FINAL DRAFT

Strategic Plan
Long-Term Ecological Monitoring Program

Denali National Park and Preserve

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Introduction

This Strategic Plan describes the development and implementation of a Long-term Ecological Monitoring (LTEM) Program at Denali National Park and Preserve, Alaska. It tiers from the park's General Management and Resource Management Plans. In turn, it lays the foundation for other documents, yet to be written, which will detail specific components of the LTEM Program. Figure 1 shows the relationship of this Strategic Plan to other park planning documents.

Legal mandates and NPS policy recognize that the ability to detect and document resource changes, and to understand the forces driving those changes, are fundamental to accomplishing the NPS mission of conserving parks unimpaired. "Monitoring is indispensable to determine desired resource conditions; to diagnose human impacts; to direct management intervention; and to measure subsequent success or failure of that intervention." (NPS 1992). Management decisions require comprehensive information about resources held in trust for the public.

In recognition of the need to detect and document resource changes, the National Park Service established a prototype Long-term Ecological Monitoring Program in 1991. The purpose of this national effort is to test strategies of developing and implementing programs to collect long-term information for detecting or predicting resource changes in the National Park System. Denali National Park and Preserve was selected to participate in this national effort.

This document is our vision of how the program, now six years into development, will be brought to fruition. It also reflects mid-course corrections that a review team recommended after evaluating the program in 1995 (Frederick 1996).

This strategic plan describes the following for the Denali LTEM Program:

1. The guiding principles, purpose and objectives, fundamental elements, and monitoring priorities that will provide the framework for the LTEM Program;

2. The relationship of the program to resource management in Denali National Park and Preserve, and its role as a national prototype; and

3. A phased approach for development and implementation of the program over the next three years (FY 1998-FY 2000).

Appended are background information about Denali National Park and Preserve, and a status report on the protocols being developed.

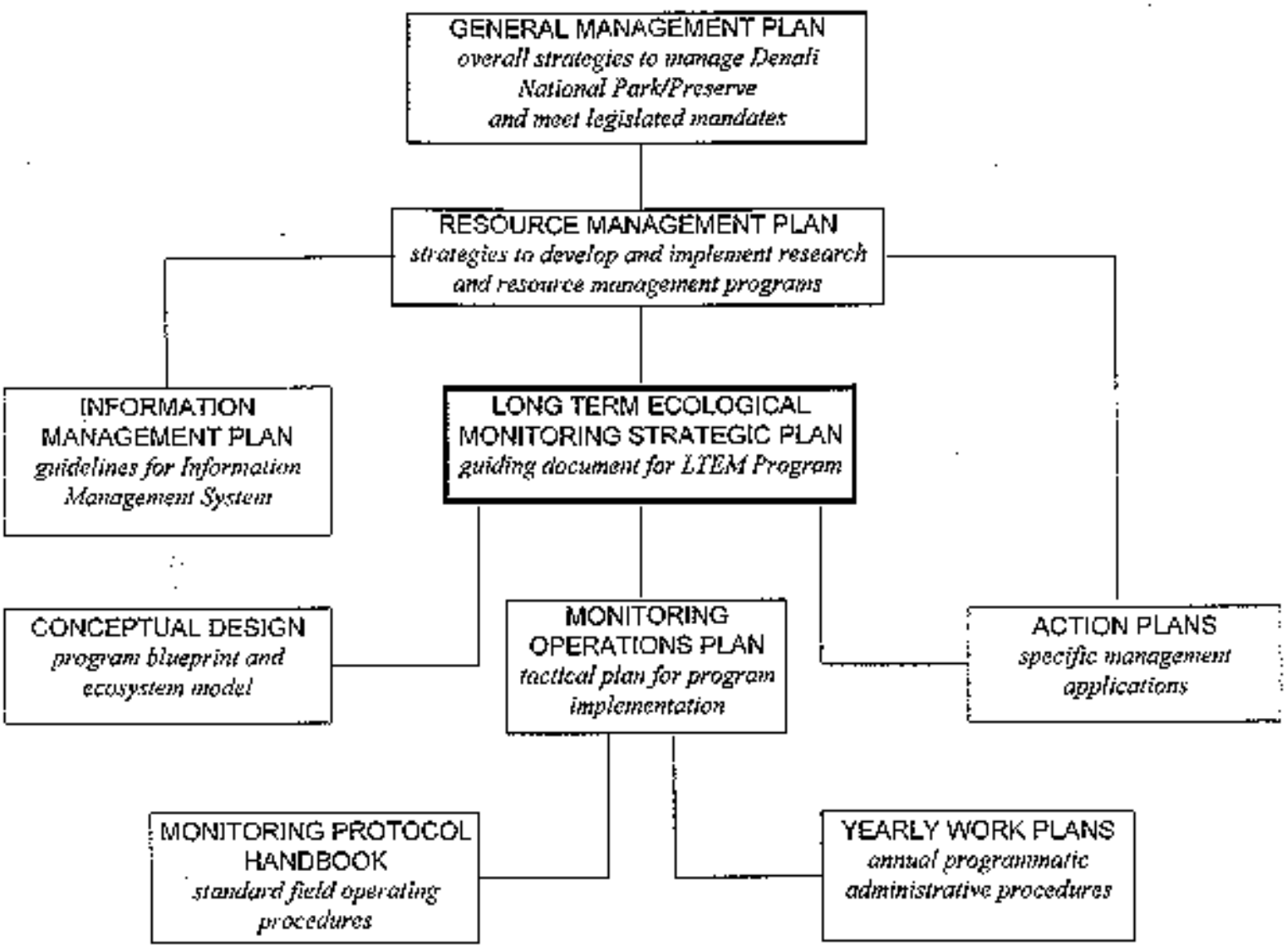


Figure 1. Relationship of this Strategic Plan for Long-term Ecological Monitoring in Denali National Park and Preserve to other Park Planning Documents

