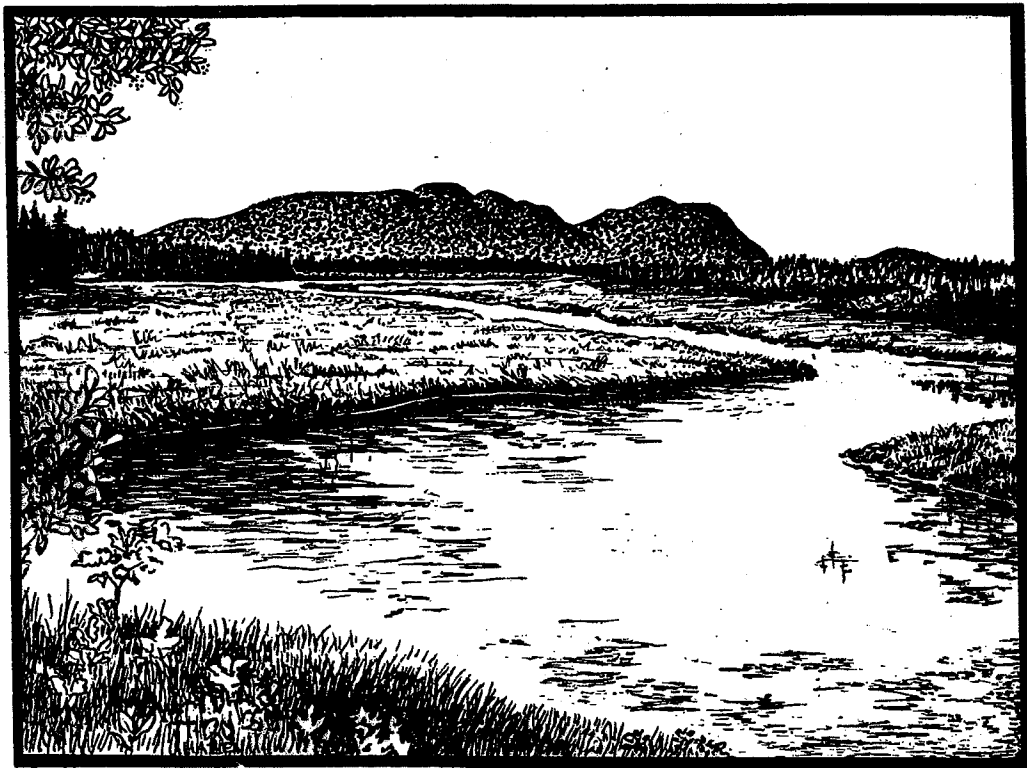


LONG-TERM ECOLOGICAL MONITORING PARK PROPOSAL:

ACADIA NATIONAL PARK



OCTOBER 1993

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LONG-TERM ECOLOGICAL MONITORING PARK PROPOSAL:

ACADIA NATIONAL PARK

Introduction

Acadia National Park (ANP) submits the following proposal for consideration as a prototype long-term ecological monitoring park in the Servicewide Inventory and Monitoring (I&M) Program. The long-term monitoring (LTM) of park resources is a common goal of the National Park Service (NPS) and ANP, and is widely recognized as fundamental to the management of park natural resources. This proposal documents a proactive approach to the management of ANP natural resources, and will serve as a model for other parks in designing and implementing an LTM program.

Acadia's General (GMP) and Resource Management (RMP) Plans specifically identify the development and implementation of an LTM program as a fundamental goal supporting the park's primary mission - the protection and preservation of outstanding natural, cultural, scenic, and scientific values. In addition, the park has completed an annotated natural resource bibliography, identified and received Regional approval for a targeted natural resources staffing plan that identifies an LTM program manager and basic support staff, and held a natural resources scoping session which identified a conceptual model for a long-term monitoring program that builds on our existing program.

Background

Acadia National Park preserves approximately 16,500 hectares on Mount Desert Island, the Schoodic Peninsula, and other islands in the Maine archipelago. The park includes the highest rocky headlands on the Atlantic shore of the United States, and its landscape is a testament to numerous glacial events. Although relatively small in size, the park preserves a rich complement of life zones (e.g., intertidal to subalpine) and community types. These include mixed deciduous forests interspersed among northern coniferous forests, and fresh water that courses through lakes, ponds, and bogs before draining into saltwater marshes and marine estuaries. This diversity is a result of the park's unique topography, northern temperate climate, and the effects of over two hundred years of western civilization.

The unique combination of topography, geology, biota, and inter-related processes are specifically acknowledged in the enabling legislation as being of "great scientific interest." Recognizing the history of scientific efforts and the richness of flora and fauna, scientific investigations were, and are, critical in understanding, managing, and protecting these significant resource values.

Current Resource Monitoring Program

The park has identified and implemented several key programs which monitor resource conditions and address management concerns. These programs are conducted in addition to the other management and park operations, and are the foundation of our long-term monitoring program. Additional funding could greatly enhance these and other important monitoring programs with additional staff and technical support. Listed in order of their frequency, they include:

Air Resource Monitoring

The park, a Class 1 area under the Clean Air Act and the only NPS Class 1 area in the Northeast, cooperates with the NPS Washington Air Quality Division (WASO-AQD), and participates annually with new regional and state research and monitoring efforts aimed at quantifying/verifying present air resource values and methodologies used. ANP is one of 24 NPS air monitoring TREND sites. TREND sites represent the long-term air network and are selected as representative of ecoregions, as well as areas of known air quality problems such as ozone non-attainment and visibility impairment at Acadia. Our program consists of:

- 1) Ozone Monitoring - continuous monitoring, with data since 1982 (NPS TREND Site)
- 2) Visibility Monitoring - daily photographic and optical monitoring, with data since 1979
- 3) Particulate Monitoring - twice weekly, with data since 1979 (IMPROVE Site)
- 4) NADP Monitoring - weekly with data since 1981
- 5) Nitrogen Oxide and Volatile Organic Compound monitoring - 1991 & 1993, summer season, in cooperation with the State of Maine and EPA
- 6) Sulfur Dioxide Monitoring - continuous 1988-1991, twice weekly with IMPROVE network, 1991 - present.

Water Resource Monitoring

Numerous lakes and ponds are found within the park or contiguous to the park boundary, and several are sources for local town drinking water supplies. Due to their importance as a significant park resource and our cooperative interest with the Maine Department of Environmental Protection (MDEP) and local towns, the park has acquired baseline water quality research and monitoring data since the early 1980s. Our long-term water resource program will be more fully defined with the completion of the Water Resources Plan (due September 1994). Our current program consists of:

- 1) Lake Water Quality Monitoring - bimonthly spring through fall with data back to 1976
- 2) Bacterial Water Monitoring - bimonthly, summer 1993, at swimming beaches

Vegetation Resource Monitoring

Numerous research programs have been and are being conducted in the park on vegetation resources. Research has focused on understanding plant communities, and inventorying plant species and habitats of concern. Our current monitoring program consists of:

- 1) Forest Stand Composition and Species Abundance - reassessments on a cyclic basis since 1980.
- 2) Alien Species Monitoring - the park has annually monitored and managed the spread of purple loosestrife (*Lythrum salicaria*) every summer since 1986.
- 3) Locally Rare and Endangered Species - following an intensive three-year effort in the mid-1980's (Greene 1990) which was supported by Natural Resources Preservation Program funding, annual inspections for rare species are now park funded.
- 4) Browse Impacts from Herbivores - assessments of white-tail deer (*Odocoileus virginianus*) and snowshoe hare (*Lepus americanus*) browsing along permanent transects and near six exclosures are being conducted every ten years (since 1981). Some exclosures date back to the 1940's.
- 5) Biological Effects of Ambient Ozone - long-term trend monitoring plots are currently being established to assess severity of visible injury to selected indicator species, and include preliminary assessment of genetic diversity for some selected species.

Wildlife Resource Monitoring

Current wildlife monitoring programs focus on federally listed species and invertebrate pests:

- 1) Bald Eagle (*Haliaeetus leucocephalus*) - nesting success of bald eagles has been monitored in cooperation with the Maine Department of Inland Fisheries and Wildlife (MDIF&W) since the early 1980's. Monitoring includes aerial overflights at least twice a year for all known eagle nests to determine occupancy and productivity.
- 2) Peregrine Falcon (*Falco peregrinus*) - following a successful reintroduction program in 1984-1986, historical aeries have been closely monitored by the park. Successful nesting sites are monitored each year on a regular basis until after falcons have fledged.
- 3) Invertebrates - forest insect pests such as spruce budworm, and gypsy moth are monitored annually in cooperation with the US Forest Service (USFS).

Climatic Resource Monitoring

Weather data have been recorded for Mount Desert Island since 1893 including temperature (high, low, and current), precipitation, snowfall, snowpack, wind speed and direction. Atmospheric weather data have been collected in the park since 1940. Fire weather data have been collected throughout the fire season

(April - October) since 1926. This information is valuable in assessing changes in resource conditions and composition and rates for several biological processes. The park will continue the following weather monitoring:

- 1) Fire Weather - daily during fire season.
- 2) Atmospheric Weather - daily. This monitoring was enhanced in 1991 to include continuous monitoring for wind speed, wind direction, temperature and relative humidity/dew point.

1.0 MANAGEMENT SUPPORT OF LONG-TERM MONITORING PROGRAM

Management Need

The park is fully committed to the development of a comprehensive, institutionalized, long-term monitoring program. This commitment is documented in the GMP which states that the primary resource management goal is "...to perpetuate the natural, scenic, and cultural resources of ANP" (ANP 1992). The GMP identifies additional resource management objectives:

- (1) protect and manage the park's natural resources;
- (2) improve the knowledge base through expanded inventory, monitoring, research, and data-base management;
- (3) maintain and improve air and water quality through monitoring programs and proactive involvement; and
- (4) develop carrying capacity objectives and measures including public information and education.

These objectives serve as the philosophical foundation for the RMP, which identifies specific LTM objectives. The park's natural resource program will:

- (1) understand and maintain ecosystem function in as natural a condition as possible;
- (2) identify and delineate the entire spectrum of resources within the park insuring their continued viability;
- (3) establish and conduct efficient periodic inventory, monitoring, and assessment of the major resource systems within the park; and,
- (4) insure the appreciation of Acadia's natural resources.

Prior planning efforts were instrumental in the identification of 11 monitoring project statements (Appendix A), including three statements specifically addressing the development and implementation of the LTM program. Supporting these statements are an additional 16 inventory and 21 research project statements (Appendix B) which will provide information about park resources and enhance the development of a comprehensive monitoring program.

The park conducted a natural resource LTM scoping session involving specialists from the park, NPS Cooperative Park Studies Units (CPSU), Maine-based natural resource organizations, the NPS North Atlantic Regional Office (NARO), and NPS Washington (WASO) Air and Water programs, and other interested scientists. The session identified a monitoring strategy, described later in this proposal, based on the following objectives:

ANP LTM Objectives:

Integrate existing and future monitoring procedures into a model long term natural resources monitoring program that:

- * determines present and future resource conditions;
- * establishes empirical limits of resource variation;
- * provides early diagnosis of abnormal conditions;
- * identifies potential agents of abnormal anthropogenic change; and,
- * evaluates management actions.

2.0 INVENTORY VERSUS MONITORING

Acadia has an impressive history of research which dates back to the late 1800's. The magnitude and variety of scientific investigations at the park was not known until recently when a comprehensive annotated bibliography of investigative studies was completed (Greene et al. 1992). This project was initiated by the park's natural resource staff, then expanded in scope and supported by WASO I&M funding as a first step toward developing a comprehensive inventory and monitoring program. More than 1,000 scientific investigations, dating back to 1867, were noted and critically reviewed for scientific value and for potential applicability to our long-term monitoring program.

Our LTM program will build upon these investigations as they form the information baseline of the proposed monitoring components (4.7 LTM Program Model). Each investigation is cited and can be reviewed in the park's Natural Resource Bibliography (Greene et al. 1992). Almost all of these references have been collected and incorporated into the park library. Because of this extensive history of prior research at Acadia, no new inventories will need to be completed to implement our proposed LTM monitoring program. The park has identified several important resource inventories (Appendix B) that still need to be completed, however they are not critical to the development or implementation of the LTM program.

Funding and organizational structure to implement these monitoring components are identified in the (6.0) Long-Term Monitoring Budget and (8.0) Infrastructure and LTM Organization.

Scientific investigations at Acadia have been conducted by reputable scientists and university research programs in the northeastern United States. Currently, NPS scientific efforts are coordinated through NARO which contracts with researchers at many universities or colleges in the Northeast including those at which formal CPSUs have been established (i.e., the University of Maine, the University of Rhode Island, State University of New York-ESF). The park and NARO Science programs have also developed and maintained a close working relationship with the College of the Atlantic, especially in the development of geographic information data bases and the previously mentioned annotated bibliography.

3.0 PROGRAM READINESS

The park's recognition of natural resource management and the establishment of a professional program has been exciting and remarkable in the short 13 years since it's inception. The creation of a LTM program, although greatly enhanced by the extensive history of scientific investigations (described above), is credited to management's commitment that the GMP and RMP identify a LTM program as one of the highest priorities in the proactive management of park resources. The park has identified a comprehensive LTM program (Figure 1), including a staffing plan inclusive of LTM positions, which outlines the necessary infrastructure, project statements that address resource information needs, prioritizes inventory and research efforts addressing LTM concerns in park planning documents, and allocates staff resources to update and expand the LTM program and implementation strategy. Our readiness is based on this commitment.

3.1 Implementing Existing Monitoring Protocols

We view major portions of the LTM program as ready to implement due to the previous scientific efforts conducted in the park and surrounding area. These efforts have established monitoring sites and protocols, and are the foundation of our proposed program (App. C). We have developed, with peer review by many scientists (see section 5.0 Scientific Credibility) and NPS specialists, a prototype LTM program for ANP based on this rich scientific background. The monitoring program is described in greater detail in the Monitoring Design section (4.0) of this proposal. The program is ready to test and implement once funding becomes available.

3.2 Cooperative Arrangements

The park continues to be the benefactor of interest, support, and appreciation for the diversity of its resources by the scientific community, and the support of scientific investigations and resource monitoring by park management. The park actively pursues and supports credible scientific activities, continuing a long history of privately supported projects. The park also has several established cooperative arrangements to facilitate activities benefitting the park and the cooperator. We feel confident that the list of cooperative arrangements will increase as the park's LTM program becomes established. To date, the following cooperative arrangements exist:

Cooperators (Cooperative Agreements):

- Maine Dept. of Inland Fisheries and Wildlife (MDIF&W)
- Maine Dept. of Environmental Protection (MDEP)
- Maine Dept. of Marine Resources (MDMR)
- Maine State Planning Office (MPO)
- College of the Atlantic (COA)
- University of Maine (Orono)
- University of New Hampshire
- University of Massachusetts (Amherst)
- University of Rhode Island

- University of Vermont
- State University of New York-ESF (Syracuse)
- Dartmouth College
- Center for Field Research (Earthwatch)
- Garden Club of America
- Friends of Acadia
- Bar Harbor, Seal Harbor, and Northeast Harbor Water Companies

National Biological Survey (NBS) Cooperative Research Units

University of Maine - Dr. Allan O'Connell, Unit Leader

University of Rhode Island - Dr. Charles Roman, Unit Leader

State University of New York-ESF - Dr. Brian Underwood, Unit Leader

3.3 Outyear Funding Requests

Budgetary support for the development of a LTM program has been identified as essential to the full implementation of the program. As outlined in the LTM Implementation Schedule (section 4.9) and Budget (section 6.0), the park is seeking sources of additional funding needed to design, implement, and maintain the program. The park natural resource staff has updated project statements (ACAD-N-001 & ACAD-N-058) in the RMP requesting funding to implement the LTM program with adequate staff, infrastructure, and program support. These requests and this proposal identify incremental increases to the LTM budget commensurate with the increasing complexity and workload of the LTM program (i.e., program establishment, implementation, development, and research). See proposal sections on LTM Program Implementation (4.9) and LTM Budget (6.0) for a full description of these program areas.

4.0 MONITORING DESIGN

4.1 Introduction

The park has prepared an ecosystem monitoring strategy that will incorporate present and proposed resource monitoring programs into a comprehensive LTM program, identify additional inventory and monitoring needs, and identify related short- and long-term research. The proposed strategy is supported by several ANP planning documents, a number of resource identification and prioritization scoping sessions (with both internal and external expertise), a park management commitment and support in preparing this proposal, and the completion of the park's research and resource management bibliography.

The foundation of our LTM program is the historic body of research identified in the research and resource management bibliography. Studies with relocatable monitoring sites and credible design and methodologies were selected to form the basis of the LTM program. Suitability to the goals and objectives of our LTM plan, specific ability to address management concerns, and cost effectiveness were also used in the screening and selecting process. Selected studies are currently being used to reevaluate resource conditions. These

and selected others would become fully reestablished under our LTM proposal (i.e., adding personnel, infrastructure, and a program budget; see LTM Model, LTM Implementation, and LTM Budget).

4.2 Threats and Objectives

The LTM monitoring methodologies will address:

- 1) acquiring a **better understanding** of forest, aquatic, and other significant resources and processes,
- 2) the impacts of **air and water nonpoint source pollutants**,
- 3) effects of **forest fragmentation** on the integrity of park forest communities, processes, and species,
- 4) **community vegetative characterization** (e.g., richness, composition, structure, and diversity) with specific attention to threatened and endangered species, and species of concern to management,
- 5) the impacts of **adjacent land use practices**,
- 6) the effects of **management actions** on park forest communities especially the suppression of fire,
- 7) **climate change** on forest communities' characteristics (i.e., structure, composition, growth, etc.), and
- 8) the introduction and proliferation of **exotic species**, and their effects on native biota and natural processes.

4.3 Management Questions

The LTM program will be established to address specific management concerns and broaden and strengthen our knowledge of resource and ecological conditions. Monitoring would, to the greatest extent possible, replicate baseline monitoring site design and methodologies from earlier studies for comparative analysis. Other investigations may be implemented to address specific questions or data gaps and enlarge our monitoring network.

The chronologic development of the plan and program are described in the following sections.

4.4 Scoping Sessions

To identify the scope and direction of the LTM program, the park held two major resource scoping sessions. The first was with the park staff and the second with an assembled group of managers, scientists, and specialists from other parks and NPS units, the State of Maine, and ANP. The objectives of these sessions were to:

- 1) review and identify resources, relationships, and processes of significance in assessing resource health, and to address sources of anthropogenic effects; and,
- 2) identify the parameters for a model long-term resource monitoring program, and develop a conceptual strategy, budget, and timetable to implement this program.

These sessions identified and prioritized the objectives of the monitoring program, determined significant resources to be monitored in assessing the condition, natural variation, and threats to resources and related processes, and developed a strategy to implement a long-term monitoring program. Described below is a conceptual model and implementation strategy of the long-term monitoring program.

4.5 Selection of LTM Program Components

Twenty-nine monitoring programs are identified in developing a comprehensive LTM Plan (Figure 1). Twenty-one of these programs are included in the LTM budget request for either full or partial funding. Other programs are funded by the park or will be developed with cooperator support. The monitoring programs to be funded (Figure 1) were selected on the basis of their capability to address the LTM Plan objectives, be supported by previous research and data, and meet the criteria of this funding initiative.

4.6 LTM Program

The following narrative describes a comprehensive ecosystem monitoring program for ANP. The park recognizes the resources that are included as being of great importance due to their representation in previous scientific effort, their suitability as indicators of ecosystem health, and ability to address the LTM program objectives. This document provides the direction needed to establish a fully funded and operational LTM program.

