Space Administration

NCRN – National Capital Region Network

NCTC – National Conservation Training Center

NETN – Northeast Temperate Network

NGO – Non-Governmental Organization

NIS – Non-indigenous Species

NP – National Park

NPS – National Park Service

NRC – Natural Resource Challenge

NRCS – Natural Resource Conservation Service

NTSA – National Trail System Act

QA/QC - quality assurance and quality control

SAMAB - Southern Appalachian Man and the Biosphere

SOPs – Standard Operating Procedures

USA-NPN – USA National Phenology Network

USFS – U.S. Forest Service

USFWS – U.S. Fish and Wildlife Service

USGS – U.S. Geological Survey

VCE – Vermont Center for Ecostudies

VizVol - AMC's Visibility Volunteers

WA -- Wilderness Area

WASO – Washington Service Office

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This document is a compilation of products produced by the Northeast Temperate Network, the other five Networks through which the Appalachian Trail passes, as well as other I&M Networks. Because it draws from so many sources it is not possible to individually acknowledge everyone who played a role. However, it is important to thank those who participated in the various workshops and meetings that lead to the development of this program. The Appalachian Trail began as a collaborative effort between a small number of forward thinking individuals, exists today as a collaboration between agencies and organizations, and the environmental monitoring program and this document follow that tradition – neither would be possible without collaboration.

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Executive Summary

Knowing the condition of natural resources is fundamental to the National Park Service's mission to manage park resources "unimpaired for the enjoyment of future generations." Park managers are confronted with increasingly complex and challenging issues that require a broad-based understanding of the status and trends of park resources. To assist managers accomplish this goal, the National Park Service has initiated a long-term ecological monitoring program, known as "Vital Signs Monitoring," to provide the minimum infrastructure needed to track the overall condition of natural resources in parks and to provide early warning of situations that require intervention. The scientifically sound information obtained through this systems-based program has multiple applications for management decision-making, park planning, research, education, and promoting public understanding of park resources.

To facilitate collaboration, information sharing, and economies of scale in inventory and monitoring, the NPS has organized those parks with significant natural resources (more than 270) into 32 networks. The Appalachian National Scenic Trail (APPA) is administratively part of the Northeast Temperate Network (NETN) – one of 13 parks that comprise the NETN. In addition, the APPA crosses though parts of five other networks: Eastern Rivers and Mountains (ERMN), Mid-Atlantic (MIDN), National Capital (NCRN), Appalachian Highlands (APHN), and Cumberland Piedmont (CUPN). Funding for the APPA monitoring program supports one employee who conducts the day-to-day activities of the program and who collaborates with staff from the Appalachian Trail Park Office (ATPO), staff from other networks, and other programs and agencies to implement a program that monitors the highest-priority vital signs.

This environmental monitoring plan is the result of a multi-year investment in planning and design, and forms the foundation for a long-term, ecological monitoring program that will build upon existing knowledge of APPA ecosystems and to make maximum use of partnerships with other programs, agencies, and academia.

Goals of Vital Signs Monitoring

- Determine the status and trends in selected indicators of the condition of park ecosystems to allow managers to make better-informed decisions and to work more effectively with other agencies and individuals for the benefit of park resources.
- Provide early warning of abnormal conditions of selected resources to help develop effective mitigation measures and reduce costs of management.
- Provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments.
- Provide data to meet certain legal and congressional mandates related to natural resource protection and visitor enjoyment.
- Provide a means of measuring progress towards performance goals.

Over the next several years, the APPA monitoring program will acquire existing data whenever possible, will develop new protocols when necessary, and will promote existing protocols when available (Chapter 5) to address the suite of APPA vital signs (see table). Monitoring protocols are detailed study plans that explain how data are to be collected, managed, analyzed, and reported, and are a key component of quality assurance for a long-term monitoring program.

Data and information management is central to the APPA environmental monitoring program. The APPA will follow procedures outlined in the NETN monitoring plan and data management plan to compile, analyze, synthesize, and report monitoring results, including analysis and reporting of data collected by others. The APPA environmental monitoring program will also use the NETN strategy to make data available and useful to park mangers, planners, and other key audiences.

Vital signs for the Appalachian National Scenic Trail. Vitals signs for which the APPA Environmental Monitoring Program will implement monitoring using available data.

Level 1	Level 2	Level 3	Monitoring Objectives
Air and Climate	Air Quality	Ozone	Monitor the status and trends in tropospheric ozone by synthesizing data from existing sources.
		Visibility	Track the status and trends in visibility using existing monitoring sites along the APPA.
		Atmospheric Deposition	Monitor the status and trends of acid deposition upon forest soils and aquatic ecosystems within the APPA corridor.
	Weather and Climate	Phenology	Determine variability and long-term trends in climate using available data on select weather parameters, including air temperature, precipitation, cloud cover, and wind speed and direction.
Water	Water Quality and Quantity	Water Resources	Using existing data, determine long-term trends in water temperature, pH, conductivity, dissolved oxygen, and flow/stage/level in selected freshwater resources based on recommendations by the USGS.
Biological Integrity	Invasive Species	Non-indigenous invasive terrestrial and aquatic plants	Maintain a list of target species known from the local region. Develop a "risk of occurrence" model for target species based on life history attributes, dispersal modes, invasion corridors, vectors of spread, invasion potential and known locations. Implement procedures to identify incipient populations (i.e. small or localized) and new introductions of selected non-indigenous plants in areas of high and moderate management significance.
	Focal Species or Communities	Alpine and High-elevation Vegetation	Determine long-term trends in species composition and community structure of selected alpine and high elevation plant communities. Monitor temporal change in elements of stand structure, overstory and understory/herbaceous diversity, and vegetation condition in order to assess ecological integrity.
		Forest Vegetation	Analyze existing forest data (FIA, and other) for large-scale (e.g., landscape) trends in status and condition.
		Breeding Birds	Determine long-term trends in species composition and abundance of forest and montane passerine species in selected areas along the APPA
		Rare Plants	Identify and monitor the condition and status of occurrences of select high-priority rare plants (G1 & G2; S1) and some less-rare plants (G3 & S2)
Human Use	Visitor and Recreation Use	Visitor Use	Monitor the status and trend in visitation impacts in high volume areas, including campgrounds, side trails and scenic vistas.
Landscapes	Landscape Dynamics	Landscape Dynamics	Determine status and trends in the areal extent and configuration of land-cover types on the APPA and immediately adjacent lands. Monitor changes in the extent and condition of ecological systems along the APPA

Chapter 1 - Introduction and Background

Introduction

Natural systems in the United States are increasingly being affected by human activities, including urbanization, pollution, habitat fragmentation, and introduced species. The National Park Service (NPS), through Congressional enabling legislation, is mandated to protect, preserve, and conserve park resources. Through natural resource monitoring, managers can identify and understand normal limits of natural variation in park resources, as well as detect changes and causes of change that are due to anthropogenic and other stressors. "Vital signs" monitoring is one of the key components of the NPS Natural Resource Challenge (NRC).

The NRC, launched in late 1999, is a major program to revitalize and expand the natural resource program within the NPS and to improve park management through greater reliance on scientific knowledge. The vital signs monitoring networks are a key component of the NRC; the networks link parks with shared natural resource and geographic characteristics in order to facilitate collaboration, information sharing, and economies of scale in natural resource monitoring (Fancy et al. 2009). The networks coordinate the gathering of both baseline resource information and information on long term trends in the condition of National Park System resources.

Vital signs are a subset of physical, chemical, or biological elements and processes of ecosystems that are selected to represent the overall health or condition of park resources, known or hypothesized effects of stressors, or elements that have important human values (Faber Langendoen et al. 2006, Fancy et al. 2009). This subset of resources and processes selected for monitoring is part of the total suite of natural resources that park managers are directed to preserve "unimpaired for future generations" (National Park Service Organic Act of 1916), including water, air, geological resources, plants and animals, and the various ecological, biological, and physical processes that act on those resources. Because of the need to maximize the use and relevance of monitoring results for making management decisions, vital signs may include elements that were selected because they have important human values (e.g., harvested or charismatic species) or because of some known or hypothesized threat or stressor/response relationship with a particular park resource. Therefore, vital signs may or may not be indicators of overall ecosystem condition. The broad-based, scientifically sound information obtained through natural resource monitoring has direct application to management decision-making, research, education, and promoting public understanding of park resources (Fancy et al. 2009).

Appalachian National Scenic Trail Environmental Monitoring Program

The Appalachian National Scenic Trail (APPA) Environmental Monitoring Program (EMP) is a close collaboration between the Appalachian Trail Park Office (ATPO), the Appalachian Trail Conservancy (ATC) and the Northeast Temperate Network (NETN).

Appalachian Trail, Grafton Notch State Park, ME. J. Stephen Conn photo

The APPA EMP operates within the NETN, and while each member of this collaboration maintains their own priorities and responsibilities, communication among members of each organization is essential. Monitoring is a central component of natural resource stewardship in the NPS, and in conjunction with natural resource inventories and research, it provides the information needed for effective, science-based decision-making and resource management. The APPA EMP is consistent with this NPS objective and focuses on indicators that represent the diversity of ecological systems and anthropogenic stressors that are thought – or are known – to affect the APPA and the surrounding region. The challenge is to identify a discrete set of indicators that cover the range of ecological resources and stressors that typify the APPA region and that will provide meaningful information to resource managers while staying within the program's budgetary constraints. In many instances, the program will rely entirely on readily available data and information, while in a few isolated instances the APPA EMP may supplement existing data with data collected by citizens. To be successful, the APPA EMP must effectively communicate its findings to resource managers, cooperators and other audiences. The APPA EMP will do this by using resources available within the NETN, other networks through which the APPA passes, and the ATPO, the ATC, as well as through other data analysis and information dissemination tools.

Justification for Integrated Natural Resource Monitoring

National park managers are confronted with increasingly complex and challenging issues that require a broad-based understanding of the status and trends of park resources. Balancing these complex issues is critical to NPS' ability to manage park resources "unimpaired for the enjoyment of future generations." Service-wide goals for monitoring are as follows (NPS 2007):

- Determine status and trends in selected indicators of park ecosystem condition to allow managers to make better-informed decisions and to work more effectively with other agencies and individuals for the benefit of park resources
- Provide early warning of abnormal conditions and impairment of selected resources to help develop effective mitigation measures and reduce costs of management
- Provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments
- Provide data to meet certain legal and Congressional mandates related to natural resource protection and visitor enjoyment
- Provide a means of measuring progress towards performance goals, including those required by the Government Performance and Results Act (GPRA)

To complete the necessary integration, the NPS Inventory and Monitoring (I&M) program has established a three-phase planning and design process (NPS 2010).

- Phase 1 of the process involves defining goals and objectives; beginning the process of identifying, evaluating and synthesizing existing data; developing draft conceptual models; and completing other background work that must be done before the initial selection of vital signs. Each network is required to document these tasks in a Phase 1 report, which is then peer reviewed and approved at the regional level before the network proceeds to the next phase. This Phase 1 report becomes the Introduction/Background and Conceptual Models chapters of the final monitoring plan.
- Phase 2 of the planning and design effort involves prioritizing and selecting the vital signs that will be included in the network's initial integrated monitoring program.
- Phase 3 entails the detailed design work needed to implement monitoring, such as developing specific monitoring objectives for each vital sign,

developing sampling protocols and a statistical sampling design, developing a plan for data management and analysis, and determining the type and content of various products of the monitoring effort such as reports and websites.

After completion of each phase, each network reports their progress for NPS review within a structured report (such as this one).

The APPA Vital Signs Monitoring Plan followed the standard three-phase process mentioned above but deviates from phases 2 and 3 of the NETN plan in the following important ways:

- Phase 1 – The APPA Vital Signs Monitoring Plan closely mirrors the Phase 1 elements of the NETN Vital Signs Monitoring Plan (Mitchell et al. 2006).
- Phase 2 – Selection of vital signs for the APPA followed a less formal process than the NETN process, and was accomplished during a two-day meeting between scientists and managers most familiar with the APPA resources.
- Phase 3 – Unlike the NETN plan, the approach taken for the APPA relies on existing data and resources, and consequently less attention is directed toward sampling design and more is given to identifying existing resources and ways to capture those data. However, if new sampling protocols are developed for the APPA EMP, the approach described in the NETN Vital Signs Monitoring Plan will be used. The strategies for data management and analysis, and a plan for reporting monitoring results are retained from the NETN plan.

Like most parks, the APPA is an open system, with threats such as air and water pollution, and invasive species originating beyond the park boundary. The inherent complexities of managing natural resources that are affected by impacts originating from afar demand a multi-agency, ecosystem approach because no single spatial or temporal scale is appropriate for every system component or process.

Natural resource monitoring seeks to provide site-specific information needed to identify and understand changes in complex, variable, and imperfectly understood natural systems; provide insight into whether observed changes are within natural levels of variability; and detect undesirable human influence. However, developing from scratch a program that relies on "new" data specific to the APPA region would be prohibitively expensive and unrealistic given the trail's configuration and the limited resource management capacity. For this reason, the APPA EMP intends to maximize the use of data collected by federal and state agencies, universities, and other organizations.

Background

The ATPO manages the APPA in close coordination with the ATC, the U.S. Forest Service (USFS) and nearly 100 other Federal, state and local agencies and non-profit organizations. Their collective objective is to preserve and promote the enjoyment of the varied scenic, historic, natural and cultural qualities of the APPA as it passes through 14 states, 6 other National Park Service units, 8 National Forests, and numerous state parks and forests in a region stretching from Maine to Georgia. The trail corridor is nominally 305 meters (1,000 feet) in width, is comparable in area to Rocky Mountain National Park and passes through seven ecoregions at the "section" level (Bailey 1980; Figure 1.1). The APPA contains some of the last remaining old growth forests in the East, but it is also subjected to varying levels of human disturbance including air pollution, land cover change, and invasive species. The APPA passes through six NPS Inventory and Monitoring Program networks (Table 1.1) with the NETN serving as the lead. In its role as the lead network, the NETN has committed to work with and engage the other networks, parks, and agencies found along the APPA. From north to south, the trail passes through the following networks:

- NETN: This is the northernmost section of the trail, extending from Mount Katahdin to approximately the New York-New Jersey border, comprising nearly 41% of the entire corridor and 80% of the land that is owned by the NPS. This

Table 1.1. Inventory and Monitoring Networks that intersect the Appalachian NST.

Network	Length in km (Miles)	Trail Hectares (Acres)	Ecoregion (Sections)	% of known rare plant occurrences within the APPA
Northeast Temperate Network (NETN)	1271 (790)	41,453 (102,432)	Green-Taconic-Berkshire Mountains New England Piedmont Hudson Valley White Mountains	52 %
Eastern Rivers and Mountains Network (ERMN)	201 (125)	6,331 (15,645)	Hudson Valley Lower New England Northern Ridge and Valley	1 %
Mid-Atlantic Network (MIDN)	483 (300)	14,636 (36,167)	Blue Ridge Mountains Northern Ridge and Valley	8 %
National Capital Region Network (NRCN)	113 (70)	4,078 (10,077)	Blue Ridge Mountains Northern Ridge and Valley	1 %
Appalachian Highlands Network (APHN)	1,207 (750)	32,493 (80,293)	Blue Ridge Mountains Northern Ridge and Valley	27 %
Cumberland-Piedmont Network (CUPN)	129 (80)	3,210 (7,931)	Blue Ridge Mountains	11 %
Totals	3,404 (2,115)	102,201 (252,545)	7	100%

Note: The Appalachian National Scenic Trail is generally accepted to be approximately 3,510 km (2,180 miles) long, and trail miles for each network are slightly underestimated due to the data resolution.

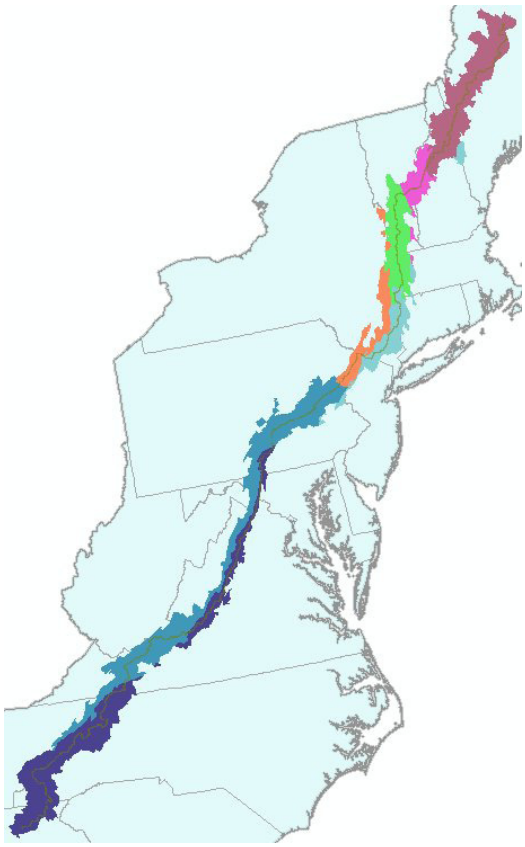


Figure 1.1. Ecoregion "sections" intersecting the Appalachian National Scenic Trail

section of trail includes habitats ranging from wetlands to alpine vegetation communities, as well as examples of most terrestrial communities present in the Northeast.

- Eastern Rivers and Mountains Network (ERMN): This section of the APPA includes New Jersey and the northern half of Pennsylvania, and includes the Delaware Water Gap National Recreation Area (DEWA).
- Mid-Atlantic Network (MIDN): This segment of the APPA includes the southern half of Pennsylvania, and northern Virginia. Shenandoah National Park is in the MIDN.
- National Capital Region Network (NCRN): This section includes Maryland and West Virginia. C&O Canal and Harpers Ferry National Historic sites are in the National Capital region.
- Appalachian Highlands Network (APHN): This portion extends from Mid-Virginia to the Georgia border, and includes the Blue Ridge Parkway and Great Smoky Mountains National Park.
- Cumberland-Piedmont Network (CUPN): This is the southern-most section of the APPA, including only Georgia.

Sunrise on the AT. Mark Larson photo.

In 2000, a small group of scientists, policy makers, and land managers met to discuss using the APPA as a scientific mega-transect for monitoring the environmental health of the eastern United States (Foster and Filipovich 2000). The concept was revisited several times in subsequent years and in 2006 the NETN, the ATPO, and the ATC co-hosted a symposium to discuss using the APPA as a natural resource monitoring laboratory (Appalachian Trail Conservancy 2007). Symposium participants represented non-profit organizations, public agencies, and universities. Since the 2006 symposium, the APPA EMP has played an instrumental role in the creation of the A.T. MEGA-Transect (ATMT), the goals of which closely parallel those of the I&M-based APPA EMP. In broad terms, the shared goals of the ATMT and the APPA EMP are:

- Monitor – Collect and synthesize existing and new data on key indicators of environmental health from agencies, organizations, researchers, and citizen scientists
- Understand – Transform status and trend data into knowledge through analysis, synthesis, and modeling
- Inform – Provide early warning of undesirable conditions or trends, such as climate change, as a means of better protecting the resources and reducing costs of management
- Engage – Share knowledge by engaging, educating, and involving decision makers, stakeholder organizations, and citizens

Related Programs

The U.S. Fish and Wildlife Service (USFWS), in partnership with other federal agencies, organizations and stakeholders have identified a number of geographically distinct areas called Landscape Conservation Cooperatives (LCC). Within each of these areas, landscape-scale stressors including habitat fragmentation, genetic isolation, spread of invasive species, and water scarcity can be studied. The APPA EMP will likely be a key component of the Appalachian Region LCC. Though the LCC initiative is distinct and independent of the APPA environmental monitoring initiative, the two efforts are closely aligned and will certainly complement one another.

Legislation, Policy and Guidance

National park managers are directed by federal law and NPS policies and guidance to know the status and trends in the condition of natural resources under their stewardship in order to fulfill the NPS mission of conserving park resources. The mission of the NPS (National Park Service Organic Act 1916) is:

"…to promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purposes of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations".

Congress strengthened the NPS' protective function, and provided language important to recent decisions about resource impairment, when it amended the

Northern Dusky Salamander. Tray Mountain, Georgia. Outpostbabu photo.

Organic Act in 1978 to state that "the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established…"

More recently, the National Parks Omnibus Management Act of 1998 established the framework for fully integrating natural resource monitoring and other science activities into the management processes of the National Park System. The Act charges the Secretary of the Interior to "continually improve the ability of the National Park Service to provide state-of-the-art management, protection, and interpretation of and research on the resources of the National Park System," and to "… assure the full and proper utilization of the results of scientific studies for park management decisions." Section 5934 of the Act requires the Secretary of the Interior to develop a program of "inventory and monitoring of National Park System resources to establish baseline information and to provide information on the long-term trends in the condition of National Park System resources."

Congress reinforced the message of the National Parks Omnibus Management Act of 1998 in its text of the FY 2000 Appropriations bill:

"The Committee applauds the Service for recognizing that the preservation of the diverse natural elements and the great scenic beauty of America's national parks and other units should be as high a priority in the Service as providing visitor services. A major part of protecting those resources is knowing what they are, where they are, how they interact with their environment and what condition they are in. This involves a serious commitment from the leadership of the National Park Service to insist that the superintendents carry out a systematic, consistent, professional inventory and monitoring program, along with other scientific activities, that is regularly updated to ensure that the Service makes sound resource decisions based on sound scientific data."

The 2006 NPS management policies updated previous policy and specifically directed the Service to inventory and monitor natural systems:

"Natural systems in the national park system, and the human influences upon them, will be monitored to detect change. The Service will evaluate possible causes and effects of changes that might cause impacts on park resources and values. The Service will use the results of monitoring and research to understand the detected change and to develop appropriate management actions."

Further, "The Service will:

- Identify, acquire, and interpret needed inventory, monitoring, and research, including applicable traditional knowledge, to obtain information and data that will help park managers accomplish park management objectives provided for in law and planning documents;
- Define, assemble, and synthesize comprehensive baseline inventory data describing the natural resources under NPS stewardship, and identify the processes that influence those resources;
- Use qualitative and quantitative techniques to monitor key aspects of resources and processes at regular intervals;
- Analyze the resulting information to detect or predict changes (including interrelationships with visitor carrying capacities) that may require management intervention and provide reference points for comparison with other environments and time frames; and,
- Use the resulting information to maintain—and where necessary restore—the integrity of natural systems." (NPS 2006).

There are many additional statutes that provide legal direction for expending funds to determine the

condition of natural resources in parks and specifically guide the natural resource management of NPS units (Table 1.2).

Table 1.2. Statutes that provide legal direction for expending funds to determine the condition of natural resources in parks and specifically guide the natural resource management of NPS units.

Taylor Grazing Act 1934
Fish and Wildlife Coordination Acts, 1958 and 1980
Wilderness Act 1964
National Historic Preservation Act 1966
National Environmental Policy Act of 1969
Clean Water Act 1972, amended 1977, 1987
Endangered Species Act 1973, amended 1982
Migratory Bird Treaty Act, 1974
Forest and Rangeland Renewable Resources Planning Acts of 1974 and 1976
Mining in the Parks Act 1976
American Indian Religious Freedom Act 1978
Archaeological Resources Protection Act 1979
Federal Cave Resources Protection Act 1988

Park Enabling Legislation

Enabling legislation of an individual park provides insight into the natural and cultural resources and resource values for which it was created to preserve. These values may evolve with time, through evolution of park management, legal interpretations, and explicit additions to park enabling legislation. The enabling legislation for the National Scenic Trail system highlights the importance of "trails so located as to provide for maximum outdoor recreation potential and for the conservation and enjoyment of the nationally significant scenic, historic, natural, or cultural qualities of the areas through which such trails may pass" (Public Law 90-543, 1968).

The APPA began as a "project" for the NPS following passage of the National Trails System Act (NTSA) in 1968. For ten years following the NTSA passage, the APPA was disconnected in many places and was frequently routed along roads. In 1978 Congress passed significant amendments to the NTSA, authorized $90 million for land acquisition, expanded eminent domain authority, and directed the NPS to make land acquisition the highest priority for the APPA. The outcome of that process involved the acquisition of approximately 2,550 individual tracts of land comprising more than 44,920 ha (111,000 acres) in ten states from Maine through Virginia. At the same time, the USFS acquired approximately 22,845 ha (56,450 acres) and several of the states contributed a combined 7,887 ha (19,490 acres). The result of these efforts made the APPA the longest unit within the National Park System. With the land acquisition process virtually complete (only a few tracts still remain to be acquired) the APPA is enveloped by a protected corridor from Maine to Georgia that is cooperatively managed by the NPS, the USFS, 14 states, and the private volunteer community represented by the ATC (which is itself a collaborative of 30 local maintaining clubs, and more than 6,300 active individual citizens). The APPA corridor averages 305 meters (1,000 feet) in width, is comparable in size to Rocky Mountain National Park, and has visitation levels comparable to Yosemite. But unlike most other NPS units, the APPA does not have a legislative boundary to define the zone within which the NPS seeks to acquire land.

Mission

The ATPO is one of 75 Cooperative Management Partners that combine to create the APPA cooperative management system. The system is designed to preserve and provide for the enjoyment of the varied scenic, historic, natural and cultural qualities of the areas between the states of Maine and Georgia through which the Trail passes.

The APPA is administered primarily as a footpath in cooperation with the USFS and the 14 states the trail passes through, providing for maximum outdoor recreation potential as an extended trail and for the conservation and enjoyment of the nationally significant scenic, historic, natural, or cultural qualities of the areas through which the APPA passes.

The APPA is a way, continuous from Maine to Georgia, for travel on foot through the wild, scenic, wooded, pastoral, and culturally significant lands of the Appalachian Mountains.

Planning

Several official documents include information relevant to natural resource management and monitoring (Table 1.3).

Government Performance and Results Act

The Government Performance and Results Act (GPRA) guides the management of national parks in outlining measurable performance goals and requires NPS to demonstrate the attainment of those goals to the U.S. Congress. For NPS, four overarching goals provide direction for developing more specific goals:

- Category I goals preserve and protect park resources.
- Category II goals provide for the public enjoyment and visitor experience of parks.
- Category III goals strengthen and preserve natural and cultural resources and enhance recreational opportunities managed by partners.
- Category IV goals ensure organizational effectiveness.

The APPA EMP clearly assists in meeting numerous Category I goals and augments Category II and III goals. The Service-wide goal pertaining to natural resource inventories specifically identifies the objective of inventorying the resources of the park as an initial step in protecting and preserving park resources (GPRA Goal Ib1). This vital signs monitoring plan identifies the indicators or "vital signs" for the APPA (GPRA Goal Ib3a) and will be implemented to detect trends in resource condition (GPRA Goal Ib3b). In addition to the national strategic goals, each park has a five-year plan with specific park GPRA goals. As the APPA develops new GPRA goals, the APPA EMP will work with them to identify goals that may be addressed through the APPA environmental monitoring initiative.

Monitoring Goals and Strategies

An Integrated Approach to Monitoring

A key initial decision in designing a monitoring program is balancing the need to monitor for current management issues against the need to detect future, perhaps unforeseen, threats to park ecosystems (Fancy et al. 2009). Our ability to predict ecosystem response to changes in various system drivers and stressors is limited by our incomplete understanding of ecological systems and processes. For example, climate change is a threat that may trigger numerous responses, and while the APPA EMP anticipates that changes are likely it is impossible to predict or anticipate exactly how the changes might manifest themselves. Conversely, while it is impossible to

Table 1.3. Appalachian National Scenic Trail planning documents

Document	Notes
General Management Plan	In progress
Resource Management Plan	Published in 2008 (Reese et al. 2008), "…The purpose of this plan … is to document the Appalachian National Scenic Trail's natural and cultural resources and describe and set priorities for management, monitoring, and research programs to ensure that these resources are properly protected and cared for. This plan is intended to provide a medium-range, 10-year strategy to guide resource management activities conducted by the Appalachian Trail Park Office and the Appalachian Trail Conservancy … for the next decade…"
Enabling Legislation, 1968	"…trails so located as to provide for maximum outdoor recreation potential and for the conservation and enjoyment of the nationally significant scenic, historic, natural, or cultural qualities of the areas through which such trails may pass. National scenic trails may be located so as to represent desert, marsh, grassland, mountain, canyon, river, forest, and other areas, as well as landforms which exhibit significant characteristics of the physiographic regions of the Nation." 1968: Public Law 90-543

construct a program that can anticipate every possible threat stemming from a problem like climate change, a monitoring program that only focuses on well-known threat/response relationships will not provide the long-term information and understanding necessary to address unanticipated, high-priority issues that arise in the future. Each approach has proponents and critics, and many writers have enumerated advantages and disadvantages of monitoring exclusively for current threats versus designing a program that is broad and capable of accommodating unforeseen threats (e.g., Woodley 1993, Noon 2002).

Alternatively, selecting an array of measures that describe the ecological properties and processes indicative of ecosystem integrity will allow detection of change in response to unforeseen or uncharacterized stressors and perhaps provide early warning of unacceptable change. Ecological integrity has been defined as "the maintenance of… structure, species composition, and the rate of ecological processes and functions within the bounds of normal disturbance regimes" (Lindenmayer and Franklin 2002). This concept builds on earlier definitions of biological integrity, defined as the capacity to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats of the region (Karr et al. 1986). Ecological integrity is a broader concept that incorporates aspects of abiotic condition such as air and water quality. This approach is particularly useful for the APPA EMP because of the aforementioned limitations on NPS funded data collection. These limitations makes it difficult or impossible to track highly specific monitoring goals, whereas utilizing existing data and relating them to established indicators of ecosystem integrity is a realistic and cost effective alternative.

Even though the APPA EMP is administratively part of the NETN, it is focused on a single park and has its own set of vital signs and monitoring protocols. A separate program is more suitable for the APPA because the trail's ecological base and management needs (and therefore its likely vital signs) are different from parks in the array of networks through which the APPA passes. In addition, the monitoring protocols being used by each of the six networks are too intensive for the level of funding allocated for

AT trail marker. Ribarnica photo.

APPA monitoring. Consequently, the APPA EMP is on a different implementation schedule than any of the networks and the level to which monitoring is conducted along the APPA is generally less spatially intensive and may rely more on rapid assessments and qualitative data. Monitoring along the APPA will primarily involve analyzing information from existing efforts underway along the trail, plus work to identify and fill information gaps.

Interpreting Ecological Integrity

Vital signs are only relevant if they provide information for guiding management decisions, help quantify the success of past decisions, or lead to the detection and understanding of future resource change. Information must be presented in a way that is clearly understood by managers, scientists, policy makers, and the public. The APPA EMP will accomplish this by: 1) developing standard statistical summaries of vital sign metrics and making this information widely available; 2) developing a standardized data presentation portal (we are currently working with partners on an enhanced Decision Support System for resource managers that may serve this purpose); 3) collaborating with other agencies such as the U.S. Geological Survey (USGS), the USFS and the USFWS to develop landscape level analysis procedures intended to assess the condition of resources throughout the Appalachian Region; and, 4) building relationships with each of the six I&M networks through which the APPA passes to exchange data and analysis techniques.

Limitations

Ecological data and information obtained while monitoring are inherently complex and variable, with a number of limitations, some of which are due to finite monitoring resources. Ecosystems are loosely defined assemblages that exhibit characteristic patterns on a range of scales of time, space, and organizational complexity (De Leo and Levin 1997), and definitions of ecological integrity are problematic, partly because key terms such as "natural" remain vague (Noon 2002). Natural systems as well as human activities change over time, and it is extremely difficult to separate natural variability and desirable changes from undesirable anthropogenic sources of change to park resources. Moreover, limited funding prevents us from directly monitoring all resources that might be at risk. These complexities demand that the APPA EMP recognize our limited understanding of ecological systems and processes, especially as the APPA EMP attempts to use this information to inform management decisions. Each of these qualifications and concerns are particularly true for the APPA EMP, which will rely on data that were collected for a variety of purposes by different entities using widely differing methodologies, and because of the geographic expanse of the APPA.

In some cases, monitoring data might suggest a cause and effect relationship that can then be investigated by a research study. As monitoring proceeds, as data sets are interpreted, as our understanding of ecological processes is enhanced, and as trends are detected, additional issues will emerge (Roman and Barrett 1999). This monitoring plan should therefore be viewed as a working document, subject to periodic review and adjustments over time as our understanding improves and new issues and technological advances arise.

Frame of Reference

Ecological data related to resources within the APPA tend to be spatially discontinuous because few projects have defined the entire APPA as the area of interest. One way to overcome the lack of spatially continuous data is to rely on data obtained from "off-trail" locations that are otherwise similar. The only difficulty in relying on off-trail data is establishing an appropriate buffer within which data are acquired. In the past, buffers were defined arbitrarily at set distances (e.g., 2 miles or 5 miles) but, because distances are not ecologically based, some data were missed that should have been included. A solution to this problem is the HUC10 shell, based on watersheds defined by the USGS (Figure 1.2). Watersheds are defined at the fifth level of the Hydrologic Unit Code system, with each being given a discrete 10-digit code (HUC10). The hydrologic unit system was developed by the USGS and subsequently modified by the Natural Resource Conservation Service (NRCS). The HUC10 shell, or the general frame of reference used to establish an area of interest around the APPA, is the 'outer' boundary of all HUC10 hydrologic units that are within 5 miles of the APPA land base. There are 177 individual HUC10 hydrologic units within this shell. Though they are termed watersheds, Omernik (2003) explains that hydrologic units are not always true watersheds and that some hydrologic elements contained within the HUC10 shell may not include all upstream components of a true watershed. However, for the purpose of defining an area of interest the APPA EMP believes the hydrologic unit system is satisfactory.

The APPA EMP selected the HUC10 scale because it incorporates all areas of immediate interest to APPA resource managers as well as areas that are more distant but potentially of great ecological similarity. Coarser (i.e., larger scale) levels of categorization incorporate areas that are far beyond the spatial "zone" of interest, while finer (i.e., smaller scale) levels of categorization omit areas that are of interest to APPA resource managers. Ultimately, the HUC10 shell does not guarantee that projects or data within it will be of interest, or that data and activities beyond it are not of interest, but it does provide a starting point and some degree of guidance when attempting to determine if data or activities are worthy of further consideration.

Ecological Resources of the Appalachian National Scenic Trail

Overview

The amount and quality of baseline natural resource information available for the APPA is extremely variable. A large amount of data exists for air, biological, and geologic resources. However, most of these inventories, environmental analyses, management plans, and other documents have been compiled at a local or regional level, and more often

Figure 1.2. Watersheds (based on USGS 10-digit Hydrologic Unit Codes, or HUC10) define the area of interest around the Appalachian National Scenic Trail

than not, for a land base other than the APPA (e.g., for a National Forest, or a state).