Agency Roles and Relationships

Many entities are involved in the Denali LTEM Program, including: national-level staff for both the National Park Service (NPS) and U.S.Geological Survey, Biological Resources Division (USGS-BRD); staffs at Denali National Park and Preserve and the Alaska Biological Science Center of USGS-BRD; the Principal Investigators, from academia, other institutions and NPS, who are developing various protocols; peer reviewers; and professionals and technicians who carry out monitoring activities.

Development of the LTEM Program is a joint and cooperative endeavor of the NPS and USGS-BRD. Denali National Park and Preserve will be responsible for setting the general boundaries of the program and for determining the questions it will be designed to answer. The USGS-BRD Alaska Biological Science Center will be responsible for designing and testing the program, and ensuring its scientific validity. The National Park Service will implement the monitoring program. Participation by university scientists and consultants in all aspects of the program will be encouraged.

Guiding Principles

The following principles reflect our basic assumptions about what we are trying to do, and provide more specific guidance about how we will go about it. All long-term monitoring activities will be evaluated against these guiding principles, which set standards for a fully successful program.

1. The program will attempt to develop linkages between ecosystem condition, and management needs and actions. To the extent possible, the program will anticipate the causes, mechanisms and indicators of human-induced change.

2. The program will be grounded in an interdisciplinary scientific approach based on a conceptual ecosystem model and integrated in its strategies.

3. The program will recognize the significant contributions that Denali, as a pristine, subarctic terrestrial site, can make to understanding large-scale ecological processes.

4. Program design will reflect the hierarchy of ecosystems at multiple spatial and temporal scales.

5. The program will use adaptive management. It will be regularly evaluated and revised based on new information and techniques.

6. The program will be managed on a sustainable basis, and will include or add only those elements that can be supported over the long-term. Realistic assumptions about the availability of financial and operational resources to support the program will be used.

7. Program participants will be cognizant of its role as a prototype. Mechanisms for documenting and transferring lessons learned in developing the program will be encouraged.

8. Methods used will be repeatable, statistically sound, and readily implemented. They will be low-impact and consistent with park values.

Purposes of the LTEM Program

Resource monitoring may be described in terms of a long-term, or "strategic", component and a "tactical" component. The LTEM Program is strategic, that is, it provides basic knowledge about the status and trends of park resources. It answers questions that have a major influence on park ecosystems, are multi-generational or long-term in nature, and are on a large spatial scale. Tactical monitoring answers very specific questions, has a limited life span, and is usually carried out at a small spatial scale. Strategic monitoring is designed to continue in perpetuity. In some instances, monitoring that begins as a tactical activity will eventually be incorporated into the LTEM Program.

The purpose of the Long-term Ecological Monitoring Program at Denali National Park and Preserve is to develop broadly-based, scientifically-sound information on the current status and long-term trends in the structure and function of the park's ecosystems to:

1. Improve management decision-making on park resource preservation concerns that are primarily local and regional in nature;

2. Increase our basic understanding of ecological dynamics in the taiga and tundra ecosystems of the Subarctic Biogeographic Association in interior Alaska;

3. Enhance national and global monitoring networks by representing a naturally-functioning and intact subarctic site.

To achieve these purposes, we have defined the following specific objectives:

- Document the ranges of natural variation in key ecosystem processes and structural elements;

- Develop information that can be used to identify cause and effect relationships;

- Discriminate natural change from that which is human-induced;

- Obtain information useful in predicting change prior to undesirable environmental effects;

- Provide control sites and benchmark data for comparative ecosystem research;

- Share resource status information, monitoring methodologies and program development strategies with NPS and other entities;

- Provide information upon which management responses are based when pre-determined thresholds of resource condition are reached.

Fundamental Elements of the LTEM Program

The Long-term Ecological Monitoring Program at Denali National Park and Preserve has three fundamental and interrelated elements: (1) a management focus, (2) an ecosystem approach, and (3) participation in national and international monitoring networks. These elements are closely interrelated. The ecosystem approach (Element #2) provides the context required to understand ecosystem processes and population trends that might affect the management of key species and other resources (Element #1). NPS managers also need to see how the Denali ecosystem fits in on a regional and continental scale. Participation in national and international monitoring networks (Element #3) will provide that broader context.

Each element, its importance, and its relationship to meeting the purposes of the LTEM Program is described below.

Element #1: *Management Focus*

The LTEM Program will be fully successful only when it is integrated into the decision-making process for managing the park. Therefore, a fundamental feature will be that the program provide information for management. NPS managers will need information about stressors (i.e., agents of change) and trends in the patterns of use of the park and neighboring lands. Managers also need information about specific issues. The LTEM Program will provide an umbrella for these "tactical" monitoring projects. Other significant management needs include information related to key wildlife species, subsistence uses, and sport hunting and trapping.