We propose to take a broad approach to monitoring until program components have been tested and evaluated for effectiveness in evaluating resources and ecological health. Later, as we discover where scientific data and trend evaluations from one parameter are capable of describing more than one resource condition, some monitoring programs can be reduced or dropped (or, if necessary, others added) to provide a core of resource and ecosystem indicators.

We have also identified important resources and processes for monitoring and research, thus allowing the park to attract cooperators and leverage support from other sources to develop a comprehensive resource monitoring program.

Figure 1. Acadia National Park Long-term Ecological Monitoring Plan Monitoring Components. Components which will require full I&M Program(*), partial I&M Program (**), or leveraged funding (+) are noted. Others are currently funded.

I. LANDSCAPE RESOURCES

- Climate Monitoring
- Air Quality Monitoring
- Geology Monitoring +
- Island Landscape Monitoring*

II. TERRESTRIAL RESOURCES**A. FORESTS**

- Forest Monitoring*
- Forest Understory Monitoring*
- Arboreal Lichen Monitoring*
- Forest Health Monitoring*
- Nutrient Cycle Monitoring +

B. SUBALPINE

- Vegetation Monitoring*

C. FAUNA

- Insect Monitoring**
- Avian Monitoring*
- Mammal Monitoring +
- Amphibian Monitoring*

D. T&E/SPECIES OF CONCERN

- Flora Monitoring*
- Fauna Monitoring +

III. AQUATIC RESOURCES**A. FOREST AQUATIC**

- Bio-geochemical Monitoring*
- Forest Aquatic Habitat Monitoring*
- Forest Aquatic Biological Monitoring*

B. LAKES AND PONDS

- Lake Geochemical Monitoring*
- Lake Physical Parameters Monitoring +
- Lake Biological Monitoring +

C. WETLANDS

- Estuary/Marsh Monitoring*
- Heath Monitoring*

D. SHORELINES

- Calcareous Beach Monitoring +
- Intertidal Monitoring*

E. MARINE

- Fjord Monitoring +

IV. RESOURCES OF SPECIAL CONCERN

- Offshore Island Monitoring**
- Non-native Species Monitoring

It is our intent that all monitoring methodologies for the LTM program be reviewed by the National Biological Survey (NBS). The LTM program manager will arrange a series of meetings to provide background information and the current status of each program component. These meetings would explore what questions need (and can) be investigated to answer specific hypotheses and concerns regarding the LTM program objectives. Written guidelines would articulate what products would be expected, any terms of the proposed projects, and how the research effort would interface with other monitoring and research activities.

The following sections describe the LTM program. Figure 2 is a conceptual development and implementation model of the program.

Figure 2. Acadia National Park Long-Term Monitoring Program Development and Implementation Scale.

CURRENTLY BASE FUNDED	I&M PROGRAM FUNDED	FULL LEVERAGED SUPPORT
LANDSCAPE RESOURCES		
> Climate Monitoring		
> Air Quality Monitoring		
		> Geology Monitoring
TERRESTRIAL RESOURCES		
	> Island Landscape Monitoring	
	> Forest Monitoring	
	> Forest Understory Monitoring	
	> Arboreal Lichen Monitor	
	> Forest Health Monitoring	
		> Nutrient Cycle Monitoring
SUBALPINE BASELINE		
	> Vegetation Monitoring	
FAUNA BASELINE		
	> Insect Monitoring	
	> Avian Monitoring	
	> Mammal Monitoring	
	> Amphibian Monitoring	
T&E/SPECIES OF CONCERN		
	> Flora Monitoring	
> Fauna Monitoring		
AQUATIC RESOURCES		
	> Bio-geochemical Monitoring	
	> Forest Aquatic Habitat	
	> Forest Aquatic Biological	
LAKES AND PONDS BASELINE		
	> Lake Geochemical Monitoring	
	> Lake Physical Monitoring	
	> Lake Biological Monitoring	
WETLAND BASELINE		
	> Estuary/Marsh Monitoring	
	> Heath Monitoring	
SHORELINE BASELINE		
		> Calcareous Beach Monitor
	> Intertidal Monitoring	
MARINE BASELINE		
		> Fjord Monitoring
RESOURCES OF CONCERN		
	> Offshore Island Monitoring	
> Non-native Species Monitoring		
Park Base Funded	I&M. Program Funding	NPS & Leveraged Funding

4.7 The LTM Program Model

I. LANDSCAPE RESOURCES

PHYSICAL RESOURCES

The most encompassing theme identified in developing the LTM strategy was **landscape**. Since long-term monitoring has a park-wide spatial extent, the collection of baseline resource information that directly relates to the objectives of the park LTM program is important. Baseline resources identified include **climate** (meteorological), **air quality**, **geology** and **island landscape**, and are either currently being monitored or have existing or historic information available. The island landscape, a resource commonly identified with the park, represents both ecological and aesthetic values and is recommended for monitoring funding in this proposal.

Climate Monitoring

Weather data have been collected in or near the park over the last 100 years. Continuous daily data have been collected in the park since 1940. The collection of daily high and low temperatures, precipitation, snowfall, snowpack, and wind speed and velocity will continue under the Fire Management Program and the National Atmospheric Deposition Program. This information is valuable in assessing changes in resource conditions and compositions and several biological processes. No funding is requested at this time for this component.

Air Quality Monitoring

Air quality has been monitored in the park since 1979. As a Class I Area and TREND monitoring site, the collection of ozone, particulates (IMPROVE), and other gaseous pollutants will be continued following the established guidelines for these programs. Additional monitoring components and programs may be identified and implemented by WASO AQD and/or MDEP program in supporting air resource management and research. No funding is requested at this time for this component. Biological effects monitoring would require additional funding.

Geology Monitoring

The unique terrain can be explained by the geologic history of the area. Geologic resources have been inventoried, researched, and mapped and are available in the park GIS. The geologic resource did not meet the selection criteria for this funding initiative, however future or ongoing research may contribute to our resource knowledge base. No funding is requested for this component.

Island Landscape Monitoring

Scenic values are identified as a critical resource in the enabling legislation and GMP. These values are heavily influenced by adjacent land use activities and monitoring is recommended. Land use practices and related habitat fragmentation can be monitored using landscape monitoring techniques, which will assist management in planning and mitigation efforts. A substantial amount of historic land use information, including extensive aerial photography coverage of the area is available. In addition to providing useful data on scenic impacts from

adjacent land use, cyclic surface and aerial photography could greatly compliment the analysis of resource monitoring data and enhance resource knowledge, mitigation, and protection efforts.

Surface landscape monitoring will employ existing scenic vista research (Jacobson and Dominie 1988, Rieley and Associates 1988, Steinitz et al. 1988) and the Land Protection Plan (ANP 1988) in developing a surface landscape monitoring procedure. Funding is needed to analyze park viewsheds using nearly 50 years of historic photographs, to determine appropriate monitoring sites and viewsheds, and to determine a monitoring methodology and strategy to be used in mitigating and protecting park scenic vistas and resources. We recommend this program be developed by the National Biological Survey. Project results will be used to determine the frequency of surface landscape monitoring.

The aerial landscape project will use existing aerial photography to document the type and rate of forest stand structure and edge changes (Likens 1987) in and near the park, and to develop an aerial landscape monitoring protocol. Funding is needed to digitize and research existing aerial photography, and to use the analytic capabilities of GIS to assess the impacts to forest communities, species, and processes. We must also establish a strategy and methodology to monitor landscape resources, and provide data for forest and other resource modeling to be used in mitigating and protecting park resources. We recommend this project be developed by the National Biological Survey. The NBS will recommend the frequency, scale, and format of aerial photography purchases. The park LTM forest ecologist and GIS specialist will implement this monitoring program. I&M Program funding is being requested to support this monitoring.

II. TERRESTRIAL RESOURCES

A. FOREST RESOURCES

Forest communities comprise the most dominant landscape cover for the park and surrounding area. Historical park forest assessments have focused on the biological effects of air pollutants and on evaluating forest community response, primarily related to fire occurrence, following two hundred years of human activity and disturbance.

Monitoring Design

The forest communities monitoring program is based on the establishment of new and periodic remeasurement of historical study sites and monitoring plots. Following review by NBS scientists, our forest monitoring program will monitor the ten forest communities (see Appendix D) identified by Patterson (1983, and Univ. Massachusetts, pers. comm.). Other vegetative assemblages representing important community types are addressed in terrestrial sections which follow. These forest communities represent the predominant range of diversity as delineated in the park's vegetation map (Waggoner 1981) in tracking changes with the dominant and understory woody species. To assess community variation due to site factors, natural successional trends, past and current disturbances, and assure statistical integrity and data comparability, approximately thirty permanent replicate study locations will be established. Twenty-six study locations (see Figure 3), representing the 10 forest

community types, were identified in the original study and have corresponding baseline data. Additional sampling has occurred at most locations, and these sites have been permanently marked and located with global positioning system (GPS) technology. Parallel sampling transects will be located in the study to maximize sampling and avoid transitional zones and community edges. Sample plots, at least twenty per study location, will be placed along transect lines at 44 meter intervals. These sample plot locations will use the same sample plot point centers for the forest and woody understory monitoring program. Non-woody understory and other forest monitoring programs (see Amphibian, Landbird, Invertebrate and Small Mammal Sections) will be located at the intermediate stations between the forest/woody understory sample plots (see Figure 4). These locations will be permanently identified as the intermediate reference points. At these reference points an auxiliary transect line, a length of 22 meters, will be established perpendicular to the main transect line. The monitoring programs listed above will use either the reference point as the sample point center (mammal), the intermediate transect point (understory non-woody), or the distal end of the auxiliary transect line (landbird) to designate monitoring locations.

Forest Monitoring

This monitoring program uses the Bitterlich variable radius methodology (Patterson et al. 1983b, Bonham 1989) for trees and the fixed radius technique to assess regeneration and shrubs (Patterson, Univ. Mass. pers. comm.). Measurements include total canopy cover, the Braun-Blanquet species cover/abundance (Patterson et al. 1983b) and the Kuchler (1956) physiognomic classification (Patterson et al. 1983b). Representative individuals for each species of dominant, co-dominant, and sapling/seedling classes have been aged. The study locations will be stratified and a resampling strategy developed for a rotational five year interval. Monitoring will be analyzed to produce values for species abundance, cover, and structure within these forest communities. Evaluating changes in spruce-fir and northern hardwood forest stands with concurrent monitoring information (i.e., forest landscape, climate, air, hydrology, forest health, disturbance, fire, etc.) may identify causative agents (e.g., air pollution, forest pests, habitat fragmentation, climate change, etc.) influencing stand dynamics and structure, species composition, and species vigor (Likens 1987, Foley and Associates 1992). I&M Program funding is being requested to support this monitoring.

Forest Understory Monitoring

Following review by NBS scientists, understory monitoring will be separated into woody and non-woody programs, utilizing existing methodology and historical data (Patterson, Univ. of Mass., pers. comm.). The fixed radius plot methodology will focus on woody species below diameter breast height (DBH). This monitoring will use the sample plot center point (see Figure 4) in measuring a 11.7 foot (1/100th acre) radius circle in sampling regeneration and shrubs by species. Total ground cover for a combined herb/grass value will be estimated within the plot. Downed woody debris, forest litter, and depth of duff will be collected from three representative measurements per sample plot. Monitoring vegetative species and composition shifts, productivity, and vigor (White 1979) are important in predicting fire behavior and fuel modeling (Patterson et al. 1983b), animal occurrence (Garman 1991, Ralph et al. 1993) and forage availability (Thomas and Verner 1986), and succession. Replicate sampling of understory woody vegetation will occur on a five year cycle.

Figure 3. Forest Study Sites on Mount Desert Island.

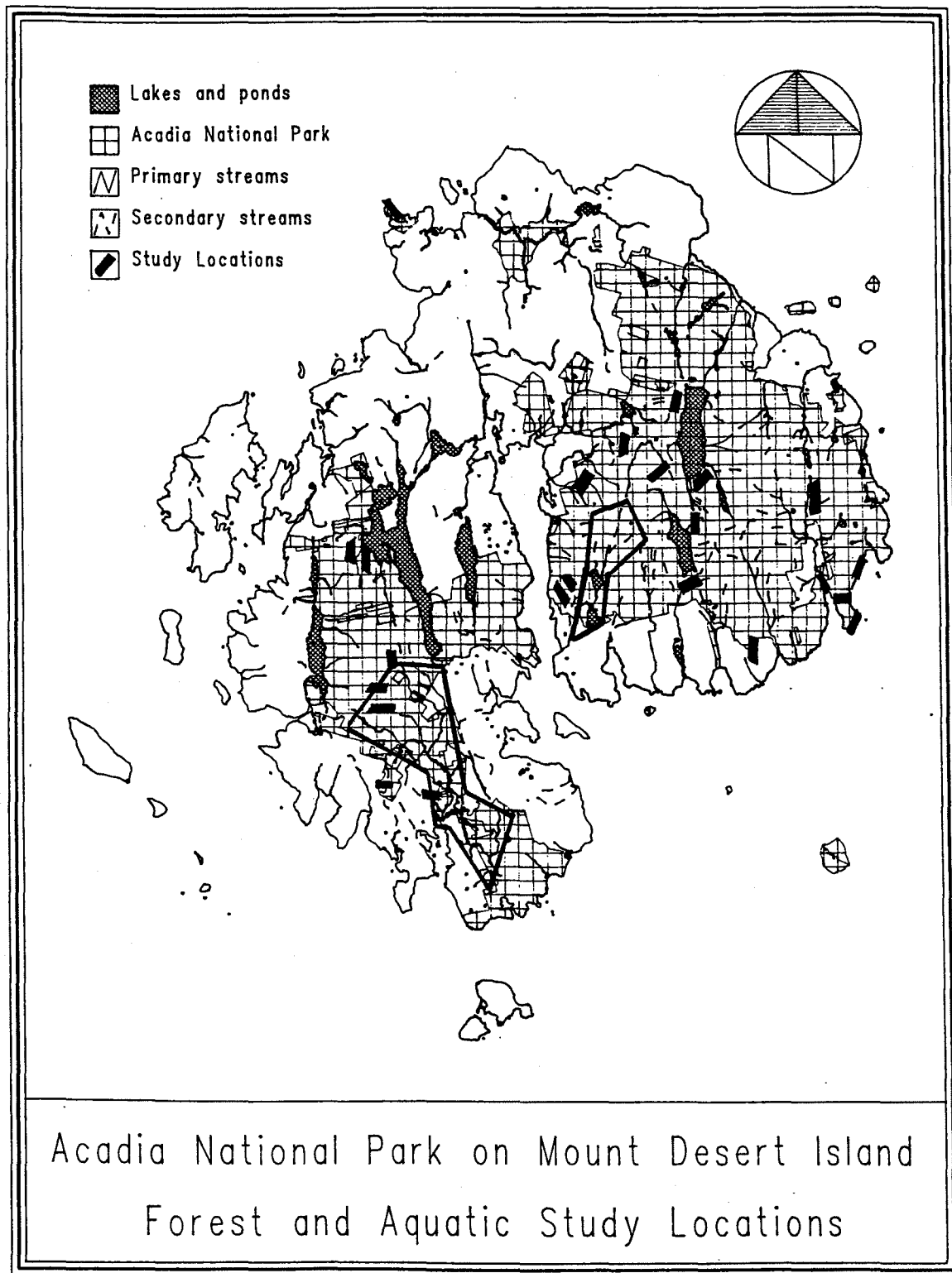
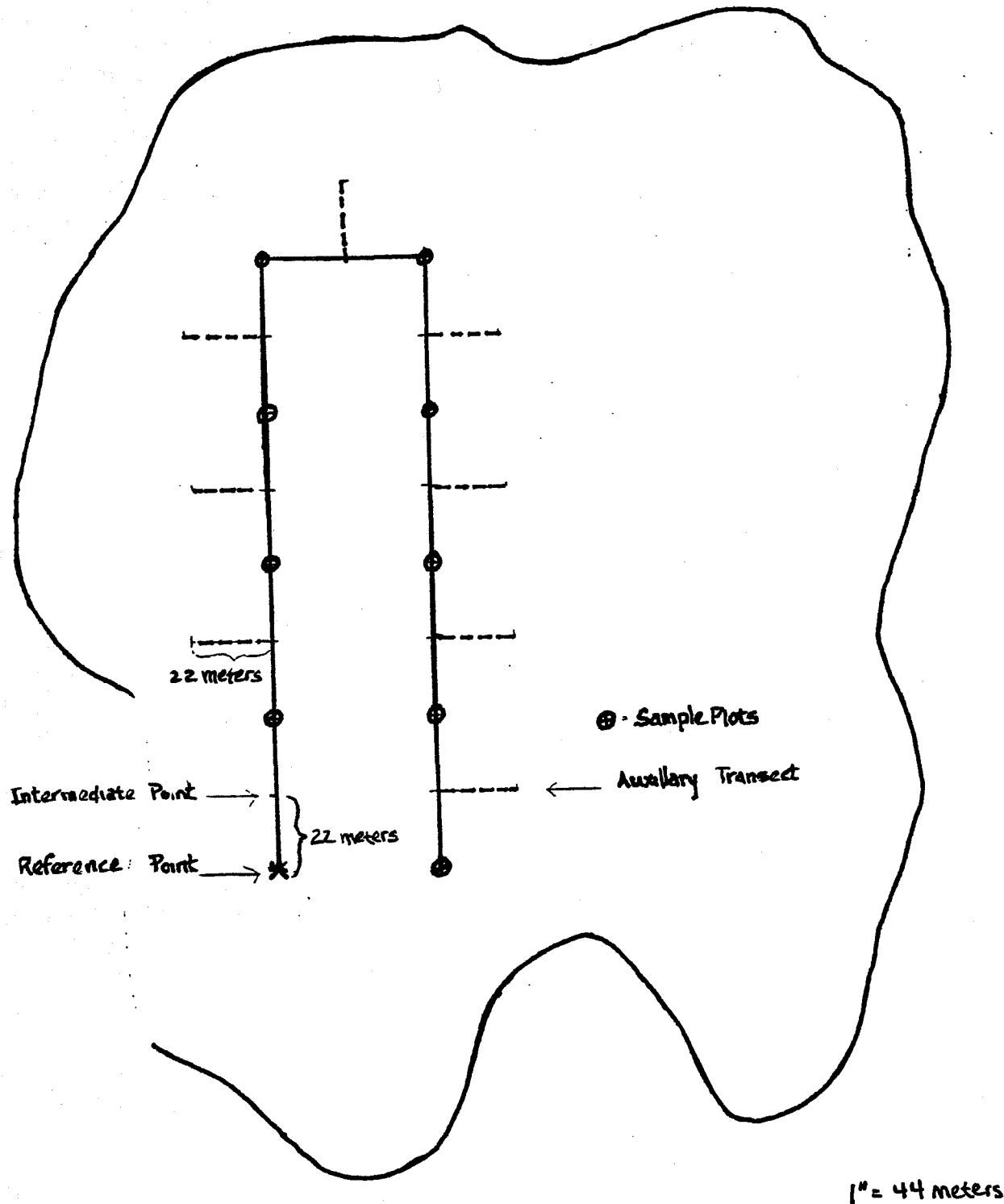


Figure 4. Forest monitoring sampling design based on Patterson et al. (1983b). Twenty-six study sites have been established representing ten major forest communities on Mount Desert Island, Isle au Haut, and the Schoodic Peninsula. Isle au Haut and Schoodic Peninsula are not shown.



Monitoring cover of understory non-woody species, including bryophytes, will be estimated by species (Bonham 1989, Garman 1991) using a 1m x .5m sampling frame. Monitoring will occur along the auxiliary transect line by placing the long side of the sampling frame along the northern or eastern edge of the transect. Preliminary sampling will establish a species-diversity curve that will be used to determine the number of permanent sample frame sites to provide statistically valid sample size, and will be placed along the auxiliary transects. Understory species changes may indicate air pollution effects (Jackson et al. 1993), different hydrologic yields and quality (Foley and Associates 1992), nutrient loading and changing nutrient cycles (Fernandez 1991), and animal species changes (Jones 1986). Remeasurement will occur twice a year, in early spring and late summer, for the first three years to establish a baseline, after which time the data will be reviewed to determine future sampling frequency. I&M Program funding is being requested to support this monitoring.