The ATPO, ATC, and NPS I&M Program have accumulated a significant amount of natural resource inventory and monitoring data, with the most complete inventory being the inventory of rare species and exemplary natural communities. This inventory is the result of an intensive 12-year effort that was completed in 2001.

Physical

Air Quality

The APPA traverses "regionally" high elevation areas for much of its length and passes through a number of designated "Class I Areas." A Federally-designated Class I Area is defined under the Clean Air Act to include national parks greater than 2,428 ha (6,000 acres), wilderness areas and national memorial parks greater than 2,023 ha (5,000 acres), and international parks that existed in 1977. There are six Class I areas along the APPA, including two national parks, Great Smoky Mountains National Park (NP) and Shenandoah NP; and four wilderness areas, the James River Face Wilderness Area (WA) in Virginia, the Lye Brook WA in Vermont, and the Presidential Range-Dry River and Great Gulf WA's in New Hampshire). The management goal for Class I parks is to protect and maintain clean air to the greatest degree possible.

Degraded air quality can reduce visibility, impact human health in both the short-term and long-term, and cause ecosystem effects that are not readily apparent. Impacts can injure various species of trees and other plants, acidify streams and lakes, and leach nutrients from soils. Air pollution may also cause or worsen respiratory problems – a serious concern for hikers. Little of the air pollution experienced by hikers and affecting APPA resources is generated in close proximity to the trail, but Weathers et al. (2006) have developed a model that estimates the depositional load throughout the eastern United States and Lawrence et al. (2010) intend to adapt this model to the entire APPA region. Thus, from a management perspective controlling air pollution along the APPA may be an unachievable goal, but the APPA does serve as an indicator of air pollution throughout much of the eastern United States.

Water

The APPA passes many lakes, ponds, streams, and wetlands that provide drinking water and scenic resources for hikers as well as important habitat for wildlife and plants. Because the predominant location of the APPA is the high ground of mountains and ridge crests, the trail is often at the top of the watershed. While this position on the landscape protects the APPA's water resources from direct impacts like those associated with human development and the cumulative impacts of multiple upstream activities, this landscape position is not immune from impact. Higher elevation waters tend to be more sensitive to acid deposition, and the effect of erosion due to poor trail design or storm damage tends to be more problematic.

Maintaining waters in an unimpaired state represents a special challenge for the APPA. Almost all sources of pollution, except erosion, are from offsite sources. Water quality is a major concern because long-distance hikers in remote areas of the APPA are dependent upon springs and creeks for their drinking water. By monitoring the APPA headwaters, the APPA EMP can assess the quality of the water before it moves down through the watershed, therefore creating a clearer picture of the impacts of air pollution on our water resources than can be had by monitoring

lower in the watersheds. This is important both for protecting the natural conditions along the APPA and for protecting the water for its downstream uses. The USGS is currently finishing a project to assess water quality data obtained along the APPA and from waters close to the APPA that are highly representative of APPA resources.

Biological

Fauna

A list of animal species that occur within the APPA is likely to include the majority of species that might be found in each of the states through which the APPA passes, with the exception of species that are obligate to habitats that do not occur on the APPA (e.g., salt marsh sparrows and other coastal inhabitants). This expectation notwithstanding, a complete species list does not exist for the APPA and inventories of rare animal species along the APPA are incomplete. To help address the rare animal species gap, the NETN worked with researchers to complete mammal inventories for the portions of the APPA in Maine (Yates et al. 2010) and between Connecticut and Central Pennsylvania (Sedivec and Whidden 2007). There are five (5) Federally-listed endangered animals historically known to exist in the Trail corridor (McNees 2005, Table 1.4).

Flora

The majority of the APPA is characterized by temperate deciduous forest but the trail also encompasses small unique habitats such as grassy balds, heath balds, mountain bogs, cliffs and rock outcrops, talus slopes, and beech gaps.

The temperate deciduous forests that dominate the

Canada Lynx. Keith Williams photo.

APPA region are characterized by broadleaf trees, including oak, hickory, maple, beech, and birch, often mixed with conifers such as hemlock, spruce, fir, and pine on drier or higher elevation sites. Other terrestrial habitats include alpine vegetation, rocky outcrop woodlands, and old-field successional habitats and plantations. A variety of wetland and aquatic habitats are present within these forests, including forested and shrub swamps, marshes, wet meadows, fens and bogs, lakes, rivers, ponds, and vernal pools.

Worldwide, temperate deciduous forests have been highly altered and possess the highest index of human disturbance of any major biome (Hannah et al. 1995), and high indices of fragmentation (Ritters et al. 2000). The eastern United States is no exception, where temperate deciduous forests have been heavily used for timber, cleared for agriculture, or converted into towns and cities. Even so, regrowth of forests on abandoned farms in the last 50-100 years has created a new mix of primary and secondary forests, and

Table 1.4. Federally-listed fauna historically known to exist along the Appalachian National Scenic Trail (E = Endangered)

Common Name	Latin Name	Status	Last Observed
Shenandoah salamander	Plethodon shenandoah	E	1991
spruce-fir moss spider	Microhexura montivaga	E	1977
dwarf wedgemussel	Alasmidonta heterodon	E	2010 in Upper Delaware
Carolina northern flying squirrel	Glaucomys sabrinus coloratus	E	2000
gray bat	Myotis grisescens	E	2003

increased levels of overall forest cover (Foster and Aber 2004).

Most natural resource monitoring along the APPA is carried out by volunteers, and the bulk of what has been done to date has focused on rare plant species. A noteworthy exception is the vegetation mapping project that is currently underway. At the conclusion of the vegetation mapping project (2015), a more comprehensive listing of plant species present on the APPA will be available. There is one (1) Federally-listed plant species and one (1) Federally-listed lichen historically found along the APPA (McNees 2005; Table 1.5).

Temperate deciduous forest along AT in North Carolina. Alex Ford photo.

Invasive Species

Invasive species are typically non-indigenous organisms that once introduced into an area cause ecological and sometimes economic damage. States frequently generate invasive or noxious species lists aimed at controlling species with known detrimental economic effects. Invasive plant populations can quickly expand and eliminate less competitive indigenous species, while invasive insects and fungi can attack and kill (or weaken) their hosts throughout an entire region. The resulting impacts affect recreational opportunities, economic use (forestry and agriculture), wildlife, plant communities, and essential native ecosystem functions. Invasive species (plants, animals and pathogens) are considered by some to be one of the top four threats to the health and sustainability of America's forests, alongside fire, loss of open space, and unmanaged recreation (U.S. Forest Service 2006).

Invasive non-indigenous species have been introduced to areas along the APPA and other natural areas by humans, animals, wind, and water. In some cases, human introductions may have been through hiking-related activities or management practices. In large part, the spread of these problematic species has gone unchecked and is likely resulting in dramatic and devastating changes to natural systems, and could potentially displace many indigenous plants and animals. Among the more significant of these resources are rare species, and trail resource managers consider invasive plants to be one of the primary threats to rare species occurrences. Clearly, the key to addressing this issue requires an understanding of the species involved, knowledge of the habitats most at risk, documenting the scope of the problem, initiating efforts to prevent and detect new invasions and control those that are underway, and education.

Because of the narrow corridor occupied by the APPA and the large number of visitor access points (e.g., access trails), invasion by invasive species is a constant concern and one that is exceedingly difficult to manage. A good example of the threat posed by invasive non-indigenous species is the balsam woolly adelgid that has infected and destroyed much of the Fraser fir dominated overstory that was common in southern high-elevation areas (Potter et al. 2005). The NPS has a great interest in invasive non-

Table 1.5. Federally-listed plants and lichens historically known to exist along the Appalachian National Scenic Trail (E = Endangered; T = Threatened)

Common Name	Latin Name	Status	Last Observed
small whorled pogonia	*Isotria medeoloides*	T	2003
rock gnome lichen	*Gymnoderma lineare*	E	1996

Japenese barberry infested forest, NH. Eli Sagor photo.

indigenous species management, and has established Exotic Plant Management Teams (EPMTs) as part of the Natural Resource Challenge to help manage problematic plants in selected regions and parks across the nation. While the focus of the EPMT program is on developing lists of invasive species and implementing management and eradication programs, there remains a continuing need to identify and track invasions, monitor treatment effectiveness and develop "early detection" methodologies as a preventive strategy. Early detection of invasive species is frequently cited as the best way to deal with non-indigenous and invasive species, and has been selected as a vital sign by each of the NPS I&M networks that overlap the APPA. Natural resource managers from the ATPO and the ATC are currently developing an invasive non-indigenous species detection program that will rely on a series of targeted inventories. This approach to understanding the invasive species problem has been used before along the APPA, with mixed results. Past efforts have relied on hikers to identify invasive species during their journey in a "travel log" format. The exact location, abundance, and expanse of invasions are not always recorded, and nearly all of these efforts have focused exclusively on the trail and the immediate area surrounding the footpath. In contrast to the "travel log" approach, new strategies under consideration will use more rigorous sampling techniques in discrete areas where invasions are anticipated or where potentially impacted resources are most sensitive.

Existing Appalachian National Scenic Trail and Adjacent Monitoring Programs

Data collected from existing monitoring programs provides historical comparisons and context for the data collected by the APPA EMP. In many cases, the APPA EMP will utilize data available from the programs currently in place, especially where measures, sampling locations, and sampling protocols are on or immediately adjacent to the APPA corridor. The APPA EMP anticipates that dataset compatibility will vary because the monitoring programs have differing objectives. To help us develop partnership opportunities with monitoring efforts being conducted by other federal and state agencies, universities and non-government organizations (NGO), the APPA EMP also reviewed national, regional, and local monitoring efforts that may be relevant to natural resource monitoring near the APPA. These 'outside the park' monitoring efforts are summarized in the appendix, Adjacent Monitoring Programs.

Goals and Objectives for the Appalachian National Scenic Trail Environmental Monitoring Program

Monitoring objectives for the APPA help focus the monitoring program and facilitate partnerships for monitoring. Monitoring objectives, identified below, were used during vital sign development to ensure the identification of a full spectrum of ecological attributes and management issues for possible monitoring. More detailed monitoring objectives have been identified for individual vital signs as part of protocol development, and may be found in Chapter 5. Table 1.6 presents our monitoring objectives in the NPS Inventory and Monitoring program's Ecological Monitoring Framework.

Camping at Max Patch, Appalachian Trail, Tennessee/North Carolina. Frank Kehren photo.

Table 1.6. Appalachian National Scenic Trail monitoring objectives, organized in the Inventory and Monitoring Program's Ecological Monitoring Framework.

Level 1	Level 2	Vital Sign	Objectives
Air and Climate	Air Quality	Ozone	Monitor the status and trends in tropospheric ozone pollution by synthesizing data from existing sources.
		Visibility	Track the status and trends in visibility using existing monitoring sites along the ANST.
		Atmospheric Deposition	Assess the impacts and trends of acid deposition upon forest soils and aquatic ecosystems within the ANST corridor.
	Weather and Climate	Climate Change and Phenology	Determine variability and long-term trends in climate using available data on select weather parameters, including air temperature, precipitation, cloud cover, and wind speed and direction. Monitor several indicator plant and animal species for major phenological stages.
Water	Water Quality	Water Resources	Use existing data to determine long-term trends in water temperature, pH, conductivity, dissolved oxygen, and flow/stage/level in selected freshwater resources based on recommendations by the USGS.
Biological Integrity	Invasive Species	Non-native invasive terrestrial and aquatic plants	Maintain a list of target species known from the local region. Develop a "risk of occurrence" model for target species based on life history attributes, dispersal modes, invasion corridors, vectors of spread, invasion potential and known locations. Implement procedures to identify incipient populations (i.e. small or localized) and new introductions of selected non-native plants in areas of high and moderate management significance.
	Focal Species or Communities	Alpine and High Elevation Vegetation	Determine long-term trends in species composition and community structure of selected alpine and high elevation plant communities. Monitor temporal change in elements of stand structure, overstory and understory/herbaceous diversity, and vegetation condition in order to assess ecological integrity.
		Forest Vegetation	Analyze existing forest data (FIA, and other) for large (e.g., landscape) scale trends in status and condition.
		Breeding Birds	Determine long-term trends in species composition and abundance of forest and montane passerine species in selected areas along the ANST
		Rare Plants	Identify and monitor the condition and status of select high-priority rare plants (G1 & G2; S1) and some less rare plants (G3 & S2) at locations (occurrences) where the plants are known
Human Use	Visitor and Recreation Use	Visitor Usage	Assess visitation impacts in high volume areas, including campgrounds, side trails and scenic vistas.
Landscapes	Landscape Dynamics	Landscape Dynamics	Determine status and trends in the areal extent and configuration of land-cover types on the ANST and immediately adjacent lands. Monitor changes in the extent and condition of ecological systems along the ANST

Chapter 2 - Conceptual Ecological Models

Introduction

Conceptual ecological models built to identify key system components, linkages, and processes form a critical step in the design of a long-term monitoring program. The need for conceptual ecological models has been well established (National Research Council 2000, Elzinga et al. 2001, Noon 2002), and is a recognized component of the NPS Inventory and Monitoring program. The APPA conceptual models are based on the NPS I&M Program's conceptual modeling methodology. Conceptual models identify key components of ecological systems, including elements of ecological integrity that integrate the effects of multiple drivers and stressors acting upon a system over time. Conceptual models also improve the planning process by facilitating discussion and by supporting the evaluation and refinement of the monitoring program by explicitly identifying the key system elements that the APPA EMP understands (Maddox et al. 1999). Given the complexity of natural systems and the variety of factors that influence ecological processes, there is a clear need for conceptual modeling as a tool to help organize information and synthesize a more complete understanding of system components and interactions. Failures in the development of major ecosystem monitoring programs have been attributed to the absence of sound conceptual models (National Research Council 1995).

A primary objective of the NPS I&M Program is to facilitate adaptive management by monitoring status and trends in:

- The ecological condition of park resources
- Key anthropogenic stressors acting upon park systems
- Focal park resources

To accomplish this objective, conceptual models developed for the APPA are both "effects-oriented" and "predictive" ("stressor-oriented") (Trexler and Busch 2002). The APPA conceptual models incorporate elements of ecological integrity, which integrate the effects of multiple drivers and stressors acting upon a system over time, as well as specific anthropogenic stressors and focal park resources. These conceptual models provide the foundation for describing potential vital signs and ranking their importance.

Conceptual models from other networks as well as models prepared for other purposes were considered for the APPA vital signs monitoring plan. The models chosen for the APPA monitoring plan represent a balance between highly detailed models that split individual resource components more finely than APPA resource managers need, and those models that generalize too broadly. Models developed for the NETN were best suited for the purpose of the APPA monitoring plan. Of the general conceptual ecosystem models developed by the NETN (Mitchell et al. 2006), the most applicable and relevant to the APPA are for terrestrial and aquatic biomes. Wetlands are also included, though they are slightly less characteristic of the Appalachian region. The terrestrial and aquatic ecological divisions are further divided into a series of ecosystems and communities:

Terrestrial	Forests and woodlands Cliff and outcrop communities Alpine and high-elevation communities Grasslands
Aquatic	Streams (riverine) Ponds and lakes (lacustrine)

A combination of diagrammatic conceptual models and written narratives are used to describe the current understanding of those components and interactions that are considered key to the APPA. The models for the APPA are general, but consistent with the landscape scale at which resources along the APPA are managed and understood. The APPA EMP has not attempted to describe the effect stressors have on every type of terrestrial and aquatic resource found along the APPA. The proportion and distribution of the terrestrial and aquatic resources along the APPA are highly variable within and among regions, making it prohibitively complicated to thoroughly summarize and describe effects to every resource.

Terrestrial Systems

The APPA follows the Appalachian Mountains through some of the most mountainous regions in the eastern United States; consequently the systems

found along the APPA tend to be those that are associated with comparatively high elevations. Though dominated by forest (~92% of APPA land is forested), the lands through which the APPA passes contain valued alpine vegetation, as well as substantial areas of rock outcrops, open fields, successional old-field habitat, and balds. Some of these communities are natural, and some are maintained to satisfy historical, cultural, and/or scenic mandates. The trail also passes through areas of agriculture (~2% of land area) and human development (~3% of land area), which present different challenges and monitoring needs. This range of ecological habitat supports a wide diversity of plant and animal species. Some geographically restricted communities, such as the montane spruce-fir forests of New England, harbor habitat specialists such as Bicknell's Thrush (Catharus bicknelli), a rare songbird that will only breed in this restricted habitat. Trail lands as a whole are also thought to play a role in the conservation of migratory bird species, many of which are of concern due to declining populations, restricted ranges or other conservation issues (Shriver et al. 2005).

The upland conceptual model adapted from the NETN Vital Signs Monitoring Plan (Mitchell et al. 2006, Figure 2.1) provides an appropriate general characterization of the resources, processes, drivers, and stressors affecting APPA terrestrial ecosystems. The main terrestrial ecosystems are described below. The key drivers, processes, and stressors of all three

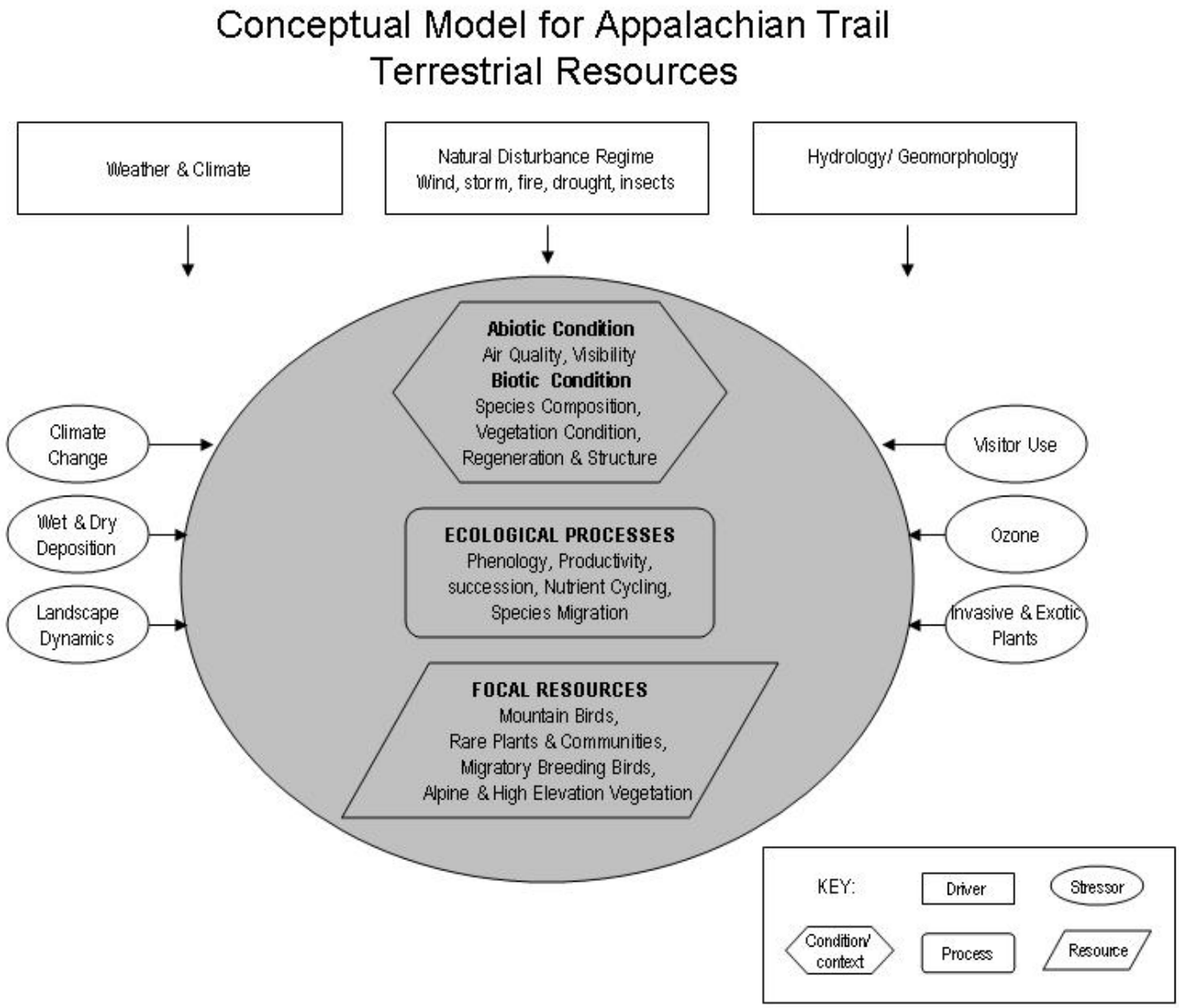


Figure 2.1. Terrestrial conceptual model adapted from the NETN Vital Signs Monitoring Plan.

APPA conceptual models are discussed in the last sections of this chapter.

Forests and Woodlands

Forested systems found in the region surrounding the APPA can be divided into five general groups (Westveld 1956, Foster 2004, Shriver et al. 2005):

- Spruce-fir forest found at higher elevations in northern New England and along the Maine coast, dominated by red spruce and balsam fir, with white and black spruce. The spruce-fir forest also exists at higher elevations in the southern Appalachians, and includes the Red Spruce-Fraser Fir community.
- Northern hardwood forest of northern New England, dominated by American beech, yellow birch and sugar maple, with a variety of other hardwood species and hemlock and white pine.
- Central mixed hardwood forest extending much of the length of the APPA, and dominated by oaks, hickories and other hardwood species.
- Cove forest occupying low- to mid-elevations in the southern Appalachians, dominated by deciduous hardwoods and sometimes with hemlock.
- Dry Oak-Pine forest found along ridgelines and exposed slopes.

Cliff, Outcrop, and Rock Shelter Communities

This habitat type may occur at all elevations, with conditions being highly dependent on where the cliff, outcrop, or rock shelter is located. For example, higher elevation sites are typically characterized by colder, harsher conditions that slow natural succession and favor the species that are adapted to these open, rocky habitats. Conversely, middle-elevation sites may be more dependent on fire, and fire suppression may seriously threaten the continued existence of many species of plants and animals associated with these communities.

Grasslands

Typically found in low- to middle-elevation areas, grasslands are not common along the APPA (<1% of land area). Grasslands are traditionally fire dependent but current management relies more upon grazing and mowing.

Alpine and High-elevation Communities

These are the highest elevation plant communities found along the APPA. Alpine plant communities are sometimes referred to as "islands" that are surrounded by forests of conifers and deciduous trees. In Maine and New Hampshire, alpine vegetation may be found atop some of the highest summits over which the APPA passes. No alpine areas exist in the southern Appalachians but some of the high summits over which the APPA passes are topped by Red Spruce-Fraser Fir forest, grassy balds, or heath balds, all of which are unique to the region. The most obvious and immediate threats to alpine areas and high-elevation communities are trampling and other recreation-related impacts, acid precipitation, and climate change.

Spruce-Fir forest of Maine. Rebecca Sudduth photo.

Freshwater Aquatic Systems

APPA freshwater aquatic systems are broadly defined as regionally high-elevation waters that are relatively unimpacted by stressors such as anthropogenic land use typical of lower-elevation waters within the same region. However, they are more exposed to other phenomena such as acid deposition that disproportionately affect high elevation waters. There are numerous lakes and ponds along the APPA, ranging in size from very small (<1 ha or 1.5 acres) to more than 15 ha (37 acres), and the APPA crosses many streams and rivers that vary from first order headwater streams to tidal rivers. Less than 1% of

the total APPA "area" is described as "open water." The form, structure, and occurrence of APPA water resources vary considerably throughout the region with characteristics and occurrence dependent on the coinciding geology, climate, and terrestrial ecological systems present. These resources serve many uses along the APPA, including: drinking water for hikers, visitors, and wildlife; providing scenic and aesthetic value; habitat for plants and animals; and a source of water for downstream public water supplies, fisheries, and hydropower generation. From an aesthetic perspective, water resources along the APPA are a key part of the trail experience. Seeps, springs, and wells are a source of water occurring along the length of the APPA and represent a discharge point for shallow ground water that may or may not be linked to freshwater aquatic ecological systems. Groundwater is not considered an APPA ecological system independently, but is a crucial component of all other water resources. The freshwater aquatic conceptual model adapted from the NETN Vital Signs Monitoring Plan (Mitchell et al. 2006, Figure 2.2) provides an appropriate general characterization of the resources, processes, drivers, and stressors affecting APPA freshwater aquatic ecosystems. The main aquatic ecosystems are described below.

Streams and Rivers

The APPA crosses 1,760 streams and 94 rivers. The great majority of the stream crossings are intermittent, first or second order streams that are representative of the forested mountainous and higher elevation terrain that characterizes much of the APPA region, and that are of greatest interest for monitoring and management. Higher-order streams and rivers, while present, are less characteristic of the APPA region, generally emerge outside the APPA region, and are beyond the scope of this monitoring plan.

Streams in the APPA region generally exhibit the following characteristics (Bailey et al. 1994):

1. Physical habitat structure generally includes steep slopes, high gradients, shallow depths to channel bottom, narrow floodways, extensive woody debris, and a mix of small pools and riffles. These streams are typically located in forested

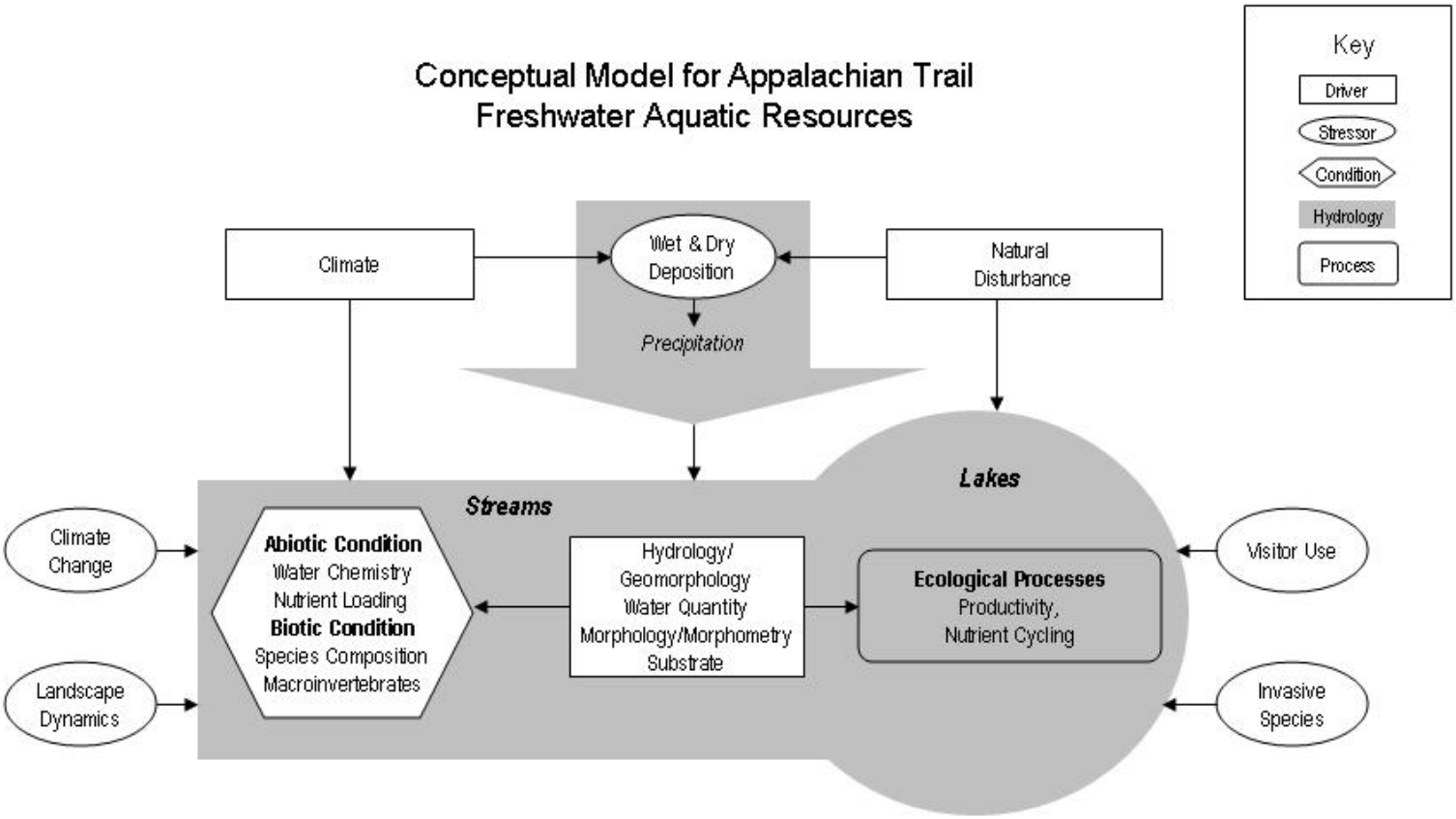


Figure 2.2. Freshwater aquatic resources conceptual model adapted from the NETN Vital Signs Monitoring Plan.

catchments with extensive forest canopy cover and may traverse through small isolated wetland areas.

2. Flow regime is significantly influenced by ground water inputs, with baseflow being maintained by ground water. Higher flow conditions are the result of precipitation events and snowpack melting. Whether a stream has intermittent or continuous streamflow depends on numerous factors such as drainage area size, depth and type of soils, depth to bedrock, catchment slope and precipitation. Excessive rainfall events and the rapid melting of snow pack results in the highest flow conditions of high elevation tributaries. Regardless of stream size, these extreme high flows can move comparatively large amounts of forest litter and sediment.
3. Water quality is influenced greatly by ground water conditions, the type and amount of vegetative cover, soil and geologic characteristics, climatic and precipitation patterns, and the type and degree of disturbance in the catchment. Because of the short path between the point of origin and the discharge point, basic water chemistry will often be similar to that of the predominant water source. For example, streams that are dependent on rainwater and snow melt will typically have moderate to high amounts of acidity (pH under 7), low amounts of dissolved and suspended constituents, low conductance and buffering capacity, cool temperatures, and measurable amounts of dissolved oxygen. Core or basic physical parameters include temperature, conductance and pH. Acid neutralizing capacity and alkalinity are also important core water quality indicators. More complex measurements of trace metals and nutrients may be important to track environmental stressors such as atmospheric deposition, biologically available contaminants, and ecosystem productivity.
4. High elevation tributaries serve as important habitat areas for a diverse mix of terrestrial and aquatic species, including salamanders, aquatic insects, songbirds (many of which may be neotropical migrants) as well as a wide range of vegetative communities. High elevation tributaries generally have limited or non-existent fisheries.

Ponds and Lakes

There are 76 lakes and ponds along the APPA. These relatively small waterbodies serve as important recreational areas, water supplies, and as locations for camping and shelters for overnight usage. Ponds attract wildlife such as mink, bear, and moose, and larger bodies may also serve as loon nesting sites.

Most natural ponds along the APPA generally have low pH (less than 7), low ionic strength and nutrient levels, and poor acid neutralizing capacity. Water sources include surface tributaries (streams and wetlands), ground water and precipitation. For ponds having little or no surface drainage area, most water will be from ground water. Natural ponds along the APPA were typically formed as a result of the last glacial period, although some natural high elevation ponds may have been formed by historic beaver activity.

Wetlands

Wetlands represent a diverse set of ecological communities that occur along the transition between terrestrial and aquatic systems and only cover approximately 1.2% of all APPA land area. Driven by hydrology and defined based on physiochemical environment and biota, wetlands are some of the most productive and diverse ecological systems on earth (Keddy 2000). The physiochemical environment of a wetland is defined as the soils, chemical properties, and processes that interact with the hydrology to influence the biota. The wetland conceptual model adapted from the NETN Vital Signs Monitoring Plan (Mitchell et al. 2006, Figure 2.3) provides an appropriate general characterization of the resources, processes, drivers, and stressors affecting APPA wetland ecosystems.

System Drivers and Processes

Climate

Climate is the long-term averaging of shorter duration weather events. “Climate is what you expect, weather is what you get” (Robert A. Heinlein). Climate describes the conditions to which ecological systems adapt, and incorporates components such as temperature, rain and snowfall, humidity, and wind (among others) that exist in a specified area.
It is not possible to concisely describe the climate typical of the APPA due to its length, and the fact that it follows higher elevation ridgelines for much of its length but runs through valleys and intermediate elevations as well. General trends include warmer and

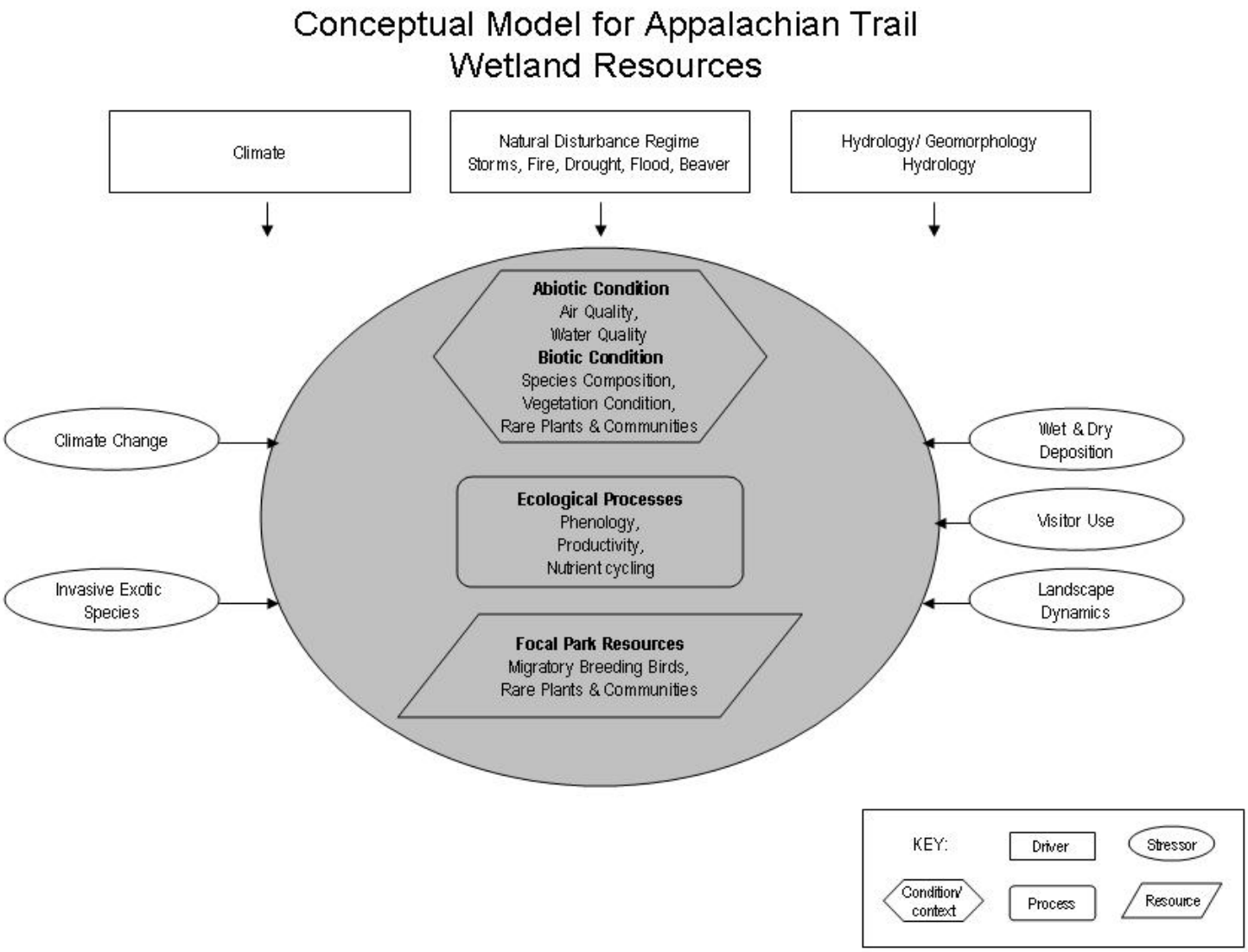


Figure 2.3. Wetland conceptual model adapted from the NETN Vital Signs Monitoring Plan.

more humid conditions at the southern extent of the APPA with cooler, relatively drier conditions in the north. These are very broad generalizations with too many exceptions to make them valuable at nearly any scale finer than continental. Understanding the climate of the APPA requires a regional perspective and reliance on available weather stations located close to the APPA.