Element #2: *Ecosystem Approach*

An ecosystem approach is the second fundamental element of the Denali LTEM Program. An ecosystem approach is concerned with both the biological and physical aspects of the environment and the relationships among and between them. A basic understanding of the fundamental relationships which drive Denali ecosystems will build the foundation for the LTEM Program. A conceptual ecosystem model will be used to provide a framework for our growing knowledge of ecosystems in Denali park.

Element #3: *Participation in National and International Monitoring Networks*

The third fundamental element will be participation in other monitoring programs aimed at understanding broad-scale patterns of ecosystem change. Representation of subarctic study sites in broader networks is often quite limited or wholly lacking. By participating in monitoring networks, we will learn where Denali fits into the big picture. This context is vital to interpret information gained from other aspects of the LTEM Program aimed at

understanding patterns of change within the park. Participation in networks enhances the scientific web that the park is tied into and may afford opportunities to leverage more funding and investigative effort.

Priority Monitoring Topics

To meet its management objectives for Denali, the National Park Service has established the following high-priority needs that its monitoring program should address:

- Document meteorological patterns, particularly those affecting the timing and length of the snow-free season.
- Provide early warning of changes in air quality, particularly visibility, due to local contamination, regional development and global influences.
- Detect changes in water quality of streams and lakes due to visitor use, park development, resource extraction activities and global influences.
- Detect changes in the productivity (including fish, primary producers and benthic invertebrates) of streams and lakes due to park development and resource extraction activities.
- Document patterns of glacial activity in response to global warming, and develop predictive capabilities of the effects of surges or recessions on mountaineering, other park uses, and downstream resources.
- Detect significant changes in the structure, composition and distribution of major vegetation communities due to regional and park development, and global influences.
- Monitor fire regimes (frequency, intensity, location, and areal extent) to evaluate the effects of fire management strategies on plant succession and habitat quality.
- Detect changes in the distribution, behavior or population dynamics of animal species highlighted in the park's enabling legislation, such as grizzly bears, moose, caribou, Dall sheep, wolves, swans and other waterfowl, in reponse to changes in habitat quality, park use or harvest.
- Provide early warning of changes in distribution, abundance and productivity of species of national/international concern, such as neotropical migratory land birds.

- Detect changes in the occurrence of deformities, population abundance or distribution of species, such as the wood frog, sensitive to contaminant deposition in air and water.

- Document trends in the abundance and productivity of animal species representative of all trophic levels.

- Detect changes in distribution, abundance or productivity of umbrella, keystone and indicator species, such as grizzly bears, golden eagles, salmon, arctic ground squirrels, microtines, and merlin.

- Discern changes in biodiversity, including introduction or loss of species, due to habitat fragmentation/loss, park and visitor activities, and regional development.

- Detect trends in abundance and distribution of rare native species and of introduced non-native species due to access, development and visitor activities.

This list is preliminary. These attributes will be re-evaluated as the conceptual model and resource inventories are completed, and as NPS managers identify additional information needs.

Information Management System

A strong Information Management System is a fundamental requirement of the Denali LTEM Program. The system will be the primary means for tying all aspects of the program together. Because many different people will collect and analyze data over many years, an efficient system for organizing, archiving and using the data will be crucial. The Information Management System will integrate the information needed to build ecosystem knowledge, and to help managers understand where Denali fits into broad scale monitoring networks. It must also provide information in a format useful to NPS managers.

The Information Management System will be compatible with other existing and planned systems for indexing resource information of Denali National Park and Preserve, including its Annual Investigators Report database, museum collection database, bibliographic database, and Geographic Information System. An *Annual Report* will highlight the administrative status of the program and the principal findings from each major element of the program. A major synthesis of findings and results will be produced at intervals of 5-10 years. Reports will include Executive Summaries or other mechanisms to facilitate the transfer of information to managers and other non-scientists, and to other monitoring programs.

Relationship of the LTEM Program to Resource Management in Denali National Park and Preserve

The LTEM Program is an integral component of the park's resource management program, which is carried out by the Research and Resource Preservation (RRP) Division. The primary responsibilities of the RRP Division are to:

- *inventory* park resources;
- *monitor* the status and trends of park resources;
- *protect* resources from the adverse impacts of human activities;
- *mitigate* those impacts when they occur; and,
- *interpret* the results of research and resource management activities for park managers and the public.

The park Resource Management Plan (RMP) describes all these components of the resource management program in detail (NPS 1997).

The LTEM Program will help the RRP Division provide high-quality scientific information to NPS managers, thus improving their ability to make management decisions. Initially, we will approach this task retrospectively, that is, relying on evidence of past changes to govern decisions. Eventually, as we gain experience and knowledge of natural ecosystem functions, we hope to move into a prospective mode—one in which the information gathered will aid in forecasting changes in resource conditions.

Ideally, this approach will be linked to thresholds or predetermined resource conditions that are used to trigger a management response. Examples might include wildlife population sizes that would trigger changes in hunting seasons, or loss of groundcover that triggers closure of a trail or campground. Managers and scientists will both play a role in applying what we have learned—managers to set the limits of change which are acceptable in meeting NPS mandates, and scientists to interpret monitoring data and scientific literature which define the current state of ecosystem knowledge.