Arboreal Lichen Monitoring

Lichens are an extremely diverse floral group and exist in most vegetative communities in the park (Wetmore 1984). Some species are known to be sensitive to gaseous pollutants or as bioaccumulators of trace metals and elements (Belnap et al. 1993). Lichen collections and studies in the park have identified SO₂ sensitive species and their distribution (Wetmore 1984). Arboreal lichen species have been used to assess forest and individual tree health (Stubbs et al. 1988).

Monitoring arboreal foliose lichens will incorporate the methodology of Pearse et al. (1993), with the work tested and described by Stubbs et al. (1988) and Stubbs et al. (1990), and will be established at selected forest study locations. The studies will evaluate two measures of lichen health - luxuriance and density - on tree boles (> 50 cm) located at the intermediate reference points. The methodology will follow Stubbs et al. (1990) and will be evaluated using the Modified Luxuriance-Density Index (ML-DI). The monitoring program will be implemented by a qualified lichen specialist under the direction of the LTM forest ecologist. A procedural manual will be developed through a contractual agreement which will allow LTM staff to conduct future monitoring field assessments and collections. Study sites based on Jackson et al. (1993) will be established in year one (i.e. FY 3 from establishment of the park as a prototype) using the forest monitoring design. We will implement ML-DI measurements and conduct baseline chemical analysis on sensitive species (Wetmore 1984) in the second year. ML-DI measurements will be completed and the monitoring manual will be produced in the third year. ML-DI remeasurements are estimated to occur every five years (Stubbs, Univ. Maine, pers. comm.) with chemical analysis at an interval which will be determined. I&M Program funding is being requested to support this monitoring.

Threatened/Endangered and Species of Concern

As described later (see Section 4.7 II. D), the threatened/endangered and species of concern monitoring program will conduct monitoring in forest communities using methodologies described in White and Bratten (1981). Species shifts and abundance may reflect habitat changes, visitor pressures or collection of rarities (White and Bratten 1981), and air or hydrologic effects (Belnap et al. 1993). I&M Program funding is requested to support this monitoring.

Forest Health

The forest monitoring program will be enhanced with the development of a forest health monitoring program. The USFS has conducted forest pest and health surveys since the 1940's over forests throughout the nation. These surveys have covered Mount Desert Island and vicinity, and historic and current data are available. Other forest investigations have noted the occurrence of forest pests. The LTM program manager and forest ecologist will cooperate with NBS staff in identifying a project tailored to assess park forest community health and develop a monitoring program. The project will identify present conditions and forest pest occurrence in and adjacent to park forest communities. The project will address how threats such as adjacent land use and habitat fragmentation may influence forest pests and disease (Shenandoah NP 1990) impacts in forest communities and how monitoring will detect and track forest health. The initial project will be two years in length, and the subsequent monitoring program will coincide with the five year cycle for forest plot remeasurements. I&M Program funding is being requested to support this monitoring.

Amphibian Monitoring

Forest ground cover is important to amphibians for thermoregulation and reproduction. Changes in amphibian species composition, abundance, and distribution can reflect microhabitat disturbances, water pollution, and climatic changes (Jones 1986). The forest amphibian monitoring program will be established along the auxiliary transect lines (see Figure 4) with sampling locations and methodology replicating recommended LTM project protocols. The monitoring frequency will be integrated into the LTM program forest monitoring remeasurement schedule and be conducted by the LTM forest ecologist and staff. I&M Program funding is being requested to support the development and implementation of this monitoring program (see 4.7 II. C.).

Landbird Monitoring

This monitoring program will follow the Avian Monitoring Program protocols described later in this proposal. It would be designed to use the distal ends of every other auxiliary transect (forest monitoring design), with additional point sites added to maintain appropriate methodology standards (Ralph et al. 1993). Landbirds are good indicators of habitat change related to climate change (Temple and Weins 1989), fragmentation (Robbins et al. 1989), and biological diversity (Wilson 1988). I&M Program funding is being requested to support this monitoring (see 4.7 II. C.).

Small Mammal Monitoring

Small mammal populations and abundance reflect habitat change (Cooperrider et al. 1986) and are an important predator food source (Call 1986). This monitoring program will use the forest monitoring design and study plots and will be established at both the forest study plots and the intermediate reference points. Monitoring will follow described protocols (see 4.7 II. D) and plots will be randomly placed within a 11.7-foot radius circle from the study and reference points (at least 20 locations). Following the first three years of baseline monitoring, the resampling interval will alternate with the forest-understory remeasurement schedule. The LTM program will leverage support from local universities and funding is not being requested to implement this monitoring.

Nutrient Cycle Monitoring

The park has been identified as a possible satellite monitoring site (Foley and Associates 1992) with the Forest Health Monitoring Program (USFS and EPA) (Stolte et al. 1992). Nutrient loading (McNulty et al. 1990) may indicate climatic change, air pollution and acid precipitation and directly effects forest health, structure, and composition (Foley and Associates 1992). The park's commitment to developing and implementing a comprehensive LTM program could leverage support in developing a forest biogeochemical (nutrient) cycle monitoring program (Fernandez, pers. comm.) to complement the Forest Monitoring Program. The park's unique location at the eastern edge of the ecotone between northern coniferous and northern hardwood/pine forests suggests that this monitoring/research would complement the climate change and atmospheric deposition programs at the Hubbard Brook Forest Study (USFS) and the Howland Integrated Forest Study (UM/EPA/International Paper Company). Once selected as a prototype, the park will pursue this cooperative association. No funding is being requested at this time.

B. SUBALPINE

The mountain summit (i.e, subalpine) communities at ANP are known to support rare plants, receive heavy visitation and high exposure to gaseous pollutants. They may be especially vulnerable to the effects of climate change. These areas have been identified in the Maine Critical Areas Program, and have specific mention in the park's enabling legislation. A study is ongoing to characterize subalpine communities and has established permanent monitoring sites (Foley et al. 1991)

Vegetative Monitoring

Subalpine vegetative communities at ANP may be exhibiting composition shifts, changes in species richness, and reduced reproductive vigor from air pollution, visitor disturbance, climate change, and exotic species introductions. Monitoring this community would complement forest, wetland, and intertidal monitoring efforts serving a complementary role as an indicator of natural and induced perturbations.

The LTM program manager and biologist (vegetation) will cooperate with NBS researchers, reviewing Foley et al. (1991) in identifying and developing a subalpine resources monitoring program. The project will establish the key resources to be monitored, describe present community and species conditions, and recommend a monitoring methodology. The project will identify and address how threats (i.e., climate change, atmospheric deposition, visitor impacts, gaseous pollutants, etc.) may impact subalpine communities and how monitoring will detect and track resource health. The initial project will run for two or three years. The project will establish the monitoring program protocols and remeasurement strategy. I&M Program funding is being requested to support this monitoring.

Insect Monitoring

As described later (see section 4.7 I. C), indicator species identified by Ginsberg (1993) will follow monitoring protocols and the remeasurement strategy identified in the insect research program. Shifts in species distribution and abundance may indicate vegetation changes or ecosystem stresses (Erhardt and Thomas 1991). I&M funding is requested to support this

monitoring pending completion of the research inventory and monitoring project (see section 4.7 I. C., Ginsberg 1993).

Avian Monitoring

Landbirds, especially neotropical species (e.g., thrushes, etc.), are common on park mountaintops and are indicators of ecosystem health of park, regional and international attention. Permanent transects established for the vegetative monitoring program will also serve as point counts sites for avian monitoring. The monitoring protocols (Ralph et al. 1993, Super 1993), identified in the Avian Monitoring section (see section 4.7 I. C) will be followed. I&M funding is requested in the Avian Monitoring section (4.7 II. C.) to conduct this monitoring.

Threatened/Endangered and Species of Concern

As described later (see section 4.7 II. D), the threatened/endangered and species of concern monitoring program will conduct monitoring in forest communities based on White and Bratten (1981). Species shifts and abundance may reflect habitat changes, visitor pressures or collection of rarities (White and Bratten 1981), and air or hydrologic effects (Belnap et al. 1993). Monitoring funding is requested to support this monitoring.

C. FAUNA

Insect Monitoring

The park has an incomparable insect fauna data set (Johnson 1927, Procter 1946) upon which to develop a monitoring program. Over 6000 species were identified in Procter's 27 field seasons of collecting, and this diversity presents a challenge in monitoring populations and related ecosystems. Identifying candidate taxa to be inventoried and monitored has professional support and has been identified in the RMP (ACAD-N-0047).

Ginsberg (1993) has conducted initial surveys in confirming taxa that have regional distribution and replicating previous collections (Procter 1946). NBS FY 94 Funding (RMP Project Statement ACAD-N-047) has been sought to implement a three year study that will reinventory selected invertebrates, establish a regional T&E/species of concern list, identify suitable monitoring protocols and key monitoring locations, develop guides for taxonomic identification and a regional roster of invertebrate specialists, and recommend species to be monitored in park communities (i.e., forest, aquatic, shoreline, etc.). This project will also develop methods to use invertebrate monitoring as an early warning system for perturbations to park ecosystems.

The insect monitoring program will implement recommended methodologies, incorporating the following programs. The forest aquatic biological monitoring program will monitor species identified by previous aquatic investigations (White 1989, Mack and Gibbs 1989). The forest amphibian monitoring program will identify all trapped ground dwelling species (Greene 1992). The forest health monitoring program will monitor forest pest and insect populations. I&M Program funding is requested to implement these monitoring programs.

Avian Monitoring

Birding is a major visitor activity and favorite pastime of area residents (ANP 1992), and is perhaps a reflection of the diversity of avifauna - at least 330 species (Jones 1987a & b). Many species are migrants (e.g., warblers, harlequin duck, etc.) and may serve as regional, international, as well as park indicators of ecosystem conditions (Temple and Weins 1989). The landbird monitoring program has been identified in the RMP (ACAD-048) as an important natural resource and significant factor in visitor enjoyment. As an initial step to the development of a landbird monitoring program, the park conducted a preliminary field investigation of park nesting landbird species and habitats, reviewed monitoring methodologies to determine their suitability to park species and habitats, contacted other NPS bird monitoring programs and researchers. A report was prepared addressing the findings with recommendations on developing a landbird monitoring program (Super 1993). The park expects to initiate with local Audubon specialists a BBS program in 1994.

The Random Stratified Point Count (Ralph et al. 1993) method will be used to monitor in marsh, heath, and subalpine communities (e.g., non-forest landbird monitoring program). Monitoring will follow guidelines and recommendations of Desante et al. (1993), Simons et al. (Unpub) and Super et al. (in press). Monitoring will occur annually from late May till the third week of June following the strict QA standards described by Desante and Burton (1993) and Simons (unpub). The data will supplement other nesting landbird monitoring beginning May 1994. The data will also be shared with park cooperators in the Northeast Working Group, Partners in Flight Program and MDIFW Non-game program. The program will build on the forest landbird monitoring (i.e., Point Count) and BBS programs. Both the forest and the non-forest programs may be expanded to monitor fall migrants. The park will seek other support in monitoring other groups of birds (i.e., shorebirds, raptors, breeding waterfowl and alcids, etc.). Funding is requested to develop and implement this monitoring component.

Mammal Monitoring

Over forty species of mammals are known to inhabit the park and surrounding area (Coman 1981). The earliest investigations (Bailey 1925 and Manville 1942) found similar numbers of mammals. Mammals have been both negatively and positively important to residents and visitors reflecting recreational activities (e.g., viewing, hunting, and trapping), and as pests by damaging crops and landscape plantings. Predator and furbearer trapping is still conducted on lands adjacent to the park and on inholdings. Research has focused on deer, small mammals, and furbearers. Currently several research projects are investigating relationships between the recently naturalized eastern coyote and white-tailed deer.

Large mammal studies present information about species densities and distributions (Favour 1940, Muller-Schwarze 1979a & b, Collins 1990) with several studies (Gilbert and Harrison 1982, Dubec 1987, Sacki 1991) identifying monitoring techniques. The natural resource staff, through the RMP, will continue to cooperate with local universities and leverage support in institutionalizing monitoring programs (ACAD-N-064, -058, -001) for these species.

Small mammals serve as an indicator of habitat change and collected data can assist in tracking habitat and ecosystem changes and identifying causative reasons. Monitoring small mammals is cited by Anderson (1984) as an easy and basic measure of habitat condition and change. Several efforts (Davis 1961, Garman 1991, and several others) on MDI and in the park have been made to characterize small mammal populations providing a species list and information on distribution. Monitoring programs will be established in the forest and non-forest vegetative communities (see Forest, Heath, Subalpine, Beach, and Offshore Island monitoring sections).

The small mammal monitoring program will use replicate tested monitoring protocols at established study sites for the community being monitored. Non-destructive trapping with three trap sizes, as tested by Garman (1991), will be placed along established transects or at permanent sites and conducted over several trap nights (Note: species density curves will determine the statistical standard for number of traps and total trap nights). The capture/recapture methodology will identify species, density, distribution, habitat relationships, and species relationships. The monitoring will be annual for the first three years to establish a baseline and a rotational interval will be established consistent with the ongoing monitoring schedule. The LTM program manager and staff specialist will seek additional cooperators and support to implement this monitoring component.

The park will monitor furbearer harvest records (ACAD-N-030) and identify research and monitoring programs and request funding support (ACAD-N-001, -023, -058) in the RMP. No I&M funding is requested at this time to design or conduct monitoring.

Amphibian Monitoring

Amphibian populations are recognized as indicators of microhabitat changes resulting from direct management activities, macrohabitat changes and habitat fragmentation (Hunter et al. 1992), or non-point sources of pollution (Jones 1986). Their contribution in monitoring aquatic community health (Jones 1986) is widely accepted and the park has identified a two phase amphibian project (ACAD-021) that 1) conducts a parkwide species status in the four recognized IUCN amphibian habitat types (terrestrial, aquatic, vernal, and wetlands), and 2) tests and develops park and regional monitoring protocols. The development of amphibian monitoring protocols is the number two priority in the RMP and has been submitted for FY94 NBS funding. The project statement identifies that non-destructive monitoring techniques will be used.

The monitoring protocols developed from the NBS amphibian study for the four IUCN habitat types will be implemented at permanent monitoring sites in the forest and non-forest community types. I&M funding is requested to develop and implement the monitoring program.

D. THREATENED/ENDANGERED AND SPECIES OF CONCERN

The LTM program as designed institutionalizes monitoring of key forest and non-forest community components with the flexibility to adjust monitoring component parameters addressing new concerns, monitoring protocols and techniques, species and/or ecosystem

information, and management direction. The selected monitoring components and inherent LTM program flexibility will monitor ecosystem conditions directly associated with threatened and endangered (T&E) species, and species of concern. Monitoring T&E/Species of concern and the related habitats or communities provides significant information and protection for these species.

Flora

The park has completed an initial floral inventory for rare, T&E, and species of concern. Funding limitations allowed only likely habitats to be surveyed, however Greene (1990) identified the need to establish a monitoring program for known species and their habitats and be watchful for new or other suspected species as a method to track and expand T&E and species of concern monitoring.

Based on the work and advice of Greene (1990), a monitoring program will be implemented following White and Bratten (1981) and Great Smoky Mountains National Park (GRSM) (Rock, GRSM, pers. comm.) by:

- 1) assessing and mapping known populations using the park's GIS and region's GPS,
- 2) prioritizing the species using a refined species ranking system developed and used by the Nature Conservancy (TNC) and Maine Nature Heritage Program (MNHP),
- 3) establishing permanent plots of appropriate size to characterize and monitor habitats,
- 4) locating individuals and populations with a global positioning system (GPS) to known reference points and photo points, and,
- 5) developing a strategy to reassess species and populations according to the prioritization process (White and Bratten 1981).

Only in cases of anticipated impacts, would the program resample species differently from the predicted 5-20 year resampling interval as determined by the weighting scale and prioritization process. Information will aid species protection and management activities as well as identify changes to populations and habitat conditions related to pollutants, climate change, and adjacent land uses. I&M funding is requested to implement this monitoring.

Fauna

The park has two federally listed species, the bald eagle and the peregrine falcon. Park staff currently monitor both species through park resource base funding with cooperative support from MDIFW and support groups. The harlequin duck (*Histrionicus histrionicus*) is currently a federally listed Class II species and is will likely be listed as a Threatened Species in the near future. The park has cooperated with state biologists by funding or providing support for several research projects (Mittelhauser 1989, 90, 91) related to wintering harlequin duck populations. The park will continue to support monitoring and research projects for T&E species and has requested additional resource base funding (ACAD-N-001 & ACAD-N-060) to providing enhanced management and protection.

Numerous other species have been identified by MDIFW Endangered Species Program as of special concern within the state (McCollough, MDIF&W, pers. comm). Most species need

additional information to determine their biological status and candidacy for further federal recognition. The LTM program, although not specifically monitoring for any of these species, will be an indicator of conditions and health of key resources (i.e., prey, habitat, etc.) directly related to T&E/species of concern. In addition, the branch of natural resources will continue to develop linkages and support in conducting all management activities (i.e., education, protection, research, monitoring, etc.) with T&E and species of concern. No I&M funding is requested at this time for monitoring.

III. AQUATIC RESOURCES

Water resources are broken into artificial categories owing to resource relationships and the coordination of LTM Plan monitoring programs. The categories also reflect park priorities due to legal responsibility, funding and cooperator availability, objectives, and operational capabilities.

FOREST AQUATIC RESOURCES

Aquatic systems are closely related to the terrestrial communities that they border and reflect the inputs they receive and the outputs they provide (Likens 1985). Interpreting the health of aquatic systems can reflect the health of the surrounding communities presenting an opportunity for collaborative monitoring efforts (e.g., air, vegetation, etc.) to be used in monitoring resource and ecosystem health and serve as an early warning system. An excellent assessment of long-term trends in forest and other vegetative communities can be obtained by integrating vegetation and surface water monitoring into calibrated watersheds (Kahl, Univ. of Maine, pers. comm.). This practical approach allows the added advantage of knowing nutrient fluxes on a watershed basis in evaluating resource and watershed health. Our monitoring program will capitalize on the numerous water quantity and quality research and inventory projects that have been conducted in the park and on MDI. The reestablishment of previous studies with tested and peer reviewed methodologies expedites implementation of the LTM program, enhances data analysis and trend evaluations, and is cost effective. The park is currently developing a Water Resources Plan that will recommend monitoring programs (Kahl, Univ. of ME., pers. comm.) similar to those outlined below.

Monitoring Design

The monitoring design reestablishes a geochemical stream assessment project and identifies complementary habitat and biological inventory and research opportunities. The program will use two previously monitored watersheds, one emptying into a lake and the other into a salt/fresh water marsh. A third drainage will be selected in the area burned by the 1947 wildfire allowing for hydrologic and bio-geochemical comparative analysis with coniferous forest communities (Kahl, pers. comm. and Foley and Associates 1992) and how similar inputs effect park vegetative and aquatic resources. Selection of the third drainage will be based on existing data, relationship to lakes and ponds, and ability to address threats and LTM objectives. Implementation of tested methodologies allows for comparative analysis with historic findings and expedites implementation of hydrologic and aquatic monitoring.

Funding will be needed to support the development of monitoring design, field testing, and implementation.

The reestablishment and implementation of the aquatic habitat, biological, and streamside vegetation monitoring programs are described below.