Climate is both a system driver and a stressor capable of modifying other drivers and stressors. The modifying capability of climate is the basis for the world-wide concern about "climate change." Every other system driver and process, from disturbance regimes to nutrient cycling, and every stressor (see below) from invasive species to acid deposition may behave unpredictably if the climatic conditions to which they have adapted are changed.

Disturbance Regimes

Disturbance regimes are another key driver affecting APPA ecological systems. In forested ecosystems throughout the APPA region, wind and ice storms, fire, and damage from pests and disease are most notable. Windstorms create small- to medium-sized gaps that rapidly regenerate (Lorimer and White 2003), whereas extreme wind events associated with less frequent major storms create much larger openings. Areas opened by wind storms create habitat for earlier successional species within the forest mosaic, with the size of the opening being the dictating factor. Periodic ice storms can cause substantial damage over large regions, but tend to result in regeneration rather than stand replacement (Lorimer and White 2003). Historically, fire has been infrequent within the northern hardwood forest, but was more common

within the central hardwood forest and probably also within the transitional mixed forest between northern hardwood and spruce-fir (Cogbill et al. 2002). Insect pests and disease are also important agents of natural disturbance, particularly in the low diversity coniferous forest (Lorimer and White 2003).

Floods and droughts have a major effect on aquatic and wetland ecosystems along the APPA. Floods can occur during any season, but are most widespread in the spring when large frontal systems bring steady rain that falls on frozen or saturated ground. In the summer and fall, thunderstorms and hurricanes can cause local flooding (Maloney and Bartlett 1991). Floods are natural recurring events that can cause major morphological shifts in river systems, and cause widespread erosion and sedimentation, especially when coupled with urbanization. Droughts are more difficult to define and quantify than floods, but are also natural recurring events along the trail.

Increased erosion is another potential consequence of disturbance, both natural and human induced. Erosion is a natural process that under normal conditions helps enforce stream stability, provides a natural source of nutrients, and provides material for land formation. However, when accelerated, erosion may destabilize streams and may result in the loss of land, including trails and properties. Other causes include increased inputs of water into an otherwise stable system (e.g., runoff from developed areas and unusually frequent storm events due to climate change), problems with bridges or crossings (e.g., improper positioning or sizing of culverts or bridges), or physical disturbances to banks. Changes to natural erosion patterns may be episodic or incremental, but in either case they can lead to habitat alteration within the water resource itself, or to adjacent lands in the case of more dramatic events. Increased rates of sedimentation can affect wetlands by adding sediment-borne pollutants, burying vegetation and seed banks (Neely and Baker 1989), and changing the water depth and hydroperiod.

Hydrology/Geomorphology

Hydroperiod, the frequency and duration of inundation, defines the hydrology of an area and largely determines whether an upland, wetland (including type of wetland), or open water will develop in a particular setting. In combination with the underlying geology, the hydroperiod influences soil type and characteristics as well as the plant community found at a particular location. For streams, hydrologic information can be used to understand why a system is perennial or seasonally intermittent. Hydroperiod is influenced by basin morphology, size of the influence area, connection to groundwater, and long-term climatic conditions (Larson 1995, Lent et al.1997, Kirkman et al. 1999, Brooks and Hayashi 2002), and is the most important physical factor driving the composition and diversity of the floral and faunal communities and system productivity (Semlitsch et al. 1996, Schneider 1999, Mitsch and Gosselink 2000, Brooks 2004). Determining the hydroperiod of a site not only provides detailed information about site condition, structure, and function but also can be used to better understand the ecological effects of changing weather patterns.

Delaware Water Gap, PA. Nicholas T. photo.

Nutrient Cycling

Nutrient cycling is a fundamental ecological process that is intrinsically linked to the composition, productivity and function of ecosystems (Figure 2.1, Figure

2.2, and Figure 2.3), and the utility of using measures of nutrient cycling as indicators of ecosystem status, function or integrity has been widely recognized (Harwell et al. 1999). Nutrient cycling in terrestrial systems involves nutrient uptake and storage, litter production and decomposition, transformation by fauna and flora, nutrient input and export (Foster and Bhatti 2006), and nutrient cycling in freshwater and wetland ecosystems involves similar processes. For the APPA, understanding what to anticipate for nutrient cycling and productivity regardless of whether the system is terrestrial, aquatic, or wetland will provide insight into ecosystem condition and function, and stressors such as non-point source pollution and land use (Figures 2.1, 2.2, and 2.3).

Ecosystem Productivity

Ecosystem productivity provides a measure of energy flow through the system; productivity is the amount of energy stored as organic matter. Within an ecological system, annual productivity varies with climate and patterns of disturbance as well as with stressors such as insect or herbivore browsing and atmospheric deposition and ozone (Ollinger et al. 2002, Laurence and Andersen 2003). Thus, productivity provides an integrated measure of the status of an ecological system or of specific taxa and is an important measure in all ecological systems.

Stressors

Ecosystems along the APPA are subjected to a suite of anthropogenic stressors unlike anything that existed prior to European settlement. Many of the stressors are the same as those that affect other parks, but the APPA's long and narrow conformation means that a larger percentage of the land area is directly affected by "external" activities than most other parks. For example, adjacent land use change is a primary concern because the boundary of the APPA land area is so long and because it comes into contact with so many different land owners.

Stressors act as agents of change in a myriad of related and often interacting ways. While the effects of some stressors, like acidic deposition, have been extensively studied and are well understood (Driscoll et al. 2001a), the effects of other important stressors, like climate change, are complex and unpredictable enough to elude our current understanding despite concerted and ongoing study (McNulty and Aber 2001). The impacts of many stressors will vary depending upon land use history (Foster et al. 2003), and the combined impact of a suite of interacting stressors is certain to yield unexpected results (Aber et al. 2001).

Climate Change

Anthropogenic climate change is both directly and indirectly altering many key environmental parameters that control the structure, composition and function of ecosystems. While accurate prediction of the effects of the suite of global climate change stressors upon ecosystems is currently beyond our abilities, a large body of research has been assembled that yields some insight into what may occur. Available evidence indicates that human activities have accelerated the concentration of greenhouse gases in the atmosphere (IPCC 2002), and as a result the climate of the northeastern United States is projected to become warmer and perhaps wetter over the next 100 years (New England Regional Assessment Group 2001). Conversely, the southeast is projected to warm slightly less than the northeast and possibly become drier (Appalachian Trail Conservancy 2009; U.S. Global Change Program 2010). These changes will likely affect the structure and function of all ecosystems. For example, elevated CO2 has been shown to increase photosynthetic rates and tree growth, though this may be a short-term effect (Long et al. 1996, Rey and Jarvis 1998) that is likely to be limited under field conditions by nutrient availability (Curtis and Wang 1998, Johnson et al. 1998). Similarly, if atmospheric moisture levels increase and result in higher levels of precipitation, base and storm water levels will likely increase and could increase erosion and alter stream morphology.

There are a number of scenarios that may occur depending on what climatic changes manifest themselves. If stream temperatures rise, conditions that support cold water fish populations that are currently at the edge of their range may change and those populations may disappear. Likewise, if temperatures rise sufficiently, forest composition is likely to shift in response, with hardwood species slowly displacing conifer species in more northerly and higher elevation locations (Potter et al. 2010). In 2004, Beckage et al. (2008) resurveyed plots initially established in 1964 and found that hardwood species were more common in the lower portion of the

Wolf Rocks, PA. Nicholas T. photo.

northern hardwood-boreal forest ecotonal zone. For species that are limited to higher elevations, suitable habitat may eventually vanish.

Several geophysical and biological studies indicate that spring is coming earlier in New England. Warming is evident in the southern Appalachians as well where the down-slope limits of red spruce have shifted upslope in response to warming (Appalachian Trail Conservancy 2009). The annual date of the last hard spring freeze shifted significantly earlier between 1961 and 1990 (Cooter and Leduc 1995) and lilac bloom dates at 4 stations occurred significantly earlier between 1959 and 1993 (Schwartz and Reiter 2000). The effects climate change will have on hydrology in the northeast are just beginning to be understood. Much of the significant change towards earlier lake ice-out dates in New England since the 1800s occurred from 1968 to 2000 (Hodgkins et al. 2003). All of 11 studied rivers in New England had significantly earlier winter/spring high flows from earlier snowmelt, with most of the change occurring in the last 30 years (Hodgkins et al. 2003). Furthermore, snow density on or near March 1 has significantly increased in coastal Maine over the last 60 years, indicating earlier spring melting (Dudley and Hodgkins 2002). Increases in air temperature and reduced rainfall (U.S. Global Change Research Program 2010) may result in shorter winters and earlier ice-out.

Wet and dry deposition

Derived from nitrogen and sulfur emissions from electric utilities, manufacturing, agriculture and other sources, acidification occurs as precipitation (wet deposition), directly onto vegetation immersed in clouds and fog (occult deposition), and also by direct transfer of particles and gases (dry deposition). Deposition of sulfur and nitrogen in rain and snow can acidify soils and surface waters, negatively affecting fish, plants, and other biota (Likens 1985). The Appalachian Mountains receive some of the highest nitrate, sulfate, and heavy metal deposition rates in North America. Although deposition effects have not been studied along the APPA specifically, acid deposition and associated adverse effects have been studied in Great Smoky Mountains National Park, Shenandoah National Park, the Adirondack Park and a number of National Forests in the Appalachian Mountains. Based on the results from these investigations, it is reasonable to infer that soil and surface water acidification, soil nutrient imbalance, as well as plant and animal species loss may be occurring within the APPA region. While sulfur deposition has decreased since the 1990 Clean Air Act standards were enforced, ecosystem recovery along the APPA is not well understood and may be happening more slowly than expected (Lawrence 2010). Episodic acidification has been demonstrated during spring snowmelt and rain events, which is a stress to the aquatic environment.

Measures of atmospheric deposition are critical for understanding water chemistry and stress (Likens and Bormann 1974). Atmospheric deposition is particularly problematic along the APPA where many of the waters are at the “top” of their respective watersheds, a location where there is a proportionately small surface area to buffer these inputs, and the surrounding soils and surface water bodies may have inherently low acid neutralizing capacity (ANC). ANC is key to successful resource recovery, dictating the capacity of lakes and streams to buffer acidic inputs

and prevent further acidification (U.S. Environmental Protection Agency 2004).

Ozone

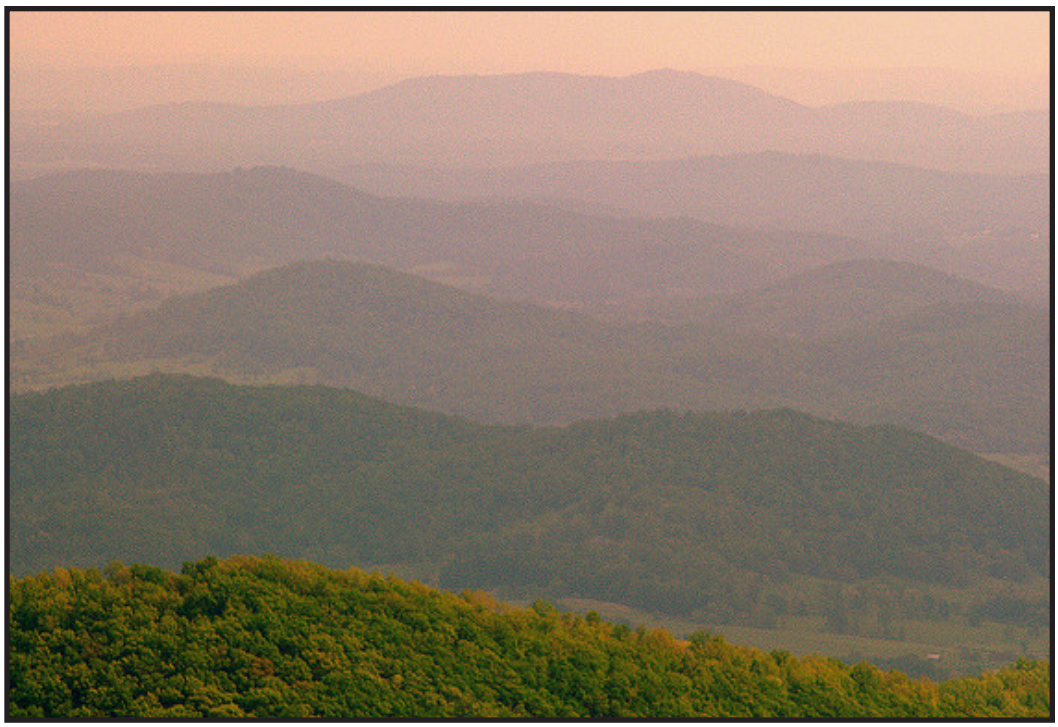
Tropospheric (ground-level) ozone is a damaging phytotoxin of significant concern at several locations in the eastern United States (U.S. Environmental Protection Agency, 1996). Ozone is formed by sunlight acting upon nitric oxides and simple hydrocarbons from industrial emissions and motor vehicles. Thus, tropospheric ozone levels vary rapidly in space and time, and are highest on sunny, still days in areas within and downwind of urban centers, industrial facilities and transportation corridors (Shriver et al. 2005). The APPA is not immune from the effect of ozone – despite being relatively remote – because it is still downwind of several major industrial and transportation centers where ozone is prevalent.

Elevated ozone levels pose risks to the hiking community by possibly causing lung damage or stress, as well as to the forest through which the APPA passes by causing a visible spotting or "stipple" on the upper surface of leaves on plants that are sensitive to ozone stress. These impacts can cause reduced photosynthesis, reduced growth, premature aging, and leaf loss with or without the occurrence of foliar injury (Shriver et al. 2005).

Non-indigenous Species

The effects of invasive exotic species on the structure, composition and function of natural systems have been a chief concern of ecologists and land managers for more than 20 years (Drake et al. 1989). Invasion of native habitats by non-indigenous species or by native species whose densities are becoming unnaturally inflated (e.g., white-tailed deer) is presently recognized as second only to direct habitat loss and fragmentation as a threat to biodiversity, and terrestrial systems are being seriously impacted by several species of invasive exotic insect pests and pathogens. The hemlock wooly adelgid has caused widespread mortality of hemlock across the eastern U.S. since introduction here in the 1950s, and threatens to rapidly and substantially reduce or eliminate eastern hemlock throughout much of its range (Orwig et al. 2002) including substantial portions of the Appalachian region. This could have substantial impacts on associated taxa such as forest birds. Invasive exotic earthworms are another important taxa currently spreading through northeastern forests causing "keystone" changes to soil structure and nutrient cycling (Hendrix 1995). Many species of invasive exotic terrestrial plants are also currently impacting eastern terrestrial ecosystems, by competing with native flora, altering habitat, and altering ecosystem dynamics such as nutrient cycling and hydrology (Mack et al. 2000).

The extent of the non-indigenous species (NIS) throughout the APPA region is currently not well understood. Several projects have been undertaken that used the footpath as the focal point, but no attempts have been made to assess the problem on APPA lands that are away from the trail. Conventional wisdom suggests that NIS are most problematic in the vicinity of disturbances and human activity but this theory has not been validated for the APPA.



Shenandoah National Park. Numb Photo photo.

Hemlock Woolly Adelgid. Cornell Fungi photo.

Landscape Dynamics

While agriculture and silviculture activities generally do not occur directly within the APPA corridor (land management activities occur and some agriculture leases exist on land owned by NPS), they do occur on lands immediately adjacent to the APPA or are within the viewshed of the APPA and can have significant ecological consequences. Widespread clearing for agriculture and logging for timber have left very few terrestrial systems in the eastern United States untouched. The APPA itself threads through some of the most remote areas in the east, but it is also very close to some of the most densely settled areas within the United States (115 cities with populations greater than 50,000 and approximately 15-20% of the entire United States population lives within 241 kilometers (150 miles) of the APPA). Consequently, the APPA corridor represents a vital north-south connection between otherwise fragmented forests in this region. In comparison to the watersheds immediately surrounding the APPA – defined by USGS 10-digit hydrologic unit codes – the corridor and surrounding land base contains more forested land (92% versus 67%), and less developed and agricultural land (3% versus 9% and 2% versus 20%, respectively). A large and growing body of scientific literature documents the negative impacts of habitat fragmentation on biodiversity in a wide variety of ecological systems (Fahrig 2003), and the APPA is considered an important part of any regional effort to address fragmentation. The impacts of fragmentation have been especially well documented upon avian communities, and population declines of a variety of forest interior avian species are linked to habitat fragmentation (Rich et al. 1994, Austen et al. 2001).

The APPA is also affected by the extensive network of roads that exist in the east. Impacts come from the roads themselves, road shoulders, parking lots, and associated disturbances such as pollutants (e.g., de-icing chemicals) and invasion by exotic species (Brothers and Spingam 1992, Spellerberg 1998). Roads are among the most widespread forms of habitat modification and can have profound effects on wetland communities (Trombulak and Frissell 2000, DiMauro and Hunter 2002, Gibbs and Shriver 2002, Forman et al. 2003). Road construction has been implicated in the significant loss of wetland biodiversity at both local and regional scales for birds, herptiles, and vascular plants (Findley and Houlahan 1997).

Though not traditionally included as part of landscape dynamics, hydrologic alterations are combined with landscape dynamics under the APPA monitoring plan. Hydrologic alterations can be man-induced or natural. Human-induced alterations can come from a wide range of land use practices including installation of culverts, channel alteration, artificial impoundments, or water withdrawals and discharges (Rosenberg et al. 2000). Natural hydrologic disturbances can occur through ecological succession, beaver engineering, sediment transport, severe weather events, and ice scouring and can change the abiotic and biotic attributes of terrestrial, aquatic and wetland systems (Junk and Wantzen 2004, Pollock et al. 2003). Both types of alterations can directly affect aquatic flow regime, flooding, sediment transport and water quality; can affect geomorphology over the long term by dampening peak flows, changing patterns of aggradation and degradation, and stream channel morphology; cause local scour; and can severely

alter suitable habitat for aquatic organisms (Poff et al. 2006). Even small hydrologic changes to small headwater streams can cause the trail to erode, bridges to fail or segments of the trail to flood.

Visitor Use

Visitor use is a key concern for APPA resource managers but poses a great management dilemma as well. One of the APPA Park Office's goals is to increase use of the APPA, but visitation can increase adverse impacts to the resources that NPS is obligated to maintain "unimpaired" for future generations. Specifically, the NPS mission is to "preserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations" (http://www.nps.gov/aboutus/mission.htm). The goal of encouraging use by the current generation can lead to consequences that impair the trail for future generations. For example, high use by visitors can lead to erosion and soil compaction, introduction of invasive species, and general degradation of the experience due to overcrowding in certain locations (Shriver et al. 2005). It is a complex task to balance the NPS mission of preserving resources unimpaired while also promoting increased use of those resources.

Vernon Valley, NJ. Nicholas T. photo.

Chapter 3 - Selecting and Prioritizing Vital Signs

Introduction

The NPS' I&M Program is charged with identifying the key components of park ecosystems that indicate ecological condition and can be tracked over time, and this chapter outlines the process for prioritizing and selecting vital signs, how the APPA EMP decided on the process, and the resulting list of APPA Vital Signs.

Strategy

Before the decision to include the APPA within the NETN, the NETN began selecting vital signs for its parks by establishing a core science team with members representing expertise in forest ecology and vegetation science, aquatic ecology, wetland ecology, herpetology, ornithology, biogeochemistry, conservation biology, and ecological data management. The team collaboratively selected and prioritized vital signs for all NETN parks.

Selecting a set of vital signs for the APPA benefited from the NETN process, though the APPA vital sign selection process ultimately followed a less formal process and involved fewer participants. While the NETN process began with a comprehensive list that was subsequently narrowed, the APPA process began with an acknowledgment that it was not realistic to select vital signs that required extensive data collection. Available and legacy data will form the foundation of the APPA EMP, with data collected by citizen scientists and targeted projects filling identified data gaps.

Vital Signs Selection Workshop

NETN staff organized and hosted a 2-day APPA Vital Signs selection workshop at the National Conservation Training Center (NCTC), Shepherdstown, WV in October, 2004. Meeting attendees (Table 3.1) reviewed a list of available datasets, programs, and a preliminary list of data gaps to produce an initial list of 11 vital signs (Table 3.2) that represented the most important issues to resource managers. This collection of eleven vital signs were identified and discussed in the November 2005 report entitled "Appalachian Trail Vital Signs" (Shriver et al. 2005).

Environmental Monitoring Symposium

In October 2006, NETN helped to coordinate the APPA Environmental Monitoring Symposium at the NCTC. The meeting brought together approximately 70 researchers and managers from agencies, universities and non-governmental organizations to explore the possibility of establishing the APPA as an

Table 3.1 Attendees at APPA Vital Sign selection workshop

Name	Affiliation
Fred Dieffenbach	Northeast Temperate Network
Greg Shriver	Northeast Temperate Network
John Gunn	State University of New York
Jim Comiskey	Mid-Atlantic Network
Shaun Carter	National Capital Region Network
Matt Marshall	Eastern Rivers and Mountains Network
Robert Emmott	Appalachian Highlands Network
Pamela Underhill	Appalachian Trail Park Office
Casey Reese	Appalachian Trail Park Office
Kent Schwarzkopf	Appalachian Trail Park Office
Don Owen	Appalachian Trail Park Office
Michelle Miller	Appalachian Trail Conservancy
Matt Stevens	Appalachian Trail Conservancy
Tonnie Maniero	NPS Air Resources Division
Steve Fancy	NPS Inventory and Monitoring Program

Table 3.2 Selected Vital Signs

Original Title	Current Title
Ozone	Ozone
Visibility	Visibility
Atmospheric Deposition	Atmospheric Deposition
Migratory Breeding Birds	Breeding Birds
Mountain Birds	Breeding Birds
Forest Vegetation	Forest Vegetation
Rare, Threatened, and Endangered Species	Rare, Threatened, and Endangered Species
Invasive Species	Non-indigenous Species
Visitor Usage	Visitor Usage
Alpine and High-elevation Vegetation	Alpine and High-elevation Vegetation
Landscape Dynamics	Landscape Dynamics

environmental monitoring focal point. The symposium helped to form what is now known as the A.T. MEGA Transect, borrowing the name from National Geographic and their "Explorer-in-Residence" Michael Fay. The ATMT is broader than the I&M driven APPA EMP, but the two efforts complement one another. Subsequent to the 2006 symposium, two additional vital signs were added to the APPA EMP: phenology and water quality and quantity.

Fall on the AT in Tennessee. Christopher Gollmar photo.

Vital Sign Prioritization

Following the 2006 symposium several attendees formed the ATMT Coordination Team and met regularly to push the ATMT initiative forward, and by extension help the APPA EMP. One area where the APPA EMP benefitted was vital sign prioritization. The Coordination Team (Table 3.3) reviewed the twelve (12) vital signs selected by the Inventory and Monitoring Program and produced a prioritized list that weighed each vital sign against the following eight (8) criteria:

- Existing project (ongoing, or completed within 2 years)
- Funds available to revise existing protocol or develop new protocol
- Protocol suitable for citizen implementation (existing or under development)
- Ease of implementation
- Cost to implement
- Links directly to management
- Critical need
- Charisma

Table 3.3 APPA Coordination Team members

Name	Affiliation
Laura Belleville	Appalachian Trail Conservancy
Fred Dieffenbach	Northeast Temperate Network
Don Owen	Appalachian Trail Park Office
Nick Salafsky	Fundamentals of Success
Caroline Dufour	Appalachian Trail Conservancy
Pete Irvin	U.S. Forest Service
Marsha McNiff	U.S. Geological Survey
Brian Mitchell	Northeast Temperate Network
Mari Omland	Independent
Steve Paradis	Appalachian Trail Conservancy
Jennifer Shirk	Cornell University
Matt Stevens	Appalachian Trail Conservancy
David Meriwether	U.S. Forest Service

After applying the ranking criteria, the list of vital signs is prioritized as follows:

Phenology
1 Breeding birds
Rare Plants

Visibility
2 Visitor use
Water quality and quantity

3 Forest vegetation

4 Alpine and high-elevation vegetation

5 Non-indigenous species
Landscape dynamics

6 Atmospheric deposition
Ozone

Appalachian National Scenic Trail Vital Signs

Phenology

Climate is a key driver of natural systems that affects system structure, composition, and function, and can help explain changes or variation in other vital signs. Measures of climate such as precipitation and temperature are critical to understanding the ecological condition of aquatic and terrestrial resources and biota (Hynes 1975, Poff 1997). Monitoring basic climate variables will provide a long-term record of the trends associated with climate change. Although park resource managers cannot stop climate change, having information about current and potential changes will enhance their ability to proactively manage. This information will also help them understand whether observed ecological changes are due to climate change or other stressors.

Biotic responses to climate change will likely be one of the most important conservation issues in the coming decades, and phenological shifts (changes in the timing of biological events) are among the most commonly cited changes that might occur as a result. By establishing baseline phenological indictors along the APPA, the APPA EMP will be positioned to document observable biotic responses to climate change. The APPA EMP should be able to offer insight into the early impacts of climate change upon functioning ecosystems, and the APPA EMP will begin to build an awareness of how different species respond to climate change and how their responses may alter ecological relationships and ecosystem functions. As an important first step, the APPA, NETN, Appalachian Mountain Club and the USA National Phenology Network (USA-NPN) have joined forces to develop a phenology protocol that will rely on volunteers and trail clubs to collect data throughout the Appalachian region as well as at other NETN parks. If successful, this effort will become a model phenology monitoring system suitable for large scale implementation.

Juvenile Bicknell's Thrush, VT. Kent McFarland photo.

Breeding Birds

This faunal group provides a useful biotic indicator for the effects of habitat fragmentation and habitat loss, is a highly visible and charismatic group, and is an optimal faunal group to monitor because:

1. Birds are among the most easily and inexpensively detected and identified vertebrates
2. A single survey method is effective for many species
3. Accounting and managing for many species with different ecological requirements promotes conservation strategies at the landscape scale
4. Many reference datasets and standard methods are available
5. Response variability is fairly well understood
6. Management activities aimed at preserving habitat for bird populations, such as for neotropical migrants, can have the added benefit of preserving entire ecosystems and their attendant ecosystem services.

Mountain birds, a specific category of breeding birds, are a primary interest of APPA resource managers. Mountain birds are dependent upon montane spruce-fir forest, an uncommon habitat type in northern New England. Though rare in the region, it is the dominant forest type along approximately 225 kilometers (140 miles) of the APPA in Vermont, New Hampshire, and Maine (Shriver et al. 2005). Montane spruce-fir habitat occurs primarily above 975 meters (3,200 ft) in southern Vermont and as low as 701 meters (2,300 ft) in northern Maine (Lambert and Faccio 2005). Montane spruce-fir forests are dynamic environments

Hikers on the Trail in Maine. Chewonki Semester School photo.

in which steep slopes and shallow soils expose many stands to the damaging effects of wind, ice, and erosion. The variety of age classes that results from natural disturbance provides diverse habitat structure for breeding birds.

Partnering with existing forest, mountain, and other bird monitoring programs provides an opportunity to make inferences about APPA resources from beyond the APPA corridor. This is critically important for the APPA because activities and actions that happen on adjacent lands exert a greater influence on the relatively narrow ribbon of land that comprises the APPA than might be the case for parks with greater land area to perimeter ratios. An example of a regional monitoring effort that combines APPA interests with those on adjacent lands is the partnership with the Vermont Center for Ecostudies to implement a mountain bird monitoring protocol to help guide management decisions affecting mountain bird populations and other natural resources. The protocol (Hart and Lambert 2008) includes Standard Operating Procedures (SOPs) and follows NPS I&M protocol development guidelines. Time and resources permitting, the APPA EMP will look for opportunities to partner with other organizations, universities or agencies to interpret existing data from BBS, eBird, and other programs.

Rare Plants

Between 1989 and 2001 NPS cooperated with each of the fourteen (14) state Natural Heritage programs to document vascular plants and rare or exemplary communities found on APPA lands. The inventories conducted by the Natural Heritage programs were extensive but not exhaustive, documenting approximately 530 total species and 1,750 species occurrences. Each inventory included descriptions and maps of each species occurrence, as well as threats and management recommendations to protect them. Although the majority of the species detected in the inventories are not legally threatened or endangered, many of them are species that are being impacted by various stressors and could provide an early warning of ecological changes. Approximately 22% of all species occurrences have been monitored since the APPA rare plant monitoring program was started in 1999. Monitoring has been qualitative, relying on volunteers to make visual observations to assess plant and population condition. In 2007, the NETN funded a programmatic review of the existing program that resulted in more than 80 recommendations for improvement (Dufour 2008). Following the review, a new protocol was drafted in 2008 that addressed many of the identified concerns (Tierney 2010). The new protocol was tested during 2009 and 2010.

Visibility

Particles in the air from natural sources such as dust and smoke as well as anthropogenic sources such as automobiles and industrial operations are the main causes of visibility impairment. Particles decrease visibility and alter the color at scenic vistas (Malm 1999), and also may adversely affect human health (U.S. Environmental Protection Agency 2006). The particles not only decrease the distance one can see; they also reduce the colors and clarity of scenic vistas (Figures 3.1 and 3.2).

Figure 3.1. Example of a day with good visibility at Great Smoky Mountains NP (courtesy NPS)

Figure 3.2. Example of a day with poor visibility at Great Smoky Mountains NP (courtesy NPS)

The Interagency Monitoring of Protected Visual Environments (IMPROVE) program monitors visibility, primarily in areas designated Class I under the Clean Air Act. The intent is to prevent further visibility degradation in Class I areas and resolve any existing problems.

The APPA passes through six Class I areas with IMPROVE sites: Great Smoky Mountains NP in Tennessee and North Carolina, Shenandoah NP and the James River Face WA in Virginia, the Lye Brook WA in Vermont, and the Presidential Range-Dry River WA and Great Gulf WA in New Hampshire. Additionally, IMPROVE monitoring is conducted at a number of other locations near the APPA. Visibility impairment has been documented at all locations. In 1999, Congress passed the Regional Haze Rule, which requires states to develop and implement plans to reduce pollutants that contribute to visibility impairment in Class I areas. The intent of the program is to improve visibility on the days that are considered the worst, as well as on the days with best visibility. The NPS performed visibility trend analyses for four IMPROVE sites near the APPA (Table 3.4). Three locations show statistically significant improvements – for Great Smoky Mountains NP and Dolly Sods WA, the improvement is on the worst days, and for Lye Brook WA the improvement is on the best days. The APPA EMP will continue to rely on existing data and analyses for reporting this high-priority vital sign.

Visitor Use

Visitor impacts rated a high priority designation due to the clear management implications of this fundamental park issue. Significant impacts result from trampling and removal of resources, erosion, and general disturbance. Some parts of the APPA are more heavily visited than others, and balancing between maintaining an unimpaired visitor experience and encouraging more people to visit and explore the APPA is complicated.

Monitoring visitor use is more than simply counting the number of visitors. Visitor impacts directly and indirectly cause soil compaction, loss of organic litter, loss of mineral soil, loss of vegetative ground cover, damage to trees, loss of sensitive species, habitat alteration, introduction of exotic species, modification of wildlife behavior, and altered water quality (Marion and Wimpey 2010). Understanding the problem involves assessing the intensity of visitors, location of visitor use, and activities of visitors (e.g., walking and resource removal). For the APPA one of the complicating factors is the reality that there are hundreds of unmonitored access points. Difficulties notwithstanding, several researchers have expressed an interest in developing procedures to assess and monitor visitor impacts along the APPA, and the APPA EMP has actively supported several funding proposals aimed at developing a methodology to monitor visitor use. Until funding is obtained to develop an appropriate protocol, the APPA EMP will not independently develop a methodology.

Water Quality and Quantity

Water chemistry is an essential component of any long-term aquatic monitoring program (Gilliom et al. 1995). Water chemistry is widely applicable, is critical for interpreting the biotic condition and ecological processes of park aquatic resources, and affects the

bioavailability of contaminants and the metabolism of aquatic species. Water quality parameters are sufficiently well known that abnormal conditions and trends can be recognized or determined statistically.

Water quantity measures can be used to describe the physical extent and volume of aquatic habitat within a water body, and are affected by factors including: precipitation, evapotranspiration, water withdrawals, ground water recharge/discharge, and climate change. Without basic hydrologic information, it is not possible to accurately interpret the condition of any water resource. Thus, water quantity is an important component of water resource monitoring.