Role of the Denali LTEM Program as a Prototype

Since it is a prototype, the Denali program plays an important role beyond its application at Denali. We are strongly committed to sharing program development strategies, protocols, results and applications with other parks, agencies and the scientific community at large.

In 1991, Denali National Park and Preserve was selected as one of four parks where a prototype monitoring program would be developed. The other three parks were Shenandoah, Great Smoky Mountains and Channel Islands. LTEM Programs developed at these parks were to serve as a guide for development of monitoring programs in other national parks.

The Denali long-term monitoring effort differs from the efforts made at the other three original prototype parks in several respects. These parks already had some type of monitoring program—generally related to clearly identified threats and issues—when their LTEM programs were initiated. At Denali, the LTEM Program started largely from scratch. Compared to the other prototype parks, Denali is pristine, and the development of its program is not being driven by immediate threats. The Denali program therefore has the "luxury" of laying a solid and broad baseline for detecting change.

The major distinction, however, is related to the enormity of the Denali landscape. Due to the scale of the landscape, the approaches taken in monitoring elsewhere are not directly applicable. In addition, our level of knowledge of ecological relationships in subarctic landscapes is not as advanced as in the other Biogeographic Associations. The natural environment is extreme and highly variable, confounding our abilities to tease apart natural from anthropogenic change. The Denali program must therefore address issues related to scale and the attendant logistical constraints inherent in monitoring the resources of large Alaskan parks.

Another important distinction is related to the Alaska National Interest Lands Conservation Act (ANILCA), the 1980 law that created Denali and the other Alaska parks. ANILCA additions resulted in a gradient of land designations that permit various human activities, often around a protected core. The combination of pristine areas juxtaposed with lands subject to consumptive use is an important feature of natural parklands in Alaska. Monitoring approaches and techniques developed in Denali should apply to major land use designations throughout Alaska.

Phased Approach to LTEM Program Development and Implementation, 1998-2000

We will use a phased approach to finish the development of and implement the Denali LTEM Program. Our approach will generally follow the "step down" plan used at Channel Islands National Park (Davis 1997). We envision four phases—design, development, transition, and implementation. Figure 2 outlines the major tasks that will occur in each phase, and their approximate timelines. Below, we describe in more detail the major activities that will be undertaken in the immediate three years to finish development of the program (USGS-BRD) and transition to implementation (NPS).

Continued Development of the LTEM Program

Design and development-related work led by the USGS-BRD staff at the Alaska Biological Science Center (ABSC) is planned to continue for roughly 3 more years. The purpose of this section is to generally describe where development efforts will be concentrated. With the goal of bringing the development phase to completion by the end of 2000, ABSC will focus on the following:

1. **Closeout original protocol development efforts and incorporate data into data management system.** ABSC will closeout all contracts and agreements for pilot studies for protocols developed for the Denali LTEM Program, including Avian Point Counts, Monitoring Avian Productivity and Survivorship (MAPS), Small Mammals, Aquatic Invertebrates, Soils, Vegetation, Data Management, Water Quality/Hydrology, Meteorology, Air Quality and Glaciers. Working with the NPS, ABSC will compile data collected between 1992 and 1997 by the pilot studies, per the approved data management protocol.

2. **Develop conceptual ecosystem model.** ABSC will develop a conceptual ecosystem model for Denali National Park and Preserve.

3. **Finish conceptual design.** ABSC and Denali staff will complete a Conceptual Design paper which incorporates the conceptual ecosystem model and the results of workshops held in 1996. The design paper will explain and document program purposes, the process for selecting and prioritizing monitoring attributes, sampling design, and other program components.

4. **Continue protocol development.** ABSC will continue research, as deemed appropriate, for completion of protocols not yet considered fully operational.

5. **Assess Rock Creek watershed variables.** ABSC will conduct a critical assessment of variables addressed by pilot studies in the Rock Creek watershed for power to detect changes or trends, cost, and importance to understanding underlying ecosystem processes. This analysis will result in a recommendation of the suite of variables suitable for retention by the LTEM Program, and possible expansion to other watersheds. This analysis will also consider whether Rock Creek is a viable long-term study site.

6. **Address issues related to scale.** ABSC will evaluate whether protocols developed as part of the Rock Creek watershed effort are appropriate for use at larger scales or whether different approaches are needed. Vegetation, water resources (both biotic and abiotic variables) and meteorology will be used as prototypes for upscaling, modifying, or enhancing existing protocols to landscape-level application.

7. **Address issues related to stressors and critical park resources.** ABSC will provide the functional relationship data needed to implement the "stressor" elements of the desired LTEM Program. ABSC will also look at developing linkages between watershed data and critical park resources, such as population characteristics of key wildlife species.

Transition and Implementation of the LTEM Program

The National Park Service has primary responsibility for carrying out long-term monitoring activities. Documents detailing program operations will include the Denali Resource Management Plan, LTEM Program Operations Plan, Information Management Plan, annual Work Plans and Protocol Handbooks. With the goal of completing the transition phase and entering full program operations by the end of 2000, the National Park Service will focus its efforts on the following:

1. **Implement monitoring activities.** Field operations for protocols already peer reviewed will occur while USGS-BRD completes an evaluation of their power and cost effectiveness. Established long-term wildlife monitoring operations will also continue. The NPS will provide operational funds for these activities.