Bio-geochemical Monitoring

Building on the work of Kahl et al. (1985) and Heath et al. (1992, 1993) calibrated forest watershed monitoring will be reestablished on at least two watershed sites. Bio-geochemical analytes will include at least the following: closed cell 'field' pH, air equilibrated pH, Acid Neutralizing Capacity (ANC), conductivity, dissolved oxygen content (DOC), Si, Al, NH₄, Ca, Mg, K, Na, Cl, NO₃, SO₄, total P and N. Bacteria, seston, turbidity, and total suspended solids (TSS) will be included at selected times of the year. These analytes allow interpretation of processes related to acidic deposition, forest nutrient cycling, and geochemical weathering. Knowledge of the latter is essential for long term interpretation of nutrient cation supply for forest health interpretations. Sampling for all or part of the above list would occur at least weekly, with automated samplers to collect more frequently during hydrologic episodes. Comparable regional watershed monitoring programs have found excellent geochemical mass balances can be obtained when approximately 80 samples per year are collected for each stream (Kahl, pers. comm.). Sampling frequency will probably be reduced in succeeding years once a baseline for the watershed and system is developed.

Parshall flumes will be installed and discharge will be recorded hourly. Specific details of hydrologic implementation will be specified as stream sites are located (i.e., electrical power, access, etc.). Data will be recorded with data loggers, probably using solar charged batteries.

Monitoring at a site downstream of a landfill (now closed) on Marshall Brook will be reestablished. This monitoring will include historical survey analytes (Boyle et al. 1987, Gerber et al. 1989), organics, hazardous substances, and trace metals. Instrumentation is not warranted. Remeasurement will occur at least in the spring and summer representing the highest and lowest hydrologic events or based on past data patterns and monitoring contaminant concentrations.

Field quality control will follow established QA/QC guidelines prepared by the LTM aquatic ecologist. Data analysis will be compatible with Kahl et al. (1985) and Boyle et al. (1987) as determined to meet QA/QC standards and be cost effective. I&M Program funding will be necessary to support this monitoring.

Forest Aquatic Habitat Monitoring

Episodic events alter stream course habitats affecting habitat availability, species diversity and species distribution (Jung et al. 1989). Vegetation cover, substratum, depth, width, debris retention, and pool-riffle are important parameters in characterizing aquatic habitats for biological species and tracking the effects of hydrologic events and streamside vegetation changes (Shenandoah NP 1990). Hydrologic fluxes and the bio-geochemistry are largely responsible for habitat conditions and monitoring is best accomplished by recurring

research/monitoring programs (Flora, WASO/NPS-WATER, pers. comm.). In coordination with the Water Resources Management Plan, we recommend that aquatic habitat monitoring be institutionalized through recurring research/monitoring projects. To implement this monitoring program and insure scientific credibility, the LTM Program Manager and representative park staff will meet with an invited group of NBS and university researchers in identifying whether an established research/monitoring program (e.g., Shenandoah/Great Smoky Mountains National Parks or Hubbard Brook Forest Ecosystem Study) is applicable and can be implemented for testing or whether to design and establish a monitoring program. Remeasurement will occur simultaneously with biological monitoring in the spring and summer representing high and low water levels and the range of vegetative cover. Initial research programs will identify key habitat remeasurement parameters and the remeasurement interval which we estimate to be approximately every ten years. I&M Program funding will be needed to develop and support this research/monitoring.

Forest Aquatic Biological Monitoring

Biological monitoring [e.g., periphyton, macroinvertebrates (quantitative, qualitative, and aerial), amphibians (addressed in II. C.), and fish] can best be achieved through institutionalized research/monitoring programs. Initial research programs will identify key biological parameters for remeasurement and the remeasurement interval which is estimated to be every ten years. The Natural Resource Preservation Branch (i.e., LTM program manager, Aquatic Ecologist, etc.) will convene an invited group of NBS and university researchers to:

- 1) identify whether an established research/monitoring program (e.g., Shenandoah/Great Smoky Mountains National Parks or Hubbard Brook Forest Ecosystem Study, etc.) is applicable and can be implemented for testing, or
- 2) replicate the protocols of Boyle et al. (1987) in Marshall Brook and implement these protocols at the other streams, or
- 3) design and establish a research/monitoring program that incorporates the bio-geochemical and habitat monitoring programs.

Remeasurement is estimated to occur in the spring and summer, representing the best availability of biologic lifestages (Cummins 1974) during the research/monitoring years. I&M Program funding will be needed to develop and support this research/monitoring program.

LAKES AND PONDS

Lakes and ponds are highly valued scenic features and important hydrologic systems at ANP. Their organization, bio-geochemistry, and rates and seasonality of processes reflect the inputs from their surrounding watershed and airshed. Their importance as municipal water sources for local residents and to the island's economic stability is well documented (ANP 1992a, Jacobson and Dominie 1988, Stelpflug 1989). Their management has been an important issue with the island towns and park [ANP Water Resources Plan (in preparation)].

The relationships between lake/pond ecosystems and terrestrial (vegetative), landscape (e.g. air), and stream resources suggests that lake/pond monitoring would enhance our

understanding of these related systems. Data and analysis would further analytic evaluations of ecosystem health, modeling simulations, and predictive assessments of threats.

Numerous water quality investigations and inventory projects on lakes and ponds have been conducted in the park and on MDI. Reestablishing previous studies with tested methodologies expedites the LTM program implementation, allows comparable data analysis and trend evaluations, and is cost effective. The Water Resources Plan in preparation is expected to recommend monitoring programs similar to those outlined below [Kahl, Univ. of Maine, pers. comm.).

Monitoring Design

The selected lakes will be located within a three mile radius of the air monitoring program (i.e., NADP, IMPROVE, Ozone) conducted at McFarland Hill and will be associated with calibrated forest watersheds. The monitoring reestablishes sites (i.e., 22 lakes on MDI) used by Kahl et al. (1985) and Norton et al. (1981). In addition, periodic analysis of surface sediments or sediment cores may provide desired information (e.g., Norton and Kahl 1987, Kahl et al. 1985). These lakes will be sampled at least on a quarterly schedule excluding winter.

To complement the more intensive data from the lakes mentioned above, several other lakes in or bordering the park that were sampled by Kahl et al. (1985), will be sampled once per year during the fall overturn. The overturn period serves as the most representative 'index' period for lake sampling during the year (Linhurst and Associates 1986). Fall monitoring provides a cost-effective method for assessing long-term lake status, especially for acid-base conditions.

The reestablishment and implementation of the lake geochemical biological monitoring and physical research and inventory projects are described below.

Lake Bio-Geochemical and Physical Monitoring

Replicating the work of Kahl (1985 & 1987) and numerous others, water chemistry monitoring will be reestablished collecting geochemical analytes listed for streams, plus secchi transparency, chlorophyll a, and bacteria in the selected lakes. These analytes are presently monitored in the EPA Environmental Monitoring and Assessment Program (EMAP) allowing integration with those data on a nationwide scale. I&M Program funding will be needed to support this monitoring.

Lake Physical Parameters Monitoring

Physical monitoring is influenced by seasonal events and is best accomplished by recurring research projects. To monitor lake physical parameters, our LTM program will encourage replicating the research projects of Kahl et al. (1985 & 1987), Norton and Kahl (1987), MDEP (1987 and 1989), Mack (1988) every 15 years or as determined necessary to record unique events. Research evaluations may include temperature profiles, bottom sediments, DOC, and inlet and outlet discharge data and other morphometric measurements. No I&M Program funding is requested to develop the monitoring protocols for this long-term monitoring/research program.

Lake Biological Monitoring

Biological monitoring (including some or all of, bacteria, phytoplankton, zooplankton, bottom fauna, amphibians and fish) is best achieved through recurring research/monitoring projects. In coordination with the Water Resource Management Plan, the LTM program will recommend research/monitoring projects be conducted every 10 years or as determined necessary to evaluate perceived biological changes. Mammal and avian activity will be recorded with the above mentioned taxa. I&M Program funding is requested to develop the monitoring protocols for this long-term research/monitoring program.

WETLANDS

Wetlands in and near the park have been identified and delineated in the park GIS based on 1991 aerial photography using USFWS wetland classification system (Cowardin et al. 1979) and the park's GIS vegetative cover (Calhoun et al. 1993). Two important wetland communities, marshes and heaths, were identified as components of the LTM program due to previous scientific research, their suitability as indicators of park ecosystem health, and ability to address the LTM program objectives. The development of the LTM programs for these resources are listed below.

Estuary/Marsh Monitoring

Estuaries and marshes play important ecological roles and are known for their species diversity (Doering et al. 1990). Reflecting inputs from both salt and fresh water and associated impacts and threats, monitoring can identify and track sources of pollution and degradation. Point source and non-point source pollution from recent land use activities (i.e., increases in population and associated land development, industry and business development, landfills, etc.) are suspected to be occurring or are potential impacts to park estuaries.

Research is being conducted (Doering et al. 1992) at twelve monitoring sites in Bass Harbor Marsh. Replicating the work of Doering et al. (1992) will be used to monitor Bass Harbor Marsh. Indicator parameters may include water quality, marsh hydrology, aquatic organisms (standing crop, community structure, community condition and metabolism), and eutrophication methodologies (Worf 1980, Boyle et al. 1987, Norton and Kahl 1987, and Doering et al. 1992,). Remeasurement will occur annually for geochemical and physical parameters, and on a five year interval for biological parameters following recommendations of Doering et al. (1992). I&M Program funding will be needed to support this monitoring.

The LTM program manager and aquatic ecologist will cooperate with NBS and university specialists in assessing the suitability of Doering et al. (1992) in monitoring other park marsh resources (e.g., Northeast Creek, Sand Beach Marsh, etc.). Research projects may be identified that will complement the monitoring at selected marshes including Bass Harbor Marsh. The landscape monitoring program will cooperate in evaluating adjacent land use practices and potential threats. Monitoring protocols (i.e., QA\QC, data, etc.) and a

remeasurement strategy will be identified. The additional funding for this program will be identified and requested in future funding opportunities.

Heath Monitoring

Heaths are ecologically unique communities and have been identified as important rare plant and animal sites within the park and state (Maine State Critical Areas 1988). The identification of rare plants (Eastman 1976, Gawler 1982, and Greene 1991) and fauna (Proctor 1946, Brower 1983, and Garman 1991) establish important monitoring parameters. Worley (1982), Welch (1985), and Calhoun et al. (1993) identify common parameters and methodologies to use in monitoring LTM sites (e.g., Great Heath) which have been previously inventoried and are directly related to other long-term hydrologic monitoring. Heaths contribute to historic acidic deposition evaluations (Norton 1987 and Norton and Kahl 1987) and climate change through floristic changes and biomass accumulations (Tolonen 1988). A GIS vegetative cover map identifying heaths was completed by Calhoun et al. (1993) and provides an excellent base map for identifying monitoring designs and protocols.

The LTM program manager and park staff (i.e., botanist, aquatic ecologist, etc.) will cooperate with NBS and university specialists in designing a heath monitoring program. The project will identify threats (air/water pollutants, visitor impacts, harvesting, hydrologic changes, climate change, etc.) and how monitoring will address these concerns. The project will develop monitoring design and methodologies after reviewing previous work (Worley 1982, Calhoun et al. 1993, and Welch 1985). The LTM program will use important community parameters such as aquatic organisms, especially those previously noted (i.e., T&E, insects, mammals, amphibians and vegetation), floral community composition and shifts, and hydrology. The project will integrate other monitoring program (T&E/species of concern LTM program, Landscape monitoring program, Air Quality, Avian, and Amphibian Program) design and methodologies in developing a comprehensive heath LTM program. Monitoring protocols (i.e., QA\QC, data, etc.) and a remeasurement strategy will be identified. I&M Program funding will be needed to support this monitoring.

SHORELINES

Calcareous Beach Monitoring

Sand or calcareous beaches are rare along the northern Maine coastline. Commonly known for their recreational values, they are also an important natural resource. As such, one of the park's most visited sites is a calcareous shell fragments beach known as "Sand Beach". Receiving several million visitor use days per year, management and protection of beach resources are important park objectives for this Maine Critical Area.

Sand Beach has been the site of several initial plant and animal investigations (Proctor 1946, MacArthur 1976), but Barden (1970) established permanent transects to monitor dune vegetation. Geophysical processes have been monitored at permanent monitoring stations by Allen and Connery (1991). To monitor the resources of this unique feature, the park staff and LTM program manager will cooperate with specialists in identifying a monitoring program. The group will first review the location of permanent vegetation transects and test complementary resource monitoring protocols in identifying a LTM program. The

complementary resource monitoring parameters will include replicating the geophysical process work (Allen and Connery 1991) and developing quantifiable monitoring programs for insects, birds, climate and hydrologic resources. The park will continue to document visitor use and bacterial contamination. No funding is requested at this time.

Intertidal Monitoring

The dynamic transitional area between sea and land is one of the most visited and visible resources in the park. The intertidal area provides a most interesting array of specialized organisms and is a window to the sea for visitors. Accustomed to diurnal extremes, the resources of the intertidal zone are vulnerable to several anthropogenic threats (e.g. pollution, disturbance, climate change, etc.) and impacts, especially hazardous waste spills. Several intertidal and spray zone species (e.g. lichens, invertebrates, macroalgae, etc.) are known to be indicators of environmental quality (Anderson 1984).

The threat of a major oil spill and the concentration of visitors warrants the development of a LTM Program. Cammen and Larsen (1987, 1991) established benchmarks to monitor the health of park intertidal resources and systems focusing on sea level changes and toxic accumulation. Other resource investigations on water quality (Fefer and Schettig 1980), flora (MacArthur 1977, Greene 1991, Fefer and Schettig 1980), lichens and algae (Johnson and Skutch 1928a,b, and c) provide valuable information. The LTM program manager and park staff (i.e., botanist, aquatic ecologist, etc.) will cooperate with NBS and university specialists to evaluate Cammen and Larsen (1987 and 1991) and determine what, if any, additional monitoring components, QA/QC standards, or protocols are needed to develop a comprehensive intertidal monitoring program. Selected components of the identified LTM program will be based on the LTM objectives and known threats (air/water pollutants, visitor impacts, harvesting, hydrologic changes, climate change, etc.), and will identify additional research projects that would enhance monitoring and analysis. The project will determine how other monitoring programs (e.g., T&E/species of concern monitoring program, Landscape monitoring program, Air Quality Program) should be integrated to enhance analysis efforts and the LTM program. I&M Program funding will be necessary to support this monitoring.

MARINE RESOURCES

Fjord Monitoring

Somes Sound is the only fjord on the eastern coast of the United States and has important scientific, scenic, and cultural significance to the park and state. Somes Sound may be particularly vulnerable to non-point pollutants as approximately 50% of the shoreline is outside the park boundary. Fjords are defined by their unique hydrologic structure and dynamics (Doering and Roman 1991), and anthropogenic changes and human pollutants can greatly impact fjord resources. Several investigations have been completed evaluating water chemistry and physical characteristics (Ketchum and Cass 1986, Doering and Roman 1991), providing a valuable base for long-term monitoring.

The LTM program manager and aquatic ecologist will cooperate with NBS and university specialists to design and establish a comprehensive LTM program. A monitoring

methodology, based on Ketchum and Cass (1986) and/or Doering and Roman (1991), and remeasurement schedule will be identified following the testing of methodologies. The design project will identify suitable long-term monitoring parameters from fish, avifauna, and benthos resources, appropriate monitoring methodologies, and establish a comprehensive LTM program. The research project will address the LTM objectives and known threats (hazardous spills, shoreline development and nutrient additions, etc.) in selecting the monitoring components. Information from the landscape monitoring program will be used to enhance and support analysis efforts and management planning and protection programs with state and federal agencies. The park will take the lead to coordinate monitoring implementation with other agencies. No funding is requested at this time.

IV. RESOURCES OF SPECIAL CONCERN

Offshore Islands Monitoring

Within the park's legislative boundary are 12 islands, partially or totally administered by ANP. They range in size from a few hectares to over one thousand hectares. Their resources are similar to those on Mount Desert Island, but due to their size, distance from the mainland, and intensive human use over the last two hundred years, are significant to the park, Maine's residents (Conkling 1981), and the scientific community. Atmospheric deposition, climate change, ocean pollution, and increasing visitation are growing concerns. Previous investigations have monitored acid fog and ozone effects, plant species and communities, insects, birds, mammals, and several other resources (Greene et al. 1992).

In 1992 and 1993 the park, with support from WASO and NARO, conducted island inventories of vascular plants and vertebrates and established permanent monitoring sites. The program used teachers and volunteers recruited by Earthwatch as research assistants (Mittelhauser et al. in preparation). Inventories focused on vegetative and animal resources using standard methodologies.

Due to the unique ecological status of islands and potential threats to these forest community ecosystems, the LTM program manager and staff will convene a technical workshop involving NBS and area specialists to identify a LTM program and strategy of implementation. Additional research and inventory needs will be identified and funding will be leveraged from supporting cooperators or NPS funding sources. Funding from this initiative will replicate monitoring of core community parameters. I&M Program funding is requested to fund this monitoring program.

Non-Native Species Monitoring

The park has an approved Integrated Pest Management Plan (Hazen 1991) that identifies the management and monitoring of non-native species. Of the 250 plus non-native plant species, twelve have been identified as a management concern (McInnes 1986) and mapped. Only one, purple loosestrife (*Lythrum salicaria*) was judged to be a significant threat requiring management actions. The park has proposed the development of a Non-native Plant Management Plan as a component of the Vegetative Management Plan (ACAD-N-071). Guidelines in identifying non-native plants will be distributed to the staff conducting other

monitoring or operational activities. Similar guidelines will eventually be identified for fauna, especially invertebrates that pose threats to native populations and visitors. No funding is requested.

4.8 LTM Peer Review

The LTM Plan described above was the culmination of literature searches, meetings and scoping sessions, and numerous discussions with scientific professionals. This plan has been peer reviewed by several NPS/NARO, and other regional specialists (see Scientific Credibility, 5.0) and is considered to be a responsible and scientifically credible long-term monitoring program. This LTM Plan addresses park, region and servicewide management concerns and objectives in the stewardship of Acadia's natural resources.

4.9 Implementation Strategy

The park GMP identifies the need to design and construct additional infrastructure that includes offices and other work space adjacent to and in park headquarters. This location will facilitate the exchange of information between the Division of Resource Preservation, park management, and other divisions. These facilities would include office space for staff specialists and visiting researchers, an enlarged and adequately equipped laboratory, offices for relational and spatial data management, vehicles and parking lots, and housing for researchers and temporary staff. Upon being selected as an I&M prototype park, the park will seek funding to procure the above mentioned facilities and equipment. Recognizing the increased work load in preparing for the development of the LTM program, the park will seek additional base funding from WASO and NARO to enhance existing program elements such as personnel, infrastructure, and administrative support. In addition, a LTM program manager will be hired to coordinate facility development, write position descriptions for the LTM program specialists, and prepare to implement the LTM program. Listed below is a time table and yearly budget estimate for program implementation. (Refer to Figure 1 for the organizational structure for the program.)

FY 1 - Selection as a prototype park.

Park NR and LTM programs and budget

- Seek funding for infrastructure development.
- Work with Denver Service Center & park maintenance in designing facilities.
- Complete necessary compliance reviews and building clearances.
- Branch of natural resources continues on-going long-term monitoring programs.
- Branch of natural resources locates baseline LTM sites with GPS and establishes reference points.
- Advertise and hire LTM program manager.

- Develop position descriptions for critical LTM positions, e.g. data program manager, GIS specialist (ANP position), data management specialist.
- Continue to collect GIS and data reference data.
- Hire park GIS specialist. (park base funded)
- Refine administrative needs and support to implement LTM program (staff position descriptions, etc.).
- Coordinate with NBS on Amphibian and Landbird Projects.
- Procure technical and office equipment.