Fish species richness and composition was not identified as a high priority vital sign, but certain "marquee" fish species are symbolic of healthy aquatic resources and serve to integrate the condition of these resources through time (Tonn et al. 1983, Gurtz 1993). Throughout the Appalachian region, brook trout (Salvelinus fontinalis) are regarded as a marquee species and significant resources are directed toward protecting brook trout habitat. Programs such as the Eastern Brook Trout Joint Venture (EBTJV) have helped to highlight these resources and have

Brook trout. NPCA photo.

compiled a large body of data that help to establish a baseline for evaluating the water resources specific to the APPA and may offer collaborative opportunities.

Partnering with existing water quality monitoring organizations is an appealing option for the APPA EMP. There are approximately 480 organizations that maintain some degree of interest in a watershed that intersects the APPA, and during 2010 the APPA EMP determined that nearly 100 were willing to either share their data, expand their activities to include waters that intersect the APPA, and /or work with volunteers

Table 3.4. Trends in visibility at four IMPROVE sites near the Appalachian NST (in Mm-1)[1]

	Great Smoky Mountains NP Tennessee		**Shenandoah NP Virginia**		**Dolly Sods Wilderness Area West Virginia**		**Lye Brook Wilderness Area Vermont**	
	Best Days[2]	Worst Days[2]	Best Days	Worst Days	Best Days	Worst Days	Best Days	Worst Days
1994	31	214	24	213	23	230	-	-
1995	29	189	28	186	29	200	11	109
1996	38	203	32	164	34	154	12	82
1997	35	193	27	156	32	167	12	105
1998	32	216	-	-	24	180	10	107
1999	35	190	21	138	31	155	11	103
2000	35	175	23	144	30	149	9	91
2001	29	186	30	160	31	150	9	121
2002	33	172	24	174	26	150	9	119
2003	26	173	19	153	25	159	8	101
Slope	-0.49	-3.91[3]	-0.49	-4.25	-0.46	-5.89[3]	-0.51[3]	1.67

Notes:

[1] Particle concentration in the air and reduced visibility is correlated with light extinction. Light extinction is reported in inverse megameters (Mm^{-1}) with higher values equating to greater extinction.

[2] Best Day represents the average of the 20% clearest days for a location, while worst days are the 20% haziest days for a location.

[3] Statistically significant trend (courtesy NPS Air Resources Division)

Oak-Hickory forest in southern NJ. Miguel Vieira photo.

interested in monitoring APPA water resources. Another option for assessing the health of APPA water resources is to periodically acquire data for the region from existing databases such as STORET and NWIS. The USGS is currently completing a review of APPA water resources using data available from these as well as other sources and subsequent reviews are possible. The APPA EMP recently worked with the Appalachian Trail Park Office (ATPO) on a proposal to develop a system that would automate the data acquisition process.

Forest Vegetation

Forest vegetation was identified as a high priority vital sign because forests are the dominant ecological communities associated with the APPA. Forests along the northern sections of the APPA, from Maine through the higher elevations of New Hampshire and Vermont, are dominated by spruce-fir and northern hardwood forests. As the trail passes through Massachusetts and Connecticut, northern hardwood forest types transition into central hardwood forests where species like hickory and oak replace maple and birch. Further south through the Hudson Valley, the APPA is primarily located on ridgelines where oak-hickory forests are dominant. In the southern Appalachians, the spruce-fir forests are dominated by populations of red spruce (Picea rubens) and Fraser fir (Abies fraseri). The forests of the Southern Appalachians are similar to the boreal forests found in Maine and eastern Canada but are located at higher mountain elevations (greater than 1,220 m or 4,000 feet).

The Appalachian Mountain forests face a number of threats including air pollution, human encroachment, invasive species, and climate change. Over the past two decades, Appalachian ecosystems have exhibited indicators of stress and many forest species may be declining. Recent studies of high-elevation spruce-fir forests have shown high levels of tree mortality, decreases in crown condition, and declining growth rates for both the spruce and fir populations (Shriver et al. 2005). For example, a large decline of the Fraser fir is believed to be related to infestation by an introduced pest species, the balsam woolly adelgid (Adelges piceae; Shriver et al. 2005). It appears likely that regional air pollution is detrimentally affecting the spruce populations and may be an additional stressor contributing to the decline of the fir populations (Hain and Arthur 1985).

It is not realistic to develop a new or independent APPA forest vegetation monitoring program when the USFS already operates extensive programs to assess forest resources on a large scale basis. Interpreting data that is routinely collected through the USFS' Forest Inventory Analysis (FIA) and Forest Health Monitoring (FHM) programs is the most realistic way to assess the health of the APPA forest resources. The FIA program (in 1999 FIA and FHM were consolidated and the resulting program is now referenced just as FIA) collects data from a national array of plots and is summarized annually on a number of levels, including county and statewide. The APPA EMP is currently working on a project to develop an APPA data assessment system, with the goal of developing a process specific to the APPA that can be repeated at regular intervals using readily available FIA data.

Alpine and High-elevation Vegetation

The alpine plant community, consisting of vegetation growing above tree line, is one of the rarest and most significant community types in the eastern United States, found on less than one percent of the land in the Northeast (Shriver et al. 2005). Alpine vegetation is found on the summits of only a few of the highest peaks in Maine, New Hampshire, Vermont, and New

York; yet a significant portion of this limited alpine acreage lies within the APPA corridor. In fact, the alpine areas of the APPA corridor in New Hampshire and Maine represent the only alpine areas that are within an NPS unit in the eastern United States.

The floristic community found in the APPA alpine zone contains more than 60 true arctic-alpine species, composed primarily of low-growing shrubs, cushion plants, and graminoids. Many of the plants in the alpine zone are state threatened or endangered, and several species, including Robbins cinquefoil (Potentilla robbinsiana), Boott's rattlesnake root (Prenanthes bootii), and mountain avens (Geum peckii), are globally imperiled. Most of the alpine species, while rare along the APPA, are more widespread in arctic regions of the globe.

High-elevation plant communities in the "Southern Appalachian Assessment Area" (a mountainous area from northern Virginia to northeast Alabama) include 26,535 ha (65,570) acres of montane spruce-fir forest (SAMAB 2006). This southern high-elevation forest is dominated by red spruce (Picea rubens) and Fraser fir (Abies fraseri). Examples of the southern Appalachian red spruce-Fraser fir forest may be found in the Great Smoky Mountains (NC/TN), Balsam Mountains (NC), Black Mountains (NC), Roan Mountain (NC/TN), Grandfather Mountain (NC), and Mt. Rogers/Whitetop (VA). The southern Appalachian spruce-fir forest has been severely threatened by multiple factors including exotic species infestations, air pollution, habitat degradation, rising soil temperatures, and decreasing soil moisture. Acid deposition, comprised mainly of sulfur and nitrogen compounds that increase the concentration of hydrogen ions at high elevations, greatly exceeds concentrations found at lower elevations and strongly affects fragile alpine vegetation.

The Appalachian Mountain Club (AMC) has already begun monitoring alpine vegetation under their MountainWatch program. The APPA EMP intends to partner with AMC to adopt and expand their methodology.

Non-indigenous Species

The presence and extent of invasive non-indigenous species (NIS) is a critical management concern to APPA resource managers, and timely identification and removal of new invasive species is a high management priority. However, managing invasive NIS along the APPA is made difficult by the long and narrow configuration of the resource, and the fact that a clear strategy to understand the scope of the problem has never been developed. To effectively manage the problem along the APPA, managers must rely upon the large volunteer and partner community.

Invasive NIS are a significant and growing stressor with clear ecological relevance to terrestrial systems along the entire APPA. Numerous groups of invasive NIS are of concern along the APPA, including terrestrial and wetland plants, insect pests and pathogens, earthworms, and aquatic fauna (Shriver et al. 2005). Remote sensing and targeted presence/absence surveys for particular invasive species are good "first line" ways to identify invasive and exotic species along the APPA. Lists of NIS with the potential to invade the APPA already exist in most states and some counties, and NIS surveillance and monitoring will be integrated into APPA protocols (Underhill et al. 2010).

The ATC and the ATPO view invasive NIS to be among their highest priorities and have already

Alpine zone along Maine's AT. Chewonki Semester School photo.

Feeding pattern of Emerald Ash Borer larvae. J. C. Lucier photo.

devoted considerable resources to inventory invasive species in select areas. A compelling reason for their interest is the availability of volunteers to collect data. For these reasons, the APPA EMP has begun working with ATC and ATPO to develop a NIS detection methodology that combines into a single document techniques suitable for incidental observations as well as stratified random sampling techniques.

Landscape Dynamics

Land cover data provide key information on the extent of ecological systems, integrating that information across multiple spatial scales. Land cover change was identified as a high priority issue for APPA resource managers due to concerns arising from the negative effects of habitat conversion adjacent to park boundaries – a significant concern for the APPA, with its relatively low land area to perimeter ratio that makes it especially vulnerable to outside activities.

The APPA is the focus of a recent National Aeronautic and Space Administration (NASA) grant to integrate satellite imagery with readily available Geographic Information System (GIS) data, ecological models, and project-specific data to produce an improved Decision Support System (DSS; Wang et al. 2008). The work is being lead by researchers at the University of Rhode Island and is destined to form the technological "backbone" that will support the entire APPA EMP. Landscape information is one of the main deliverables of the project.

Atmospheric Deposition

Atmospheric deposition is a stressor to terrestrial and aquatic systems along the entire length of the APPA, and has been implicated in the decline or degradation of many ecological systems in the region. Estimates of atmospheric deposition are critical for understanding water chemistry and stress (Likens and Bormann 1974). Swain et al. (1992) estimated that 90% of the mercury entering remote lakes in Voyageurs National Park (Minnesota) is derived from atmospheric deposition. Acidic deposition stresses terrestrial vegetation and alters system functioning and biogeochemical cycles. Compiling acidic deposition data is important for any long-term monitoring program because this stressor has demonstrated negative effects on aquatic systems and can alter ecological function and biogeochemical processes. The APPA EMP will work closely with the NPS Air Resources Division (ARD) to acquire data from the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) and summarize these existing data to interpret changes at the park level.

In addition to the programmatic resources available for the APPA Region, the USGS and the NPS ARD jointly launched a study in 2010 to evaluate the recovery rates of high elevation, historically acidified soils (Lawrence 2010). The project is comprised of a network of intensive, moderate and simplified study sites that pair soil, forest vegetation and water sampling. The project will span three (3) years, but the APPA EMP anticipates using the methodologies developed for this project to provide context and direction for future atmospheric deposition monitoring along the APPA.

Ozone

Ozone pollution is an important stressor of terrestrial vegetation with clear ecological and human health relevance. Atmospheric ozone concentration data is available from the Clean Air Status and Trends Network (CASTNET) network and other sources, and need only be acquired and summarized for the APPA. While the existing array of monitors are not necessarily representative of conditions on the Trail because of differences in elevation and meteorology, the sites provide a general indication of regional ozone concentrations (Shriver et al. 2005).

Summary

The list of APPA vital signs was selected based on first hand knowledge, expert opinion, discussions with resource managers, management needs, and feasibility of implementation. These vital signs represent an integrated list of ecological processes, elements of biotic and abiotic condition, system drivers and stressors, landscape condition, and focal park resources. Moreover, these vital signs are directly relevant to APPA natural resource management issues. The vital signs list provides a peer-reviewed, prioritized set of monitoring categories that guides the APPA EMP.

Hazy view along the trail in the Great Smoky Mountains. Anthony Strange photo.

Chapter 4 - Monitoring Approach

Introduction

Monitoring requires repeated measurements, preferably of permanently established plots or sampling locations, and while the NPS I&M Program was created to provide natural resource monitoring data and information at park or sub-park levels, program designers did not set this objective with the APPA in mind. The conformation (i.e., length and width) of the APPA makes data interpretation at scales smaller than regional level difficult or even impossible, and for all but a few select areas of interest (e.g., rare plants), repeat measurements along the APPA are impractical. This is due to the reality that administering a large landscape scale monitoring program is expensive and resource intensive, and the APPA EMP is unable to afford that expense. Consequently, the APPA EMP will mainly rely on data collected by other programs, agencies, parks and individuals and use these data to assess resource condition. Where those programs repeatedly monitor permanent plots (e.g., the USFS FIA program) the APPA EMP will have access to conventional monitoring data, but in many instances that will not be possible.

Spatial and temporal scales of inference are a primary consideration in developing a monitoring program. However, for a program that intends to rely primarily on existing data and data acquired opportunistically, developing a comprehensive sample design that is intended to direct the acquisition of new I&M monitoring data seemingly has little value. The plan to rely primarily on available data notwithstanding, there are going to be times when a sampling approach will aid projects proposed by other entities, and in those instances the APPA EMP will encourage sampling site co-location and use of similar methodology to strengthen our ability to interpret these data and make statistical inferences. To promote this strategy, the APPA EMP has developed a recommended sampling framework for the APPA that supports inferences at the regional level and, where possible, at a more localized scale. The strategy is "recommended" because many of the projects that will occur on the APPA are not directed or controlled by NPS and therefore NPS will have limited influence over these projects outside the permitting process.

Consequently, it is not always possible to mandate the use of a particular sampling strategy because our objectives may not align with the objectives of an individual project that the APPA EMP does not fund. Nonetheless, the availability of a well conceived, robust sampling framework will proactively address many of the problems investigators have historically encountered when working on the APPA, and the APPA EMP anticipates that many investigators will readily adopt the recommended approach.

Sampling Concepts

Probability-based Versus Judgment Sampling

There are two main categories of sampling designs: probability-based and judgmental. Probability-based

The Appalachian Trail from Maine to Georgia

AT along NC-TN border. McDowell Crook photo.

designs apply sampling theory and involve random selection of sampling units. Each member of the sampled population has a known probability of selection. These designs allow for statistical inferences to be made about the sampled population based on data obtained from the sample units.

An alternative to probability-based sampling is judgment sampling. Judgment sampling involves the selection of sample units based on the expert knowledge of professionals. Judgment sampling designs can be less expensive and easier to implement than probability-based designs, but these design methods are limited in their ability to evaluate the precision of estimates, and inferences can not be made outside of the areas actually sampled. Conversely, when using probabilistic sampling, quantitative analyses can be used to draw conclusions about the larger, target population. Whenever possible, the APPA EMP advocates the use a probability-based sample design for projects occurring on the APPA to ensure that inferences can be made beyond the area actually sampled. The most notable example of judgment sampling program on the APPA is the rare plant monitoring program that relies on expert judgment for determining sampling locations.

Random Versus Systematic Sampling

How a sample is selected from the population greatly influences the precision of the estimates, the cost of implementation, the complexity of the analyses, and the long-term flexibility of the monitoring program. There are many ways to select a sample and the appropriate methodology primarily depends on the objectives of the monitoring program and the spatial and temporal scales of inference.

Generally, there are a few basic types of sample designs and multiple variations on these types. For example, a simple random (or non-stratified random) sample is a method in which sample units are selected from a population using a completely random process, such that all sample units have the same probability of being selected. Selecting a simple random sample is relatively easy but may not be spatially balanced, and priority resources may not be included in the sample. A systematic sample generally employs a grid-based approach or a series of uniformly spaced points, and ensures spatial balance by requiring sampling at every point on the grid. The main drawback with this approach is that some ecological phenomena are spatially periodic, and a systematic sample will be inappropriate when ecological heterogeneity occurs with similar spacing as the systematic grid.

Generalized Random Tessellation Stratified (GRTS) sampling is a recently developed technique that combines a simple random sample and a systematic grid sample (Stevens 1997, Stevens and Olsen 2004). Points selected with the GRTS algorithm are ensured of being spatially balanced and randomly located. GRTS produces an ordered list of sampling locations and can select many more locations than are actually needed for a given protocol. If a particular location does not meet the sampling criteria, then the next location on the list is used instead, and the spatial balance of the sampling design will be maintained. In addition, the GRTS sampling method allows for sample size adjustments that maintain the overall spatial balance. This aspect of GRTS sampling allows for tremendous flexibility. For example, a power analysis several years into a program may reveal that the monitoring goals can be met with fewer plots, and the GRTS algorithm makes it clear which plots should be removed in order to meet the revised goals and maintain the geographic distribution of plots. The APPA EMP encourages the use of GRTS-based sampling.

Stratified Versus Non-stratified Sampling

An alternative to a non-stratified sample that would force sample units into specific, pre-defined groups is a stratified sample. In stratified sampling, a sampling frame is divided into mutually exclusive strata and samples are selected from within each stratum (Levy

and Lemeshow 1999). Benefits of stratified sampling designs include increased precision, increased efficiency, and greater information about particular subpopulations (Lohr 1999). For increased precision, strata are typically selected such that variation among units from the same strata is less than variation among units from different strata. The major problem with stratification is in defining the strata that will be appropriate over long time periods.

One major reason for using stratification is when there is high interest in stratum-specific analyses and reporting of change. In other words, stratification should be used when each stratum is of interest. Stratified random sampling designs typically allocate equal amounts of sampling effort to each stratum. This ensures that there are adequate sample sizes in each stratum for precise estimates or powerful tests of change. Equal allocation of sampling effort among strata also compensates for the inadequate sampling of rare classes that occurs under simple random or systematic sampling designs. However, equal allocation means that sample units in different strata may not have the same probability of selection (unless the strata happen to have equal areas).

Another important reason for using stratification is when a particular stratum is rare and could be missed by systematic sampling. In this case, equal allocation of effort is not critical, and stratification serves to ensure that the rare stratum is adequately sampled.

Stratification is common for projects along the APPA because it helps partition the trail into meaningful components. This may be necessary to realistically constrain the size of a study area, or as mentioned above to focus on specific resources that are found only within certain defined "zones." The HUC10 segment intersection file is an example of a stratification based on watershed. Other examples of stratification might include land areas above a specified elevation, within certain states, or areas characterized by certain vegetation communities.

In the end, the decision to stratify is a trade-off between precision and flexibility of future analyses and grouping.

Generic Sampling Frame

The APPA is approximately 3,510 km (2,180 miles) long and nominally 305 m (1,000 feet) wide. The conformation, landscape position (i.e., generally close to the spine of the Appalachian Mountain Range), and orientation (i.e., north to south) create sampling challenges but also make the APPA an ideal location to conduct ecological research. This is the rationale behind the creation of the ATMT program. The purpose of the ATMT is to entice professional and citizen scientists to conduct research and collect data that will help describe the condition of resources along the APPA and throughout the APPA region. To promote and support this objective the APPA EMP has developed the APPA Sampling Pack that is intended to solve complicated sampling questions. The Sampling Pack consists of GIS datasets that help describe the APPA region and define an area of interest around the APPA within which a "ready made" set of random sample points are located.

HUC10 shell

The HUC10 shell establishes the distal boundary of all HUC10 hydrologic units that are within 5 miles of the APPA land base (see Chapter 1, Frame of Reference). Though they are sometimes termed watersheds, Omernik (2003) explains that hydrologic units are not always true watersheds and the APPA EMP acknowledges that some hydrologic elements contained within the HUC10 shell may not include all upstream components of a true watershed. However, for the purpose of defining an area of interest the APPA EMP believes the hydrologic unit system is satisfactory (see Chapter 1, Frame of Reference).

GRTS 2 Mile

The GRTS 2 Mile layer contains nearly 800,000 randomly placed sampling points within 3.2 km (2 miles) of the APPA land base. Point locations were determined by the Generalized Random Tessellation Stratified (GRTS) algorithm, which ensures a spatially balanced random sample. The 3.2 km (2 mile) buffer was chosen because the APPA EMP wanted an array of points that went sufficiently outside the current land base to accommodate any future trail relocations. Two miles is believed to be far enough that few if any trail relocations would occur beyond that limit.

GRTS Centerline

The GRTS Centerline contains 75,000 points randomly placed on the centerline of the APPA as it existed in May 2010. Like the GRTS 2 Mile file, points were established by the GRTS process.

HUC10 Segment Intersection

This file partitions the land area surrounding the APPA into 'segments' based on the overlap between the APPA land base (land owned or administered by the APPA) with individual HUC10 hydrologic units (Figure 4.1). The file contains 177 segments ranging in area from ~ 4 to ~ 2,185 hectares (~ 10 to ~ 5,400 acres). Because a large portion of the APPA follows regionally high elevation ridgelines, the APPA footpath frequently follows the breakpoint between adjacent hydrologic units. Consequently, the segments created by the intersection of the land base and the APPA HUC10 hydrologic units often divide the APPA land base laterally as well as transversely.

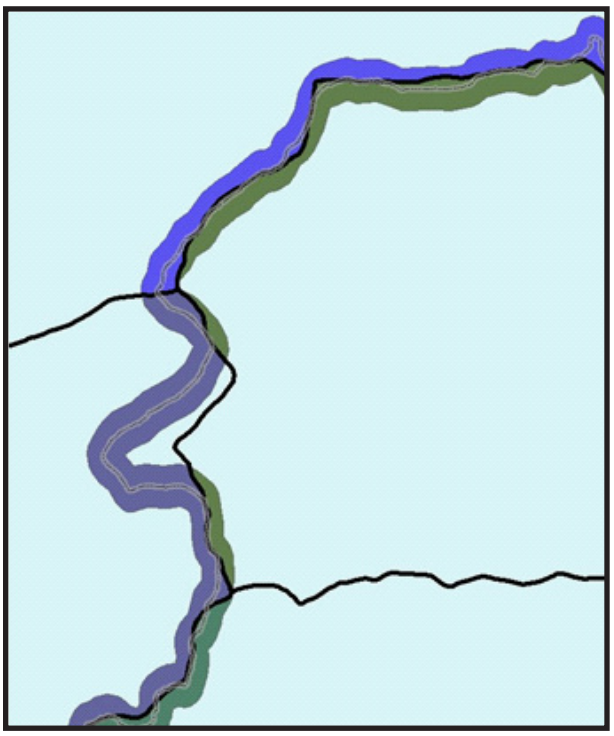


Figure 4.1 APPA land base divided into segments

GRTS HUC10 Centroids

This file contains centroid points for each of the 177 HUC10 hydrologic units that are within 8 km (5 miles) of the APPA land area. To each of these points the APPA EMP added a randomly generated ID using the GRTS process. This provides users with the ability to randomly select hydrologic unit segments along the APPA for their projects.

Co-location of Vital Signs

An advantage of the "ready made" sampling pack the APPA EMP has developed is the co-location of sampling whenever possible. While this is theoretically possible, many projects are geographically constrained so even if there is intent to sample at common locations the opportunity to do so may be precluded by geographic separation or project design. For the APPA there is both a benefit and concern about co-locating sampling. The benefit, as stated above, is that the power of data acquired from multiple studies at the same location is greatly increased and the cost to sample a site might be reduced. However, concern exists about physical impacts to the resource that might occur as a result of multiple visits. Minimizing the number of people present during a visit and the number of revisits, and reducing the amount of movement at a site during a visit are important considerations.

Summary

Although the APPA EMP does not have sufficient resources to implement and sustain a series of new monitoring projects at the scale of the APPA, it is nonetheless important to prepare a sampling strategy to support and direct projects proposed by others for implementation along the APPA. This is important to ensure the scientific merit of all work performed along the APPA, to promote consistency within the scientific community, and to ensure the greatest utility of data derived from these projects.

The APPA EMP strongly encourages the use of GRTS sampling, with co-location of multiple vital sign sampling sites at permanent plot locations. This approach will give us the ability to maintain the flexibility of statistical analyses, including the ability to associate data from multiple vital signs for more powerful statistical inference. GRTS sampling also allows us to maintain spatial balance if future power analyses or budget changes require us to adjust sample sizes up or down.

View from Ten-mile River Lean-to, CT. McDowell Crook photo.

Chapter 5 - Monitoring Projects and Protocols

Introduction

Monitoring protocols identify specific methods for gathering, analyzing, interpreting, reporting, and storing information related to park natural resource conditions and changes in condition over time. Monitoring protocols are stand-alone documents that include a narrative and standard operating procedures (SOPs) that are intended to promote consistency in data collection and management thereby ensuring that changes detected by monitoring are real and not an artifact of differences in methods or observers (Oakley et al. 2003).

For the APPA EMP, a program that will rely extensively on extant monitoring data, we plan to identify a series of "preferred" monitoring protocols and will develop a limited number of new protocols. Like a traditional monitoring program that is designed to collect new data, monitoring protocols are important for a program that relies on available data to promote sound science and policies for projects proposed by independent researchers and other agencies. A summary of the protocols the APPA EMP is developing or endorsing are listed below.

Protocols Being Developed

Non-Indigenous Species

Objective:

- Detection of non-indigenous species

Invasive non-indigenous species have been introduced to areas along the APPA and other natural areas by humans, animals, wind and water. Great concern is focused on the possibility that hiking-related activities or management practices may inadvertently transport invasive species along the footpath and further into interior areas where they do not presently occur. APPA resource managers have sought ways to understand the extent of the invasive species problem along the APPA and to date have relied exclusively on point observation data. Point data can provide valuable information, but is difficult to extrapolate to the entire land base because observations are always done in a non-random fashion in the immediate vicinity of the APPA.

During 2010, APPA resource managers worked with USFS resource managers on a project to determine the extent to which invasive species had penetrated a wilderness area. Results from the study are not yet available but the methodology used was similar to prior APPA invasive species studies – non-random and in the immediate vicinity of the footpath. In response to the USFS project, the APPA EMP held a discussion during November 2010 to debate the merits of point observations versus stratified random sampling. In response to the November meeting, the APPA EMP began development of an invasive species detection protocol that combines the point observation recommendations contained in the NETN Invasive Species Early Detection Protocol (Keefer et al. 2010) with stratified random survey methods. The draft APPA invasive species detection protocol will be completed in advance of the 2011 field season.

Rare Plants and Exemplary Communities

Objectives:

- Detect change in population size and vigor of monitored species
- Document potential threats to species from management actions, recreation and invasive species.

In 1989, the ATPO and ATC began a program to monitor sites that supported populations of rare plant species or unique communities. Because insufficient resources were available to monitor all sites, sites were selected for monitoring based on perceived degree of threat, species rarity, accessibility, and on recommendations from individual state natural heritage programs. Most rare plants identified for monitoring were understory herbs, but trees, shrubs, vines, ferns, grasses, sedges, and at least one non-vascular plant have all been monitored.

In 2007, the NETN funded a programmatic review of the existing rare plant monitoring program that resulted in more than 80 recommendations for improvement (Dufour 2008). Following the review, a new protocol was drafted in 2008 that addressed many of the identified concerns (Tierney 2010).

The new rare plant protocol was tested during the 2009 and 2010 field seasons. Prior to the 2009 field season NETN staff conducted a workshop with

Gray's Lily, Roan Highlands, East Tennessee. Jon Ericson photo.

program leaders, and prior to the 2010 field season the APPA EMP thoroughly evaluated all comments and recommendations with a subset of users and program managers and made necessary protocol improvements.

Unfortunately, the 2010 field season proved problematic because few field visits were initiated and very little data were collected. Though it had been our intent to monitor rare plant resources along the APPA at the start of the 2010 field season, changes in priorities and resource availability prevented that from happening.

During November 2010, APPA resource managers met to discuss a variety of issues including the future of the rare plant monitoring program. The value of the new protocol notwithstanding, resource managers acknowledged that data collected during recent years has diverged progressively from data available from the originating state natural heritage programs and that sustaining an independent APPA-centered rare plant monitoring program was no longer possible. Managers decided to re-prioritize all rare plant occurrences, determine which are actively monitored by others entities, and identify a select few rare plant occurrences to which limited resources will be directed.

The new rare plant monitoring protocol will be submitted for external review during 2011.

Phenology

Objectives:

- Detect changes in phenology of selected focal taxa and habitats, particularly focusing on populations occurring near the edge of species' ranges. Specific metrics may include: tree leaf-out dates and growing season length, flowering dates for herbaceous species, spring arrival dates for bird species, spring calling dates for frog species, spring emergence for insect species, and ice-out dates for lakes
- Detect changes in phenology of key invasive exotic species likely to benefit from climate change. Specific metrics may include: flowering phenology of invasive exotic plant species and emergence phenology of invasive exotic insect species
- Determine the magnitude of phenological change by comparing and contrasting current measurements to historical records and modeling efforts

Phenology is the study of the timing of biological events, with plant flowering, fall foliage, and bird migration being familiar examples. A growing body of evidence indicates that climate change has already altered phenological patterns of a wide variety of organisms including terrestrial plants, birds, amphibians, insects, and aquatic algae (Parmesan and Yohe 2003, Root et al. 2003). Notably, the northeastern United States has seen greater warming over the last century than most other regions of the country and these altered phenological patterns may have far-reaching consequences. Research shows that responses to climate change will vary among species within an ecosystem; thus responses to climate change such as altered timing of bud break, migration, or reproduction may alter competitive interactions and uncouple food webs and mutualistic relationships.

Phenological patterns such as flowering, amphibian calling, migration, and foliage are familiar to most people, but the desire to formally monitor phenology is a relatively recent phenomenon in the United States. The APPA has a large volunteer audience, and it is the availability of this volunteer workforce as well as the large hiking community that makes monitoring phenology along the APPA so appealing. The APPA EMP initially considered developing a phenology monitoring program specific to the APPA but shortly after initiating that process the APPA EMP accepted an invitation to collaborate with the USA-NPN and the AMC. AMC had already begun monitoring phenology in northern New Hampshire through their Mountain Watch Program, while the USA-NPN was interested in developing a "prototype" phenology monitoring program that would become a national model. The APPA EMP has agreed to work with the USA-NPN on the new protocol, will serve as a pilot monitoring location, will deploy a series of monitoring locations, and will enlist volunteers to become phenology monitors.

Mountain Watch in action. Amy Damon Grover photo.

Forest Vegetation

Objectives:

- Semi-quantitatively assess condition of trees by species.
- Determine status and trend in quantity and composition of tree seedling establishment in forest understory.
- Determine most common species
- Estimate status and trend in snag abundance and size class distribution
- Detect status and trend in tree growth and mortality
- Determine status and trend in coarse woody debris
- Document extent of pest and foliage problems
- Detect status and trend in live basal area

The region through which the APPA passes is predominantly forested but includes many open fields and exposed rocky areas. Key stressors include land use change and habitat fragmentation on lands surrounding the APPA corridor.

Monitoring forest vegetation along the APPA will be accomplished through periodic reviews of existing FIA (and FHM) data available from the USFS, through data collected as part of a NASA funded DSS developed by the University of Rhode Island, and using applications such as the "Forest Health Aerial Survey Viewer" (http://na.fs.fed.us/fhp/ta/av/index.shtm).

1. Analysis of existing FIA data: The USFS FIA program is a national program that tracks the status and trend of forest resources throughout the country (U.S. Forest Service 2010). Approximately 4,850 FIA plots are located within the HUC10 shell surrounding the APPA and data for these plots are freely available. Evaluating existing FIA data will rely on a Microsoft Access database that extracts and integrates data from each of the 14 states through which the APPA passes. The current version of the analysis system incorporates 24 separate analyses that organize and present data by ecoregion (province, section and subsection).
2. NASA DSS: The APPA EMP used the 177 segments created by overlapping the APPA lands with the HUC10 hydrologic unit boundaries, and grouped them according to elevation and 10 were randomly selected from this subset to represent high elevation segments. Forest monitoring for the NASA DSS began in New England during 2010 where 4 segments were identified. The methods described in the NASA DSS forest protocol are derived from the NETN Forest Health Protocol (Tierney et al. 2010).
3. Forest Health Aerial Survey Viewer: Part of the USFS's Forest Health Protection program, the

aerial survey viewer integrates information on forest health from several cooperating agencies and presents it in spatial format. The aerial viewer gives managers the ability to identify areas that are affected or damaged in some fashion, and the likely cause of the problem.

Landscape Dynamics

Objectives:

- Determine changes in land use and ecological cover types within and adjacent to the APPA.
- Quantify trends in relevant land use and cover metrics, including habitat conversion and loss, fragmentation, and reduction in functional ecosystem size (e.g., core area).
- Establish correlations between land use and land cover trends and trends in monitoring data by analyzing land change derived from long-term monitoring plots

Adjacent land use and development is a primary concern for APPA resource managers. Long-term monitoring of landscape-level indicators that represent the ecological impacts of land use changes may help managers determine patterns that may eventually threaten park ecological integrity.

The APPA is currently working with researchers at the University of Rhode Island under a NASA grant that will integrate available satellite imagery with on-the-ground data. Land cover and land use are key elements of this project and will inform decisions about buffer sizes and imagery for long-term monitoring of land use and land cover.

Water Quality and Quantity

Objectives:

- Characterize the health of "typical" APPA water resources using readily available data such as acid neutralizing capacity (ANC), pH, and alkalinity
- Detect trend in condition of "typical" APPA water resources using available data such as acid neutralizing capacity (ANC), pH, and alkalinity

Water quality and quantity together help determine the condition and trend of APPA water resources. Water quality helps establish the chemical, biological, and physical condition of a resource while water quantity determines the extent and volume of aquatic habitat.

Cooper Brook, ME. Rebecca Sudduth photo.

Both are required for a complete understanding of resource condition.

Water quality monitoring is a popular scientific activity and resource managers have historically run water quality programs on the APPA using volunteers. Past efforts have largely been opportunistic with little attention given to resource importance.

In an effort to better understand the water resources that characterize the APPA region, the APPA EMP entered into an agreement with the USGS to evaluate existing water quality data from the HUC10 shell region. The USGS report, due in early 2011, will help to characterize APPA water resources in ways not previously possible and will help identify particularly valuable water resources.

Conducting periodic "follow-up" water resource analyses is desirable but not currently realistic. In December 2010, the APPA submitted a funding request to help develop a process that will enable

resource managers to identify and review data collected since the initial USGS review.

Existing Long-term Programs

The following projects are either established or have been developed by other entities, and will be used by the APPA EMP to address several vital signs. Whenever data from existing programs are used, the APPA EMP will develop a detailed SOP describing data acquisition, data management, and reporting. The SOPs and associated databases and report templates will facilitate regular acquisition and reporting of APPA vital signs data.

Atmospheric Deposition

Objective:

- Determine changes in the deposition of pollutants including, but not limited to, sulfur dioxide, nitrogen oxides, ammonia, and mercury at index sites along the APPA

Atmospheric pollution, in the form of acid deposition, significantly impacts ecological systems in complex ways that vary across the landscape. Acidic deposition acidifies soil and water, leaching base cations (e.g., Ca2+, Mg2+ and K+) from the system and increasing the availability of aluminum (which is toxic). These biogeochemical changes can cause the decline or dieback of sensitive terrestrial species, such as red spruce and sugar maple, in addition to decreasing the richness and abundance of zooplankton, macroinvertebrates, and fish in downstream aquatic and wetland ecosystems (Driscoll et al. 2001b).