2. **Integrate monitoring activities.** LTEM Program operations will be fully incorporated into the organizational structure and daily functioning of the Research and Resource Preservation Division. Biological Science, Physical Science and Information Management Branch Chiefs will supervise the professional and technical staff who carry out field activities, manage data, and generate regular reports. Annual work plans will identify program goals which comply with the Government Performance and Results Act.

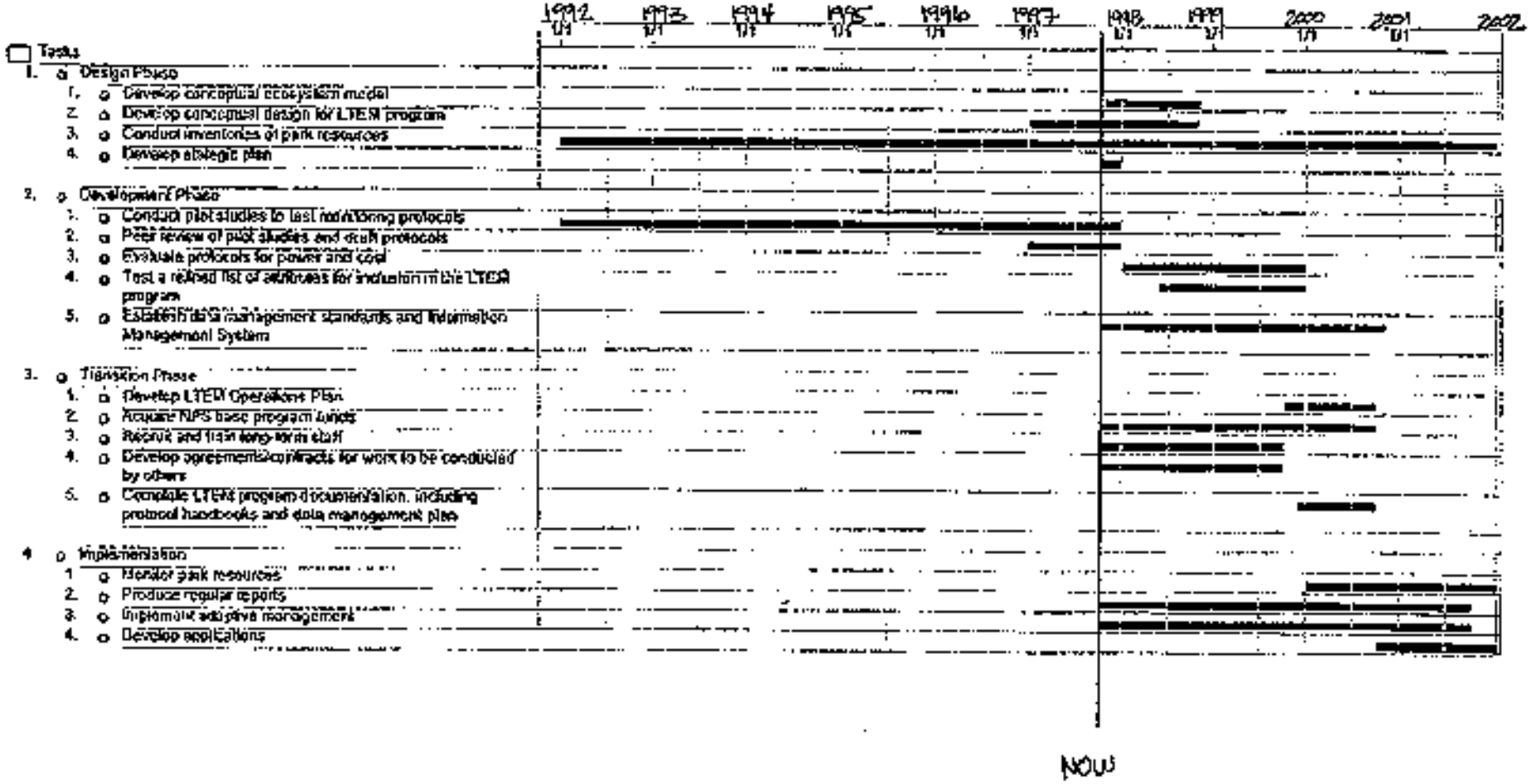
3. **Recruit employees for critical positions.** The RRP Division staffing plan identifies positions that are critical to sustain the continuity and consistency of the program. A permanent full-time employee will coordinate all LTEM activities. Key positions will be filled with permanent professional staff to provide continuous guidance over the long-term and interpret information gained through monitoring operations. Permanent technical staff, supplemented by seasonal technicians, will carry out field activities.

4. **Solicit scientific support.** Denali staff will continue to develop close ties with scientists who have a strong personal and professional commitment to long-term monitoring in general, and to the Denali program in particular. Whenever possible, the NPS will support investigators whose research efforts contribute directly to program development or implementation.

5. **Build funding partnerships.** The NPS will actively seek opportunities to leverage funds with academic institutions and other agencies, and will encourage strong relationships with potential cooperators.