Costs:

Equipment:	\$ 7,800
Personnel:	64,500
Support :	15,700
Admin. Overhead (10%):	8,800
Subtotal :	96,800
Infrastructure:	<u>300,000</u>
Total :	\$ 396,800

NBS Programs and Budget**Research Projects:**

Amphibian Monitor (incl. 30% overhead)	\$ 80,000
1) Monitoring Protocols - duration: 3 years	
Landbird Monitor (incl. 30% overhead)	\$108,000
1) Baseline/Monitoring - duration: 5 years	

Total \$188,000**FY 2 LTM Preparation****Park NR and LTM programs and budget**

- Complete construction of new facilities.
- Branch of natural resources continues on-going long-term monitoring programs.
- Branch of natural resources locates remaining baseline LTM sites with GPSU and establishes reference points, aquatic monitoring sites, etc.
- Hire data program manager (funding dependent).
- Develop & classify position descriptions for LTM program forest, aquatic, and invertebrate ecologists.
- Develop & classify position descriptions for LTM GIS, biological, physical science and data management technician positions, and botanist.
- Develop GIS/Data program hardware and software specifications.
- Develop position descriptions for LTM technical staff, e.g. librarian, information specialist.
- Prepare Data Management Plan including QA guidelines.

- Branch of natural resources develops for LTM program manager status report of existing monitoring programs.
- Continue to work with administration to implement LTM program (staff position descriptions, etc.).
- Continue NBS Amphibian and Landbird Projects.
- Procure technical and office equipment.

Costs:

Equipment:	\$ 26,900
Personnel:	109,700
Support :	9,000
Admin Overhead (15%):	21,800
Subtotal :	167,400
Infrastructure:	383,000
Total :	\$ 550,400

NBS Programs and Budget

Research Projects:

Amphibian Monitor (incl. 30% overhead)	\$ above
1) Monitoring Protocols duration: 3 years	
Landbird Monitor (incl. 30% overhead)	\$ above
1) Baseline/Monitoring duration: 5 years	

Total \$ above

FY 3 1st Year of WASO/NBS support for LTM Program

Park NR and LTM programs and budget

- Implement initial phases of LTM program with NBS.
- Branch of natural resources continue on-going long-term monitoring programs.
- Branch of natural resources and LTM Program Manager present existing monitoring programs and status.
- Hire forest, aquatic, & invertebrate ecologists, librarian, data management specialist.
- Procure GIS/Data program hardware and software.
- Develop reporting and data/technical information guidelines.
- Procure technical and office equipment.
- Cooperate with NBS on research and monitoring program development.
- Hire LTM GIS technician, biological technician-vegetation, and biological technician-wildlife, physical science technician-water, data management technician, and botanist.

Costs: Park	
Equipment:	\$ 101,700
Personnel:	482,100
Support :	78,700
Admin Overhead (20%):	132,500
Total :	\$ 795,000

NBS Programs and Budget

Research Programs	Total
Island Landscape (incl. 30% overhead)	\$65,000
1) Surface Monitoring Project 18 mon.	20000
2) Aerial Monitoring Project 18 mon.	30000
Forest Arboreal Lichen (incl. 30% overhead)	\$95,000
1) Manual/Chem Analysis duration: 3 yrs.	
Forest Health (incl. 30% overhead)	\$45,500
1) Manual/Field Establish duration: 2 yrs.	
Aquatic Habitat (incl. 30% overhead)	\$90,000
1) Data/Methods duration: 3 yrs.	
Aquatic Biology (incl. 30% overhead)	\$90,000
1) Data/Methods duration 3 yrs.	
Yearly Total \$385,000	

FY 4 2nd Year of WASO/NBS support for LTM Program**Park NR and LTM programs and budget**

- Branch of natural resources and LTM specialists continue existing long-term monitoring programs.
- Continue LTM program methodology development.
- Develop & classify position description for information management specialist.
- Update &/or prepare new project statements addressing resource data gaps, concerns, etc.
- Cooperate with NBS on research and monitoring program development.
- Prepare first LTM reports, hold first LTM Science and Monitoring Conference.

Costs:	
Equipment:	\$ 15,100
Personnel:	510,000
Supply :	115,100
Admin. Overhead (20%):	128,100
Total :	\$ 768,300

NBS Programs and Budget

Research Programs

Continue previous projects	above
Intertidal Monitoring (incl.30% overhead)	28,000
1) Field/Manual, duration: 1 yr.	

Total 28,000

FY 5 3rd Year of WASO/NBS support for LTM Program

Park NR and LTM programs and budget

- Continue LTM methodology development.
- Branch of resource management and LTM specialists continue existing long-term monitoring programs and implement new monitoring programs.
- LTM staff updates and/or prepares project statements for additional research, monitoring, and technical assistance.
- Hire information management specialist.
- Update &/or prepare new project statements addressing resource data gaps, concerns, etc.
- Cooperate with NBS on research and monitoring program development.
- LTM and park staff assist other parks in developing LTM programs.

Costs:

Park

Equipment:	\$ 20,500
Personnel:	563,100
Supply :	84,700
Admin. Overhead (20%):	133,700
Total :	\$ 802,000

NBS Programs and Budget

Research Programs

Continue previous projects	above
Subalpine Monitoring (incl.30% overhead)	56,000
1) Field/Manual/Data, duration: 2 yrs.	
T&E/Species of Concern (incl.30% overhead)	69,000
1) Field/Manual/Data, duration: 2 yrs.	
Wetland Estuary (incl.30% overhead)	28,000
1) Manual/Data, duration: 1 yrs.	
Wetland Heath (incl.30% overhead)	56,000
1) Field/Data/Manual, duration: 2 yrs.	
Yearly Total	209,000

FY 6 4th Year of WASO/NBS support for LTM Program

Park RM and LTM programs and budget

- Continue LTM program methodology development.

- Branch of natural resources and LTM program continue current long-term monitoring programs and implement new monitoring programs.
- Update &/or prepare new project statement addressing resource data gaps, concerns, etc.
- Prepare third LTM reports, final methodology reports
- Convene annual LTM Science and Monitoring Conference
- Review LTM program and reports, ANP LTM plan updated.
- LTM and park staff assist other parks in developing LTM programs.
- Cooperate with NBS on Research and Monitoring Program development.
- Publish first Multi-Year LTM Technical Report(s).

Costs:

Equipment:	\$ 32,500
Personnel:	581,600
Supply :	87,500
Admin. Overhead (20%):	140,300
Total :	\$ 841,900

NBS Programs and Budget**Research Programs**

- 1) Continue previous projects **above**
- 2) New identified Projects - as funded from additional funding requests (see FY 4 & 5)

FY 7 Park assumes LTM Program, WASO/NBS initial I&M Program Established

Park RM and LTM programs and budget

- Model LTM program institutionalized, branches of natural resources and LTM assume all long-term monitoring programs.
- Prepare annual LTM reports.
- Convene annual LTM Science and Monitoring Conference.
- LTM and park staff assist other parks developing LTM programs
- Cooperate with NBS on newly identified research and monitoring programs

Costs:

Personnel:	596,800
Equipment:	23,000
Supply:	90,300
Admin. Overhead: (20%)	<u>142,000</u>
Total:	852,100

NBS Programs and Budget**Research Programs**

- 1) Continue research projects **above**
- 2) New identified Projects - as funded from additional funding requests (see FY 4 & 5)

5.0 SCIENTIFIC CREDIBILITY

The park's relationship with the scientific community is now well established and provides access to a wealth of professional specialists. Further, we feel that the establishment of an LTM program will continue to draw support from natural and physical resource professionals due to the park and NPS support, the program's proposed long-term existence, and the rich and expanding resource data base about the park and area.

5.1 Research Support

Because of its status as the only national park in the Northeast, and its relative natural condition, the park receives a significant amount of scientific support from a wide variety of research scientists at colleges and universities throughout the Northeast, as well as from NPS and NBS cooperative units, and cooperators such as The Nature Conservancy (TNC). As the LTM program continues to evolve at Acadia, we will continue to draw on the following specialists for assistance in monitoring program development, providing peer review, and assistance with reporting. Contributors or peer reviewers of this proposal are indicated (*).

National Biological Survey Scientists

- * Dr. Charles T. Roman, Aquatic Ecologist, CPSU, Univ. of Rhode Island
- Dr. James Allen, Coastal Geomorphologist, CPSU, Univ. of Rhode Island
- * Dr. Allen O'Connell, Wildlife Biologist, CPSU, Univ. of Maine
- * Dr. Howard Ginsberg, Entomologist, CPSU, Univ. of Rhode Island
- * Mr. Gary Davis, Marine Ecologist, CPSU, Univ. California/Davis
- Dr. Brian Underwood, Wildlife Biologist, State Univ. New York-ESF

NPS Scientists and Specialists

- * Dr. Bruce Nash, Forest Ecologist, Air Quality Division
- * Dr. Mary Foley, Chief Scientist, North Atlantic Region
- * Randy Ferrin, Ecologist, Air Quality Division
- * Mark Flora, Hydrologist, Water Resources Division
- * Larry Pointer, Chief Natural Resource Management, North Atlantic Region
- * L. Petit-Waldner, Data Management Specialist, Global Climate Change
- * Nigel Shaw, Regional Geographic Information System Coordinator
- Mike Reagan, Regional Computer Coordinator
- * Tom Blount, Inventory and Monitoring Program Manager, Shenandoah NP
- * Dr. Steve Tessler, Data Management Coordinator, Shenandoah NP
- Pat Lynch, GIS Coordinator, Shenandoah NP

NPS Funded Cooperators

- * Dr. Craig Greene, Plant Taxonomist, College of the Atlantic
- * Dr. William Patterson, Fire Ecologist, Univ. Massachusetts
- * Dr. Robert Eckert, Forest Ecologist, Univ. New Hampshire
- * Dr. Tom Lee, Forest Ecologist, Univ. New Hampshire

- * Dr. Steve Kahl, Environmental Geochemist, Univ. Maine
- * Ms. Judy Allen, Data Management Coordinator, College of the Atlantic
- * Dr. Kate Beard, Geographic Information Specialist, Univ. Maine
- * Dr. Dan Harrison, Wildlife Biologist, Univ. Maine
- Dr. James Gilbert, Wildlife Biologist, Dept. of Wildlife, Univ. Maine
- * Dr. Ray Owens, Wildlife Biologist, Dept. of Wildlife, Univ. Maine

Regional Scientific Advisors

- * Mr. Allan Hutchinson, Leader, Non-Game Unit, MDIF&W
- * Dr. Mark McCollough, Wildlife Biologist, MDIFW
- Mr. Charles Todd, Endangered Species Biologist, MDIFW
- Dr. Ken Elowe, Wildlife Biologist, MDIF&W
- Dr. John Albright, Heritage Program Coordinator, State of Maine
- * Dr. Janet McMahon, Science Coordinator, Maine Chapter, TNC
- * Mr. Hank Tyler, Special Areas Coordinator, State of Maine
- * Dr. Cassie Gibbs, Aquatic Entomologist, Univ. Maine
- * Dr. Donald Cass, Chemist, College of the Atlantic
- Dr. Bill Glanz, Zoologist, Univ. Maine
- Dr. Steve Garman, Wildlife Biologist, Oregon State University
- Dr. Peter Doering, Hydrologist, University Rhode Island
- * Dr. John Anderson, Biologist, College of the Atlantic
- * Dr. Barbara Vickery, Biologist, The Nature Conservancy
- Dr. Anders Rhodin, Herpetologist, Harvard University
- Dr. Chris Peterson, Ecologist, College of the Atlantic

5.2 LTM Objectives and Standards

The goal of the LTM program is to monitor natural resources for long-term natural resource and ecosystem preservation. The following objectives were developed with the collective input of park service managers, natural resource professionals and scientists, research associates, cooperating agencies, and the public during scoping sessions held at Acadia during 1993.

ANP LTM Objectives:

Integrate existing and future monitoring procedures into a model long term natural resources monitoring program that:

- * determines present and future resource conditions;
- * establishes empirical limits of resource variation;
- * provides early diagnosis of abnormal conditions;
- * identifies potential agents of abnormal anthropogenic change; and,
- * evaluates management actions.

5.3 Scientific Credibility

This proposal is based on scientific standards which are described in the LTM Program Description (4.0), Data Management (9.0), Reporting (12.0), and Management Support of LTM Program (1.0) Sections. The development of the LTM Program is based on the recognition that scientific credibility and integrity are foremost requirements. Research scientists have assisted in preparing our LTM model and drafting this LTM plan proposal. The model and proposal have been reviewed for scientific suitability, technical practicality and cost effectiveness, and ability to address the program's objectives. These standards will be integrated into the program's implementation and eventual routine operations.

6.0 LONG-TERM MONITORING BUDGET

The budget of the LTM program (Table 1) represents actual costs in developing and operating the scientifically credible program identified in this proposal. We identify the need for "seed" monies (i.e., pre-LTM program implementation funding) to establish the infrastructure, prepare the administrative system, and employ the primary staff to effectively and professionally conduct the LTM program. The existing prototype parks exemplify the lag-time associated in hiring staff and having adequate facilities in place and how these difficulties hinder the progress and success of the initial LTM efforts. These "seed" monies will also support the development or enhancement of linkages and potentially leverage additional LTM program support.

Upon selection as a prototype park, the park will solicit initial funding to cost-share with park and NARO funds and programs (see section 8.2 Infrastructure) in developing the first phase of the LTM program. This funding will assist in the infrastructure development, hiring the primary staff, and preparing the park for the infusion of the full LTM program (i.e., staff, NBS researchers, and program operations, etc.). These monies will insure quality control and program continuity and result in a more responsive and successful program.

Following the initial development years (i.e., FY 1 & 2), LTM program will receive annual base funding increments reflecting the workload in implementing the established monitoring components and cooperating with NBS research efforts (see 4.7 LTM Program Model). The bulk of the funding is needed in the first year (i.e., FY 3) with small additional base increments to cover additional staff and operating costs (see Table 2). This strategy provides a realistic complement of funding to program development and maintains the quality control and program integrity without impacting other park operations and activities.

Table 1. Estimates of NPS costs for ANP's LTM program (in thousands of dollars).

	FY 1	FY 2	FY 3	FY 4	FY 5	FY 6	FY 7
LTM PERSONNEL							
LTM Prog. Mgr. (11/12)	44.7	46.2	53.6	55.3	57.2	58.9	58.9
Data Prog. Mgr (11/12)		44.7	46.2	53.6	55.3	57.2	58.9
Forest Ecologist (GS-11)			44.7	46.2	47.7	49.2	50.7
Aquatic Ecologist (GS-11)			44.7	46.2	47.7	49.2	50.7
Invert. Ecologist (GS-9/11)			37.0	44.7	46.2	47.7	49.2
Data Mgmt. Spec. (GS-9)			37.0	38.2	39.4	40.7	41.9
Botanist (GS-9)			37.0	38.2	39.4	40.7	41.9
Library Spec. (GS-7)			30.2	31.3	32.2	33.3	34.2
LTM GIS Tech. (GS-7)			30.2	31.3	32.2	33.3	34.2
Bio. Tech./Veg. (GS-7)			30.2	31.3	32.2	33.3	34.2
Bio Tech/Wildl (GS-7)			30.2	31.3	32.2	33.3	34.2
Phys. Tech.-Water (GS-7)			30.2	31.3	32.2	33.3	34.2
Data Mgmt. Tech. (GS-7)			30.9	31.3	32.2	33.3	34.2
Info. Mgmt. Spec. (GS-9)					37.0	38.2	39.4
Bio. Technicians (2, GS-5)	19.8	19.8					
Personnel Sub-Total:	64.5	109.7	482.1	510	563.1	581.6	596.8
INFRASTRUCTURE							
Office Equipment/supplies	2.5	8.0	20.0	2.0	3.0	10.0	2.5
Computers	3.3	6.5	21.0	3.0	6.0	3.0	3.0
Vehicles (GSA)	2.0		2.3	2.3	5.0	3.0	3.0
Vehicles (NPS)(#)		10.0 (1)	20.0 (2)			10.0 (1)	
Curatorial			1.0	1.0	1.0	1.0	1.0
GIS/Data Mgmt. Lab.			25.0	5.0	5.0	5.0	5.0
Radios		2.4	2.4	1.3			1.5
Boat			5.0				3.0
Laboratory			5.0	0.5	0.5	0.5	1.0
Infrastructure Sub-Total	7.8	26.9	101.7	15.1	20.5	32.5	23

	FY 1	FY 2	FY 3	FY 4	FY 5	FY 6	FY 7
SUPPORT							
Chemical Analysis (L,S,LI)			47.5	77.5	47.5	47.5	47.5
Equipment	10.5	1.5	6.0	1.0	1.0	1.0	1.0
Travel (5% of Personnel costs)	3.2	5.5	22.2	23.6	26.2	27.0	27.8
Publishing				2.0	2.0	3.0	4.0
Housing *	2.0	2.0	3.0	3.0	3.5	4.0	4.0
Science Symposium				4.0	4.5	5.0	6.0
ANP Administrative Costs (20% unless noted)	8.8 10%	21.8 15%	132.5	128.1	133.7	140.3	142.0
Sub-Total Support	15.7	9.0	78.7	115.1	84.7	87.5	90.3
Category Sub-Total	88.0	145.6	662.5	640.5	668.3	701.6	710.1
TOTAL	96.8	167.4	795.0	768.3	802.0	841.9	852.1

Notes:

- Grades and steps are estimates only. May change dependent on position description, prior years in service etc.
- Benefits calculated at Permanent= 33%, Seasonal=7.6%
- No cost of living increase estimates included.
- YR 1 & 2 "Seed Funding" - in preparation for implementation of LTM program
- Housing for NBS is included in project cost estimates; housing costs cover seasonal technicians and volunteers.
- NBS projects include 30% administrative costs
- FY 7 Sub-Totals and Total Budget are actual estimated based funding for Acadia National Park LTM Program.
- Chemical Analysis - L=lakes, S=streams, LI=lichens; Costs calculated using cost estimates discussed with M. Flora (WASO-Water) & S. Kahl (Univ. Maine). Tonnessen, in Stolte et al. (1993) and Tonnessen (pers. comm.) confirmed lichen analysis costs.
- NBS Research - New identified research and inventory may be identified in early years of LTM program and funding may be awarded as early as FY 6 or FY 7 but would be in addition to costs presented at this time.

Table 2. Costs estimates for NBS protocol development (in thousands of dollars).

NBS PROJECTS	FY 1	FY 2	FY 3	FY 4	FY 5	FY 6	FY 7
Island Surface Landscape			15.0	5.0			
Island Aerial Landscape			20.0	10.0			
Arboreal Lichen			32.5	32.5	30.0		
Forest Health			25.5	20.0			
Aquatic							
Intertidal				28.0			
Subalpine					28.0	28.0	
T&E/Species of concern					35.0	34.0	
Estuary					28.0		
Heath					28.0	28.0	
Amphibian	28.0	28.0	24.0				
Landbird	24.0	21.0	21.0	21.0	21.0		
TOTAL	52.0	49.0	137.5	122.5	170.0	90.0	0.0

Lichen Chemical Analysis covered in Supplies (i.e., \$30,000 FY 4)

Water Chemical Analysis begins in FY 3 (70 samples/stream x 2 streams + 2 lakes/7 months + 10 lakes x 1 sample = total cost)

7.0 SERVICEWIDE APPLICABILITY

Our LTM program has goals and objectives which are applicable to most parks. Further, these objectives are commensurate with the goals of the National Park Service long-term monitoring initiative and the legal mandates (e.g., Organic Act, Redwood Act, etc.) that direct NPS management. Our program is based on the fundamental themes of monitoring resource and ecosystem health. Products from this monitoring will enhance long-term management decisions and provide a more in-depth understanding about park resources benefitting education, protection, and scientific endeavors at the park, local, regional, national, and international levels. These themes have commonality with other major resource monitoring programs espoused by many other federal, state, and research programs worldwide. Based on this foundation, the program has application to many other park LTM programs.