The NPS monitors wet deposition through the NADP. NADP started in 1978 with 22 monitoring sites and now has over 240 sites nationwide, providing the only long-term record of precipitation chemistry in the United States. The NADP is a cooperative effort between federal and state governments, universities, and private organizations. The NPS monitors dry deposition through the CASTNET. CASTNET started in 1987 with 50 monitoring sites and has grown to over 70 sites nationwide. The network monitors dry deposition, ozone, and meteorology. The primary purpose of CASTNET is to determine the effectiveness of national emission control programs.

The APPA EMP will synthesize and present information from NADP and CASTNET sites to APPA resource managers.

Breeding Birds

Objective:

- Measure the annual population status and trend of ten target species in terms of distribution, abundance/density, and occupancy
- Relate population status and trend information to biotic and abiotic variables that may affect the target species

Breeding bird data can help identify the effects of habitat fragmentation, an ecological issue of great importance to the APPA. Within this group, mountain birds are a primary concern because so much of the APPA is within the montane spruce-fir forest. Montane spruce-fir forest is uncommon in northern New England, but it is the dominant forest type along approximately 225 kilometers (140 miles) of the APPA in Vermont, New Hampshire, and Maine (Shriver et al. 2005). Birds that utilize this habitat include several species of high conservation concern, most notably Bicknell's thrush (Catharus bicknelli). Bicknell's thrush is a rare habitat specialist that nests in montane spruce-fir forests of the northeastern United States (Atwood et al. 1996) and adjacent portions of Canada (Ouellet 1993).

Black-throated Blue Warbler. Jerry Odenettel photo.

Mountain Birdwatch, coordinated by the Vermont Center for Ecostudies (VCE), aims to track changes in the distribution and abundance of Bicknell's thrush and other mountain-dwelling landbirds of the Northeast. Volunteer observers monitor approximately 120 survey routes each year, including 18 routes on or within a mile of the APPA (Shriver et al. 2005, Hart and Lambert 2008; personal communication, J. Scarl, Mountain Birdwatch Coordinator, Vermont Center for Ecostudies, 2 May 2011).

Although mountain birds are a priority vital sign for the APPA, there is no advantage to developing an APPA-specific monitoring protocol when VCE is already administering a program that directly intersects the APPA. Accordingly, the APPA EMP has entered into an agreement with VCE to monitor this vital sign on behalf of the APPA.

Ozone

Objectives:

- Monitor status and trends in ozone levels at index sites along or near the APPA

Tropospheric (ground-level) ozone is a damaging phytotoxin of significant concern within the eastern United States. Ozone damages cell membranes, which leads to reduced rates of photosynthesis and plant growth. However, ozone damage varies in a complex manner depending on exposure, plant species, genotype, plant age, and plant stress (Chapelka & Samuelson 1998). For this reason, ozone is typically monitored both directly (in air) and indirectly as injury to indicator species (Coulston et al. 2003).

The NPS ARD operates a limited network of air quality monitoring stations that measures meteorological parameters and ozone. The gaseous pollutant monitoring program determines levels of two gaseous pollutants, ozone and sulfur dioxide. These pollutants are toxic to native vegetative species even when they are at or below the National Ambient Air Quality Standards (NAAQS). Ozone monitoring in national parks has been ongoing since the early 1980s using EPA reference or equivalent methods. This allows for the direct comparison of NPS data with data collected by state and local air pollution control agencies and the EPA. The APPA EMP will rely on available ARD data, as well as data from other agencies and locations that have yet to be determined to monitor the status and trend of ground-level ozone in the vicinity of the APPA.

Future Monitoring Efforts

The development of protocols or acquisition of existing data for the following vital signs has been deferred until resources and funding or new partners are available to address them. Objectives and other specifics presented here are preliminary, and they will be refined during the development process. In order to reduce costs of monitoring these vital signs, the APPA EMP will strive to use existing monitoring projects and data, and volunteer field workers whenever possible.

Alpine and High-elevation Vegetation

Objectives:

- Determine status and trend of priority alpine species
- Determine changes in alpine community extent

The alpine plant community, consisting of vegetation growing above tree line, is one of the rarest and most significant community types in the eastern United States. It is found on less than one percent of the

Alpine zone, ME. Lydia Davis Miller photo.

Hikers along the A.T. in New Hampshire. Dan Kasak photo.

land in the Northeast (Shriver et al. 2005). Because of the relative rarity of alpine species throughout the Appalachian region, there is some overlap between areas of interest established by this vital sign and the rare plant and exemplary community vital sign.

The AMC actively monitors species in the alpine zone in the White Mountains of New Hampshire, while high-elevation sections of the APPA are monitored in the south by groups such as the Roan Mountain citizens group. At this time there are no immediate plans to develop an APPA-specific alpine and high-elevation vegetation protocol.

Visibility

Objectives:

- Determine trends in visibility at IMPROVE sites along or near the APPA
- Determine trends in visibility at other index sites monitored by volunteers

Visibility is a measure that determines a viewer's ability to look in a direction and identify features in the distant landscape. Some parks actually identify specific examples of visibility in their enabling legislation. For example, Shenandoah National Park's legislative history says that the Washington Monument was visible (approximately 124 kilometers or 77 miles distant) from points along the [skyline] drive. References such as that make useful comparisons for current conditions. Good "natural" visibility in the eastern U.S. is estimated to average between 97 and 129 kilometers (60 and 80 miles). Visibility from the APPA is an important concern because so many people consider the APPA to represent "pristine" conditions, but visibility deterioration is a regional problem that extends to the APPA.

An example of an existing citizen science program is AMC's Visibility Volunteers (VizVol) project designed to educate and utilize the hiking community to document air pollution impacts on visibility, hiker exposure to ozone, and climate variability's influence on plant phenology in the northern Appalachian Mountains. While there are no immediate plans to adopt the VizVol methodology, it offers an established

approach that APPA volunteers could readily adopt.

Visitor Use

Objectives:

- Determine trends in visitor numbers, distribution (spatial and temporal) and activities
- Determine trends in effects of trampling on soil compaction, vegetation diversity, and vegetation condition at key locations along the APPA

The APPA is within 241 kilometers (150 miles) of approximately 20% of the U.S. population and 115 cities with populations larger than 50,000. The proximity of the APPA to large population centers means high numbers of road crossings and large numbers of visitors. Increased visitation can increase erosion, adversely impact nearby vegetation, cause soil compaction, and disturb wildlife. These impacts can be particularly significant in high elevation areas and in areas where trails are poorly marked. Visitors can impact freshwater aquatic habitats by extracting natural resources such as fish, and by contributing to erosion, road runoff, contamination, and the introduction of invasive species.

Researchers with the USGS have expressed an interest in developing a visitor use protocol and have attempted to secure funding for such a project on several occasions. Pending funding, development of a visitor use protocol suitable for implementation on any NPS long-distance trail or other park will remain an unfunded high priority.

Chapter 6 - Data Management

Objectives and Goals

The goals for managing data related to the APPA EMP are to provide accurate, efficient, and effective information and support for resource management and protection. The APPA EMP accomplishes these goals by providing assistance and support in five distinct data management areas:

- GIS support
- Relational database support
- Document preparation support
- Data integration
- Data acquisition

The NPS Strategic Plan, Mission Goal 1b, requires that "… management decisions about resources and visitors are based on adequate scholarly and scientific information…" In addition, long-term Goal #1b1 states that acquiring "… outstanding data sets … of basic natural resource inventories of all parks…." is a desired outcome. The objective of the NPS I&M Program is to provide scientifically and statistically sound data for resource management, and to ensure that quality data is available for this task. This objective establishes the following needs:

- Develop metadata for all significant spatial and non-spatial data
- Ensure very high quality for all significant data
- Develop and maintain all essential data
- Ensure that data are logically organized and retrievable
- Identify sensitive data and protect it from unauthorized access and inappropriate use
- Optimize data sharing, development, and analyses
- Ensure that all network-held digital and non-digital information (i.e., data sheets, documents, published and unpublished reports, manuscripts, photographs, maps, metadata, etc.) are archived and protected in accordance with recognized archival standards

Infrastructure

In the context of information technology, infrastructure refers to the utilities, hardware, software, and support systems that keep the information system running. Being an integral part of the NETN, the APPA EMP will rely on the infrastructure set-up and run by the NETN, including computer hardware and equipment capable of storing all spatial and non-spatial data.

Roles and Responsibilities

The APPA Environmental Monitoring Coordinator is primarily responsible for identifying the key data tasks and is the primary person who must ensure that each task has been completed.

Project Management

Project management begins with the conception and design of a project and continues until the desired end product is made available to the intended audience. The value of good project management is fully realized when validated data are readily accessible

McAfee Knob, VA. Christopher Bowns photo.

to a broad audience, and when those data fulfill the objectives of the project. Without these fundamental building blocks, it is neither possible to evaluate the success of the project nor is it possible to determine the utility of the data, because the purpose of the project is undefined.

The key project management elements that must be addressed with every project include:

- Planning and approval
- Project tracking
- Project budget
- Project design
- Project testing
- Project implementation
- Preparation
- Data acquisition and processing
- Product delivery and review
- Product integration
- Evaluation and closure

Database Design

Consistency and compatibility are two important keys to ensuring high quality data. If data are intended to be used by park mangers, network staff, the public, and the scientific community, the data must be high quality (or at least of known quality). The task of ensuring high quality data is made more difficult (if not impossible) without rigorous database standards. While database standards alone will not solve all possible problems, standards promote compatibility among data sets, and make it easier to aggregate and summarize data in the future. Defining the purpose for a database is one step that cannot be overlooked, and communication is possibly more important than database programming acuity.

Data Acquisition and Management

Acquiring readily available data is the foundation of the APPA EMP. As stated in other chapters, collecting large amounts of new data is unrealistic given existing financial and human resource limitations, whereas acquiring data collected by other parks (e.g., Great Smoky Mountains NP or Shenandoah NP), or agencies (e.g., USFWS or USFS), or organizations (e.g., universities or other NGO's) is a viable option. Acquired data do pose a dilemma that must be addressed, however. Because acquired data is ordinarily the property of another entity, our use of those data may come with limitations (e.g., USFS FIA privacy rules); may not be of optimal quality; or may be difficult to keep current. Issues and concerns notwithstanding, the fact that these data do exist and are available, even with restrictions and limitations, should over-ride any initial reservations the APPA EMP may have about using these data. Efforts to obtain and use these data should continue until the APPA EMP explicitly determines that it is no longer in the best interests of the program.

Digital data paid for or originated by NPS shall be documented, stored, and made available to cooperators, park and network staff, and others in compliance with established data distribution policies. Data that are properly documented with metadata and that are free of data distribution restrictions will be posted to NRInfo, the NPS data dissemination system, where it can be accessed by the broadest audience. Data that are not documented with metadata, or that

Northern terminus of trail. Rebecca Suddoth photo.

have data distribution restrictions (e.g., data that are not the property of NPS) may be acquired, but the APPA EMP will not freely distribute such data. Historic data, in formats other than digital, will also be obtained when available and scanned into digital format. These data will then be made available to cooperators, NPS, and others in compliance with established NETN data distribution policies.

Data that are generated through NPS activities will be permanently stored and archived along with all other project-related information. Data that are not generated by the NPS may be retained by the NPS for future use and reference, but the NPS will not attempt to maintain "archival" copies of the data in perpetuity.

Quality Assurance and Quality Control

Data collected through monitoring activities must be uniform, consistent, and accurate if they are to serve the needs of the APPA EMP and resource managers. If data do not meet these requirements, analyses and decisions based on these data may be flawed, and could produce inappropriate results and promote poor decisions. To ensure that data quality problems do not produce these undesirable consequences, the APPA EMP will ensure that data collected and created are of known quality. The quality assurance and quality control (QA/QC) program will rely on the following to deliver high quality data:

- Thoroughly evaluated scientific measurement protocols
- Standard operating procedures
- Verification, validation, and editing procedures
- Data documentation and metadata standards
- Version control
- Data quality process review and communication

Documentation

Documentation brings a project to completion by fully describing the process, limitations, application, and restrictions that might apply to a project or dataset. It makes it possible to repeat a project, and thorough documentation should include guidance on how to appropriately use a dataset. While documentary requirements may vary depending on whether it applies to a dataset, a database, an application, or a project, it will in all instances provide a road map to proper usage and understanding.

Beyond the obvious reasons for documenting a project, Executive Order 12906 (April 1994) mandates that federal agencies create metadata, or "information about data," for all geospatial data. The APPA EMP will comply with the requirements of this Executive Order, and will ensure that all projects administered on behalf of the APPA, including those that do not generate geospatial data, are fully documented with metadata and appropriate guidance.

Records Management and Archiving

The APPA EMP will defer to the organization that directly sponsors a project for maintaining and archiving documents, such as final reports prepared by staff or cooperators, program administrative documents, contracts and agreements, memoranda of agreements, and other documents related to program administration, activities, and projects. In some instances this may be the Appalachian Trail Park Office, while in others it might be the Northeast Temperate Network office.

Chapter 7 - Data Analysis and Reporting

Introduction

A primary purpose of the APPA EMP is to integrate relevant and reliable monitoring information about resource condition and present those results to APPA resource managers. To accomplish this objective, the APPA EMP is developing tools and procedures that summarize vital signs data to provide park managers with information necessary to manage natural resources.

Data needed to understand APPA ecological systems come from many sources. Unlike the NETN program which relies primarily on NPS-funded projects to collect new resource data, the APPA EMP relies on collaboration and coordination with other agencies, organizations, and data collection efforts and the integration and synthesis of data across projects, programs, and disciplines.

Data Analysis

The APPA EMP seeks to provide a quantitative understanding of the magnitude and direction of ecological changes and to provide appropriate measures of precision of these estimates.

The program plans to utilize the four data analysis steps used by NETN: data summary, status, trend analysis and synthesis. Summarizing data helps define and ensure integrity of the data, and it sets a foundation for more comprehensive analyses and effective communication of results (Palmer and Mulder 1999, Reid 2001). Status is a quantitative understanding of the data at a single point in time across the entire spatial domain of interest. Trend analysis is a process of assessing successive measurements (typically three or more) of an indicator to quantify change over time. Because the APPA EMP is reliant upon available data, the APPA EMP may not have the ability to perform trend analysis for all APPA vital signs. Synthesis is the interpretation of monitoring results, placing them within the body of existing knowledge, and discussing potential management implications.

Types of analytical approaches

The APPA EMP relies primarily on existing data from a variety of sources that incorporates a range of spatial scales and levels of biological organization (Chapter 5). Consequently, data are not easily summarized. Our goal is to focus on data that are: a) routinely acquired and readily available; b) indicative of environmental status at a mid-to-large landscape scale; c) reflective of the ecosystem or environmental component of interest; and d) not intrinsically variable, allowing separation of background variation from a change in status (Noon et al. 1999). In addition to estimating magnitude of change and associated confidence intervals, the APPA EMP will use the analytical approaches described in the NETN Vital Signs Monitoring Plan (Mitchell et al. 2006) as appropriate for each protocol, vital sign, or report.

Communicating the Monitoring Program

As previously described, the APPA EMP is a close collaboration between the ATPO, the ATC, and the NETN. While each entity maintains its own priorities and responsibilities, communication among members of each organization is essential. Communicating the status of activities to other agencies and partners on a regular basis is also important and is accomplished through periodic electronic newsletters.

ATC office. C. Thoye photo.

The APPA EMP operates within the NETN. Information about the APPA program is included within the network's administrative reports and periodic reviews, and monitoring reports will match NETN's diversity and frequency of publication (Table 7.1).

Effectively communicating the status and trends of vital signs is one of the most important aspects of a successful program, and one of our major challenges is providing reliable, meaningful information that can inform resource management at a scale appropriate to the APPA. In general, the APPA EMP will follow NETN's approach to reporting (Mitchell et al. 2006). Developing vital signs reports for the APPA presents difficulties that are not faced by NETN due to the reliance on existing data from a variety of sources and the conformation of the APPA. However, the ecological integrity scorecard approach to resource reporting that NETN uses (Tierney et al. 2009) is flexible and appealing because it gives the viewer a quick picture of resource condition and trend.

Table 7.1. Report and program schedule for the Northeast Temperate Network (NETN).

Report	Purpose	Audience	Frequency	Authors	Review
NETN Annual Administrative Report and Work Plan	Expenditure accountability Program outline Define objectives Summarize accomplishments Set work plan for next fiscal year.	Network Board of Directors National I&M program Regional I&M Coordinator Park staff	Annual	Network Coordinator APPA Environmental Monitoring Coordinator Network Data Manager	Board of Directors National I&M program
Protocol Implementation Reports	Summary for each protocol implementation	Parks Network	After each protocol implementation	Cooperators or network staff	Parks Technical committee
Vital Signs Scorecard Reports	Provide condition assessment and change in condition for specific park resources	Parks Network	Biennial	Cooperators or Network staff	Parks Technical committee
Integration and Synthesis reports	Determine trends in resource condition Integration between protocols and other data sources to correlate condition changes with observed trends.	Parks, Network Cooperators Learning centers External scientists	3-5 year intervals	Cooperators and / or network staff	Parks Technical committee external scientists National I&M program
NETN Program Review	Determine protocol effectiveness at addressing objectives and integration into resource management.	Parks Network	Every 5 yrs.	Technical Committee members Outside experts National I&M program	Parks Technical committee external scientists National I&M program

Chapter 8 - Administration

Introduction

The APPA EMP is administratively governed by the NETN and its Board of Directors. Because the APPA passes through six NPS I&M networks, the APPA EMP takes steps to communicate with and include the other networks whenever possible. These networks do not conduct APPA-specific projects. Benefits to the APPA provided by the other networks include occasional staff assistance and the availability of data from overlapping projects that networks and prototype parks are funding at parks such as Great Smoky NP, Shenandoah NP, and Delaware Water Gap NRA.

Administration

Programmatic infrastructure is provided by the NETN and follows national I&M program guidance that describes the process used to plan, manage, and evaluate the program. The APPA EMP has neither an independent Board of Directors nor a formal technical steering committee. In place of a technical steering committee, the APPA EMP maintains a list of subject matter experts who have expressed an interest in the APPA.

Board of Directors and Technical Advisors

The NETN Board of Directors provides oversight of the APPA Program, including fiscal accountability and review of annual administrative reports and work plans. Technical advisors and subject matter experts who have expressed a willingness to offer subject-specific technical advice when necessary may be asked to:

- Provide general guidance and input on strategies for APPA projects
- Provide assistance to the APPA Environmental Monitoring Coordinator with project implementation and other resource management activities
- Help identify additional financial support for APPA projects
- Promote the establishment of partnerships with other governmental agencies, organizations, and individuals
- Advocate on behalf of the APPA EMP
- Help acquire existing natural resource data and information
- Develop guidance for integrating APPA program results into educational and interpretative programs

Income, Expenses, and Staffing

The funding allocation for the APPA EMP is fixed ($150,000 annually) and sufficient to sustainably cover the cost of the Appalachian Trail Environmental Monitoring Coordinator (Table 8.1) and approximately $10,000 for travel and $21,000 for administrative overhead (e.g., office space and support by NETN staff) and "seeding" one or more small projects that support APPA monitoring efforts. No money is available for additional staff.

Partnerships

Management of the APPA would not be possible without partnerships. The ATPO maintains relationships with more than 100 government agencies and non-governmental organizations, and operation of the APPA EMP is no different. While the ATPO and ATC are the two principal partners for the APPA EMP,

Table 8.1. Staff for ANST Environmental Monitoring Program during FY2011.

Position	Primary Duties	Grade / location	Total Cost FY2011
Environmental Monitoring Coordinator	Provides direction and manages overall planning and implementation of ANST Monitoring Program. Coordinates and conducts data analyses and reporting. Oversees I&M related activities for the Appalachian National Scenic Trail including searching for, archiving, analyzing, and reporting existing data sets relevant to the trail, and working with trail staff to implement volunteer-based monitoring activities.	GS-12 (permanent) / Marsh-Billings-Rockefeller NHP	$119,000

the program also works with numerous other agencies such as the USFS, USGS and organizations such as the USA-NPN and the AMC.

Revisions

Periodic reviews of the APPA monitoring program and protocols are critical to ensuring that the program is on the right course, and if course corrections are needed, that they are accomplished quickly to save unnecessary expenditures of resources and time. The APPA program will be reviewed formally on the same cycle as the wider NETN program, at least once every five years by the NPS Washington Service Office (WASO). Following this periodic review, the Environmental Monitoring Coordinator will address any recommended changes and revisions to the monitoring program.

Lake Tiorati, NY. Wilson Bilkovich photo.

Chapter 9 - Schedule

Protocols Currently Being Implemented

Several programs are already collecting high quality data along the Appalachian NST. For each these programs, the APPA EMP will develop a detailed SOP covering how the data will be acquired, managed, and reported (Table 9.1, Chapter 5).

- Mountain birds are being monitored by the Vermont Center for Ecostudies in New York and New England, and the APPA EMP will benefit from their ongoing efforts.
- Forest vegetation is being monitored by the USFS FIA program. FIA data include a comprehensive array of forest measurements including NIS detections. The APPA EMP is currently developing procedures for acquiring, managing, and reporting FIA data.
- Visibility, ozone, and atmospheric deposition data are currently being acquired and reported by the NPS ARD. The APPA EMP will work with the ARD to ensure that the Appalachian Trail is appropriately covered in their reports.

Protocols Currently Being Developed

The APPA EMP is currently developing protocols to address several high priority vital signs (Table 9.1, Chapter 5).

- Phenology is primarily a citizen science based protocol and monitoring will occur annually at various times during the year that correspond to targeted phenological stages. Volunteer observations may be supplemented with acoustic or photographic data at index sites.
- Rare plant monitoring is volunteer driven and data have been collected sporadically. The future of the rare plant monitoring program is being considered and monitoring locations are being reprioritized.
- Invasive NIS detection is a high priority concern for APPA managers and a new detection protocol will drafted in 2011.
- Forest vegetation data will primarily be monitored via existing FIA data (above), but a protocol based on the NETN forest health protocol is being developed for use on the APPA as part of a NASA-funded DSS project. Monitoring occurred in four watersheds during 2010.
- Landscape dynamics is a key concern for APPA managers and a means to efficiently assess landscape-related change is an intended product of the NASA-funded DSS that is targeted for completion in 2013.

Protocols Under Consideration

Decisions on how to acquire monitoring data for several vital signs are pending.

- Visitor Use is difficult to monitor, and standardized and inexpensive methods are not available at this time. USGS cooperators are currently seeking funds to study visitor use along the APPA, and they may develop suitable methods if they receive funding.
- Water quality has been monitored along the APPA in the past and holds a strong appeal with citizen scientists (water quantity has never been explicitly included during prior water monitoring activities). Rebuilding a water quality monitoring program is a possibility. In 2009, an intern with the ATC reviewed several available water quality monitoring protocols and delivered a list of protocols to consider implementing on the APPA. Concurrently, the USGS was reviewing data from the APPA region for the purpose of characterizing the region's resources and offering guidance on key resources to monitor. Pending completion of the USGS report, the APPA EMP will determine whether a limited water quality monitoring program is appropriate or whether future water resource investigations will rely entirely on data from other sources.
- Alpine and high-elevation vegetation programs, as well as other programs such as the ongoing acid deposition effects study (Lawrence, 2010) will be reviewed during FY2011 to determine if any existing programs will provide suitable data for the APPA EMP.
- Visibility monitoring using citizen scientists (through projects like the Appalachian Mountain Club's VizVol program and the University of New Hampshire's Picture Post initiative) could be used to supplement the ARD visibility data acquired

at IMPROVE sites. The APPA EMP will evaluate these and other programs for more extensive visibility monitoring.

Table 9.1. NETN protocol development schedule. The schedule includes protocols the APPA EMP is ready to implement (including protocols that will rely on national programs), and protocols being considered for development as funding and resources permit (green shading).

Protocol or SOP	Vital Signs Addressed	Timeline			Protocol Developers
		Draft	Final	Implemented	
Air Quality SOP	Ozone, atmospheric deposition, and visibility	2013	2014	2014	NPS – ARD
Phenology Protocol	Phenology	2011	2012	2012	National Phenology Network
Invasive Species Protocol	Non-indigenous species	2011	2012	2012	National Park Service
Forest Vegetation Protocol (Field-Based)	Forest vegetation, non-native invasive terrestrial and aquatic plants, landscape dynamics	2010	2011	2012	State University of New York
Forest Vegetation SOP (Existing Data)	Forest vegetation, non-native invasive terrestrial and aquatic plants	2010	2012	2012	State University of New York / National Park Service
Mountain Birds SOP	Breeding birds	2012	2013	2013	Vermont Center for Ecostudies
Rare Plants Protocol	Rare plants	2009	2011	2012	State University of New York
Landscape Dynamics SOP	Landscape dynamics	2011	2013	2013	University of Rhode Island
Visibility	Visibility	To be determined			To be determined
Water Quality and Quantity	Water resources	To be Determined			To be determined
Alpine and High Elevation Vegetation	Alpine and high elevation vegetation	To be determined			To be determined
Visitor and Recreation Use	Visitor usage	To be determined			To be determined

Chapter 10 - Literature Cited

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Appendix: Adjacent Projects and Programs

The Northeast Temperate Network established a task agreement in 2003 with the State University of New York at Syracuse to search for data ("data-mine") on existing monitoring programs in the vicinity of the Network's parks. The intent of the project was to increase our awareness of existing monitoring activities around each park unit and to identify potential partnerships that may benefit the network prior to implementation of the NETN Vital Signs monitoring program. By synthesizing, reviewing, and summarizing the existing monitoring programs around NETN parks we hoped to avoid redundancy in program development. In 2011, the information identified through this project was refined and updated for the Appalachian National Scenic Trail and will provide a foundation for future scoping workshops, protocol development, and integration of NPS monitoring with other ongoing programs.

Information gathered through this effort resides in a Microsoft Access database developed by the ANST Environmental Monitoring Coordinator. The database is designed to allow future users to quickly add new programs, search for, review and edit already entered programs, and generate reports that list programs associated with the ANST.

The listings identified on the following pages represent a "working" collection of the programs that are on, near or relevant to the ANST. While we have made a concerted effort to ensure that our data-mining activities have been thorough and complete, we also recognize that there are more programs to discover. Accordingly, this list should not be viewed as a definitive listing of all programs that are near the ANST.

Appalachian National Scenic Trail

Category: Air/Climate

Appalachian Mountain Club

Mountain Watch

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** NO

Project Background:

During the first phase of Mountain Watch, data collection will focus on several air quality measurements, including visibility degradation and hiker exposure to ground-level ozone pollution that gets transported to the mountain ecosystems of the Northeast. Because alpine ecosystems are some of the most sensitive to global climate change, they cannot "migrate" to cooler climates. Participants will also contribute to databases on when alpine plants flower, trees break bud in the spring and the onset of fall foliage. Weather measurements will also be taken to correlate with longer-term climatic records to correlate with the timing of the annual cycles of plants – plant phenology.

Web Links

http://www.outdoors.org/conservation/mountainwatch/

Vital Signs

Climate Change and Phenology

Massachusetts Department of Environmental Protection

Addressing Air Toxics in Massachusetts

Status: Unknown ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) In order to protect the health of Massachusetts' residents and preserve our environment; aims to reduce the emissions and ambient air impact of a number of toxic air pollutants likely to be used by business, industry, and individuals in the state.;
2) TURA (Massachusetts Toxic Use Reduction Act)focusing on pollution prevention as a way to comply with regulatory standards while increasing the economic competitiveness of Massachusetts industry.;
3) Ozone Reduction is the reduction of volatile organic compound (VOCs) emissions from a variety of sources, including industry and mobile sources.

Web Links

http://www.state.ma.us/dep/bwp/daqc/files/airtox.htm

Vital Signs

Other

National Atmospheric Deposition Program

AIRMoN-Wet & AIRMoN-Dry

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) AIRMoN was designed to provide data with a greater temporal resolution;
2) Determining the effectiveness of emission controls mandated by the Clean Air Act;
3) Identifying source/receptor relationships in atmospheric models;
4) Evaluating the potential impacts of new sources of emissions on protected areas such as Class I Wilderness Areas;

Web Links

http://nadp.sws.uiuc.edu/airmon/

Vital Signs

Atmospheric Deposition
Other

Mercury Depostion Network (MDN)

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The objective of the MDN is to develop a national database of weekly concentrations of total mercury in precipitation and the seasonal and annual flux of total mercury in wet deposition.; 2) The data will be used to develop information on spatial and seasonal trends in mercury deposited to surface waters, forested watersheds, and other sensitive receptors.

Web Links

http://nadp.sws.uiuc.edu/mdn/

Vital Signs

Atmospheric Deposition

National Atmospheric Deposition Program

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The program is a cooperative effort between many different group, including federal, state, tribal and local governmental agencies, educational institutions, private companies, and non-governmental agencies.

Web Links

http://nadp.sws.uiuc.edu/

Vital Signs

Atmospheric Deposition

National Park Service

Visibility Monitoring

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The National Park Service and the U.S. Environmental Protection Agency (EPA) first began long-term visibility monitoring at selected national parks in 1979. In 1985, a national visibility monitoring program was established called Interagency Monitoring of Protected Visual Environments, or IMPROVE. IMPROVE is a cooperative effort led by a Steering Committee of representatives from the EPA, U.S. Forest Service, National Park Service, Fish and Wildlife Service, Bureau of Land Management, National Oceanic and Atmospheric Administration, and several interstate air quality management organizations.

Web Links

http://www.nature.nps.gov/air/monitoring/vismon.cfm

Vital Signs

Visibility

National Phenology Network

Phenology

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** NO

Project Background:

The USA National Phenology Network (USA-NPN) monitors the influence of climate on the phenology of plants, animals, and landscapes. We do this by encouraging people to observe phenological events like leaf out, flowering, migrations, and egg laying, and by providing a place for people to enter, store, and share their observations. We also work with researchers to develop tools and techniques to use these observations to support a wide range of decisions made routinely by citizens, managers, scientists, and others, including decisions related to allergies, wildfires, water, and conservation.

Web Links

http://www.usanpn.org/

Vital Signs

Climate Change and Phenology

Pennsylvania State University

Climate-induced biogeographic shifts along the Appalachian Trail

Status: Continuing ***Activity:*** Research ***Proximity:*** On Footpath ***In RPRS:*** NO

Project Background:

We will explore how ecological disturbances respond to or create feedbacks with climate-vegetation interactions under climate change. The focal area will be The Appalachian Trail (AT) MEGA-Transect which represents a north-south transect in the eastern US representing variation in current vegetation, climate, and disturbance conditions. We will merge DGYM and empirical modeling approaches to identify major model responses that are relevant for risk assessment under multiple regional climate change scenarios.

Web Links

http://www.geog.psu.edu/people/crisfield-elizabeth

Vital Signs

Climate Change and Phenology

Penobscot Indian Nation

Penobscot Air Program

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) control pollutant emissions from automobiles, factories, and other sources.

Web Links

http://www.penobscotnation.org/DNR/DNR1.htm

http://www.penobscotnation.org/DNR/air/airhome.html

Vital Signs

Atmospheric Deposition

Other

Project Budburst

Project Budburst

Status: Suspended ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Project BudBurst is a national field campaign for citizen scientists designed to engage the public in the collection of important climate change data based on the timing of leafing and flowering of trees and flowers.

Web Links

http://www.windows.ucar.edu/citizen_science/budburst/

Vital Signs

Climate Change and Phenology

U.S. Forest Service

Air Resources Program

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The Mission of the Air Resource Program is to protect and/or enhance air quality on the National Forest. As we work to implement this mission we in effect, provide for cleaner air and healthier forests in all of southern Vermont. To achieve this mission we: Monitor the effects of air quality on components of the forest ecosystem. Monitoring is done in cooperation with several state and federal agencies, and educational institutions; Evaluate the impacts of proposed new major emissions sources on Lye Brook Wilderness, our Class I Air Quality Area; Evaluate the effects of Forest Service management activities on air quality; Share our monitoring information and expertise with the public.

Web Links

http://www.fs.fed.us/r9/gmfl/resource_management/air/air.htm

Vital Signs

Other

U.S. Geological Survey

Appalachian Trail Deposition Effects

Status: Continuing ***Activity:*** Research ***Proximity:*** On Footpath ***In RPRS:*** YES

Project Background:

Key objectives include the development and refinement of thresholds for ecosystem effects from acid deposition, and the development of critical loads for acid deposition. Identifying ecological threshold values that are specific to AT soils, forests, and streams will result in more accurate critical loads, allowing for improved assessments of current and future ecosystem health. Defining critical loads will also enable NPS to set meaningful air quality management goals to ensure protection of the AT.

Web Links

http://science.nature.nps.gov/im/units/appa/projects/aciddep/aciddeposition.cfm

Vital Signs

Atmospheric Deposition

Vermont Department of Environmental Conservation

Ambient Air Toxics Monitoring in Vermont

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The toxics monitored include volatile organic compounds (VOCs), carbonyls, metals and semi-volatiles.;
2) The Vermont Air Pollution Control Division (APCD) has been monitoring a battery of toxics in the ambient air at several locations in the state since 1993

Web Links

http://www.anr.state.vt.us/air/AirToxics/index.htm

Vital Signs

Other

Vermont Monitoring Cooperative

Basic Meteorological Monitoring

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The continuous monitoring of a variety of meteorological variables.;
2) The information collected at this site can be used in conjunction with biological or physical information gathered in other projects at or near the site.

Web Links

http://sal.snr.uvm.edu/vmc/

Vital Signs

Climate Change and Phenology

Other

Category: Forest Health

Forest Inventory and Analysis

Forest Health Monitoring

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** NO

Project Background:

1) The Forest Inventory and Analysis Program tracks 3 Criteria and 67 Indicators. Criteria are: 1)Conservation of Biological Diversity; 2) Maintenance of Productive Capacity of Forest Ecosystems; 3)Maintenance of Forest Ecosystem Health & Vitality.;
2) Collect and disseminate information about the forests of the Northeastern United States relating to forest distribution, forest condition, ownership patterns, timber utilization, and forest mensuration techniques.;
3) Develop and apply scientific knowledge and technology in support of the inventory and analysis project.