Transition from a development phase to a fully operational phase will require several years of lead time to recruit and fill positions, train personnel, hand off program responsibilities, and develop the infrastructure needed to support the program. Dedicated funding is essential to ensure a successful transition. In anticipation of this need, the Denali staff submitted a proposal in 1996 to the Servicewide Inventory and Monitoring Program to revise our estimates of the funding and staff required to implement the LTEM Program.

Major Steps for Development of the Long-term Ecological Monitoring Program at Denali National Park & Preserve, 1992-2002



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APPENDIX A.

Significant Natural Resources of Denali National Park and Preserve

Denali National Park and Preserve was created in 1980 with passage of the Alaska National Interest Lands Conservation Act (ANILCA). This Act enlarged Mount McKinley National Park, originally established in 1917, from 2.1 million to 4.6 million acres and added 1.3 million acres of preserve lands where sport hunting and trapping are allowed. ANILCA also established a subsistence harvest priority on the new park and preserve lands and designated the core of the park as wilderness. Congress mandated that Denali National Park and Preserve be managed to:

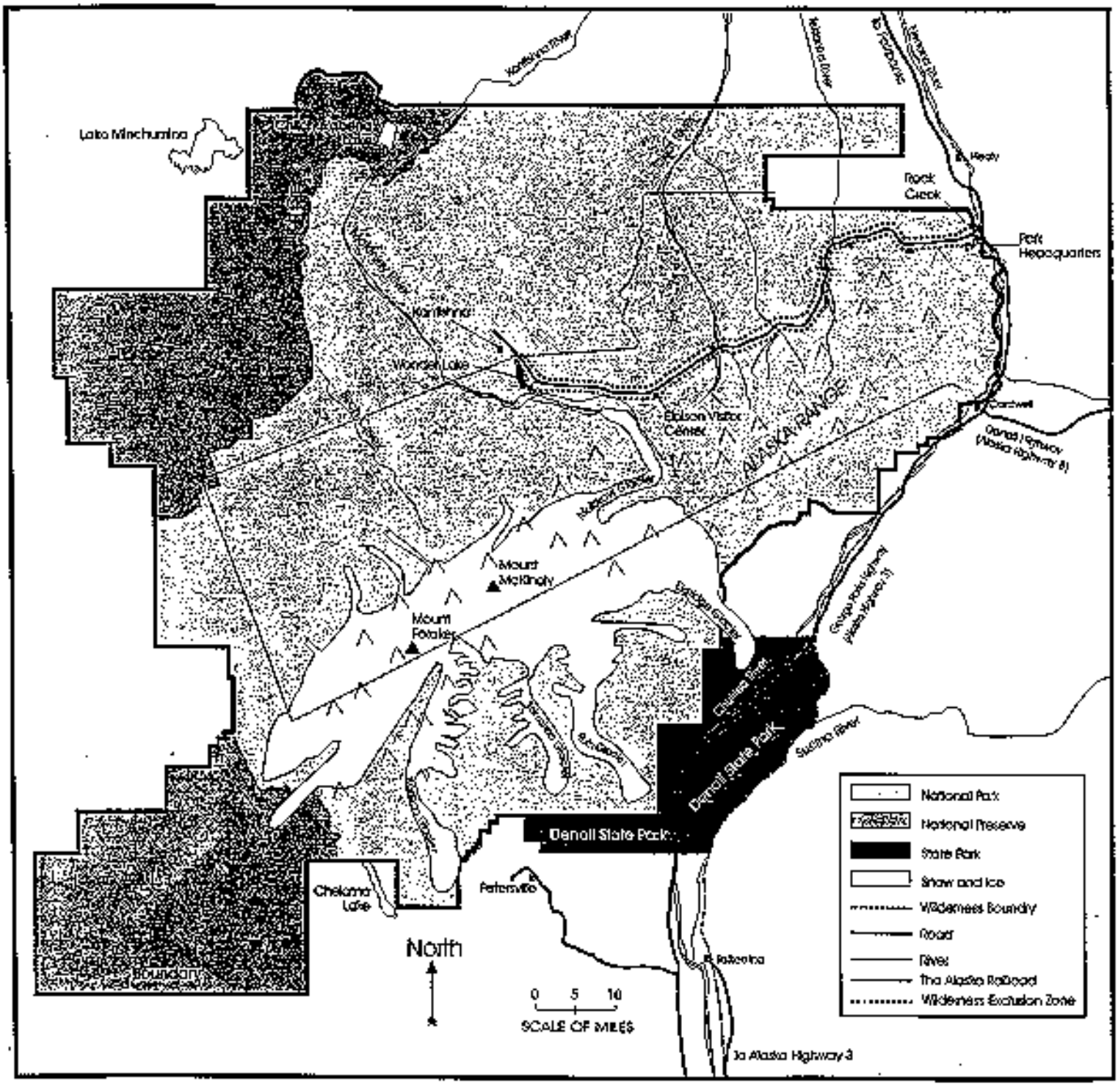
- protect and interpret the entire mountain massif, and additional scenic mountain peaks and formations;
- protect habitat for, and populations of fish and wildlife including, but not limited to, brown/grizzly bears, moose, caribou, Dall sheep, wolves, swans and other waterfowl;
- provide continued opportunities....for mountain climbing, mountaineering and other wilderness recreational activities (ANILCA, sec. 202 (3)(1)).