The proposed ANP LTM program can contribute to other NPS units with similar resources and issues (e.g., Voyagers NP, Isle Royal NP, Pictured Rocks NS, Olympic NP, Apostle Islands NS, etc.) in the following areas:

- 1) Although the park is representative of several NPS biogeographic categories reflecting the diversity of aquatic and forest communities, the dominate landscape cover is the **coniferous forest**. Our model is designed to monitor forest stands and related resources such as air, water, and associated vegetative communities (i.e., aquatic resources, subalpine communities, wetlands, etc.). This mixture of resources and communities may be directly applicable to other park units with similar resources, threats, and LTM objectives.
- 2) The Acadia LTM program illustrates a monitoring model that addresses the park's objectives using a practical approach concerning scientific integrity, cost effectiveness, and suitability to the NPS and park's mandates. The model utilizes a "**step-up**" rationale (see Figure 1), matching funding to monitoring efforts without compromising the core monitoring effort. The model identifies supplemental resource components that will be implemented with full funding.
- 3) The Acadia LTM program is designed to specifically address the diversity of forest stand and aquatic resources and processes in a structure that allows management and the scientific community a better opportunity to evaluate resource health and threats throughout the park. This broad coverage of resource diversity and attention to a variety of threats is well suited in addressing the broad spectrum of management concerns and needs while providing scientifically credible information to other resource managers and research interests. This design is applicable to many forested park and natural resource units.
- 4) The Acadia LTM program is based on monitoring long-term resource and ecosystem health and will use the acquired information to address the previously identified threats. These threats are common to many parks and natural areas and our

monitoring program may serve as a model for designing and implementing a LTM program.

5) The process that we used in developing our program, beginning with the development of planning documents to the allocation of staff resources with park base funding, may provide an example for other park service units in developing their program.

6) Other parks in the coniferous biogeographic category that have an irregular boundary and discontinuous parcels distributed over a wide area, have a functioning, base-funded natural resource staff, and have identified LTM as a major park objective will find that the process that we used in developing our program provides a model planning format. Our model illustrates that the park must strategically plan to insure that the LTM program meets park infrastructure and operations prior to full implementation. This will facilitate institutionalizing the program and increase chances for success.

7) The Servicewide I&M program should recognize the need for prototype parks which more closely represent a majority of the 250 parks with significant natural resources. These parks may be smaller in size and natural resource staff, yet may harbor a significant diversity of biota (Stohlgren et al. 1991). Selecting only parks that are large in size and staff will not provide an I&M model with suitable monitoring protocols, organizational structure, operational strategy, or directly applicable data or information to parks with a majority of resources under the stewardship of the National Park Service.

8.0 INFRASTRUCTURE AND LTM ORGANIZATION

8.1 Current Organizational Structure

The branch of natural resources lies within the division of resource preservation (Figure 5) and is responsible for conducting all natural resource management activities and operations as well as coordinating all research efforts. The division of resource preservation also includes the closely related branch of cultural resources and branch of land resources and environmental planning. The natural resource branch is headed by a branch chief who currently supervises three full-time biologists and a resource trainee (Figure 6). A biologist was hired in 1992 to coordinate the development of the park's LTM and wildlife programs. Should I&M Program funds become available, the park will recruit and hire a highly qualified (PhD level) scientist to direct the LTM program and technical staff, and will reclassify the current position as a wildlife biologist.

The resource program draws upon the direct assistance of a research-graded NBS CPSU scientist at the University of Maine. The natural resource staff supervises several full time term technician and six-month seasonal positions that are conducting a variety of resource

Figure 5. Organizational Structure of the Division of Resource Preservation

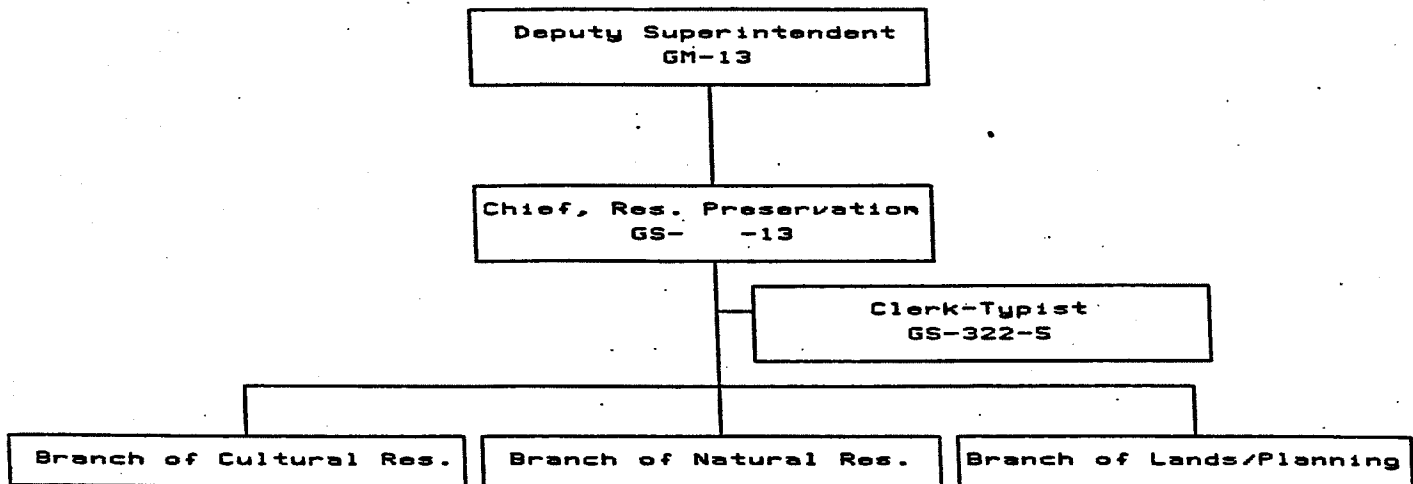
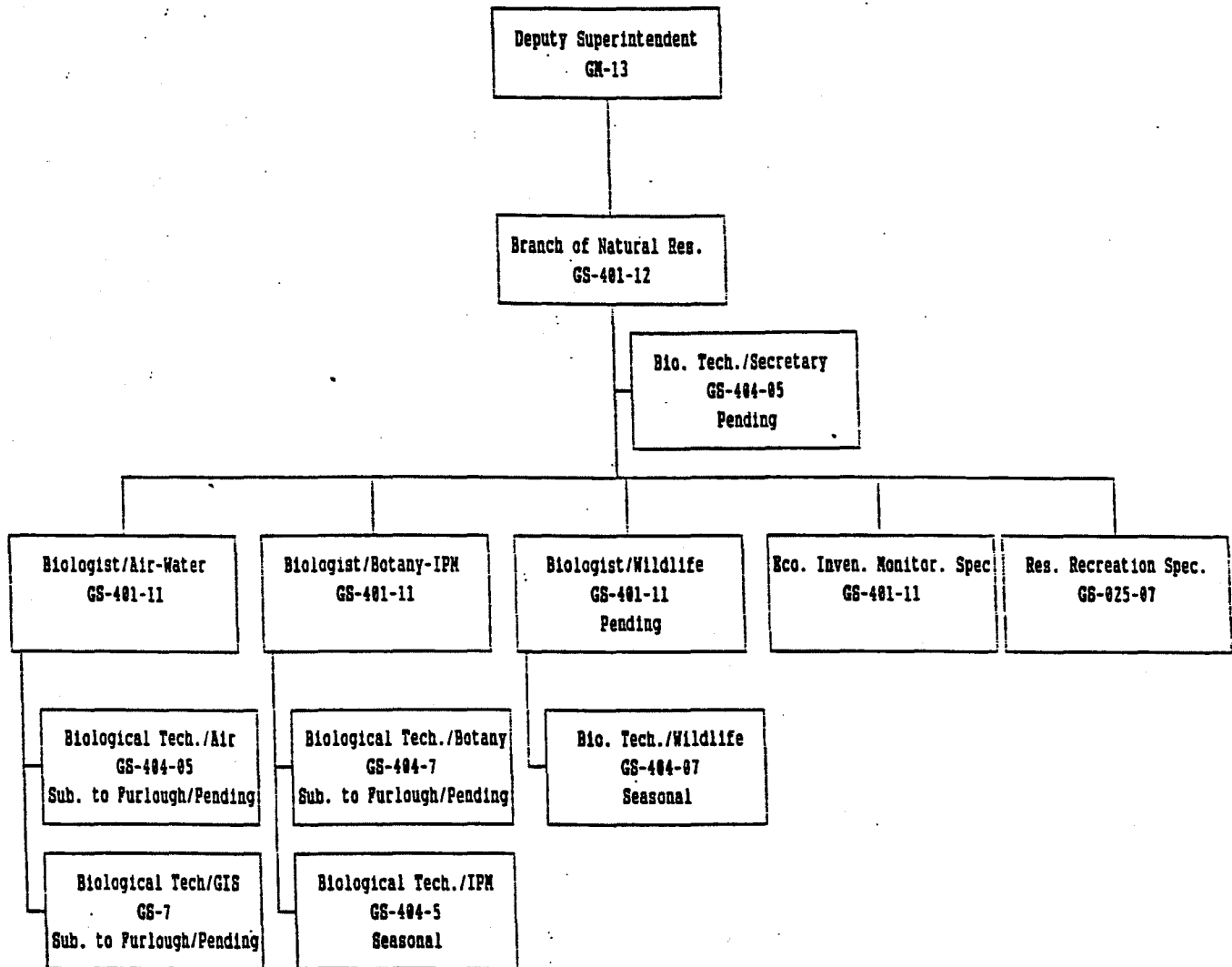


Figure 6. Current Staffing Plan for the Branch of Natural Resources



inventory, monitoring, and mitigation programs. The staff also employs a technician who assists with the park's Geographic Information System (GIS).

The budget of the branch of natural resources has grown in recent years due to efforts to develop a professionally staffed and adequately funded natural resource program. Current base funding is approximately \$250,000 and reflects a FY92 base increase of \$162,000. WASO and NARO have supported park natural resource and research programs (i.e., approximately \$200,000/year) as demonstrated by the numerous inventory and research projects funded in the last several years (Appendix F). Currently, WASO and NARO funding support exceeds \$300,000.

The resource and research staff have a small working laboratory facility, a growing natural resource reference library, small water craft, and access to the park's ocean going boats, and field and analytical equipment to support our current operations. Although the park has a small herbarium, most flora specimens collected are curated at the herbarium located at the College of the Atlantic. The natural resource program has developed a GIS with an impressive database of DLG and resource layers (see Appendix E). The GIS program has a dedicated 486DX266 computer, Altek 40 digitizing table, and HP Draftmaster II plotter. Another 486DX266 computer was recently purchased for the I&M program manager and will serve in the development and storage of LTM data during the pre-implementation years.

Park housing for visiting researchers and technicians is limited although housing is available in the local area. Because of the shortage of park housing, all research and support programs should incorporate housing costs in their total funding estimates.

8.2 Infrastructure

The park has identified the need for a comprehensive siting plan and infrastructure design to accommodate recent and projected increases in park base funding and subsequent staff for all divisions. The park recently submitted a Development/Study Package Proposal (10-238) entitled "IMPROVE MCFARLAND HILL HEADQUARTERS" assigning it our highest priority. This 10-238 package recognizes the critical needs of the branch of natural resources for expanded offices, storage, data management, GIS and map work areas, laboratory and work space, and curatorial facilities to properly house the park's 16,000 collection items. The proposal requests that the comprehensive design specifications and plans will be completed by September 1996 with construction to be completed by May 1998.

The design would include additional offices and storage areas, additional conference rooms, an increased laboratory facility, an expanded GIS and Data Management lab and related work & storage areas, a park library, and curatorial facilities to accommodate operations and programs (see App. G for cost estimates). The park has recognized the potential for future staff and infrastructure needs (i.e., ANP designated as a I&M prototype park) and these facilities would be designed to accommodate such increases.

The 10-238 mentions the possibility of the park being selected as an I&M Prototype Park, which will require additional rooms (e.g., offices, equipment storage, etc.) for program staff.

Further, the park would leverage priority ranking and support in developing this comprehensive design and construction project once recognized as an Long-Term Ecological Monitoring Prototype Park.

8.3 Proposed Organizational Structure

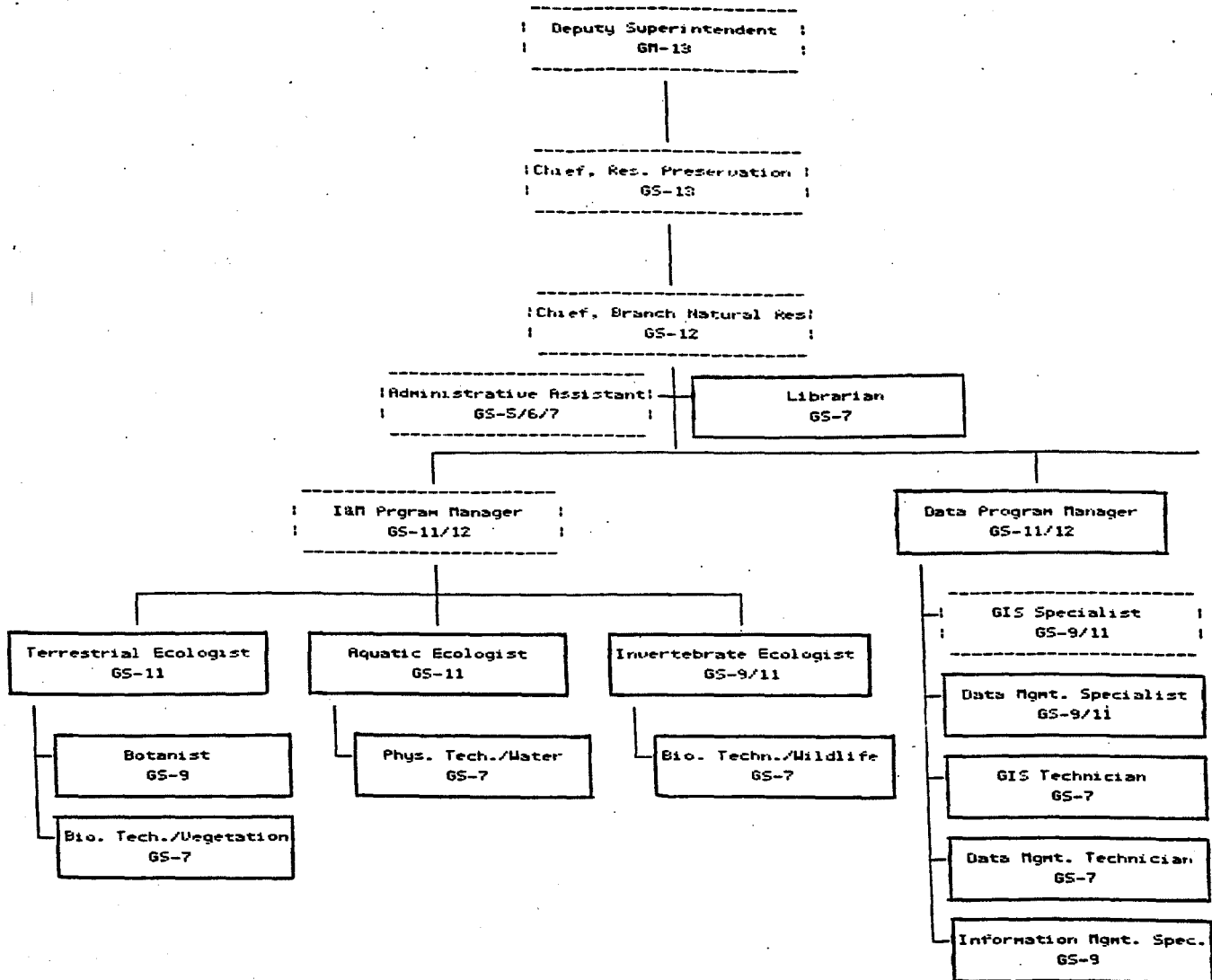
Selection as a I&M Prototype Park requires that a professional staff be employed to successfully administer and develop the LTM program. Given the complexity and diversity of the resources being monitored and a commitment to have a scientifically credible program, we have identified, at a minimum, 14 full-time employees to conduct our program (Figure 7).

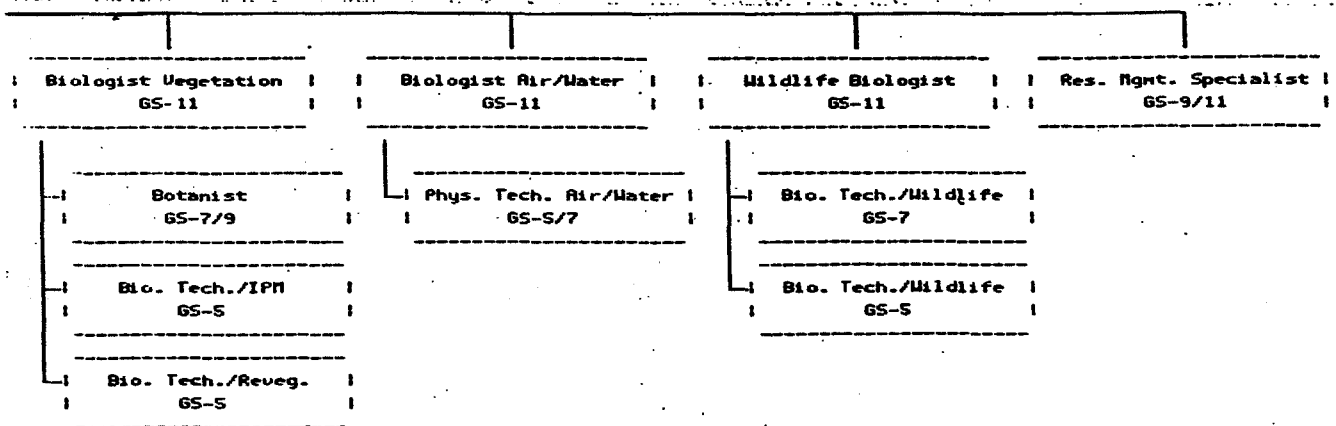
The LTM and Data Management programs will be located in the branch of natural resources. The branch chief will supervise the LTM and Data program managers. The LTM program manager will supervise the forest ecologist, aquatic ecologist, and invertebrate ecologist. The forest ecologist and aquatic ecologist are responsible for managing their respective monitoring programs and will supervise the two full-time technicians. The biological technician (vegetation) and physical technician (lake) will be field leaders and will supervise seasonal employees as well as other volunteer and cooperating technicians or interns. The data program manager is responsible for managing the LTM and park GIS/data management programs and will supervise the data management specialist, GIS specialist (i.e., position funded by the branch of natural resources) and the information management specialist. The GIS specialist will supervise the LTM GIS technician and other cooperating GIS technicians. The LTM data management specialist will supervise the LTM data management technician. The budget (see 6.0 Budget-see Table 1) identifies annual expenditures reflecting the implementation strategy (see 4.9 Implementation Strategy) and estimates the total costs of our LTM program.

Professional credibility is required of the program and staff. The primary LTM staff (i.e., LTM program manager, forest ecologist, aquatic ecologist, invertebrate ecologist, data program manager, data management specialist, GIS specialist and the information management specialist) will possess academic (e.g., Masters degrees) and experience backgrounds that illustrate their knowledge and abilities to scientifically evaluate and administratively manage their respective programs. As a basic requirement for the staff, this minimum standard will bring credibility to the program and acceptance by the scientific community and the general public. This requirement restates (see 1.0 Management Support of LTM Program and 5.0 Scientific Credibility) the intention of the park for a scientifically credible LTM program.