Web Links

http://fia.fs.fed.us/rpa.htm
http://www.fs.fed.us/ne/fia/
http://www.fs.fed.us/foresthealth/
http://www.fs.fed.us/projects/
http://www.fs.fed.us/research/sustain/

Vital Signs

Forest Vegetation

Long Term Ecological Research Network

Hubbard Brook

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** NO

Project Background:

Core Research Questions : (i) Dynamic patterns and control of primary production, over time, and in relation to natural and induced stresses or disturbances; (ii) Dynamics of selected populations of seed plants, saprophytic organisms, invertebrates, fish, birds and mammals in relation to time as well as natural and induced stresses or disturbances; (iii) Patterns and control of organic accumulation (biomass) in surface layers and substrate (or sediment) in relation to time or natural and Induced stresses or disturbances; (iv) Patterns of inorganic contributions (atmospheric or hydrologic) and movement through soils, groundwater, streams and lakes in relation to time and natural or induced stresses or disturbances; (v) Patterns and frequency of apparent site interventions (disturbances) over space and time (drought, fire, windthrow, insects or other perturbations) that may be a product of, or induce, long-term trends.

Web Links

http://www.hubbardbrook.org

Vital Signs

Atmospheric Deposition
Climate Change and Phenology
Other
Water Quality and Quantity

Manomet Center for Conservation Sciences

Recreation Stewardship Scorecard

Status: Continuing ***Activity:*** Research ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Public recreation is one of the four greatest threats to managed forests in the U.S. (Bosworth 2007). Recreational uses on private and public forest lands are rapidly increasing, especially use of off-road vehicles (ORVs) (ME ATV Task Force 2003, Jensen and Guthrie 2006). Unmanaged recreation can lead to the establishment of poorly laid out trails, which can have a large impact on soils (Leung and Marion 2000), water quality (Rinnella and Bogan 2003), biodiversity (Cole 1995), and wildlife (Marion and Leung 2001). Maintaining recreation trails is not only important for environmental values but for social and economic reasons as well. For many rural regions recreation (particularly motorized recreation) is a critical component of the local economy (Morris et al. 2005 and 2006). Degraded trails can result in loss of recreational access to private and public lands resulting in fewer recreational opportunities in the area. Poorly managed trails also compromise the enjoyment of trails (Marian and Olive 2006) resulting in people seeking other options for trips and vacations.

The goal of this project is to develop a quantitative, rapid-assessment system to assess recreational trail impacts on the forest ecosystem. By having an objective, repeatable impact assessment protocol, land managers and trail user groups will gain (1) a quantitative understanding of recreational impacts, (2) a method for identifying and prioritizing trail locations in need of repair and/or remediation, (3) a monitoring tool for tracking trail conditions over time, and (4) a clear and transparent process for evaluating environmental impacts of different recreation trails and user groups. With this tool, land managers can create science-based standards for recreation trails. These standards can be used to better communicate with public user groups the justification for trail closures, re-routing, or construction. With the scoring system, landowners and managers can set defensible benchmarks for environmental impact that will help ensure responsible recreation access to public and private lands. Moreover, a standardized scoring system will enable all recreational activities (e.g., snowmobile trails, hiking trails, ATV trails, etc.) to be evaluated under the same assessment system.

The Appalachian Trail (AT) provides an important reference point for this project for a number of reasons. First, the AT in Maine is very well maintained with volunteers contributing 20,000 hours a year to maintenance and improvements (Dave Field, personal communication). This incredible volunteer stewardship is replicated on few, if any, other recreation trails in New England. Second, the AT is a single use trail with strict restrictions on use by motorized, mountain bikes, and equestrian user groups. Finally, the surrounding corridor has limitations on land use and development that differentiate it from other trails without federal protection.

Web Links

Vital Signs
Other
Visitor Use

Natural Heritage Program

Mixed-mesophytic forests

Status: Continuing ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Vegetation Mapping

Web Links

http://www.dnr.state.md.us/wildlife/Plants_Wildlife/Md_Veg_Com/toc.asp

Vital Signs
Other
Rare Plants

Penobscot Nation Dept of Natural Resources

Forest Management

Status: Continuing ***Activity:*** Management ***Proximity:*** Adjacent ***In RPRS:*** NO

Project Background:

1) Preserve and protect water quality on the trust lands; Preserve and enhance the long-term productivity of the forest resource.;
2) Provide for the protection of the forest resource from insects, disease, fire, trespass and invasive species.;
3) Identify and protect significant natural resources located on the trust lands; including but not limited to fisheries and important wildlife habitat such as deer wintering areas, habitat for threatened and endangered species and vernal pools.;
4) Identify and protect significant cultural and archaeological resources on the trust lands; Where appropriate, emphasis the management of the forest to maintain and improve the populations of moose and white-tailed deer.

Web Links

http://www.penobscotnation.org/DNR/DNR1.htm

Vital Signs
Forest Vegetation
Other
Water Quality and Quantity

State University of New York, Environmental Science and Forestry

ANST Forest Data Analysis

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On Footpath ***In RPRS:*** NO

Project Background:

Web Links

Vital Signs

Forest Vegetation

The American Chestnut Foundation

American Chestnut trees along the Appalachian National Scenic Trail

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

The purpose of the study is two-fold. First, to increase our understanding the status of surviving remnants of the American chestnut, a species that played a key role in forests throughout Appalachia before being devastated by a blight fungus imported with Asian chestnut trees in the early Twentieth Century. Secondly, data on large individual trees with the potential to produce flowers will assist TACF in increasing the genetic diversity of its backcross breeding program, which is intended to restore the American chestnut tree to its former place in the region's forests by producing an otherwise American chestnut with the blight resistant characteristics of Asian chestnut.

Web Links

Vital Signs

Other

Rare Plants

Category: Fauna-General

Connecticut Department of Environmental Protection

Rare Animal Species

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

To conserve, protect, restore and enhance any endangered or threatened species and their essential habitat.

Web Links ***Vital Signs***

http://www.ct.gov/dep/cwp/view.asp?a=2702&q=323488&depNav_GID=1628 Other

Massachusetts Division of Fisheries and Wildlife

Rare Animal Species

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The Program's highest priority is protecting the approximately 190 species of vertebrate and invertebrate animals that are officially listed as endangered, threatened or of special concern in Massachusetts.

Web Links ***Vital Signs***

http://www.state.ma.us/dfwele/dfw/nhesp/nhesp.htm Other

http://www.mass.gov/dfwele/dfw/nhesp/species_info/mesa_list/mesa_list.htm

Natural Heritage Program

Rare Animal Species

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Actively surveys rare animal species of all vertebrate groups and selected rare species from the invertebrate groups.

Web Links ***Vital Signs***

http://www.dec.ny.gov/animals/7494.html Other

New Hampshire Division of Forests and Lands

Rare Animal Species

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The NH Natural Heritage Bureau tracks rare animal species.

Web Links ***Vital Signs***

http://www.nhdfl.org/formgt/nhiweb/ Other

http://nhdfl.org.aurora.silvertech.net/library/pdf/Natural%20Heritage/TrackingList-AnimalGeneral.pdf

Vermont Department of Fish and Wildlife

Rare Animal Species

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) We are actively tracking rare species with the following state ranks: SH, S1,S2 (breeding records only for birds). We are also interested in information on uncommon species S3.

Web Links ***Vital Signs***

http://www.vtfishandwildlife.com/ Other

http://www.vtfishandwildlife.com/wildlife_nongame.cfm

Virginia Department of Conservation and Recreation

Rare Animal Species

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Species that use discrete habitat patches or can directly benefit from habitat protection.

Web Links

http://www.dcr.virginia.gov/natural_heritage/infoservices.shtml-lists

Vital Signs

Other

Category: Flora

American Electric Power and Allegheny Energy

PATH - Potomac Appalachian Transmission Highline

Status: Continuing ***Activity:*** Inventory ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

1) Botanical Surveys along PATH project proposed and alternate routes within Park boundaries
2) Wetland Delineation for proposed PATH Project
3) Conduct Timber Stand Inventory along proposed and alternate project routes

Web Links

http://www.pathtransmission.com/

Vital Signs

Other

Connecticut Department of Environmental Protection

Rare Plant Species

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Conserve, protect, restore and enhance any endangered or threatened species and their essential habitat.

Web Links

http://dep.state.ct.us/cgnhs/nddb/nddb2.htm
http://www.ct.gov/dep/cwp/view.asp?a=2702&q=323482&depNav_GID=1628

Vital Signs

Rare Plants

Dickinson College

Glade spurge (Euphoria purpurea) along the Appalachian Trail near Hunters Run, PA

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Three small subpopulations of the PA state-endangered glade spurge, Euphorbia purpurea, occur near the Appalachian Trail between Rt. 34 and Hunters Run Road south of Mount Holly Springs. Monitoring since 1994 revealed that the plants are heavily browsed by deer and that they respond poorly to browsing (growth ceases and dieback frequently follows). Reproductive rates are naturally low in this species, especially when the plants are browsed and/or heavily shaded; and the population has been declining. In 2002, deer fences were erected around the plants, and the exclosures were expanded in 2009. Survival of adult plants and reproduction improved, but seedling survival remained almost nil because of plant competition and a tendency of the ballistically dispersed seeds to land in poor positions. With the approval of the National Park Service, I hope to continue monitoring the three subpopulations and to enhance them by 1) removing competing vegetation within the exclosures (some of this is invasive species such as Lonicera japonica), and 2) collecting seeds, germinating the seeds in the lab, and returning the seedlings to advantageous spots within the exclosures when they are large enough to compete with surrounding vegetation. The effectiveness of these techniques has already been demonstrated at another site, and the Wild Plant Program of the Pennsylvania Bureau of Forestry has approved the plan as a general strategy for preventing extirpation of this species in Pennsylvania.

Web Links

Vital Signs

Invasive Species

Institute of Ecosystem Studies

Invasion Ecology of Tree of Heaven (Ailanthus altissma)

Status: Continuing ***Activity:*** Research ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

To gather life-history information and ecology of the exotic invasive tree, Tree of Heaven, to use in the spatially-explicit model of forest dynamics, SORTIE. Little is known about the long-term trajectory, range and impacts of exotic plant invasions, particularly of long-lived organisms like trees. Critical life-history parameters needed to model these potential outcomes include: fecundity and propagule dispersal ecology, growth and survivorship studies, and ecosystem impacts of exotic species (e.g., changes in resources such as understory light and soil nutrients).

Web Links

Vital Signs

Maine Department of Conservation

Aquatic Vegetation Surveys of Selected Maine Lakes

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) If particularly outstanding examples of vegetation communities are identified, that information could be used to identify lakes and watersheds most in need of protection through mechanisms such as the Land for Maine's Future Board.;
2) This project will help establish important baseline data on the structure and composition of near shore aquatic plant communities in selected Maine lakes.;
3) the work will serve as a pilot project which will guide conservation groups, interested citizens, and others in developing strategies to monitor the vegetation of the state's lakes.

Web Links

http://mainevolunteerlakemonitors.org/index2.htm

http://www.maine.gov/dep/blwq/docmonitoring/lake/index.htm

Vital Signs

Water Quality and Quantity

Management of Invasive Non-native Plants in Maine

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) assess and track the most invasive plant species in Maine.;
2) educate landowners, land managers, nursery groups, and the general public about native alternatives to non-native plants for use in gardening, landscaping, and restoration work.;
3) generating educational materials on the ecology and management of at least five of the most invasive non-native plants in Maine.

Web Links

http://www.maine.gov/doc/nrimc/mnap/features/invasives.htm

Vital Signs

Invasive Species

Natural Communities

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species.;
2) Maine Natural Areas Program has been trying to improve the quality and quantity of data on natural community occurrences in Maine.

Web Links

http://www.maine.gov/doc/nrimc/mnap/features/community.htm

Vital Signs

Rare Plants

Maine Natural Areas Program

Small-whorled Pogonia

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.maine.gov/doc/nrimc/mnap/features/isotmed.htm

Vital Signs

Rare Plants

Maryland Department of Natural Resources

Rare Plant Species

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species.

Web Links

http://www.dnr.state.md.us/wildlife/Plants_Wildlife/rte/rteplants.asp

Vital Signs

Rare Plants

Massachusetts Department of Environmental Protection

Wetlands Conservancy Program

Status: Continuing ***Activity:*** Management ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The DEP is mapping the state's wetlands using aerial photography and photointerpretation to delineate wetland boundaries which is used to document the extent and type of the state's wetlands.

Web Links

http://www.mass.gov/dep/water/resources/protwet.htm

Vital Signs

Other

Massachusetts Division of Fisheries and Wildlife

Natural Communities

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The Massachusetts Natural Heritage Program actively inventories and tracks the distribution and status of uncommon and exemplary natural communities across the state.;
2) Conservation priority should be given to: natural communities with limited distribution across ecoregions within the state, those with restricted global distribution, and those common types for which the best documented examples occur in Massachusetts.

Web Links

http://www.mass.gov/dfwele/dfw/nhesp/natural_communities/natural_communities.htm

Vital Signs

Rare Plants

Rare Plant Species

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The Program's highest priority is protecting the approximately 258 species of native plants that are officially listed as Endangered, Threatened or of Special Concern in Massachusetts.

Web Links

http://www.state.ma.us/dfwele/dfw/nhesp/nhesp.htm

http://www.mass.gov/dfwele/dfw/nhesp/species_info/mesa_list/mesa_list.htm-PLANTS

Vital Signs

Rare Plants

Natural Heritage Program

Invasive Non-native Plants in Maine

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.maine.gov/doc/nrimc/mnap/features/invasives.htm

Vital Signs

Rare Plants

Invasive Plants

Status: Continuing ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) VA has identified 115 invasive alien plant species that threaten or potentially threaten natural areas, parks, and other protected lands in Virginia.

Web Links

http://www.dcr.virginia.gov/natural_heritage/invspinfo.shtml

Vital Signs

Invasive Species

Natural Heritage Program

Natural Communities

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) To protect natural communities which are an assemblage of plants and animals that are found recurring across a specific landscape under similar environmental conditions where natural processes, rather than human disturbances, prevail.

Web Links

http://www.vtfishandwildlife.com/

http://www.vtfishandwildlife.com/wildlife_nongame.cfm

Vital Signs

Rare Plants

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.dnr.state.md.us/wildlife/Plants_Wildlife/nhpnatcomm.asp

Vital Signs

Rare Plants

Northern Piedmont bogs

Status: Continuing ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Water Body Location and Classification

Web Links

http://www.dnr.state.md.us/wildlife/Plants_Wildlife/Md_Veg_Com/toc.asp

Vital Signs

Other

Potomac drainage floodplain forests

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.dnr.state.md.us/wildlife/Plants_Wildlife/Md_Veg_Com/toc.asp

Vital Signs

Forest Vegetation

Other

Rare Plant Species

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The NH Natural Heritage Bureau tracks the state's rarest and most imperiled plant species.

Web Links

http://www.nhdfl.org/natural-heritage-and-habitats/rare-plants-and-communities.aspx

Vital Signs

Rare Plants

Rare Plants and Animals

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Identifies the state's most significant natural areas through a comprehensive inventory of rare plant and animal species and representative natural communities.

Web Links

http://www.state.nj.us/dep/parksandforests/natural/heritage/rarelist.html

Vital Signs

Rare Plants

Natural Heritage Program

River scour communities

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Water Body Location and Classification

Web Links

http://www.dnr.state.md.us/wildlife/Plants_Wildlife/Md_Veg_Com/toc.asp

Vital Signs

Water Quality and Quantity

Sandstone glades

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Soils

Web Links

http://www.dnr.state.md.us/wildlife/Plants_Wildlife/Md_Veg_Com/toc.asp

Vital Signs

Other

Rare Plants

Shale barren habitats

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Soils

Web Links

http://www.dnr.state.md.us/wildlife/Plants_Wildlife/Md_Veg_Com/toc.asp

Vital Signs

Other

New England Wild Flower Society

The New England Plant Conservation Program

Status: Completed ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

The New England Plant Conservation Program (NEPCoP) which is administered by the New England Wild Flower Society, coordinates professional botanists and trained volunteers to survey rare plant populations. This is one facet of NEPCoP, the overall purpose of which is to prevent the extinction and promote the recovery of native plant species in New England. The voluntary collaboration of botanists, state agencies, and conservation organizations enables focused and timely understanding of rare plant populations through these surveying efforts and yearly meetings. In addition to the National Park for their planning and use, the information collected during the surveys is given to the appropriate state natural heritage program.

Web Links

Vital Signs

Rare Plants

Status: Completed ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

The New England Plant Conservation Program (NEPCoP), which is administered by the New England Wild Flower Society, uses professional botanists and trained volunteers to survey rare plant populations. This is one facet of the NEPCoP, whose overall purpose is to prevent the extinction and promote the recovery of the native plants of New England. The voluntary collaboration of botanists, state agencies, and conservation organizations enables focused and timely understanding of the rare plant populations through these surveying efforts, and annual meetings. The information collected during the surveys is given to the Massachusetts Natural Heritage Program which maintains a database on rare plants, animals and natural communities.

Web Links

Vital Signs

Rare Plants

New Hampshire Division of Forests and Lands

Natural Communities

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The NH Natural Heritage Bureau tracks "exemplary" natural community occurrences.;
2) To qualify as exemplary, a natural community in a given place must be of a rare type, such as a pitch pine/scrub oak barrens, or must be an exceptional occurrence of a common type, such as an old growth spruce/fir forest.

Web Links

http://www.nhdfl.org/about-forests-and-lands/bureaus/natural-heritage-bureau/about-us/naturalcommunities.aspx

Vital Signs

Rare Plants

New York State Department of Environmental Conservation

Ecological Communities

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) An ecological community is a variable assemblage of interacting plant and animal populations that share a common environment; in NY a classification has been developed to help assess and protect the biological diversity of the state.

Web Links

http://www.dec.ny.gov/

http://www.dec.ny.gov/61.html

Vital Signs

Other

Rare Plants

Rare Plant Species

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The New York Natural Heritage Program keeps track of the status of the state's rare flowering plants, conifers, ferns and fern allies, and mosses.

Web Links

http://www.dec.ny.gov/animals/29396.html

Vital Signs

Rare Plants

State University of New York, Environmental Science and Forestry

Rare Plant Monitoring Protocol

Status: Completed ***Activity:*** Monitoring ***Proximity:*** On Footpath ***In RPRS:*** NO

Project Background:

The Appalachian Trail (A.T.) rare plant monitoring program originates from a series of natural heritage inventories that were conducted within each of the 14 states through which the A.T. passes. These inventories, conducted from 1989 to 2001, documented rare, threatened and endangered (RTE) species and rare or exemplary natural communities within the A.T. corridor. Documentation of RTE vertebrates varied from state to state, and only a few heritage inventories include non-vascular plants and invertebrates.

The state natural heritage inventories documented approximately 1,750 occurrences of rare, threatened or endangered species and nearly 300 rare or exemplary natural communities.

Web Links

http://science.nature.nps.gov/im/units/appa/projects/RarePlants/RarePlants.cfm

Vital Signs

Rare Plants

U.S. Geological Survey

Develop On-Line Data Entry System for Rare Plant Monitoring

Status: Suspended ***Activity:*** Other ***Proximity:*** On AT Land ***In RPRS:*** NO

Project Background:

Web Links

Vital Signs

Other

University of Colorado - Boulder

Geographic Parthenogenesis: A Case Study of the Distribution of Erigeron strigosus (Asteraceae) in Georgia, U.S.

Status: Terminated ***Activity:*** Education ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

The objectives of the assignment are to document, in the field, where sexually and asexually reproducing populations of Erigeron strigosus occur in Georgia and to relate the occurrences to environmental (ex. soil) and land use (ex. disturbance) factors. My project is important to the conservation of native plant biodiversity, and will help conservation managers better understand the threats from asexual congeners leading to a loss of genetic diversity. In addition, my study will generate knowledge regarding the role the environment plays in the spread of asexual plant varieties. My proposed research will provide new and critical information about the ecological and genetic dynamics of one native species, Erigeron strigosus, but will have application to such situations with respect to many species of conservation interest.

Web Links

Vital Signs

Other

Vermont Audubon

Marsh Monitoring

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.rutlandcountyaudubon.org/

http://www.rutlandcountyaudubon.org/kentpond/

Vital Signs

Rare Plants

Vermont Department of Fish and Wildlife

Rare Plant Species

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) We are actively tracking rare species with the following state ranks (SH, S1, S2). However, we are also interested in information on uncommon species (S3).

Web Links

http://www.vtfishandwildlife.com/wildlife_nongame.cfm

Vital Signs

Rare Plants

Vermont Monitoring Cooperative

Landscape Fall Color and Leaf Drop Monitoring

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) To develop a visual rating system for monitoring fall color and leaf drop on a landscape scale on Mount Mansfield.

Web Links

http://sal.snr.uvm.edu/vmc/research/summary.php?id=62

Vital Signs

Climate Change and Phenology

Virginia Department of Conservation and Recreation

Natural Communities

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) An ecological community is an assemblage of co-existing, interacting species, considered together with the physical environment and associated processes, that usually recurs on the landscape.;
2) This present treatment is restricted to NATURAL COMMUNITIES, those which have experienced only minimal human alteration or have recovered from anthropogenic disturbance under mostly natural regimes of species interaction and disturbance.;
3) Provide a comprehensive classification of Natural Communities in VA and construct a broad framework for understanding and defining such communities at several hierachical levels.

Web Links

http://www.dcr.virginia.gov/natural_heritage/ncintro.shtml

Vital Signs

Rare Plants

Rare Plant Species

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Identify Natural Heritage Resources which are in need of conservation attention while creating an efficient means of evaluating the impacts of economic growth.; 2) Focus the inventory on the Natural Heritage Resources most likely to be lost without conservation action in the near future.

Web Links

http://www.dcr.virginia.gov/natural_heritage/infoservices.shtml-lists

Vital Signs

Rare Plants

Category: Bird

Baxter State Park

Monitoring Bicknell's Thrush

Status: Unknown ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** NO

Project Background:

1) Monitor birds at high elevation sites and their distribution in the park.

Web Links

Vital Signs

Breeding Birds

Columbia Gas Transmission

Columbia Gas Transmission - Eastern Market Expansion Project

Status: Completed ***Activity:*** Inventory ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Bald eagle nest survey and habitat assessment along the existing pipeline ROW as well as 1,320ft out from the edges of the ROW. This survey is required to address public comment regarding a bald eagle that has been observed within the area by a landowner. USFWS has stated that there are no known nests within the area; however, Columbia would like to complete a survey to confirm no nests are located within a quarter mile of the proposed Project. Also some additional access roads need to be surveyed for wetlands that were not covered under the initial field work in September 2006.

Web Links

Vital Signs

Other

Connecticut Audubon

Important Bird Areas (IBA)

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Sites that are important to endangered or threatened species, species of high conservation priority that contain rare habitat.

Web Links

http://greenwich.center.audubon.org/

http://web4.audubon.org/bird/iba/

Vital Signs

Breeding Birds

Connecticut Department of Environmental Protection

Whip-poor-Will and Nighthawk Survey

Status: Continuing ***Activity:*** Management ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Survey these species to determine whether or not the birds are undergoing a decline in their populations. Both species have been listed as a state species of special concern since 1991.

Web Links

http://www.depdata.ct.gov/wildlife/cwcs/sphblist.asp

Vital Signs

Breeding Birds

Cornell Lab of Ornithology and National Audubon Society

eBird

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

A real-time, online checklist program, eBird has revolutionized the way that the birding community reports and accesses information about birds. Launched in 2002 by the Cornell Lab of Ornithology and National Audubon Society, eBird provides rich data sources for basic information on bird abundance and distribution at a variety of spatial and temporal scales.

eBird's goal is to maximize the utility and accessibility of the vast numbers of bird observations made each year by recreational and professional bird watchers. It is amassing one of the largest and fastest growing biodiversity data resources in existence. For example, in 2006, participants reported more than 4.3 million bird observations across North America.

The observations of each participant join those of others in an international network of eBird users. eBird then shares these observations with a global community of educators, land managers, ornithologists, and conservation biologists. In time these data will become the foundation for a better understanding of bird distribution across the western hemisphere and beyond.

Web Links

http://ebird.org/content/ebird/

Vital Signs

Breeding Birds

Environmental Protection Agency

A Hierarchical Model of Avian Response to Forest Fragmentation

Status: Suspended ***Activity:*** Research ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

With this proposal we seek to develop collaboration between scientists at The Smithsonian Migratory Bird Center, the University of Minnesota's Natural Resources Research Institute, and the U.S. Environmental Protection Agency, each of whom bring a unique body of expertise toward the goal of understanding the demographic management needs of neotropical migrant birds. Management of declining long-distance migrant bird populations poses tough challenges because these birds respond to habitat and landscape configuration at local, landscape, and continental scales. The research described in this proposal is designed to further our knowledge of avian demography at each of these scales. For example, avian nest survivorship can be strongly affected by patch shape, degree of fragmentation of suitable habitat patches, and by the steepness of the gradient of habitat quality that occurs across edges between suitable and unsuitable habitat. However, local and landscape scale population trends are affected by regional source-sink dynamics and by effects on mortality that occur during migration and on non-breeding grounds. This proposal seeks to broaden an established nest-survival monitoring program in the Mid-Atlantic Piedmont, and Mid-Atlantic Ridge and Valley provinces of Central Virginia that began in 2000 under the sponsorship of the Smithsonian Migratory Bird Center. With the collaboration described in this proposal we will be able to begin to interpret local and landscape dynamics in light of continental scale demography by evaluating the utility of stable isotope and trace element methods for identifying wintering areas for specific breeding populations of Wood Thrush, enabling us to begin to study annual variation in survivorship in this long-distance migrant.

Web Links

Vital Signs

Breeding Birds

Other

Hawk Mountain Sanctuary Association

Banding of migrant raptors on Blue Mtn

Status: Suspended ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

monitor the health characteristics of migrants

Web Links

http://www.hawkmountain.org/

Vital Signs

Breeding Birds

Institute for Bird Populations

Avian Inventory Program

Status: Continuing ***Activity:*** Research ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

indices of adult population size and post-fledging productivity from data on the numbers and proportions of young and adult birds captured. estimates of adult population size, adult survival rates, proportions of residents, and recruitment into the adult population from mark-recapture data on adult birds.

Web Links

http://www.birdpop.org
http://www.birdpop.org/avianinv.htm
http://www.birdpop.org/maps.htm

Vital Signs

Breeding Birds

Maine Audubon

Important Bird Areas (IBA)

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) identify and prioritize the most important areas for bird conservation in the state of Maine.;
2) assist as needed in planning for the conservation and management of these bird-rich areas.

Web Links

http://www.maineaudubon.org/conserve/iba/index.shtml

Vital Signs

Breeding Birds

Loons and Lakes

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Determine the population status of loons in Maine.;
2) Efforts to allow municipalities the flexibility to develop watercraft restrictions on lakes within their jurisdictions, and to spread the work on the potentially lethal dangers posed to loons of fishing with lead sinkers and jigs.

Web Links

http://www.maineaudubon.org
http://www.maineaudubon.org/conserve/loon/index.shtml

Vital Signs

Breeding Birds
Other

Owl Survey and Monitoring

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) To learn more about the fluctuations in owl populations in our state and ultimately to ensure that each species remains an integral part of our ecosystem.; 2) The Maine Cooperative Owl Surveys in 2002 and 2003 allowed us to analyze a large amount of data that helped us identify the best times to survey for owls.

Web Links

http://www.maineaudubon.org
http://www.maineaudubon.org/conserve/citsci/owl.shtml

Vital Signs

Breeding Birds

Maine Department of Environmental Protection

Biological Monitoring of Loons

Status: Completed ***Activity:*** Research ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Water Quality Data

Web Links

http://www.state.me.us/dep/blwq/docmonitoring/swat/index.htm
http://www.maine.gov/dep/blwq/docmonitoring/swat/swatloon2000.pdf

Vital Signs

Breeding Birds
Other

Maine Department of Inland Fisheries and Wildlife

Bald Eagle

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Habitat "safety net" to maintain species recovery including at least 50 nesting areas under conservation ownership or appropriate easements.;
2) At least 100 additional areas under conservation ownership, appropriate easements, or cooperative agreements with private landowners.

Web Links

http://www.maine.gov/ifw/wildlife/species/endangered_species/bald_eagles/index.htm

Vital Signs

Breeding Birds
Other

Golden Eagle

Status: Continuing ***Activity:*** Management ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) MDIFW will work cooperatively with landowners to maintain suitable habitat at the few eyries once used by goldens.

Web Links

http://www.maine.gov/ifw/wildlife/species/endangered_species/golden_eagle/index.htm

Vital Signs

Other

Marshbird Surveys

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Several species of wetland-associated birds are found in Maineby broadcasting tape recordings of their vocalizations, the presence of many of these species in a marsh can be confirmed.; 2) In 2002, we completed the second and final year of our fieldworkto evaluate the distribution and relative abundance of 10 wetland bird species in the Boundary Plateau and St. John Upland regions of northwestern Maine.; 3) least bittern, yellow rail, and common moorhen are currently listed as special concern in Maine. Additional information about these species would help clarify their status, and may lead to habitat management strategies to aid in their conservation.

Web Links

http://www.maine.gov/ifw/hunting_trapping/weekly_reports/7-12-08.htm

Vital Signs

Breeding Birds

Peregrine Falcon

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) A total of 144 young peregrines produced in captive-breeding programs were successfully released at 8 different locations in Maine during 1984-1997.; 2) 1989 - 2001, but numbers of nesting peregrines did not change appreciably: 5 - 8 eyries were inhabited each year.;
3) in 2002. The statewide breeding population doubled in a single year. Peregrines inhabited 15 eyries, and 26 young peregrines fledged from ten of those eyries.;
4) Diligence by land managers has been crucial to maintaining eyries favored by peregrines.

Web Links

http://www.maine.gov/ifw/wildlife/species/endangered_species/peregrine_falcon/index.htm

Vital Signs

Breeding Birds
Other

Ruffed Grouse

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Despite its importance as a quality game bird in Maine, little management and research effort is devoted to this species because of limited dollars and personnel time.

Web Links

http://www.maine.gov/ifw/wildlife/species/ruffed_grouse/ruffedgrouse_sprucegrouse.htm

Vital Signs

Other

Maine Department of Inland Fisheries and Wildlife

Rusty Blackbird

Status: Continuing ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) We surveyed 188 sites among 84 townships during the two field seasons. Despite this amount of effort, we detected this species at only 18 of the 188 sites during summers of 2001 and 2002.;
2) Evidence of successful breeding was limited as most observations were of individuals, but we observed multiple birds at 6 of 18 occupied sites as well as a fledged brood at one site.;
3) Results of our surveys will form a base from which the first steps toward a monitoring program could be taken.

Web Links

http://www.maine.gov/ifw/wildlife/species/endangered_species/specialconcern.htm

Vital Signs

Breeding Birds
Other

Turkey

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) the Department's goal is to have a viable wild turkey population wherever suitable wild turkey habitat exists.

Web Links

http://www.maine.gov/ifw/wildlife/species/wild_turkey/index.htm

Vital Signs

Breeding Birds

Waterfowl

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Habitat protection and enhancement efforts are another form of management that the Department is using to increase waterfowl breeding populations.;
2) Waterfowl are now being managed to increase certain breeding populations

Web Links

http://www.maine.gov/ifw/wildlife/species/waterfowl/index.htm

Vital Signs

Breeding Birds

Woodcock

Status: Continuing ***Activity:*** Management ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.maine.gov/ifw/wildlife/species/plans/birds/index.htm - americanwoodcock

Vital Signs

Other

Maryland Department of Natural Resources

Bald Eagle

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species.

Web Links

http://www.dnr.state.md.us/wildlife/
http://www.dnr.state.md.us/wildlife/Plants_Wildlife/eagles/mdwleagles.asp

Vital Signs

Breeding Birds
Other

Massachusetts Audubon

Important Bird Areas (IBA)

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) To identify, nominate, and designate key sites that contribute to the preservation of significant bird populations or communities.;
2) To provide information that will help land managers evaluate areas for habitat management and/or land acquisition.;
3) To activate public and private participation in bird conservation efforts.;
4) To provide public education and community outreach opportunities.

Web Links

http://www.massaudubon.org/Birds_&_Beyond/IBAs/index.php

http://www.massaudubon.org/index.php

Vital Signs

Breeding Birds

Natural Heritage Program

Colonial Waterbirds

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.dnr.state.md.us/wildlife/

http://www.dnr.state.md.us/wildlife/Plants_Wildlife/birdingmd.asp

Vital Signs

Breeding Birds

Endangered and Threatened Species Study

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.dnr.state.md.us/wildlife/

http://www.dnr.state.md.us/wildlife/Plants_Wildlife/espaa.asp

Vital Signs

Other

New Hampshire Audubon

Backyard Winter Bird Survey

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Backyard Winter Bird Survey participants report any bird species visiting their yard and/or feeders in New Hampshire on the second weekend of February. Originally begun as a "Cardinal-Tufted Titmouse Census," it was expanded in 1987 to gather information on the distribution and abundance of many winter species in New Hampshire.

Web Links

http://www.nhaudubon.org

Vital Signs

Breeding Birds

New Jersey Audubon

Important Bird and Birding Area Program (IBBA)

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Identify both areas that are essential habitats for sustaining native avian populations (Important Bird Areas), and areas that are exceptional for birdwatching (Important Birding Areas).

Web Links

http://www.njaudubon.org/SectionIBBA/IBBASiteGuide.aspx

Vital Signs

Breeding Birds

No Affiliation

Raptor Banding Station

Status: Continuing ***Activity:*** Other ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

To trap, band, and release raptors

Web Links

Vital Signs

Breeding Birds

Raptors migrating on the Kittatinny Ridge in PA.

Status: Continuing ***Activity:*** Research ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

The objectives are to band significant numbers of raptors on the Kittatinny ridge during their southern migration.

Web Links

Vital Signs

Breeding Birds

Patuxent Wildlife Research Center

Raptor Banding and Research during fall migration

Status: Continuing ***Activity:*** Research ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Banding raptors in migration on the Kittatiny ridge to determine longevity and migrational patterns. Also to gather data on weight, wing chords, and fat content of migrants.

Web Links

Vital Signs

Breeding Birds

U.S. Geological Survey

Blue Ridge Raptor Migration and Banding Study

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

To further the knowledge of raptor migration through the use of banding.

Web Links

Vital Signs

Breeding Birds

North American Breeding Bird Survey

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) To monior the status and trends of North American bird populations.