Denali National Park and Preserve provides a unique opportunity for the study of ecosystem dynamics in an undisturbed subarctic landscape. The Alaska Range separates the maritime climate of coastal Alaska from the continental climate of interior Alaska. Denali's glaciers, soils and plant communities reflect both climate regimes.

The park contains complex and diverse geological features, including Mount McKinley, the highest mountain on the North American continent, and vast glacial landforms. The sheer ice-covered peaks of the Alaska Range and its flanking foothills form the backdrop for a diverse landscape of river valleys, extensive outwash plains and lowlands. These, in turn, support a mosaic of wetland, tundra and boreal forest habitats. A full complement of historically present wildlife interact with the environment and with each other in this near pristine landscape.

The park is a significant Class I air quality area, which is the most protected category under the Clean Air Act. Its pure air allows internationally acclaimed vistas largely unobscured by the haze of industrialization.

The Denali Wilderness, the largest continuously protected area in the world, provides premier recreation opportunities while offering easy access relative to other areas of Alaska.



PARK/REGION

Denali National Park and Preserve

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APPENDIX B.

History and Status of LTEM Program at Denali National Park and Preserve 1992-1997

Original Program Design: The Watershed Approach

Program design and protocol development began in 1992. Since 1994, the NPS and the USGS-BRD (nee NBS) have worked together to develop the program. The original proposal called for an ecosystems approach and a watershed sampling strategy. The main premise is that techniques to monitor basic resource attributes in one watershed can be replicated in other watersheds to characterize ecosystem components in large parks. The conceptual model includes principles of the hydrological cycle, hypotheses of global climate change, and biological interactions of organisms occupying intermediate positions in Alaska food webs (Thorsteinson and Taylor, 1997).

Rock Creek, a small headwater stream in the eastern end of the park, has been the main study area. Principal investigators have tested methodologies to measure a suite of physical, chemical and biological attributes in four habitats characteristic of Denali. We selected communities for study based on prevalent vegetation from lowest to highest elevation within the watershed. The structure and dynamics of plant and aquatic communities, and corresponding water and soil characteristics, are monitored at a series of permanent plots. Co-location of plots with weather stations, small mammal productivity grids, and bird productivity stations will allow comparisons of information gained through multiple disciplines.

Early results demonstrated that Rock Creek watershed is not a suitable site to apply standard techniques for bird point counts, benthic macroinvertebrates, and the Monitoring Avian Productivity and Survivorship (MAPS) Program. We moved field testing for these attributes out of the Rock Creek watershed and tested these protocols at a larger spatial scale. Since Rock Creek is an unglaciated watershed, development of glacier monitoring protocols also occurred at other locations in the park. Unlike most other attributes included in the LTEM Program, the glacier monitoring strategy incorporates multiple spatial scales from the outset.

Program Review

In 1995, an interdisciplinary review team composed of managers and scientists from the NPS and the former National Biological Service evaluated the Denali LTEM Program. The team recommended that the program develop stronger leadership, build a better conceptual framework, address issues of spatial scale beyond Rock Creek watershed, and forge links between the monitoring program, management needs and potential applications. Since 1995, scientists and managers have worked together to help correct the problems noted by the review team. Two workshops were held in 1996 that drew on the expertise of scientists from multiple agencies and institutions. The workshops clarified program goals and objectives, and

identified key Denali resources and the major threats to them. This strategic plan helps address the review team's call for a better description of the goals and objectives of the monitoring program.

Network Participation

The park participates in several national monitoring networks, which are now incorporated into the LTEM Program. The Air Quality Monitoring Network (NPS-Air Resources Division), Headquarters Weather Station (National Weather Service) and Snow Survey Network (National Resource Conservation Service) predate the LTEM Program. We have developed protocols which incorporate the standard operating procedures from these networks.

Denali's participation in monitoring networks and its status as a monitoring program prototype are already paying off in the national arena. In 1996, the Environmental Protection Agency selected Denali to participate in its Demonstration Index Site Project (DISPro), a component of the Environmental Monitoring and Assessment Program (EMAP). DISPro investigates the ecological effects of environmental stressors using a network of intensively monitored index sites in national parks. Current DISPro efforts will enhance the park's air quality monitoring capabilities to include UV-B and dry deposition.

Monitoring Attributes and Protocols

So far, the LTEM Program has produced protocols to monitor nine attributes: hydrology and water chemistry, stream invertebrates, soils, vegetation, land birds, small mammals, air quality, glaciers, and weather. While USGS-BRD coordinated peer reviews for these protocols in 1997, NPS staff and contractors implemented most of them with Servicewide Inventory and Monitoring funds.

The NPS also produced a Data Management Protocol and established a Geographic Information System. Principal investigators have been responsible for managing the data specific to their study. In 1997, NPS staff started a data inventory to determine the location and status of LTEM data. We also verified and validated the data that has been produced by the vegetation, water chemistry and hydrology monitoring studies.