The resource and research staff use a small working laboratory facility and substantial natural resource and general reference libraries. Although the park has a small herbarium, most flora specimens collected within the park are curated at the well-maintained herbarium located at the College of the Atlantic. The current resource program has developed a geographical information program with an impressive database of DLG and other resource data layers (see Appendix E). The GIS program has a dedicated 486DX266 computer, Altek 40 digitizing table, and HP Draftmaster II plotter.

Figure 7. Proposed Staffing Plan for the Branch of Natural Resources Including the LTM Program.





LTM Position

Branch of
Natural Resources

9.0 DATA MANAGEMENT

The park recognizes that data management is a key to the success of the "LTM" program. Standardizing equipment and operations, institutionalizing and managing quality assurance and quality control, and establishing and regulating protection procedures are all critical components necessary in managing the park's past, current and future data sets. The importance of this program task requires that a full time data program manager be hired early in the "LTM" program to develop the data management program and facilitate the acquisition, storage and transfer of information for all park operations. Our program will employ both a data management specialist and a GIS specialist prior to implementing additional research and comprehensive monitoring programs.

The data management specialist will develop and manage the data management program. The incumbent's primary responsibility will be to prepare a data management plan that addresses all long-term data management activities commensurate with the LTM program's objectives. However, the effectiveness of the plan will be dependent on the support and adherence to the plan by all involved persons. To achieve this objective, the data management specialist will review all position descriptions, resource contracts, and data management activities to insure that these quality control areas have been adequately addressed and become institutionalized in the LTM and natural resource programs. The following subject area components of the plan have been listed from highest to lowest priority based on their importance in developing the LTM program and protecting all resource data sets.

9.1 Quality Assurance and Control

Quality assurance and control (QA/QC) will be achieved by establishing specific guidelines in a QA/QC Standard Operation Procedure (SOP) as an integral component of the Data Management Plan. This plan will specify that all LTM efforts and research activities are based on their scientific credibility and legal defensibility, and will require that all QA/QC standards apply to both park personnel and non-agency cooperators. Components of the SOP are as follows:

- a) complete explanations of methods, protocols, and sampling strategies, (i.e., schedules, timing, etc.),
- b) complete descriptions of training and accuracy testing for monitoring teams,
- c) identified strategies for data exchange and feedback opportunities and peer review with all program activities,
- d) directions for documenting data gaps with specific explanations and code descriptions (i.e., actual zero value(s), below detection limits, data lost after collection, weather restriction, etc.),
- e) descriptions of truthing or verification procedures for all phases of data recording, data entry, data analysis, and reporting (i.e., field staff checks, computer edits, report editors, etc.),
- f) guidelines and schedules addressing backup/archiving of all data sets,

- g) guidelines, schedules, and documentation on the duplication of field records (data sheets) and storage (long-term or temporary) of all data (field or computer),
- h) standard procedures in recording all changes to information, data sets, and program methodologies, (i.e., formats of narrative descriptions, reporting locations, etc.),
- i) guidelines on conducting and proposing data analysis as a minimum assurance of accuracy levels (i.e., precision levels, sample size, design, stratification, and analysis) in all phases of the monitoring,
- j) data management will identify how to optimize the data activities to reduce human error and duplication of effort in transcribing data,
- k) the SOP will require accuracy information reporting on products generated on all LTM and park contracts and cooperators's agreements.

9.2 Dataset Management

The LTM program will greatly increase the amount of data describing park resources. The management of all datasets, including those of the past, will be viewed as components of a database that must have a unifying structure to improve efficiency and enhance information accessibility. The Dataset SOP will build upon the need to link new and old resource datasets. The data management specialist will develop the following dataset standards incorporating concerns for efficiency, networking and linkages, unifying characteristics, quality control, and comprehensive management. The components of this SOP are as follows:

- a) guidelines will be identified for standardizing and normalizing past, current, and future datasets including data cooperators to facilitate data sharing and use by staff and outside users. A structure will be developed that links and manages resource datasets. This procedure increases our opportunity to evaluate different and related resource values in assessing long-term monitoring results,
- b) the SOP will identify critical fields, citing specific description or classification measurement standards, that will be incorporated into all new project data collection or will be relocated/identified in past and current programs to enhance time-based and locational analyses,
- c) although file formats for most software allow for conversion to other formats, guidelines in the SOP will identify the standardized formats. The SOP will insure that resource data are compatible with other cooperating local, state, and federal systems to encourage data transfer and exchange,
- d) the SOP will identify the development of a Metadata database system to store, catalog and manage, and integrate data files and sets,
- e) the SOP will locate and prioritize park resource datasets and establish a schedule and process to conduct and complete this backlog, and
- f) guidelines in the SOP will address the ownership, use, and rights of all involved cooperators/parties for data collected directly by the cooperator/park or by other

cooperators or park projects, or by other requestors outside of the park, park service, or cooperators,
g) the SOP will develop dataset documentation standards and guidelines supporting the use of data dictionaries, data guides, and copies of field notes to preserve the usefulness of the data in the long-term for review, re-evaluation or unforeseen developments.

9.3 Network Design and Organization

Hardware and software interoperability is essential for long-term data management and should be designed and established to address program objectives and turnovers in personnel over the long term. The data management specialist, in cooperation with other divisions, will identify and develop an organizational and operational procedure based on user friendly, management efficient, and standardized themes. This unifying effort will guide the LTM program and park in installing a Local Area Network (LAN) insuring maximum opportunities for long-term program continuity and information exchange. The system will support networking, multitasking, archiving, data sharing, and version management at a minimum.

System management will include establishing basic requirements for the operating system. This accommodates the personal nature of the program's users and ensures operational efficiency and data accessibility. The basic objectives of system management are:

- a) to take advantage of new and updated software which allows increased access to data and analysis, computer hardware will be upgraded to meet minimum standards of software applications and operating system structures.
- b) common operating software allows users and managers the opportunity to develop programs for quality control and analysis and conduct routine maintenance, backups and archiving,
- c) a standard hierarchical directory structure will be developed to accommodate all users and facilitate software and data management.

9.4 Protection and Security

The protection of data, software, and hardware is essential to the long-term viability of the LTM program. The data management specialist will establish procedures addressing important protection and security concerns in the Data Security SOP and these are described below:

DATA

- a) backup procedures for daily and less frequent time frames will be incorporated into the computers using appropriate software, hardware or portable tape backup systems. Users will be required to routinely comply with these standards to ensure data protection.

- b) duplication procedures will be developed for field paper records and for data disks/files. Managing the master databases and coordinating the use of working copies and backups will be identified in the SOP.
- c) storage procedures will require tracking of the data, disks, and backup multiple duplicates and document their storage in one of the multiple locations. The SOP will specify the number and locations of storage facilities to safeguard data, operational and emergency disks, and all field and hard copy records.

SOFTWARE

- a) Security of all purchased software will be administered by the data management specialist with the park's procurement/property management specialist. Annual reviews will be conducted according to procurement regulations by the data management specialist.
- b) Re-boot procedures are covered by the creation of emergency standards and equipment for computers. This SOP identifies recovery procedures and necessary programs and disks. It will specify what information (operating systems, hardware setup, etc.) will be duplicated on to bootable emergency disks and the program to use in restoring a failed computer.
- c) Virus protection will be installed on each computer and be integrated in the daily startup routine. The guidelines for this protection system will be identified in the Routine Maintenance SOP. There will be guidelines on the procedures (i.e., virus checks) to use with all new software and other outside source data disks.
- d) The SOP will identify the use of software or park programs to be used in routine computer and disk operational assessments. It will specify what schedule (i.e., daily startup and backup routines) and the programs involved with these regular maintenance reviews. This SOP will identify the procedures and approval process for integrating other services into the program and park computers.

HARDWARE

- a) Each computer will be equipped to handle power inconsistencies (power surges and power supplies),
- b) Routine maintenance will be addressed in a maintenance SOP including all LTM and park computers and other hardware.
- c) A security (lockup) plan will be developed to ensure protection.

10.0 GEOGRAPHIC INFORMATION SYSTEM SUPPORT AND INTEGRATION

The Branch of Natural Resources established a functional GIS in 1989. The program has been upgraded as funds were available and currently uses two 486/DX66 desktop computers for data management including GIS applications. Data backup and archival is facilitated using a Iomega Bernoulli Box and appropriate software or tape backup with the above computer. A Hewlett-Packard Draftmaster II (8 pen) plotter and Altek 40 digitizing table complete the hardware available for conducting natural resource projects. The park chose the software program PC Arc/Info (recently upgraded to ver. 3.4D+), a DOS-based vector

system, because of its use by the local communities and land management agencies with the State of Maine, and to take advantage of support services which could be supplied by a local cooperating college. Since the program's inception in 1989, numerous data themes (Appendix E) have been created or acquired for use with natural resources and most other park operations. The GIS program actively organizes available data layers for research design, management and protection activities, and in recording all permanent research, monitoring, and park operation sites. The opportunity to do more has been limited by lack of funding for a full time GIS specialist and to a lesser degree, by the hardware. In addition, the hardware is not fully dedicated to GIS applications.

The park recognizes the value of a GIS and will continue to develop our GIS program in FY94 by hiring a geographical information system specialist. The park's recently approved staffing plan identifies this position and assigns it the highest funding priority in the resource program. The park has prepared the necessary personnel documentation and justification to begin filling this important position as soon as base funding becomes available. The incumbent will be responsible for developing a GIS Plan for the park that identifies and recommends a GIS program that will meet the needs of the LTM program and other park programs and divisions including:

- a) a plan detailing the structure and components of the park's GIS with recommendations on a base station, accessory hardware and software, and the LAN required to implement a quality GIS program in the park,
- b) a standardized description of the ArcView network system outlining the operating system, directory structure, user compatibility, and the LAN,
- c) protection procedures for data entry, storage, access, updating, backup and archiving, access to data, virus protection, and data sharing and transfer,
- d) the QA/QC standards for data collection and acquisition, data structure and analysis, and documentation regulations for all GIS data activities,
- e) guidelines on the results or "deliverable products" of all projects, programs and contracts, especially those associated with the LTM program, to ensure that they include compatible spatial datasets (i.e., data structure, file formats, normalized to park datasets, etc.), and have meet all QA/QC standards,
- f) guidelines on when and how data will be shared between park divisions, other park service units, researchers and cooperators, other interested parties, and the procedures on preparing product requests, and
- g) guidelines on the ownership, use, and rights of all involved cooperators/parties for data collected directly by the cooperator/park or by other cooperators or park projects, or by other requestors outside of the park, park service, or cooperators.

The GIS specialist will cooperate with the LTM program manager in managing the LTM GIS program. The LTM program will hire a GIS technician to coordinate program activities, assist program specialists, and cooperate with the GIS specialist and other divisions. In the interim, the park will complete an inventory of existing spatial data and prioritize this backlog of spatial information according to it's support of the LTM program and suitability for other park GIS applications. The park staff is establishing a work agreement (dependent

on funding) with a local GIS cooperator to update and process the spatial data into GIS useable datasets. The park will use the prioritized list to schedule the work and assist in the development of these datasets.

The park's PC system is currently limited by its inability to use topographical data (digital elevation models). The park will enhance its GIS program using funding from the WASO I&M program to purchase a base station and compatible LAN, acquire appropriate equipment and storage facilities for the resource datasets, and fund the LTM GIS technician (see 4.9 LTM Implementation Strategy, 6.0 Budget and 8.3 Organizational Structure).

11.0 LINKAGES AND LEVERAGES

11.1 Linkages

The objectives of our LTM program explicitly state the park's interest in long-term monitoring (see LTM Objectives). These objectives focus mainly on the direct benefits to the park, other park units, and the immediate area. However, the park's support of an LTM program is also an acknowledgement of the equally important contribution that this program can make in the monitoring, protection, and management of natural resources on a regional, national and international scale. At these scales, the park's intention will be a more involved role as a cooperator in regional resource and ecosystem monitoring initiatives and efforts. The park and LTM program will continue to strengthen our regional role with the following regional land and resource managing agencies and groups.

Land Managers:

- * The Nature Conservancy
- * National Parks Canada
- * The Canadian Wildlife Service
- * Maine Coast Heritage Trust
- * The Maine Island Trail Association
- * State of Maine
- * USFWS - Petite Manan Wildlife Refuge
- * US Navy - Winter Harbor Group Security Activity
- * University of Maine - Howland & Bear Brook Research Sites
- * USFS & EPA - Forest Health Program

The long-term ecological integrity found at ANP is relatively unique in the Northeast and is viewed by the scientific community as a very desirable location for LTM research. Acadia is considered a key location by the State, EPA, Northeast States Coordinated Air Unit Management (NESCAUM), US Forest Service, and Canada for air quality monitoring and research.

Specifically, the park has been included in regional and international air research and monitoring initiatives such as the North Atlantic Regional experiment and the Gulf of Maine study. In addition, we have actively cooperated in the USFWS's peregrine falcon recovery

and Partners in Flight programs, and with Maine DIF&W's efforts in the harlequin duck Canadian/US Recovery working group and the International Union for Conservation of Nature and Natural Resources (IUCN) Declining Amphibian Task Force.

ANP's LTM program may become more closely associated with two regional long-term monitoring programs as a comparative and complementary satellite monitoring site. The park is listed as a satellite long-term monitoring program called the Forest Health Monitoring Program, a program funded out of EMAP and administered by the USFS. Acadia is also listed as a satellite to the Hubbard Brook LTER. Although there are some differences in the objectives of these programs, there will be many similarities in the resources and ecosystems being monitored. The collaborative efforts will build a scientific analysis network and effectively strengthen the findings and concerns of our collective monitoring. The park intention is to become more closely associated with the following programs in monitoring the trends of resources and ecosystems.

- * Hubbard Brook Long-term Monitoring Site - USFS Research Program
- * Howland and Bear Brook Long-term Monitoring Sites - University of Maine and International Paper Company

As previously stated, the LTM program will continue to strengthen working relationships with the following agencies:

- * Maine Dept. of Inland Fisheries and Wildlife
- * Maine State Planning Office (Natural Heritage Program)
- * Maine Dept. of Environmental Protection
- * U.S. Fish & Wildlife Service
- * Maine Dept. of Marine Resources
- * U.S. Forest Service

11.2 Leverages

The park has established a very good working relationship with WASO and NARO pertaining to resource management and the development of our program. ANP is the only national park in the Northeast, and has benefitted from that status both regionally and at the WASO level. For example, in fiscal year 1992 the park received a base funding increase of \$162,000 for natural resource management. On numerous occasions, WASO and NARO have funded inventories and research (see Appendix F or B) as well as a variety of management projects and activities in the development of our resource management program. The park will continue to build upon these favorable working relationships in implementing and developing the LTM program. The recently implemented Cost Share Program may continue to be a significant asset in the development of our program (see following list of cooperative funding sources).

Because of its status, Acadia attracts considerable attention from news media, academia, and other environmental and natural resource agencies and groups. In addition, the park has

sought and acquired support from the following sources, and hopes to perpetuate these relationships in developing and implementing the LTM program:

Funding Sources

- * National Park Foundation
- * Maine Dept. of Inland Fisheries and Wildlife
- * National Parks and Conservation Association
- * Earthwatch (Center for Field Research)
- * Garden Clubs of America
- * Mount Desert Island League of Towns
- * Eastern National Parks and Monuments Association
- * Friends of Acadia
- * NPS - Park base funding (FTE positions and infrastructure)
- * NPS - North Atlantic Region Office - Office of Scientific Studies & Resource Management Program
- * NPS - Water Resource Division
- * NPS - Air Quality Division
- * NPS - WASO Wildlife and Vegetation & I&M programs
- * National Interagency Fire Center

Support Sources

- * Volunteers in Parks Program
- * College of the Atlantic Honors Program
- * Other university honors programs
- * Student Conservation Association
- * Volunteer Research Programs

12.0 REPORTING PROGRAM

12.1 Objectives of the Reporting Program

The park encourages the presentation of natural resource information and the results of the LTM program. Sharing information, whether in peer reviewed journals or with the park staff and visitors, will educate the public on the contribution of long-term resource monitoring in managing natural resources and ecosystems as well as build professional and public support for the findings and techniques of our program. To accomplish this objective, the LTM program manager will develop an information plan with the broad themes of:

- 1) educating the public,
- 2) sharing results with managers and policy-makers, and
- 3) publishing/presenting information to professional audiences.

The plan will be developed with the Interpretation Division to enhance their educational outreach programs, especially Resource Acadia. The LTM program manager will invite other researchers, cooperators, and other park specialists to present information about the park, other LTM programs, and related topics of interest.

12.2 Reporting Program Components

The LTM information plan will achieve program objectives by developing and institutionalizing the following programs:

- a) quarterly presentations - upon establishing the base LTM program, in-park presentations will be scheduled quarterly to share information on various aspects of the program or individual projects. Presentations from park cooperators, researchers, and division specialists will be encouraged;
- b) annual reports - the LTM program will prepare an annual review of the program including chapters on each of the projects. The report will cite topics of interest such as results, methodology evaluations, available data, overall progress, staffing and expectations for the future.
- c) "Acadia Ecosystems" - this seminar will be sponsored by the park LTM and RM divisions. It will initially occur infrequently but will be offered annually upon full implementation of the LTM program. The focus will be to provide an opportunity for information exchange and hopefully encourage regional LTM research and monitoring specialists to participate in one of the sessions addressing 1) reports on research and monitoring methodologies, 2) reports on research and monitoring results, 3) workshops and training, and 4) discussion seminars reviewing present and new LTM directions and approaches within the Acadia ecosystem.
- d) two/five year reports - depending on the nature of the research or type of monitoring and at the discretion of the LTM manager and park management staff, summary reports for each of the monitoring projects will be published on two or five year intervals following WASO I&M prototype park publication standards. The reports will be more detailed featuring data analysis and results, but will highlight the effectiveness of the methodology, suitability in monitoring the resource and the ecosystem, evaluate the suitability as an indicator in predicting ecosystem health, and make recommendations for the future.
- e) professional articles - all approved methodologies and long-term results will be encouraged for publication in peer-reviewed journals, symposia, and conferences. Pre-publication review by a technical advisory committee will be required to insure scientific integrity and legal defensibility.
- f) deliverable products - all cooperators, NBS and NPS scientists, and other involved parties will be notified in writing (i.e., in contracts, MOU's, etc.) of the "deliverables" that are expected in conducting and completing their projects. These will identify participation in the monthly presentations, chapters in the annual and five year reports, and project products.

13.0 THREATS TO ACADIA NATIONAL PARK RESOURCES

Despite Acadia's long history, protection of resources is no more insured today than it has been since the first lands were transferred into federal jurisdiction. Visited annually by millions of people from the increasingly urban population centers of the Northeast and

Canada, threats to the resources are both direct and indirect. Impact levels are compounded by the park's complex boundary and geographic location which create the potential for adjacent-area and long-distance threats to the integrity of park resources. Although the growing natural resource staff identified, assessed, and begun to mitigate many resource threats and impacts in and near the park, their efforts are largely reactive. Further, many impacts may be unnoticeable over short time frames and must be observed in a structured monitoring system diagnosing induced and/or potential agents of change as distinct from natural conditions and variations. Being able to answer questions about the long-term effects on resources from visitor use, adjacent lands activities, and regional-to-global environmental changes is a proactive management approach that incorporates visitor awareness and enjoyment without compromising the park's natural resource values.