Web Links

http://www.pwrc.usgs.gov/BBS/

Vital Signs

Breeding Birds

Raptor Research by Banding During Migration

Status: Continuing ***Activity:*** Research ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

To study the dynamics of raptor populations with emphasis on causes of mortality due to man-made hazards such as environmental contamination, lyme disease, collision with automoblies, power lines and gunshot. Objective is to find ways to reduce or eliminate such hazards. Additionally,data from banded birds are used in monitoring raptor populations. Results from raptor banding support national conservation programs and are made available to researchers by the Bird Banding Lab.

Web Links

Vital Signs

Breeding Birds

U.S. Geological Survey

Wind Gap Raptor Banding Station

Status: Continuing ***Activity:*** Research ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

To determine longevity and migration patterns for indigenous raptors. Also to discern and patterns in wing chord, weight, and fat data on caputured birds.

Web Links

Vital Signs

Breeding Birds

Vermont Center for Ecostudies

Mountain Bird Monitoring Protocol

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Web Links

http://www.vtecostudies.org/

Vital Signs

Breeding Birds

Vermont Monitoring Cooperative

Bicknell's Thrush

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** NO

Project Background:

1) To monitor population densities and determine the breeding ecology of Bicknell's Thrush, to assess the conservation status of this bird regionally, and to determine the effects of ski area development on the forest bird community.

Web Links

http://sal.snr.uvm.edu/vmc/research/wildlife.php

Vital Signs

Breeding Birds

Forest Bird Monitoring

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** NO

Project Background:

1) To determine long-term bird population changes in protected, non-fragmented habitats.;
2) Results will help provide insights into how forest fragmentation in unprotected areas may affect the relative abundance of forest-breeding songbirds.

Web Links

http://sal.snr.uvm.edu/vmc/research/wildlife.php

Vital Signs

Breeding Birds

Category: Mammal

Biodiversity Research Institute

Mammal Inventory of the Appalachian Trail in Maine

Status: Completed ***Activity:*** Research ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Inventory efforts will focus on expanding knowledge of at risk small mammal species identified during prior natural heritage inventory work. The areas of concern are those parts of the AT corridor that are located in Maine. The researchers will sample and identify the occurrences of as many species as possible, even though the inventory methods and sampling procedures will be chosen to increase the likelihood of detecting the target species.

Web Links

Vital Signs

Other

East Stroudsburg University

Appalachian Trail Mammal Inventory for Pennsylvania, New Jersey, New York, and Connecticut: 460 trail miles

Status: Completed ***Activity:*** Inventory ***Proximity:*** On Footpath ***In RPRS:*** YES

Project Background:

Small mammals comprise more than 50% of the at-risk (i.e., rarity ranks of S1, S2, or S3) mammals in Appalachian Trail (AT) states. However, these species have not been comprehensively surveyed within the AT corridor. Since the monitoring of at-risk species populations will likely become an important component of an AT Ecological Monitoring program, it is important to fill the gaps in knowledge for the most critically imperiled species likely to occur within the AT corridor.

The main objective of this study is to survey Appalachian Trail fee and easement lands occurring in Pennsylvania, New Jersey, New York, and Connecticut for S1, S2, or S3 mammals, and in addition to survey the AT corridor within the Delaware Water Gap National Recreation Area. A secondary objective is to document all mammals associated with the sites surveyed for focal species.

Web Links

Vital Signs

Other

Maine Department of Inland Fisheries and Wildlife

Black Bears

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species.;
2) The Department's goal, chosen with public input, is to maintain the bear population at its current level.

Web Links

http://www.maine.gov/ifw/wildlife/species/bear/index.htm

Vital Signs

Other

Canada Lynx

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.maine.gov/ifw/wildlife/species/endangered_species/canada_lynx/index.htm

Vital Signs

Other

Maine Department of Inland Fisheries and Wildlife

Coyote/Wolf

Status: Continuing ***Activity:*** Management ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) this research will be an essential step in determining whether it is feasible or desirable to recover wolves in Maine and the rest of the Northeast.;
2) a genetic study to clarify whether Maine's coyotes are true coyotes or coyote/wolf hybrids, and to determine whether our coyotes can be distinguished from eastern Canadian wolves.;
3) Information from this research will help our Department better understand how to approach enforcement issues concerning the incidental killing of wolves by trappers or snarers, and may give insight into the behavior of our coyotes

Web Links

http://www.maine.gov/ifw/wildlife/index.htm

Vital Signs

Other

Marten

Status: Continuing ***Activity:*** Management ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species.

Web Links

http://www.anr.state.vt.us/furbearer/animals/marten.html

http://www.maine.gov/ifw/wildlife/species/plans/mammals/-americanmarten

Vital Signs

Other

Moose

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of the species

Web Links

http://www.maine.gov/ifw/wildlife/species/moose/index.htm

Vital Signs

Other

New England Cottontail

Status: Unknown ***Activity:*** Research ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) A cooperative Master's project between MDIFW and Dr. John Litvaitis, University of New Hampshire, was started in the Fall of 1999. The objectives of this project were to;
a) determine the current distribution of New England cottontails in Maine using snowtrack, fecal pellet, and live trapping surveys;
b) characterize the attributes of sites occupied by New England cottontails in Maine;
c) develop a monitoring protocol capable of detecting status changes of New England cottontails in Maine.;
2) Having a clear set of management goals for New England cottontail is critical at this time, since the species is on the verge of being listed as either a Threatened or Endangered species by the U.S. Fish and Wildlife Service.

Web Links

http://www.maine.gov/ifw/wildlife/pdfs/newenglandcottontailguide.pdf

Vital Signs

Other

Penobscot Meadow Vole

Status: Unknown ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

Vital Signs

Other

Maine Department of Inland Fisheries and Wildlife

Whitetail Deer

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) we have set population objectives of 15 or 20 deer/mi2 for each central and southern Maine WMD.;
2) In northern and eastern Maine, the road to a more abundant deer population must involve increasing and restoring some of the deer wintering habitat that was lost during the past 3 decades.

Web Links

http://www.maine.gov/ifw/wildlife/species/deer/index.htm

Vital Signs

Other

Natural Heritage Program

Delmarva Fox Squirrel

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.dnr.state.md.us/naturalresource/fall2002/squirrel.html

http://www.dnr.state.md.us/wildlife/

Vital Signs

Other

New Hampshire Fish and Game Department

Moose Research in North Country

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) To track the movements and habitat use as well as population dynamics, mortality and habitat needs.; 2) Information collected on the study moose will enable Fish and Game biologists to more effectively manage the state's overall moose population.

Web Links

http://www.wildlife.state.nh.us/

http://www.wildlife.state.nh.us/Newsroom/News_2003/News_2003_Q3/Moose_Research_090403.htm

http://www.wildlife.state.nh.us/Wildlife/Wildlife_profiles/profile_moose.htm

Vital Signs

Other

New York State Museum

Albany Pine Bush Carnivore Research Project

Status: Continuing ***Activity:*** Research ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Establish the distribution and relative abundance of carnivores in the PB reserve;
2) Evaluate the health of carnivore populations in terms of population size, disease, genetic diversity, and animal dispersal between reserve fragments.;
3) Estimate the diet of different carnivore species through fecal analysis.;
4) Change in relative abundance and diversity of prey communities (e.g., rodents and smaller carnivores).;
5) Related change in seed predation or dispersal by rodents.;
6) Change in nest predation rates for birds. Related change in browsing and grazing intensity by deer and rabbits.

Web Links

http://www.nysm.nysed.gov/WildSci/pinebush.html

Vital Signs

Other

Smithsonian Institute

Large Mammal Photomonitoring

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Web Links

Vital Signs

Other

Smithsonian Institute

Pilot Project for Mammal Survey Along Appalachian Trail: Influence of landscape structure on mammal occupancy

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On Footpath ***In RPRS:*** YES

Project Background:

The purpose of this study is to develop a protocol for monitoring mammal species along the Appalachian Trail. The pilot study will occur May-November 2009 along the AT in Virginia, West Virginia,Maryland, Pennsylvania, Tennessee, and North Carolina. The survey will use infra-red trip-cameras to photograph wildlife species at specific points along the trail. It will rely on volunteers to adopt sections of the trail and agree to move cameras from point to point on a monthly basis. The cameras are digital so the pictures will be shared between the volunteers, the organizations, and the scientists.

The goals of the project, are fourfold:
1) To understand the influence of landscape structure on mammal occupancy
2) To understand the changes in air and water quality and the health of the plants and animals on lands associated with the trail.
3) To more effectively protect that land's natural resources.
4) To foster public appreciation for nature generally and conservation of the Appalachian Trail specifically.
5) To better tell the story of the status of the health of the Appalachian Trail's lands to visitors, trail neighbors in Virginia, West Virginia, and Maryland, and the general public.

Web Links

Vital Signs
Other

Vermont Monitoring Cooperative

Small Mammal Survey and Monitoring

Status: Completed ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links
http://sal.snr.uvm.edu/vmc/research/summary.php?id=50

Vital Signs
Other

Category: Herp

Maine Audubon

Maine Amphibian Monitoring Project

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) determining preliminary population trends for many of Maine's frogs and toads

Web Links

http://www.maineaudubon.org/

http://www.maineaudubon.org/conserve/citsci/mamp.shtml

Vital Signs

Other

Maine Department of Inland Fisheries and Wildlife

Amphibian and Reptile Conservation

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) MDIFW participates in PARC meetings designed to improve communication on efforts to conserve threatened herptile species in the Northeast, and to identify new projects of regional priority for implementation.;
2) PARC's mission is to forge partnerships among diverse public and private organizations in an effort to stem recent declines of amphibian and reptile (herptile) populations worldwide.

Web Links

http://www.maine.gov/ifw/wildlife/species/endangered_species/reptile_amphibian_list.htm

Vital Signs

Other

Amphibian Monitoring

Status: Unknown ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) determining preliminary population trends for many of Maine's frogs and toads.

Web Links

http://www.maine.gov/ifw/wildlife/species/marap.htm

Vital Signs

Climate Change and Phenology

Other

Blandings and Spotted Turtles

Status: Continuing ***Activity:*** Management ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) More than 80 turtles were marked or radio-tagged to gather information on nesting and hibernation sites, movements, and the types of wetlands used.;
2) Most significantly, her work demonstrated the importance of small pocket swamps and vernal pools as productive foraging and breeding habitats, with individual turtles often requiring multiple wetlands within a single activity area.;
3) MDIFW is committed to working with landowners and towns to help conserve remaining large blocks of habitat needed to sustain viable populations of these rare turtles.

Web Links

http://www.maine.gov/ifw/wildlife/species/plans/reptiles/

Vital Signs

Other

Maine Amphibian and Reptile Atlasing Project

Status: Completed ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species.;
2) From 1986-1990 over 250 volunteers from around the state contributed approximately 1,200 records of observations of amphibians and reptiles.;
3) MDIFW continues to maintain a statewide database for amphibians and reptiles.

Web Links

http://www.maine.gov/ifw/wildlife/species/marap.htm

Vital Signs

Other

Maine Department of Inland Fisheries and Wildlife

Wood Turtles

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) About 40 radio-tagged turtles were tracked and the nests located, and documented their movements and habitat use.;
2) summer temperature influences hatching success of wood turtles - a critical factor influencing population viability at the northern edge of the specie's range.;
3) Now studying the conservation genetics of wood turtles.;
4) at the state level, several of Maine's major watersheds host unique wood turtle populations that have been isolated from one another over hundreds or thousands of years.

Web Links

http://www.maine.gov/ifw/wildlife/species/endangered_species/specialconcern.htm

Vital Signs

Other

Natural Heritage Program

Bog Turtle

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://dnr.maryland.gov/wildlife/habitat/wildacres/waturtles.asp
http://www.dnr.state.md.us/wildlife/

Vital Signs

Other

Reptile and Amphibian Surveys

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.dnr.state.md.us/wildlife/Plants_Wildlife/pdfs/herpchecklist.pdf

Vital Signs

Other

New York State Department of Environmental Conservation

Herp Atlas

Status: Completed ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Herp Atlas was a ten year survey that was designed to document the geographic distribution of New York State's herpetofauna.

Web Links

http://www.dec.ny.gov/animals/277.html

Vital Signs

Other

No Affiliation

Monitoring of Wood Turtles (Glyptemys insculpta)

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

1) Determine population size (males, females and juveniles)
2) Locate and monitor hibernacula (to determine fidelity)
3) Locate and monitor estivation sites
4) Continue to locate nesting sites to determine which females are using same on yearly basis.
5) Monitor hatching success,ie clutch size, fertility and hardiness of hatchlings

Web Links

Vital Signs

Other

U.S. Geological Survey

Great Smokey Mountains NP I&M Project

Status: Continuing ***Activity:*** Research ***Proximity:*** Adjacent ***In RPRS:*** NO

Project Background:

1) As possible, evaluate current distributions and abundance of amphibian species in the Park with literature reports of past investigations.;
2) Provide a geographically-referenced inventory of the amphibian resources of the Great Smoky Mountains National Park.;
3) Develop and transfer to the Great Smoky Mountains National Park and National Park Service a series of protocols suitable for long-term monitoring of amphibian populations in the Smokies and other Appalachian Parks.;
4) Provide indices of abundance of Park amphibian species, referenced to locations and habitat types.

Web Links	***Vital Signs***
http://cars.er.usgs.gov/Amphibians_and_Reptiles/Herp_Program_Goals/herp_program_goals.html	Other

Stream Salamanders

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Adjacent ***In RPRS:*** NO

Project Background:

1) Using quadrat and transect survey methods to count and estimate stream salamander populations.;
2) Our goals are to determine the status and trends of stream salamanders in the Northeast with long-term monitoring and to assess population sizes in relation to landscape, habitat, and water quality variables.

Web Links	***Vital Signs***
http://www.pwrc.usgs.gov/nearmi/	Other

Survey of Amphibian Populations found in Naturally Fishless Lakes in Maine

Status: Continuing ***Activity:*** Research ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

The objectives of this research are to identify and compare the amphibian assembalges that occur in Maine's naturally fishless lakes and those that have previously been stocked with fish. Maine Department of Inland Fisheries and Wildlife (MDIFW) stocks game fish in Maine's lakes to enhance recreational fishing opportunities, and many of the state's lakes also contain illegally stocked bait fish. Some of these lakes are historically naturally fishless. Recently completed studies in Maine (Schilling 2008, Schilling et al. 2008, 2009) have documented that lakes with natural and stocked fish populations support invertebrate communities that differ from those naturally without fish. The introduction of fish to historically fishless lakes may also affect the amphibian species that reside, breed, or feed in these water bodies. Introduced fish may affect amphibian species abundance and composition by changing food resources, eating the amphibians, eating aquatic insects that prey on amphibians, and alter the lake habitat so that amphibian breeding and refuge sites are modified. In Maine naturally fishless lakes may occur in landscapes as part of larger aquatic complexes including wetlands that support amphibian communities. Many amphibian species are highly mobile and may travel among water bodies in these complexes; the effects of fish introductions into one lake, therefore, may affect amphibian populations in the surrounding terrestrial and aquatic landscapes. Amphibian species that are palatable to fish, for example, may be consumed by fish or may avoid fish by altering their movements in the landscape to locate alternative fishless sites. Lakes stocked with fish may become biological sinks for amphibian populations that continue to use the water bodies for egg-laying in spite of the presence of fish, resulting in their offspring, or the adults themselves, being consumed by fish. It is not clear whether there are mechanisms in naturally fishless lakes that have been stocked with fish that allow amphibians to persist in these modified environments.

We currently are examining amphibian use of naturally fishless lakes and nearby wetlands in Maine's Downeast region. We conducted a pilot study in 2006 in western Maine to begin to document amphibian assemblages in selected lakes. Studies conducted in the central and western United States have documented declines in certain amphibian species following fish introductions to historically fishless lakes, whereas other species have increased or do not seem to be affected by these introductions. Information gained from studies conducted in the western and central U.S. is not necessarily transferable to the eastern U.S.; the lake environments are very different among these regions, and many of the amphibian species are unique to the regions. The landscape surrounding the lakes and the wetlands occuring in this landscape matrix also differ among these regions, making it difficult to predict amphibian responses to these perturbations.

In this study we hope to document amphibian species occurrence in Maine%e2%80%99s lakes that either are currently fishless or are known to have been historically naturally fishless and currently contain fish populations. Ultimately, we hope to determine which amphibian species are most resistant to fish introductions in these systems and identify landscape and lake features (e.g., proximity to alternative lakes and wetlands, amount of cover available within lakes) that may enhance amphibian persistence following fish introductions. Previous studies have demonstrated that conservation of terrestrial habitats surrounding wetlands is essential for the survival of many amphibian species. We would like to determine if conservation of multiple wetlands within given landscape that contains these naturally fishless lakes is also essential to persistence of amphibian populations.

Web Links	***Vital Signs***
	Other

Vermont Monitoring Cooperative

Salamanders and Frogs on Mount Mansfield and The Long Tral

Status: Unknown ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The purpose of this study is to establish baseline population data that can be compared to future surveys and be compared to data collected in the following years to look for trends or changes in population numbers and species over time.

Web Links

http://sal.snr.uvm.edu/vmc/index.php

Vital Signs

Other

Category: Fish

Eastern Brook Trout Joint Venture

Eastern Brook Trout Joint Venture

Status: Continuing ***Activity:*** Research ***Proximity:*** Adjacent ***In RPRS:*** NO

Project Background:

The Eastern Brook Trout Joint Venture (EBTJV) is a recognized Fish Habitat Partnership operating under the National Fish Habitat Action Plan. The EBTJV coordinates efforts that build private and public partnerships to improve brook trout habitat. The long-term goals of the EBTJV are to implement a comprehensive conservation strategy to improve aquatic habitat, raise public awareness, and prioritize the use of federal, state and local funds for brook trout conservation.

In 2005, in recognition of the need to address regional and range-wide threats to brook trout, a group of public and private entities formed the EBTJV to halt the decline of brook trout and restore fishable populations. The partnership spearheaded a range-wide assessment of brook trout populations and threats to brook trout and brook trout habitat in the Eastern United States. Seventeen states are working to prioritize policy changes and on-the-ground actions to improve water quality and restore brook trout habitat and populations in their individual state using locally-driven, incentive-based, and non-regulatory programs.

Web Links

http://www.easternbrooktrout.org/

Vital Signs

Other

Maryland Department of Natural Resources

Freshwater Fish: Rare Animal Species

Status: Continuing ***Activity:*** Management ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species.

Web Links

http://dnr.maryland.gov/fisheries/fmp/index.asp-fresh

Vital Signs

Other

Natural Heritage Program

Freshwater Fish

Status: Continuing ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.vtfishandwildlife.com/wildlife_nongame.cfm

Vital Signs

Other

Penobscot Nation Dept of Natural Resources

National Fish Tissue Study

Status: Unknown ***Activity:*** Research ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The statistical design of the 4 year study will allow us to develop national estimates of the mean concentrations of 268 chemicals in fish tissue from lakes and reservoirs of the lower 48 States.;
2) study results will define national background levels for the 265 chemicals in fish, to provide a baseline to track progress of pollution control activities, and to identify areas where contaminant levels are high enough to warrant further investigation.

Web Links

http://www.epa.gov/waterscience/fishstudy/

http://www.penobscotnation.org/DNR/DNR1.htm

Vital Signs

Other

U.S. Fish and Wildlife Service

Atlantic Salmon Watersheds, Maine

Status: Continuing ***Activity:*** Research ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Mapping spawning and nursery habitat, developing watershed land cover information, providing assistance to watershed coalitions by identifying potential threats to salmon survival, providing technical assistance to partners.;
2) restoring natural river channels, and developing on-the-ground parnerships to protect salmon habitat.

Web Links

http://www.fws.gov/GOMCP/maps_salmon.html

Vital Signs

Water Quality and Quantity

U.S. Geological Survey

Landscape-scale influences on the abundance and distribution of fishless lakes in Maine

Status: Suspended ***Activity:*** Research ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Throughout much of the 20th century, the introduction of game fish to inland waters of the United States and Canada was conducted at a furious pace. The goal of these introductions was generally to enhance game-fishing opportunities. Until recently, fishless lakes were viewed as having little or no value to society, as indicated by the term barren that was widely used to describe them (e.g., Nilsson 1972). Over the past several decades, however, there has grown a considerable body of knowledge supporting views of such barren water bodies as habitats for uniquely structured animal communities (e.g., McPeek 1998), as excellent trophic habitats for waterfowl (e.g., Mallory et al. 1994), and as landscape-level source habitats for amphibians (e.g., Funk and Dunlap 1999) and other biota (e.g., Drake and Naiman 2000).

Accurate estimates of the number and distribution of naturally fishless habitats, prior to the widespread stocking efforts of the mid- to late 20th century, are few. Fewer than 45% of the 16,000 high lakes in the western United States' mountains remain unstocked, although 95% were naturally fishless (Leavitt et al. 1994). The rehabilitation of stocked lakes is now a priority for national park management in North America (Bahls 1992).

Maine Department of Inland Fisheries and Wildlife (MDIFW) has documented at least 30 fishless ponds in Maine spread throughout the state; many ponds currently with fish are known to have been fishless prior to stocking. Other fishless ponds likely exist, but this has not been confirmed. The ability to predict the likelihood that a particular pond is currently or historically fishless based on its landscape setting and geomorphic features would assist the MDIFW in balancing recreational management objectives with the responsibility to protect unique wildlife habitats.

The overall objective of this study is to determine the distribution, abundance, types and biological composition of fishless lakes in Maine by:
determining the effects of the introduction of fish on macroinvertebrate communities of fishless lakes in Maine
identifying geomorphic and geographical factors controlling the distribution and abundance of fishless lakes in Maine
building a GIS-based model predicting the probability that a given lake is fishless
assessing the accuracy of the model using macroinvertebrate indicator species
assessing the conservation status of fishless lakes in Maine

This permit application is to request permission to sample aquatic invertebrates using light traps, plankton nets, littoral sweep nets, and a sediment coring device during 2-3 visits in July-August 2005 to document aquatic invertebrate species composition at Lily Pond in Track 106-17 of the Appalachian Trail in Maine. This pond has been classified as naturally fishless with the GIS model developed as part of our survey of fishless ponds in Maine. MDIFW recently stocked this pond with trout. One purpose of our study is to identify changes and differences in the aquatic invertebrate community after fish stocking. This would be accomplished by sampling the littoral, pelagic, and benthic invertebrates. Our benthic samples would also provide confirmation that the pond was historically and naturally fishless before the recent stocking event.

Web Links

Vital Signs

Other

Category: Invertebrate

Carleton College

Using Aquatic Macroinvertebrate Collections to Evaluate Streams Along the Appalachian Trail in Virginia

Status: Completed ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Objectives/Hypotheses:

1.Using multimetric analysis of the macroinvertebrate community of a stream, make an assessment of the environmental health of each stream. Baselines for pristine and severely degraded streams will be established with chemical and physical identification of streams.

2.Compare the relative abundance of different macroinvertebrates at similar streams along the Appalachian Trail, compare results with VASOS data from around the state of Virginia. This will be the most difficult hypothesis to draw clear conclusions from, because the date of sampling will vary (from early June for northern sites, to mid July for southeastern sites), and streams will vary in size, flow, substrate composition, elevation, and vegetative surroundings.

3.There will be a negative correlation between environmental quality and potentially harmful surroundings, and a positive correlation between environmental quality and potentially beneficial surroundings. Surroundings I will look at include distance from upstream road, how highly trafficked that road is and whether or not it is salted during the winter, distance from adjacent or upstream farms and if possible the type of farming or grazing done on that land, urban or residential areas upstream or not, nearby industry, whether the stream is located in a forested or protected area, and proximity to any mining sites). These factors will be both predetermined through GIS-generated maps and on-site assessment of surroundings.

4.There will be a negative correlation between abnormal levels of dissolved oxygen, chemicals, heavy metals, and pH in each stream and its environmental quality, as assessed by presence of species intolerant of pollutants and diversity and abundance of macroinvertebrates.

Web Links

Vital Signs

Water Quality and Quantity

Connecticut Department of Environmental Protection

Connecticut Butterfly Atlas

Status: Continuing ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Collect data, in the form of vouchers and field forms, over one or more of five field seasons from 1995 through 1999. Vouchers are either specimens or photographs, and provide the information needed to produce a map of each species' distribution.

Web Links

http://dep.state.ct.us/cgnhs/nddb/nddb2.htm

http://www.ct.gov/dep/lib/dep/wildlife/pdf_files/outreach/fact_sheets/btrflygdn.pdf

Vital Signs

Other

Maine Department of Environmental Protection

Caged Mussel Study

Status: Completed ***Activity:*** Research ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Water Quality Data

Web Links

http://www.state.me.us/dep/blwq/docmonitoring/swat/swatcagedmussel2000.pdf

Vital Signs

Other

Maine Department of Inland Fisheries and Wildlife

Butterflies

Status: Continuing ***Activity:*** Research ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.maine.gov/ifw/wildlife/surveys_reports/index.htm

Vital Signs

Other

Maine Department of Inland Fisheries and Wildlife

Clayton's Copper

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.maine.gov/ifw/wildlife/species/endangered_species/claytons_copper/index.htm

Vital Signs

Other

Dragonflies

Status: Continuing ***Activity:*** Management ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://mdds.umf.maine.edu/~odonata/.

http://www.maine.gov/ifw/wildlife/species/endangered_species/state_list.htm

Vital Signs

Other

Tomah Mayfly

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species.

Web Links

http://www.maine.gov/ifw/wildlife/species/endangered_species/tomah_mayfly/index.htm

Vital Signs

Other

Maine Forest Service

Pine Shoot Beetle (Tomicus piniperda) in Maine

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) protect the forest, shade and ornamental tree resources of the state from significant insect and disease damage;
2) to provide pest management and damage prevention for homeowners, municipalities, and forest land owners and managers

Web Links

http://www.state.me.us/doc/mfs/idmhome.htm

http://www.state.me.us/doc/mfs/idmhwa.htm

http://www.state.me.us/doc/mfs/psb.htm

Vital Signs

Forest Vegetation

Invasive Species

Natural Heritage Program

Butterflies

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.dnr.state.md.us/wildlife/

http://www.dnr.state.md.us/wildlife/Plants_Wildlife/mdbutterflies.asp

Vital Signs

Other

Dragonflies

Status: Continuing ***Activity:*** Education ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Distribution and Status of High Priority Species

Web Links

http://www.dnr.state.md.us/wildlife/Plants_Wildlife/pdfs/nhpodonates.pdf

Vital Signs

Other

Natural Heritage Program

Freshwater Mussels

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Web Links
http://www.maine.gov/ifw/wildlife/species/endangered_species/invertebrate_list.htm

Vital Signs
Other

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:
1) Distribution and Status of High Priority Species

Web Links
http://www.dnr.state.md.us/wildlife/Plants_Wildlife/rte/rtedwm.asp

Vital Signs
Other

Sussex County Mosquito Control

Nuisance and Vector Mosquito Surveillance

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:
The purpose of our study is to estimate mosquito population densities, species abundance, and to monitor arboviral activities, all in the interest of protecting public health.

Web Links

Vital Signs
Other

Vermont Institute of Natural Science

Vermont Butterfly Survey

Status: Continuing ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:
1) The Vermont Butterfly Survey is a five-year census to document the relative abundance and distribution of butterflies across Vermont.;
2) To learn which butterfly species exist in Vermont.;
3) Allow Vermonters to contribute to a greater understanding of the nature of their state.

Web Links
http://www.vtecostudies.org/VBS/

Vital Signs
Other

Category: Water

Androscoggin Watershed Council

Androscoggin Watershed Council

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The Mission of the Androscoggin Watershed Council is to improve environmental quality and promote healthy and prosperous communities in the Androscoggin River Watershed.

Web Links

http://www.androscogginriver.org

Vital Signs

Water Quality and Quantity

Antietam Creek Watershed Alliance

Antietam Creek Watershed Alliance

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The mission of ACWA is to protect and promote the Antietam Creek through education, preservation, and hands-on projects.

Web Links

http://www.acwamd.org

Vital Signs

Water Quality and Quantity

Aquashicola Pohopoco Watershed Conservancy

Aquashicola Pohopoco Watershed Conservancy

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Our watershed goals include educating, protecting and preserving our watersheds the Aquashicola and Pohopoco

Web Links

http://www.apwc-pa.org/

Vital Signs

Water Quality and Quantity

Berks County Conservancy

Berks County Conservancy

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The Berks County Conservancy addresses conservation projects related to land use and water resources. “The vision of the Berks County Conservancy is to be a cornerstone of excellence in the stewardship of the environment. Clearly identified with our speci

Web Links

http://www.berks-conservancy.org

Vital Signs

Water Quality and Quantity

Black River Watershed Action Team

Black River Watershed Action Team

Status: Continuing ***Activity:*** Other ***Proximity:*** Adjacent ***In RPRS:*** NO

Project Background:

To promote stewardhsip of our watershed's health. We've conducted a volunteer cleanup effort for the past three years and have a long-term plan for water monitoring, erosion control, wildlife habitat restoration, and community education. We work with scho

Web Links

http://www.blackriveractionteam.org

Vital Signs

Water Quality and Quantity

Bushkill Stream Conservancy

Bushkill Stream Conservancy

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The BSC monitors and works to improve the quality of the Bushkill Creek and tributaries in Northampton County, PA.

Web Links

http://bushkill.org/

Vital Signs

Other

Cobb County

Cobb County Watershed Stewardship Program

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The Cobb County Watershed Stewardship Program educates and trains citizens, schools, and organizations interested in protecting their watersheds. Through stream monitoring workshops and community projects (stream clean-ups, storm drain stenciling, stream buffer re-vegetation), we hope to improve county waterways and enable citizens to become watershed stewards. We also offer school education programs about water quality and ecology.

Web Links

http://watershed.cobbcountyga.gov/files/watershed.htm

Vital Signs

Water Quality and Quantity

Community Partners for Healthy Streams

Status: Continuing ***Activity:*** Management ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The Cobb County Adopt-A-Stream program educates and trains citizens, schools, and organizations interested in protecting their watersheds. Through stream monitoring workshops and community projects (stream clean-ups, storm drain stenciling, stream buffer re-vegetation), we hope to improve county waterways and enable citizens to become watershed stewards. We also offer school education programs about water quality and ecology.

Web Links

http://watershed.cobbcountyga.gov/files/CPHealthyStream.htm

Vital Signs

Water Quality and Quantity

Coosa River Basin Initiative (C.R.B.I.)

Coosa River Basin Initiative (C.R.B.I.)

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

CRBI's mission is to create a cleaner, healthier, more economically viable Coosa River Basin. We work in both Georgia and Alabama in the areas of: advocacy, water monitoring, education, and restoration.

Web Links

http://www.coosa.org

Vital Signs

Water Quality and Quantity

Deerfield River Watershed Association

Deerfield River Watershed Association

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Our missin is to protect, preserve, and enhance the natural resources of the Deerfield River watershed. We run volunteer monitoring programs on water quality, marsh wildlife, and invasive plants; we sponsor forums and workshops, organize cleanups, maintain an 8-mile hiking trail, organize outings in the watershed, intervene with FERC on the river's settlement agreement, and advocate for protection of our beautiful watershed.

Web Links

http://www.deerfieldriver.org/

Vital Signs

Water Quality and Quantity

Georgia Environmental Protection Division

Georgia Adopt-A-Stream

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Georgia Adopt-A-Stream is a stsatewide water quality monitoring program that provides citizens with the training and protocols to monitor their streams, lakes, wetlands and estuaries. In addition, we help citizens network and organize at the watershed lev

Web Links

http://www.georgiaadoptastream.org/htm

Vital Signs

Water Quality and Quantity

Haywood Waterways Association, Inc.

Haywood Waterways Association, Inc.

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) To educate the residents of Haywood County on the importance of protecting the waterways and Pigeon Watershed in Haywood County, North Carolina.
2) To focus attention on the Pigeon River Basin as a natural, economic and recreational resource to be conserved and enhanced for this and future generations.
3) To work with public agencies, conservation interests, businesses, community groups, and public and private land owners, to develop and implement a strategy for the conservation and improvement of the water quality and habitat of the Pigeon River and its tributaries in Haywood County.

Web Links

http://www.haywoodwaterways.org

Vital Signs

Water Quality and Quantity

Hiram College

Mercury and pH throughout backcountry water sources in the Appalachian Mountain range.

Status: Unknown ***Activity:*** Research ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

The purpose of this study is to measure pH and mercury concentrations in various water sources, such as streams, springs, and lakes in the Appalachian Mountain range and to determine sources of water contamination. This study will serve as a water quality reference to the general public and will also present an educational experience to me as a Hiram College student.
Industries and coal-fired power plants release emissions including mercury and acids (Nitrogen Oxides and Sulfur Dioxide) that are detrimental to environmental health. In order to determine mercury concentrations MAR, a mercury testing resource, will be used. pH readings will initially be recorded in the field by using pH paper, but will also be tested at Hiram College in order to make sure pH readings didn%e2%80%99t change from the field to the lab. After mercury concentrations and pH readings are determined, a Geographic Information System (GIS) will be used to produce maps depicting regionalized mercury concentrations and pH levels. Wind pattern maps will then be obtained and studied alongside these water quality readings to determine sources of mercury emissions and causes of pH variances.
This information will then be presented to the general public, thus advancing public knowledge on the effects industrial zones and coal-fired power plants have on water sources in the Appalachian Mountains. Results will not only further knowledge on emission paths and effects on water quality, but will also provide a water quality reference to future hikers, fishing enthusiasts, and homeowners.
Hikers on the Appalachian Trail rely on natural water sources, such as streams, springs, and lakes, for drinking water. This study will allow hikers to check water quality in specific areas to prevent consumption of untreated, contaminated water. Many homeowners in the Appalachian Mountain range also rely on streams, springs, lakes, and groundwater for a source of water in their homes. Similar to the hikers, homeowners need to have information about their water source if it is in an area known for mercury contamination or hazardous pH levels.
An increase in particle concentration throughout the food chain, commonly called biological magnification, is a problem in areas with high mercury concentration. Mercury in water is absorbed by fish and over time increases in concentration in fish. Fishers in the backcountry have little or no information available to determine which mountainous areas contain high or low mercury levels. When fishermen eat fish from highly contaminated water sources, the mercury from the fish is ingested and poisons the body. Mercury poisoning can be prevented by presenting fishers with contamination level information.
Conducting this study will also allow me to gain field experience. I am currently a student at Hiram College in Hiram, Ohio and I am pursuing a degree in Environmental Studies. Specifically, I am interested in hydrology as my area of concentration. This study will allow me to gain practical field experience in hydrology. Professor Jim Kercher, professor of Chemistry at Hiram College, along with other faculty at Hiram College will be working with me to guide the experiment and to advance my knowledge of hydrology. Studying pH and mercury will also allow me to interact with mapping systems and water-testing equipment. In order to map concentrations by region, I will use a mapping system called Geographic Information System (GIS). I will also use MAR, mercury testing equipment, which will present me with hands-on learning experience. While testing water samples I will be enrolled in two classes. The first class being Environmental Studies 298: Practicum: Field Experience and the other class being Environmental Studies 481: Senior Research. Along with these classes I will present conclusions of the study to Hiram College faculty and students to spread knowledge concerning water quality in the Appalachian Mountain range.