The park LTM objectives identify the need to know resource conditions in assessing abnormal conditions or threats. Acquiring information on empirical limits, population parameters, and ecosystem processes on park resources will allow for the establishment of standards on which the severity of threats can be accessed. Our LTM model demonstrates how we will incorporate ongoing monitoring into an expanded and more comprehensive resource preservation program. That program will then be able to assess the conditions of resources and processes, how these resources relate and function on an ecosystem scale, and will be capable of addressing the following documented known and suspected threats.

13.1 Resource Knowledge

Although the park has a high level of knowledge about many resources, information about natural relationships and biological processes over the long-term are largely unknown. Further, the park lacks the resources to develop and implement a comprehensive strategy and program to monitor the health of resources and ecosystems and identify potential agents of change or threats. Long-term monitoring is valuable in that it addresses the limits of variation in a natural functioning ecosystem and reveals changes that may not be detectable until the resource has been seriously impacted. Information from this monitoring will be used to make recommendations on park planning and management, enhance education and interpretative programs, collaborate on regional resource health assessments and identify causative impacts and threats, and provide resource data for international and global resource monitoring programs.

13.2 Specific Threats

Air Pollution

Long distance and local area air pollutants have been monitored since the late 1970's. Ozone and visibility reducing particulates such as sulfates, nitrates and fine organics have been found to be high during the warmest months of the year. Visible injury and physiological impacts to park vegetation have been documented in an ongoing biological effects research project. Future assessments of impacts to communities' structure, richness, interactions and ecosystem processes will, in part, be determined by using monitoring design and protocols. Results will be used on both the local and national levels in reviewing permits, providing

information on air quality standards and regulatory guidelines, human health levels, and effects on park resources from air pollution including visibility impairment.

Water Pollution

Water resources are an important component of natural processes and resources in the park. They help to define the park's scenic splendor, provide recreation, and for some lakes, are the source of drinking water for several communities. Monitoring has been conducted intermittently by the park, state, and the Mount Desert Island League of Towns over the past several years on several lakes within and adjacent to ANP. Impacts to water resources may come from atmospheric deposition, high visitor use, adjacent landfill leachates, adjacent land use patterns, and oil or hazardous material spills on land or in the marine intertidal environment. Impacts could be subtle or catastrophic. Long-term monitoring will assist in documenting resource conditions and provide early diagnosis of threats and abnormal conditions. Results will be incorporated into local and state land-use planning and water-use regulations, town and park recreational uses, knowledge about water resources and ecosystems, and in national databases addressing legislation and management of atmospheric deposition and water quality.

Habitat Fragmentation

The park has an irregularly shaped and discontinuous boundary. Increasing development and changing land-use practices along many segments of the boundary have and are reducing, dividing and fragmenting communities and populations, and are affecting ecosystem processes. Long-term monitoring will document resources and spatial area requirements and prepare a ranking system for additional adjacent lands related impacts analysis based on the susceptibility of resources, processes, and/or communities to land-use practices. Results will be used in preparing and enforcing local and state zoning regulations, protecting park resources, and serving as a model for other parks addressing adjacent land issues that are becoming increasingly separated from contiguous blocks of natural area buffer zones or a natural landscape.

Visitor Use

Park recreational visitation was estimated at over 2.3 million in 1992 (ANP 1992) and continues to increase annually. Long-term impacts to park resources remain largely unknown. Visitor impacts include trampling of near-trail borders, incidental and commercial collecting and harvesting, solid waste generation, disturbance of sensitive habitats and wildlife, and the development of services to accommodate visitors in the park. Impacts are suspected to occur in all GMP planning zones. Long-term monitoring will establish resource conditions and tolerance levels, and identify criteria in protecting resources. Results will be used to develop minimum impact standards for resources when developing visitor services, prepare management plans, manage visitation, and to identify visitor impact research needs.

Sensitive Species and Critical Habitats

The park harbors approximately 46 federally or state listed species of special management concern. Fifteen Maine Critical Areas are protected in the park. Abnormal conditions and agents of change coupled with visitor impacts could endanger these resources and interrelated biological processes. The potential loss of genetic information and biodiversity would be

detrimental to the long-term maintenance of Acadia's biotic communities and related processes. Long-term monitoring will establish the status and condition of these resources, identify the introduction of alien species, and develop criteria in protecting resources. Results will be used in preparing cooperative park and state management plans, managing visitation, and identifying sensitive species and critical area research needs.

13.6 Fire

The role of fire on ecosystem dynamics at Acadia has been under investigation for more than a decade (Patterson et al. 1983b). Paleoecological studies utilizing fine resolution pollen and charcoal analysis of lake sediments have provided an historical fire record dating to the end of glaciation. In addition, this research has allowed for the reconstruction of variations in vegetation density and structure. Although the incidence of fire has been relatively low, especially for large scale ecosystem altering fires, projected climatic changes could result in warmer temperatures with more frequent and longer droughts. Also, the increasing urbanization of land surrounding the park requires additional information to manage natural functioning natural systems while at the same time protecting property values. Ever increasing urbanization also increases the likelihood of ignition and rate of spread of fires. Additional research and long term monitoring of the role of fire on ecosystem dynamics will be needed to provide the information needed to protect and manage fire related resource values.

13.7 Climate Change

The park is well located biogeographically for monitoring long-term climate change. Acadia is positioned along a widely recognized transition zone that appears to be an extension of the "tension zone" that extends from Minnesota to New York. In Maine, 67 woody plant species (28% of the woody taxa in the state) reach either their northern or southern limits in this zone (McMahon et al. 1990). Further, climate models indicate that the largest predicted increases in temperature will occur during winter in the northern U.S. with average winter temperatures increasing 4-6 degrees C. in the northeast (Wang et al. 1991. Mohnen and Wang 1992). Preliminary climate change related research is being conducted by the University of Maine on cold tolerance of jack pine (*Pinus banksiana*) and pitch pine (*P. rigida*), two species at the southern and northern limits of their respective ranges, as well as other selected coniferous species. Several other studies have been conducted or proposed that would compliment future climate change research at Acadia. A proposal has been submitted to include Acadia in the NPS Global Climate Change Program. Implementation of the proposed LTM program will provide the type of long term stability and resource information needed to evaluate climate change trends.

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APPENDICES

Appendix A

The Acadia RMP identifies the following monitoring project statements:

- ACAD-N-001 Basefund and Upgrade Administration of Natural Resource Program
- ACAD-N-035 Develop Comprehensive "LTM" Strategy and Protocols
- ACAD-N-041 Implement Comprehensive "LTM" Program
- ACAD-N-058 Base Program, Inventory and Monitoring
- ACAD-N-034 Acquire New Landscape Imagery for GIS Thematic Data
- ACAD-N-002 Establish Air Quality Monitoring Base Funding
- ACAD-N-016 Implement Bald Eagle and Peregrine Management Plans
- ACAD-N-009 Fire Management Plan (monitoring identified)
- ACAD-N-012 Purple Loosestrife Management Plan (monitoring identified)
- ACAD-N-042 Maintain Park-wide Bibliography
- ACAD-N-014 Establish Harlequin Duck Monitoring Program

Appendix B

RMP identifies the following 16 inventory project statements:

- ACAD-N-021 Inventory Abundance and Distribution of Reptiles and Amphibians
- ACAD-N-013 Inventory/Evaluate Fisheries Resources in Park Waters
- ACAD-N-047 Biodiversity and Conservation of Invertebrates in NAR
- ACAD-N-046 Rare and Endangered Plant Inventory
- ACAD-N-036 Ecological Inventory of Offshore Islands
- ACAD-N-037 Inventory Species/Abundance/Distribution of Bryophytes
- ACAD-N-066 Biodiversity/Distribution of Bats on Park Lands
- ACAD-N-045 Inventory/Assessment of Old Growth Vegetation
- ACAD-N-048 Determine Status of Songbird Populations
- ACAD-N-044 Ecological Inventories of Conservation Easements
- ACAD-N-038 Complete Flora and Fauna Baseline Inventories
- ACAD-N-039 Inventory Resource Impacts on Trails
- ACAD-N-022 Inventory Status of Large Mammals in the Park
- ACAD-N-023 Investigate Park Furbearer Populations
- ACAD-N-027 Determine Population Status of Wood Ducks
- ACAD-N-028 Northern Flying Squirrel Inventory

RMP identifies the following 21 research project statements:

- ACAD-N-004 Abundance and Distribution of Carnivores on MDI
- ACAD-N-005 Deer/Hare Effects on Vegetation
- ACAD-N-011 Ecology of Lyme Disease in ANP Area
- ACAD-N-032 Nonpoint Source Pollutant Loading Model ANP Watersheds
- ACAD-N-035 Develop Comprehensive I&M Strategy and Protocols
- ACAD-N-024 Fire Behavior and Effects on Vegetation
- ACAD-N-062 Study Long Term Fire History
- ACAD-N-017 Nesting Ecology and Success of ANP Area Bald Eagles
- ACAD-N-020 Establish Protocols and Assess Impacts at Anemone Cave
- ACAD-N-050 Global Climate Change
- ACAD-N-003 Effects of Ozone on Vegetation
- ACAD-N-043 Establish Baseline Water Quality for Somes Sound
- ACAD-N-030 Hunting/Trapping Impacts on Game Species Populations
- ACAD-N-025 Fire Interactions: Water/Biota/Soils
- ACAD-N-065 Monitoring Abundance and Distribution of Carnivores on MDI
- ACAD-N-031 Water Quality and Ecology of Bass Harbor Marsh
- ACAD-N-007 Coyote-Deer Interactions
- ACAD-N-033 Monitoring and Modeling of Photo-oxidants
- ACAD-N-008 Ecology of Sub-Alpine Vegetation in the Park
- ACAD-N-006 Fisher Reintroduction
- ACAD-N-018 Population Dynamics & Viability of Spruce Grouse on MDI

Appendix C

I. FOREST

- * Forest Health Monitoring - USFS
- * Forest Pest Surveys - USFS
- * Invertebrate Monitoring Program - NPS/NBS/Researchers
- * Partners in Flight Program - Multiple Agencies
- * Biological Effects (Ozone) - Multiple Agencies, NPS-AQD
- * Global Climate Change - Multiple Agencies
- * Forest Health - Howland Research Site - University of Maine & Cooperators
- * Other Coniferous Forest Parks
- * Amphibian Monitoring Program - Multiple International, National, State
- * Maine Ecological Reserve System - Maine

II. HYDROLOGIC

- * National Atmospheric Deposition Program - Multiple National, State Agencies
- * State and Town Monitoring - Maine, Towns

III. LANDSCAPE

AIR

- * National Atmospheric Deposition Program
- * Particulates - NPS-AQD & Multiple National, State Agencies
- * Ozone - NPS-AQD & Multiple National, State Agencies

IV. SCENIC

- * State Planning - Maine Planning Office
- * Town Planning - Town & State Planning Offices

Appendix D

MAJOR FOREST COVER TYPES:

Spruce-Fir
Birch-Aspen
Mixed Hardwood-Conifer
Mixed Conifer
Northern Hardwoods
Red Oak
Old Growth Spruce
Eastern White Pine
Jack Pine
Unique Forest Communities:
 Pitch Pine
 Black Spruce-Tamarack Swamp Forest

Twenty-two vegetative cover types, with one subdivision for Old Growth, have been identified and delineated (Waggoner 1981). The remaining vegetative covers are listed below. Bare rock, developed, and waterbody were also delineated but are not included.

Hemlock Forest
Northern White Cedar Forest
Birch-Aspen Scrub
Alder Scrub
Salt Marsh
Fresh Marsh
Shrub Bog
Sphagnum-Sedge Bog
Floating Vegetation
Old Fields and Meadows
Heath Scrub
Red Maple

Appendix E

ACADIA GIS DATA LAYERS

- All data, except where noted, is coordinated in UTM's.
-MDI = Mount Desert Island, SCH = Schoodic Peninsula,
IAH = Isle au Haut, EAS = Easement area
-DLG = USGS Digital Line Graph file

Description	M DI	SC H	IA H	EA S	Comments
shore outline	X				DLG
shore outline			X		not in UTM
roads-1st,2nd,3rd,4th class (4 layers)	X				DLG
trails	X				DLG
carriage trails	X				
hydro-polys (lakes and ponds)	X				DLG
streams-primary & secondary (2 layers)	X				DLG
vegetation (1979)	X	X			
soils	X				
park boundary	X				
Maine critical wetlands	X				
Public water supply watersheds	X				
area burned by 1947 fire	X				
historic fire ignition points	X	X			
1989 active beaver lodges	X				
transect locations-Flying squirrel study, (Higgins, 1992)	X				
transect locations-Lyme Disease study, (Hazen, 1989-92)	X				
contour lines for = > 1000' ASL	X				
purple loosestrife infestations	X				
rare plant locations (Greene, 1990)	X				
National Wetlands Inventory	X	X	X	X	
gross range map for spruce grouse					N.America
range polygons & movements of radio-tagged spruce grouse (Whitcomb, in prep.)	X				
Gulf of Maine outline					
outline of Maine					
surficial geology	X				
bedrock geology	X				
Island Inventory (The Hop, Baker I., Bar I., Schoodic I., Pond I., etc.)					

DATA LAYERS IN PROCESS:

1. Acquisition of DLG layers for our entire legislated boundary (Penobscot Bay shipping channel to the Hancock/Washington County line) from the ME Office of GIS. These data will need minimal processing at COA to get them into a compatible media for us. We will also get the state tic grid and a cover of the Maine towns.
2. Cooperative Agreement with College of the Atlantic (COA). We will be acquiring: tax maps for MDI, land use for MDI, wildlife habitats of concern, and Scenic, Ecological, and Cultural areas outside the park boundary, based on the Jacobson/Dominie study.
3. Cooperative Agreement with College of the Atlantic. Expand the park boundary cover to show all areas within the legislated boundary, including easements, lands owned in fee, and some information on adjacent lands. Several existing databases will be linked with the spatial information.

Appendix F

Some examples of NPS WASO and NARO support for natural resource projects at Acadia.

FY Year:	Funding Source:	Project Title:	Funding:
92-96	WASO-DSC, CCS	Native Plant Revegetation Program	\$ 135,000
93-96	WASO	Bald Eagle Contamination/Habitat Assessment	150,000
89-94	WASO-AQD, NARO	Effects of Ozone on Native Vegetation	610,000
92-94	NARO	Spruce Grouse Ecology	45,000
91-94	WASO	Coyote/Deer Interactions	161,000
93-94	WASO-WQD	Develop Water Resource Management Plan	50,000
93-94	WASO-NRPP	White-tail Deer Fawn Mortality	50,000
91-93	WASO-WQD	Nutrient Exchange in Bass Harbor Marsh	150,000
91-93	WASO-WQD	Inventory Wetlands	24,000
91-93	WASO-WQD	Study Somes Sound Water Quality	40,000
93	WASO-AQD	Study Pathological Injury to White Pine	40,000
93	NARO	Invertebrate Monitoring	10,000
92-93	WASO, NARO	Ecological Inventory of Islands	121,000
93	NARO	Baker Island Management Plan	6,000
92-93	NIFC	Long-term Fuel Monitoring Research	60,000
91	WASO-WQD	Nonpoint Pollution Modeling	30,000
91-92	NARO	Subalpine Plant Ecology & Impacts Study	30,000
92	NARO	Support Development of Bald Eagle and Peregrine Falcon Management Plans	5,000
90-92	WASO-NRPP	Fisher Reintroduction Feasibility Study	75,000
89-91	WASO-NRPP	Herbivore Effects on Vegetation	41,462
90-91	NIFC	Fire History	60,000
89-91	NARO	Support Exotic Plant Management	7,500
91	WASO-WQD	Water Resource Scoping Report	30,000
88-90	WASO-NRPP	Calibrated Watershed	45,000
87-90	WASO-NRPP	Carnivore Ecology	58,712
88-90	WASO-NRPP	Rare & Endangered Plant Survey	25,000
87-89	WASO-NRPP	Intertidal Zone Monitoring	27,000
87-88	WASO-AQD	Visibility Assessment	27,500
87-88	WASO-NRPP	Jack Pine Ecology	57,000

Appendix G

LTM PROGRAM SPACE CHART
Infrastructure workchart for LTM Program

Space Costs to remodel existing building for LTM Staff/Program

Office

LTM Resource Staff	Ind.	Space	Rms	Totals
Managers/Specialists	4 ind. x 100sq.ft.		4	=450 sq.ft.
Techn. (fte)	2 ind. x 100sq.ft.		2	=100 sq.ft.
Techn. (seas)	4 ind. x 60 sq.ft.		1	=240 sq.ft.
NBS/Scientists	3 ind. x 100sq.ft.		1	=300 sq.ft.
Subtotal				1090 sq.ft.

(Note: * = 150 sq.ft. for Managers)

GIS/DATA	Ind.	Space	Rms	Totals
Managers/Specialists	4 ind. x 100sq.ft.*		4	=450 sq.ft.
Techn. (fte)	2 ind. x 100sq.ft.		1	=200 sq.ft.
NBS/Scientists	2 ind. x 100sq.ft.		1	=200 sq.ft.
Subtotal				850 sq.ft.

(Note: * = 150 sq.ft. for Managers)

<u>Support Rooms</u>	<u>Space</u>	<u>Rms</u>	<u>Totals</u>
Conference Room	(15' x 15')	1	= 225 sq.ft.
Library/Files	(20' x 20')	1	= 400 sq.ft.
Restrooms	(5' x 12' x 2)	2	= 120 sq.ft.
Equipment Storage	(10' x 20')	1	= 200 sq.ft.
Labs			
GIS - work space	(10' x 20')	1	= 200 sq.ft.
Analytical (remodel)	(10' x 20')		= 200 sq.ft.
Subtotal			= 2440 sq.ft.
Total (net area)			= 3285 sq.ft.

Option 1

Total (gross area) (x 30% corridors and walls) = 4270 sq.ft.

Space Costs to for new building for LTM Staff/Program

<u>Support Rooms</u>	<u>Space</u>	<u>Rms</u>	<u>Totals</u>
Conference Room	(20' x 20')	1	= 400 sq.ft.
Break Room	(10' x 12')	1	= 120 sq.ft.
Library/Files	(20' x 20')	1	= 400 sq.ft.
Restrooms	(5' x 12' x 2)	2	= 120 sq.ft.
Equipment Storage	(10' x 20')	1	= 200 sq.ft.
Labs			
GIS-main rm/stor.	(10' x 20')		= 200 sq.ft.
GIS-work space	(10' x 20')		= 200 sq.ft.
Analytical	(20' x 20')		= 400 sq.ft.
Curatorial	(20' x 20')		= 400 sq.ft.
Subtotal			2440 sq.ft.
Total (net area)			4380 sq.ft.

Appendix G (Continued)

Option 2

Total (gross area) (x 30% corridors and walls)= **5694 sq.ft.**

Design & Construction (DSC Overhead - 56%)

Option 1 - Remodel Space : 4270 sq.ft. x \$160.00/sqft. = \$683,200.00

Option 2 - Space & new building: 5694 sq.ft. x \$160.00/sq.ft. = \$911,040.00

If a new building is identified, the following building costs have not been identified in the above space costs.

UTILITIES

Water/Sewer (well/Eagle Lake - treatment facility) \$ 60,000
(water, sewer, power, phone)

SITE DEVELOPMENT

Parking Lot (approx. 12 employees/year round), \$ 50,000
18 vehicles, walks- clearing, earthwork, landscape)
Building Landscaping (one time)

NET CONSTRUCTION COSTS

\$1,021,040

DSC OVERHEAD

\$ 571,782

Location (site (GMP), NPS/NARO Apprv., compliance,
planning, project planning, construction supervision,
contingency)

DSC - 56% (taken from DSC class C Estimating Guide)

TOTAL \$1,591,822

TOTAL (GROSS CONSTRUCTION COSTS)

Option 1 \$ 683,200

Option 2 \$ 1,591,822

NOTE: Values/% taken from DSC Class C Estimating Guide)