Web Links

Vital Signs
Atmospheric Deposition
Water Quality and Quantity

Housatonic Valley Association Inc

Housatonic Valley Association Inc

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The Housatonic Valley Association was founded in 1941 and works to protect the water quality and natural resources of the Housatonic River and its watershed in southwestern Massachusetts, western Connecticut, and eastern New York. HVA accomplishes this go

Web Links
http://www.hvatoday.org

Vital Signs
Water Quality and Quantity

Interstate Commission on the Potomac River Basin

Interstate Commission on the Potomac River Basin

Status: Continuing ***Activity:*** Management ***Proximity:*** ***In RPRS:*** NO

Project Background:

Back Creek Water Quality Initiative

Web Links
http://www.potomacriver.org/cms/

Vital Signs
Water Quality and Quantity

Lake Winnipesaukee Watershed Association

Lake Winnipesaukee Watershed Association

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Lake Lay monitoring ongoing since 1982
Publication of booklet "A Special Place" - A NH Lake "User's Manual"
Ongoing public education efforts. Tributary monitoring project.

Web Links

http://www.winnipesaukee.org

Vital Signs

Water Quality and Quantity

Long Term Ecological Research Network

Coweeta Hydrologic Laboratory

Status: Continuing ***Activity:*** Research ***Proximity:*** Adjacent ***In RPRS:*** NO

Project Background:

The Coweeta watershed contains 5600 acres of mountain land divided into distinct small drainages. The steep slopes, varying in elevation from 2250 to 5230 feet above sea level, are covered with dense forest typical of the southern Appalachian mountains. Each of the experimental watersheds has a weir in its stream to measure the flow of water. The weir is an accurate stream gauging instrument. The height of the water behind the weir blade is continuously monitored by an automatic recorder. Silt that accumulates in the ponding basin behind the weir may also be measured. These measurements are used to show how disturbances to the watershed change stream characteristics.

Web Links

http://www.srs.fs.usda.gov/coweeta/

Vital Signs

Water Quality and Quantity

Loudoun Watershed Watch

Loudoun Watershed Watch

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Organization - Loudoun Watershed Watch (LWW) is a consortium of citizen groups, local and state authorities, and individuals concerned with the quality and health of streams in Loudoun County, Virginia. Vision - LWW shares a common vision with citizens ac

Web Links

http://www.loudounwatershedwatch.org

Vital Signs

Water Quality and Quantity

Maine Audubon

Vernal Pools

Status: Continuing ***Activity:*** Research ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Vernal pools are small, usually ephemeral wetlands that are essential breeding sites for 4 of Maine's species: wood frogs, spotted and blue-spotted salamanders, and fairy shrimp.;
2) inventory and study vernal pools in southern, central, and northern Maine.

Web Links

http://www.maineaudubon.org/
http://www.maineaudubon.org/conserve/citsci/vip.shtml

Vital Signs

Other
Water Quality and Quantity

Maine Department of Environmental Protection

Biological Monitoring of Lakes

Status: Unknown ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Water Quality Data

Web Links

http://www.state.me.us/dep/blwq/docmonitoring/swat/swatlake2000.pdf

Vital Signs

Atmospheric Deposition
Water Quality and Quantity

Maine Department of Environmental Protection

Biological Monitoring of Rivers and Streams

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Water Quality Data

Web Links

http://www.maine.gov/dep/blwq/docmonitoring/biomonitoring/index.htm

Vital Signs

Water Quality and Quantity

Maine Natural Areas Program

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Provide water quality information;
2) Define and characterize Maine lakes

Web Links

http://www.maine.gov/doc/nrimc/mnap/features/ecosystems.htm

http://www.mainevolunteerlakemonitors.org/

Maine Volunteer Lake Monitoring

Vital Signs

Water Quality and Quantity

Stream Team Program

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) A stream team is a group of who people who have banded together to promote stewardship of their local stream.

Web Links

http://www.maine.gov/dep/blwq/docstream/team/streamteam.htm

Vital Signs

Water Quality and Quantity

Surface Water Ambient Toxic Monitoring Program

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) comprehensively monitor the lakes, rivers & streams, marine & estuarine waters of the State on an ongoing basis.;
2) Incorporate testing for suspected toxic contamination in biological tissue & sediment, may include testing of the water column & must include biomonitoring & the monitoring of the health of individual organisms that may serve as indicators of toxic contam;
3) collect data sufficient to support assesment of the risks to human & ecological health posed by the direct and indirect discharge of toxic contaminants.

Web Links

http://www.maine.gov/dep/blwq/docmonitoring/swat/index.htm

http://www.state.me.us/dep/blwq/docmonitoring/swat/2001swatexsum.pdf

Vital Signs

Other

Water Quality and Quantity

Maine Department of Inland Fisheries and Wildlife

Vernal Pools

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Water Body Location and Classification;
2) learn about why some vernal pools receive greater wildlife use than others.;
3) wildlife use and characteristics of vernal pools in three southern Maine townships: Biddeford; Kennebunkport; and, North Berwick.

Web Links

http://www.maine.gov/ifw/wildlife/habitat_data/significant_habitat_data.htm

Vital Signs

Other

Rare Plants

Water Quality and Quantity

Maine Volunteer Lake Monitoring Program

Maine Volunteer Lake Monitoring Program

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Maine Volunteer Lake Monitoring Program sponsors monitoring of over 375 lakes by trained volunteers. The majority of volunteers monitor transparency; approximately 10% monitor dissolved oxygen, and a small group has been trained to monitor other parameter

Web Links

http://www.mainevolunteerlakemonitors.org/

Vital Signs

Water Quality and Quantity

Maryland DNR

Maryland Stream Waders

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Trained volunteers collect benthic macroinvertebrates from freshwater streams to supplement the Maryland Biological Stream Survey in monitoring the overall health of streams across Maryland.

Web Links

http://www.dnr.state.md.us/streams/streamWaders.asp

Vital Signs

Water Quality and Quantity

Massachusetts Division Of Ecological Restoration

Riverways Program

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

To promote the restoration and protection of the ecological integrity of the Commonwealth's watersheds: rivers, streams and adjacent lands. The Riverways Program was created to encourage and support local river protection initiatives as a vital complement to state action.

The Riverways Programs provide guidance and support to citizen groups doing shoreline surveys, fishway observations, water quality monitoring, and some habitat evaluations.

Web Links

http://www.mass.gov/dfwele/der/riverways/index.htm

Vital Signs

Water Quality and Quantity

Middle Nolichucky Watershed Alliance

Middle Nolichucky Watershed Alliance

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Improve water quality in the Middle Nolichucky River Watershed by monitoring water quality, cleaning streams, installing stormwater BMPs and other water quality BMPs.

Web Links

http://middlenolichuckywatershedalliance.org

Vital Signs

Water Quality and Quantity

Monocacy Creek Watershed Association,Inc.

Monocacy Creek Watershed Association,Inc.

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

To protect preserve and enhance Monocacy Creek and it's watershed. We publish the "MCWA Bulletin" twice a year.
We construct stream improvements with help from school groups and boy scouts.

Web Links

http://www.pipeline.com/~rlfreed/monoc.htm

Vital Signs

Water Quality and Quantity

National Committee for the New River

National Committee for the New River

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Adjacent ***In RPRS:*** NO

Project Background:

NCNR protects land critical for preserving important wildlife habitat, rare and endangered species, cornerstones of biodiversity, and working farmland along the New River and its tributaries, through voluntary acquisitions and conservation easements.

NCNR works with private landowners to stabilize eroding stream banks, restore riparian buffers to preventing further erosion, and to create healthy riparian habitat for wildlife and aquatic life.

NCNR works to increase citizens' capacity to defend and protect the New River watershed, by working with local citizens to identify and address specific land and water use activities that threaten the New River's health, wildlife, and scenery.

Web Links

http://www.ncnr.org

Vital Signs

Water Quality and Quantity

Natural Heritage Program

Vernal Pools

Status: Continuing ***Activity:*** Management ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Water Body Location and Classification

Web Links

http://www.mass.gov/dfwele/dfw/nhesp/vernal_pools/vernal_pools.htm

Vital Signs

Water Quality and Quantity

New Hampshire Lakes Lay Monitoring Program

New Hampshire Lakes Lay Monitoring Program

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The Lakes Lay Monitoring Program offers a wide range of monioring options for participants, with over two decades of experience supporting volunteer monitoring of lakes and watersheds throughout New Hampshire. We emphasize a modular approach that matches

Web Links

http://extension.unh.edu/WatRes/NHLLMP.htm

Vital Signs

Water Quality and Quantity

New Hampshire Volunteer Lake Assessment Program (NH VLAP)

New Hampshire Volunteer Lake Assessment Program (NH VLAP)

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The Volunteer Lake Assessment Program is a cooperative program between the New Hampshire Department of Environmental Services (DES) and lake residents and lake associations.

Volunteer monitors are trained by DES to use lake monitoring equipment to collect lake water quality data, to survey the surrounding watershed, and to sample the streams and rivers that are tributaries to the lake. Sampling frequency is flexible, with most monitoring groups choosing to sample monthly throughout the summer (June through August). Each of the participating lakes must be sampled in the presence of a DES biologist at least once per summer. This meeting is an important annual event in which the volunteer monitors have an opportunity to express any watershed concerns. Also, the event allows DES biologists to evaluate the quality assurance of the volunteer sampling techniques.

The data gathered are reviewed for quality assurance and imported into the DES Environmental Monitoring Database (EMD). During the off-season, DES biologists interpret the water quality data, perform trend analyses, and compile the results into an annual report for each lake. Quality data gathered through VLAP also help DES to conduct statewide surface water quality assessments. Assessment results and methodology are published by DES every two years as a requirement of the Federal Clean Water Act.

Once the volunteer monitors receive the data and the annual report for their lake, DES encourages the volunteers to relay the information to their respective associations, organizations, businesses, and local government. Volunteers are also kept informed of the latest issues in lake management and water quality through the production of an annual newsletter, distribution of technical and educational materials, conducting regional workshops, and providing information on important legislation. In addition, DES biologists give presentations at lake association meetings, upon request. Educational initiatives, such as those mentioned above, allow volunteers to recognize potential water quality or shoreland violations around the lake and report their findings to DES. Volunteer monitors are dedicated, proactive lake stewards who are concerned for the well-being of their lakes.

Web Links

http://des.nh.gov/organization/divisions/water/wmb/vlap/index.htm

Vital Signs

Water Quality and Quantity

Pennsylvania Department of Environmental Protection

Water sampling near Palmerton, PA

Status: Unknown ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Spring water samples will be collected and analyzed for metals concentrations to faciliatate future human health and ecological risk assessments

Web Links

Vital Signs

Water Quality and Quantity

Pigeon River Fund

Pigeon River Fund

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) To improve surface water quality;
2) To enhance fish and wildlife management habitats;
3) To expand public use and access to waterways, and
4) To increase citizens' awareness about their roles in protecting these resources.

Web Links

http://www.pigeonriverfund.org/index.html

Vital Signs

Water Quality and Quantity

Rivanna Conservation Society

Rivanna Conservation Society

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The Rivanna River is one of our nation's most historic rivers and its watershed includes the City of Charlottesville and some or all of Albemarle, Fluvanna, Greene, Louisa, and Nelson Counties. The Rivanna Conservation Society, a 501(c) (3) nonprofit organization, was created in 1991 to promote the protection and improvement of the ecological, scenic, recreational and historical resources of the Rivanna River and its tributaries.

Web Links

http://www.rivannariver.org/

Vital Signs

Water Quality and Quantity

Rivers Alliance of Connecticut

Rivers Alliance of Connecticut

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

RAC aims to protect and restore rivers in Connecticut through public policy development, grassroots and volunteer action, and public education. Rivers Alliance of Connecticut is the only statewide nonprofit dedicated to protecting and enhancing Connecticut's rivers, streams, and watersheds. We promote and support environmentally sound state policies, assist the state's many watershed and river groups, and educate the public about the importance of water conservation and aquatic habitats. We are a membership-based nonprofit corporation founded in 1992. Our 600 members include 100 organizations.

Web Links

http://www.riversalliance.org

Vital Signs

Water Quality and Quantity

Sheffield Land Trust

Sheffield Land Trust

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Be a voice for all who seek to guard the natural resources and rural character of Sheffield as it develops; preserve significant tracts of land, which enhance the quality of life for all who live, work or visit Sheffield; work in concert with town and reg

Web Links

http://www.lta.org

Vital Signs

Other

Sleepy Creek Watershed Association

Sleepy Creek Watershed Association

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Our mission is to protect and preserve Sleepy Creek and its watershed and to educate the community on the value of this precious natural resource in Morgan County, WV.

Web Links

http://www.sleepycreekwatershedassociation.org/

Vital Signs

Water Quality and Quantity

Smith Mountain Lake Association

Smith Mountain Lake Association

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The Lake Association is interested in improving life at the Lake and in the surrounding Counties by working to enhance water quality, balance water quantity, improve water safety, encourage responsible development and work with our local and state government.

Web Links

http://www.smlassociation.org/ASPSMLA/news05a_home.asp

Vital Signs

Water Quality and Quantity

U.S. Fish and Wildlife Service

Gulf of Maine Watershed Habitat Analysis

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) Identified, mapped, and ranked important fish and wildlife habitat for priority species throughout the Gulf of Maine watershed.

Web Links

http://www.fws.gov/northeast/gulfofmaine/projects/habitat_analysis.htm

Vital Signs

Other

Water Quality and Quantity

U.S. Geological Survey

Level-1 Water Resource Inventory

Status: Continuing ***Activity:*** Research ***Proximity:*** On Footpath ***In RPRS:*** NO

Project Background:

Water resources along the AT include lakes, ponds, streams, rivers, seeps, springs, wells, and wetlands. The form, structure, and occurrence of these water resources vary considerably and their characteristics and occurrence depend on the geology, climate, and the terrestrial ecological systems found in any particular area. Water resources serve many uses along the AT, such as a source of drinking water for hikers, visitors, and wildlife, providing recreational, scenic and esthetic value, habitat for plants and animals, and a source of water for downstream uses (such as public water supplies, fisheries, hydropower generation).

The AT crosses about 1,700 streams and 100 rivers from Georgia to Maine. The great majority of these crossings are intermittent (zero order), first and second order streams (having a width of less than 5 meters) (source M. Robinson, ATC, 2006). These lower order streams are representative of the forested mountainous and higher elevation terrain that characterizes most of the AT region. It is the zero, first and second order streams that are of most concern for monitoring and management (we will term these high elevation tributaries). Higher order streams and rivers are typically found at lower elevations and bottom lands and are reflective of larger drainage basins, and multiple contributing land uses.

There are 75 lakes and ponds along the AT (M. Robinson, ATC, 2006). These lakes and ponds (collectively called ponds) are a combination of natural and man-made waterbodies; natural ponds are thought to be more common from New Jersey northward on the Trail. These natural ponds tend to be small, in high elevation catchments, or in lowlands between ridges and mountains. Ponds often serve as important recreational areas, whether for swimming, a water supply source, or the site of camping/shelters for overnight usage. The natural ponds provide habitat frequented by wildlife such as mink, bear, and moose; and larger ponds also may serve as loon nesting sites. Human-made ponds are found along the length of the AT and were generally constructed for water supply, agricultural, and hydropower purposes.

Web Links

http://science.nature.nps.gov/im/units/appa/projects/wqlevel1/wqlevel1.cfm

Vital Signs

Water Quality and Quantity

Vermont Department of Environmental Conservation

Biomonitoring and Aquatic Studies Section (BASS)

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) To conduct environmental monitoring of aquatic resources, with an emphasis on the assessment of biological integrity.;
2) BASS also conducts special studies in areas of special concern such as acid rain, malformed frogs, aquatic nuisance control and seasonal pools.

Web Links

http://www.anr.state.vt.us/dec//waterq/bass.htm

Vital Signs

Water Quality and Quantity

Virginia Save Our Streams Program

Virginia Save Our Streams Program

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The purpose of Virginia Save Our Streams is to educate individuals about water quality and stream ecology and to train individuals to make observations of their stream (using biomonitoring) that is useful to state water quality agencies.

Web Links

http://www.vasos.org

Vital Signs

Water Quality and Quantity

Water Environment Federation

World Water Monitoring Day

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Whether it's keeping fats, oils, and grease out of drains, supporting upgrades to local wastewater facilities, putting trash in the trash can instead of the toilet, or even picking up after your pet, everyone can play an important part in protecting the world's water resources. To help you learn more, resources here include a series of fact sheets on common water quality topics, and a glossary of water terms. You can also visit the Water Heroes page to meet real-life professionals who work very hard to keep our water resources clean and safe. It's up to everyone to help preserve and protect the world's limited water supply, and your participation is important!

Web Links

http://www.wef.org/

Vital Signs

Water Quality and Quantity

West River Watershed Alliance

West River Watershed Alliance

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Our mission is to protect and preserve the West River, Saxtons River and Williams River and their watersheds. We manage water quality monitoring programs on these rivers, as well as providing educational opportunities for the surrounding communities and local governments.

Web Links

http://wrwavt.blogspot.com/

Vital Signs

Water Quality and Quantity

Westfield River Watershed Association, Inc.

Westfield River Watershed Association, Inc.

Status: Continuing ***Activity:*** Other ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

The Westfield River Watershed Association, Inc. (WRWA) was founded in 1952 for the purpose of protecting and improving the natural resources in the Westfield River Watershed, as well as expanding recreational and other land use opportunities for individuals.

Web Links

http://www.westfieldriver.org

Vital Signs

Water Quality and Quantity

Category: Other

Appalachian Trail Conservancy

Corridor Monitoring

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** NO

Project Background:

Corridor monitoring involves the regular, systematic gathering of information about the A.T. corridor for the specific purpose of protecting A.T. lands from encroachment.

Web Links

http://www.appalachiantrail.org/protect/steward/corridor.html

Vital Signs

Other

Environmental Monitoring

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On Footpath ***In RPRS:*** NO

Project Background:

The Environmental Monitoring program involves gather information regarding air and water quality, wildlife habitat, and forest health and the changes that occur over time. Program furnishes volunteer and staff for ATPO projectes.

Web Links

http://www.appalachiantrail.org/site/c.mqLTIYOwGIF/b.4806039/k.9B32/AT_MEGATransect.htm

Vital Signs

Water Quality and Quantity

Connecticut Department of Environmental Protection

Dioxin Monitoring

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Adjacent ***In RPRS:*** NO

Project Background:

1) To track the movements and habitat use as well as population dynamics, mortality and habitat needs.;
2) Information collected on the study moose will enable Fish and Game biologists to more effectively manage the state's overall moose population.

Web Links

http://www.ct.gov/dep/cwp/view.asp?a=2684&Q=321790&depNav_GID=1744&depNav=|

Vital Signs

Other

Dickinson College

Temperate-Climate Monitoring of Basalt Weathering Rates in Cumberland County, PA

Status: Continuing ***Activity:*** Research ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

The weathering of silicate rocks plays a significant role in regulating atmospheric CO2 (Walker et al., 1981; Berner et al., 1983), cycling nutrients in soil (Hyman et al., 1998; Chadwick et al., 1999; Derry et al., 2005; Starr and Lindroos, 2006; Amundson et al., 2007) and shaping landscapes (i.e., Dethier, 1986; Pavich, 1986; Pope et al. 1995; Dixon and Thorn, 2005; Dixon et al., 2008). As the most abundant silicate rock in the Earth%e2%80%99s crust, basalt is of special interest because it readily weathers accounting for 30 - 35% of the atmospheric CO2 drawdown that has been attributed to silicate weathering (Dessert et al., 2003).
Basalt weathering rates have been measured in laboratory dissolution experiments (i.e., Gislason and Eugster, 1987; Eick et al., 1996; Gislason and Oelkers, 2003), modeled using reactive transport codes (i.e., Hausrath et al., 2008; Steefel, 2008; Sitchler, 2008), and measured in soil profiles and watersheds (i.e., Dessert et al., 2001; Louvat and Allegre, 1997; Gaillardet et al., 2003; Zakharova et al., 2007). Field based weathering rates calculated using water chemistry are an estimate of the instantaneous weathering rates whereas rates constrained from solid chemistry (soil profiles) are estimates of the average weathering rates integrated over the total duration of weathering. To date, most field-based investigations of basalt weathering have focused on tropical (i.e., Buss, 2007; Sak et al., 2004, in review; Navarre-Sitchler et al., in press) or arctic environments (i.e, Hausrath, 2008) and the calculated weathering rates increase with temperature following an Arrhenius relationship (Sak et al., 2004; Navarre-Sitchler and Brantley, 2007).
Herein, I propose to establish a long-term monitoring site in a temperate-climate in order to constrain field-based basalt weathering rates. The proposed site is located along the Appalachian Trail easement in Cumberland County, PA (Figure 1). This site is characterized by a mean annual temperature of 10.6%c2%b0C and a mean annual precipitation of 1053 mm yr-1.

Web Links

Vital Signs

Other

Great Smoky Mountains Institute at Tremont

Great Smoky Mountains Institute at Tremont

Status: Continuing ***Activity:*** Education ***Proximity:*** Adjacent ***In RPRS:*** NO

Project Background:

To provide programs that will increase the awareness, appreciation and understanding of the natural and cultural resources of Great Smokey Mountains National Park and promote appropriate stewardship of the resources.

Web Links

http://www.gsmit.org/

Vital Signs

Other

Lehigh Gap Nature Center

Lehigh Gap Nature Center

Status: Continuing ***Activity:*** Education ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

Conservation science education and research, with emphasis on youth. Acres of woods, fields, and river, place of restoration project, oldest heath field left in PA, operates Bake oven Knob Hawk Watch down ridge west of center.

Web Links

http://lgnc.org/

Vital Signs

Other

Rare Plants

Long Term Ecological Research Network

Harvard Forest

Status: Continuing ***Activity:*** Research ***Proximity:*** Adjacent ***In RPRS:*** NO

Project Background:

Since 1907 the Harvard Forest has served as a center for research and education in forest biology and conservation. The Long Term Ecological Research (LTER) program, established in 1988 and funded by the National Science Foundation, provides a framework for much of this activity. An understaning of forest responses to natural and human disturbance and environmental change over broad spatial and temporal scales pulls together research topics including biodiversity studies, the effects of invasive organisms, large experiments & permanent plot studies, historical & retrospective studies, soil nutrient dynamics, and plant population & community ecological interactions. Major research in forest-atmosphere exchange, hydrology and regional studies places the work in regional and global context, aided by modeling tools. Conservation and management research and linkages to policy have been part of the Forest since its beginning, and the approaches used in New England can often apply to international studies.

Web Links

http://harvardforest.fas.harvard.edu/

Vital Signs

Atmospheric Deposition

Forest Vegetation

Invasive Species

Other

Water Quality and Quantity

Maine Department of Inland Fisheries and Wildlife

Ecoregional Survey

Status: Continuing ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) identifies known locations of all natural features and wildlife habitats.

Web Links

http://www.maine.gov/ifw/hunting_trapping/weekly_reports/index.htm

Vital Signs

Other

Rare Plants

National Park Service

Visitor use impacts

Status: Suspended ***Activity:*** Monitoring ***Proximity:*** On Footpath ***In RPRS:*** NO

Project Background:

Web Links

Vital Signs
Visitor Use

Natural Heritage Program

Ancient xeric sand dunes

Status: Continuing ***Activity:*** Research ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:
1) Geology

Web Links
http://www.dnr.state.md.us/wildlife/
http://www.dnr.state.md.us/wildlife/Plants_Wildlife/Md_Veg_Com/toc.asp

Vital Signs
Other

Appalachian Plateau wetlands

Status: Unknown ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:
1) Water Body Location and Classification

Web Links
http://www.dnr.state.md.us/wildlife/

Vital Signs
Water Quality and Quantity

Circumneutral seepage wetlands

Status: Continuing ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:
1) Water Body Location and Classification

Web Links
http://www.dnr.state.md.us/wildlife/
http://www.dnr.state.md.us/wildlife/Plants_Wildlife/Md_Veg_Com/toc.asp

Vital Signs
Other
Water Quality and Quantity

Ecological Reserve System

Status: Continuing ***Activity:*** Management ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:
1) Distribution and Status of High Priority Species

Web Links
http://www.maine.gov/doc/nrimc/mnap/reservesys/index.htm

Vital Signs
Other

Limestone glades and woodlands

Status: Continuing ***Activity:*** Inventory ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:
1) Soils

Web Links
http://www.dnr.state.md.us/wildlife/

Vital Signs
Other
Rare Plants

New York State Museum

Inventory of Sterling Forest (1998 to 2000)

Status: Completed ***Activity:*** Inventory ***Proximity:*** On Footpath ***In RPRS:*** NO

Project Background:

1) Scientists from the New York State Museum have conducted faunal and floral inventories of the recently acquired Sterling Forest State Park. Lists of species were generated for amphibians, reptiles, fish, crayfish, mammals, insects (butterflies, moths, dragonflies, and damselflies), and plants.

Web Links

http://www.nysm.nysed.gov/bri/

Vital Signs

Forest Vegetation

Southern Appalachian Man and the Biosphere

Southern Appalachian Man and the Biosphere

Status: Unknown ***Activity:*** Research ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The Southern Appalachian Man and the Biosphere (SAMAB) Program is a public/private partnership that focuses its attention on the Southern Appalachian Biosphere Reserve. The program encourages the utilization of ecosystem and adaptive management principles. SAMAB's vision is to foster a harmonious relationship between people and the Southern Appalachian environment. Its mission is to promote the environmental health and stewardship of natural, economic, and cultural resources in the Southern Appalachians. It encourages community-based solutions to critical regional issues through cooperation among partners, information gathering and sharing, integrated assessments, and demonstration projects.

Web Links

Vital Signs

Invasive Species

Other

TRC Environmental Corporation

Kibby Wind Power Project Transmission Line Corridor Investigations

Status: Continuing ***Activity:*** Other ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Collection of environmental data (vernal pool identification, wetland delineation, general environmental characterization, rare plant survey) associated with assessment of a potential transmission line corridor traversing the Appalachian Trail at/near its intersection with Route 27 in the vicinity of Stratton, Maine.

Web Links

Vital Signs

Other

U.S. Department of Agriculture

Northern Piscataquis and Northern Somerset County Soil Survey

Status: Unknown ***Activity:*** Inventory ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Part of National Cooperative Soil Survey. Auger borings or small holes would be made beyond the view from the trail and away from threatened & endangered plants. Borings and holes would always be filled in. No motorized vehicles or mechanized equipment would be used.

Web Links

http://soils.usda.gov/survey/online_surveys/maine/

Vital Signs

Other

Northern Piscataquis County Soil Survey (initial survey).

Status: Continuing ***Activity:*** Inventory ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Part of National Cooperative Soil Survey. Auger borings or small holes would be made beyond the view from the trail and away from threatened & endangered plants. Borings and holes would always be filled in. No motorized vehicles or mechanized equipment would be used.

Web Links

Vital Signs

Other

U.S. Fish and Wildlife Service

Appalachian Landscape Conservation Cooperative

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Adjacent ***In RPRS:*** NO

Project Background:

The Department of the Interior and U.S. Fish and Wildlife Service are facilitating a coordinated network of LCCs across the United States, to address major environmental and human-related factors that limit fish and wildlife populations at the broadest of scales, including developing adaptation strategies in response to climate change. The science provided by these partnerships will inform biological planning and conservation design, and help direct research and monitoring necessary to inform decisions about conservation delivery.

The Northeast Region will lead the development of the North Atlantic LCC in 2010, while also beginning development of the Appalachian LCC. The Northeast Region will also be supporting the development of the Great Lakes and South Atlantic LCC. Proposed for official funding in fiscal year 2011, the Appalachian LCC will extend from southern New York State to central Alabama, and from southern Illinois to central Virginia, including all or portions of the Blue Ridge, Valley and Ridge, Appalachian Plateau and Interior Low Plateau physiographic provinces. The region supports some of the largest expanses of contiguous forest remaining in the eastern U.S. and portions of the Appalachian LCC are recognized by the United Nations as biodiversity hotspots of global importance.

Web Links

http://www.fws.gov/northeast/science/alcc.html

Vital Signs

Alpine and Hight Elevation Vegetation
Atmospheric Deposition
Breeding Birds
Climate Change and Phenology
Forest Vegetation
Invasive Species
Landscape Dynamics
Other
Ozone
Rare Plants
Visibility
Visitor Use
Water Quality and Quantity

U.S. Fish and Wildlife Service

North Atlantic Landscape Conservation Cooperative

Status: Continuing ***Activity:*** Research ***Proximity:*** Adjacent ***In RPRS:*** NO

Project Background:

The Department of the Interior and U.S. Fish and Wildlife Service are facilitating a coordinated network of LCCs across the United States, to address major environmental and human-related factors that limit fish and wildlife populations at the broadest of scales, including developing adaptation strategies in response to climate change. The science provided by these partnerships will inform biological planning and conservation design, and help direct research and monitoring necessary to inform decisions about conservation delivery.

The Northeast Region will lead the development of the North Atlantic LCC in 2010, while also beginning development of the Appalachian LCC. The Northeast Region will also be supporting the development of the Great Lakes and South Atlantic LCC. The region is building upon strong partnerships to create the North Atlantic LCC, which, guided by the principles of strategic habitat conservation (SHC), will develop and communicate landscape-scale scientific information to shape conservation across the Eastern Seaboard south to Virginia. The North Atlantic LCC will be part of a network of LCCs initiated by USFWS in 2010 that covers the Atlantic and Gulf coasts of the United States, a geographic area that, when compared to other areas globally, is highly susceptible to impacts precipitated by climate change, including sea level rise and storm surges.

Web Links

http://www.fws.gov/northeast/science/nalcc.html

Vital Signs

Alpine and Hight Elevation Vegetation
Atmospheric Deposition
Breeding Birds
Climate Change and Phenology
Forest Vegetation
Invasive Species
Landscape Dynamics
Other
Ozone
Rare Plants
Visibility
Visitor Use
Water Quality and Quantity

University of Rhode Island

NASA Decision Support System

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On Footpath ***In RPRS:*** YES

Project Background:

This project represents a collaborative multi-agency effort to improve decision-making on management of the Appalachian National Scenic Trail (A.T.) by providing a coherent framework for data integration, status report and trend analysis. The A.T.-DSS is to integrate NASA multi-platform sensor data, NASA Terrestrial Observation and Prediction System (TOPS) models, and in situ measurements from A.T. MEGA-Transect partners to address identified national biological diversity priorities of ecological forecasting. The TOPS models allow multi-platform sensor data to be integrated, making it possible to obtain near real-time observations of current (nowcast) ecological conditions as well as predictions for future ecological condition over extensive areas (Nemani et al., 2009). By integration of NASA EOS data and modeling products that link climate models (e.g., through TOPS) and ecological models (e.g., habitat suitability) with in situ observations, the A.T.-DSS will provide needed geospatial information and improve the effectiveness of decision-making in management of the A.T. lands and environment for conservation of biodiversity.

Web Links

http://www.edc.uri.edu/ATMT-DSS/default.html

Vital Signs

Forest Vegetation
Landscape Dynamics
Other

University of Vermont

Acoustical Monitoring of Biodiversity and Phenology: A Pilot Wildlife Monitoring Partnership for Adaptive Management.

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

Phenology provides perhaps the easiest and best method for tracking ecological responses to climate change, as stated by the Intergovernmental Panel on Climate Change. The functioning of nearly all ecological processes and phenomena depends on the timing of phenological events (e.g. plant leaf expansion, flowering, fruiting, and animal migrations and reproduction). Particularly important to natural resource managers, the abundance of a population depends on its phenology and the phenologies of the species with which it interacts. As the timing of key phenological events change in response to climate change, ecosystem functions and the abundance of species will change too. This project will explore the use of acoustical monitoring methods to produce high quality, continuous observations from a variety of locations in order to monitor temporal and spatial patterns in species occurrence. Using Vermont and New York NPS units as pilot locations, this exploratory research project will test multiple acoustical monitoring methods and develop rigorous procedures for implementing continuous monitoring of biodiversity and phenology at numerous sites.

Web Links

http://www.coopunits.org/Vermont/Research/Active/2.0386181121E10/

Vital Signs

Climate Change and Phenology

Utah State University

Palmerton Zinc Superfund Site Appalachian Trail Degradation Study

Status: Completed ***Activity:*** Inventory ***Proximity:*** On AT Land ***In RPRS:*** YES

Project Background:

This study will determine the biophysical condition of the Appalachian Trail, associated side trails and the trail corridor within a specified area of the Palmerton Zinc Superfund Site (Site). The characteristics of the trail tread and the condition of soil and vegetation in and adjacent to the trail will be assessed using methodologies common to foot trail condition studies. The study will compare conditions in the affected area with control areas of similar topography and trail location characteristics. Visitor use estimates will also be determined on all Site trails and control area trails included in the study.

Web Links

Vital Signs

Water Quality and Quantity

Vermont Monitoring Cooperative

Vermont Monitoring Cooperative

Status: Continuing ***Activity:*** Monitoring ***Proximity:*** Unknown ***In RPRS:*** NO

Project Background:

1) The mission of the Vermont Monitoring Cooperative is to serve Vermont through improved understanding of long-term trends, annual conditions, and interdisciplinary relationships of the physical, chemical, and biological components of forested ecosystems in Vermont.

The VMC also promotes the efficient coordination of multi-disciplinary environmental monitoring and research activities among federal, state, university, and private-sector agencies and interests with common interests in the long-term health, management, and protection of Vermont's forested ecosystems.

VMC works towards its mission and goals with a professional staff, web-based Project Library, education and outreach programs, and continuing efforts to support and coordinate Vermont's forest ecosystem interests.

Web Links

http://sal.snr.uvm.edu/vmc/index.php

Vital Signs

Other

Rare Plants

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 632/107644, May 2011

National Park Service
U.S. Department of the Interior

Natural Resource Program Center
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www.nature.nps.gov

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