Over the years, a number of research and monitoring studies have evolved to address specific management issues. Many began as short term tactical projects to investigate the status of wildlife species of special public interest. The monitoring components of on-going studies of caribou population dynamics, predator-prey relationships, and golden eagle reproductive success have been operational longer than most other activities under the LTEM Program. We also monitor moose and Dall sheep populations. Various funding sources, including NPS and USGS-BRD base funds, support these activities. While standard methodologies exist to measure these attributes, protocols still need to be written.

Some progress has been made in identifying and quantifying stressors themselves. The air quality network tracks the magnitude and timing of contaminants deposition. A three-year

water quality inventory throughout the park, completed in 1996, provides information on the background levels of aquatic nutrients, ions, metals, and water-borne contaminants. Daily monitoring and mapping of wildland fires helps quantify the role of fire as an intrinsic stressor on vegetation communities, air resources and other ecosystem components.

Table 1 shows the current status of monitoring activities associated with the LTEM Program, regardless of funding source. The table includes only those attributes for which some protocol development or implementation activities are occurring. Italicized entries indicate network affiliations. Phase refers to the stage of development or implementation of a particular monitoring activity. In many cases, field operations are on-going concurrent with final development work on some aspect of a particular protocol. For example, NPS has implemented vegetation monitoring at Rock Creek while USGS-BRD prepares to complete power analysis of the data, and determine costs and strategies to expand the technique's spatial scale. This stage is referred to as transitional.

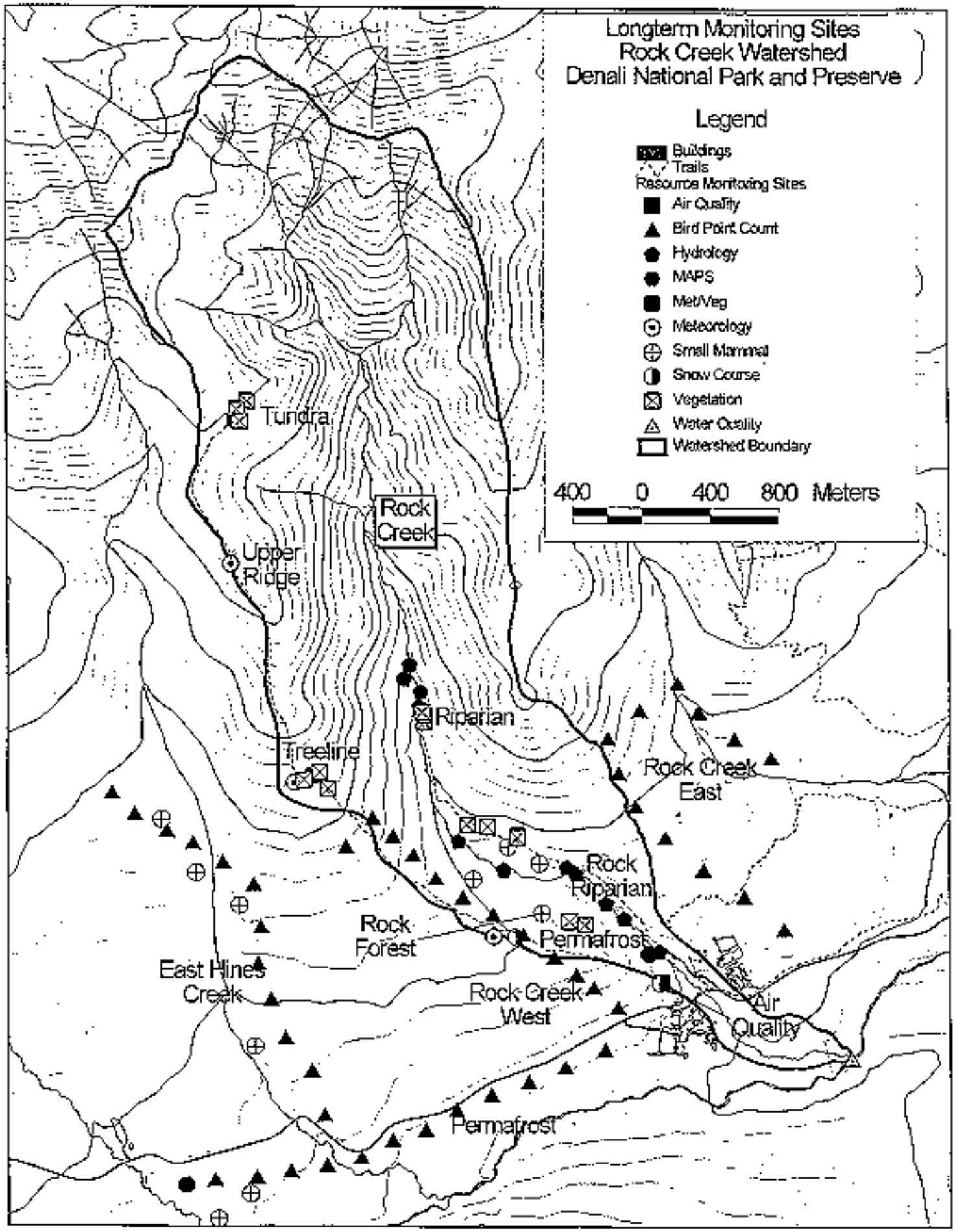
Table 1. 1997 Status of LTEM Program Components

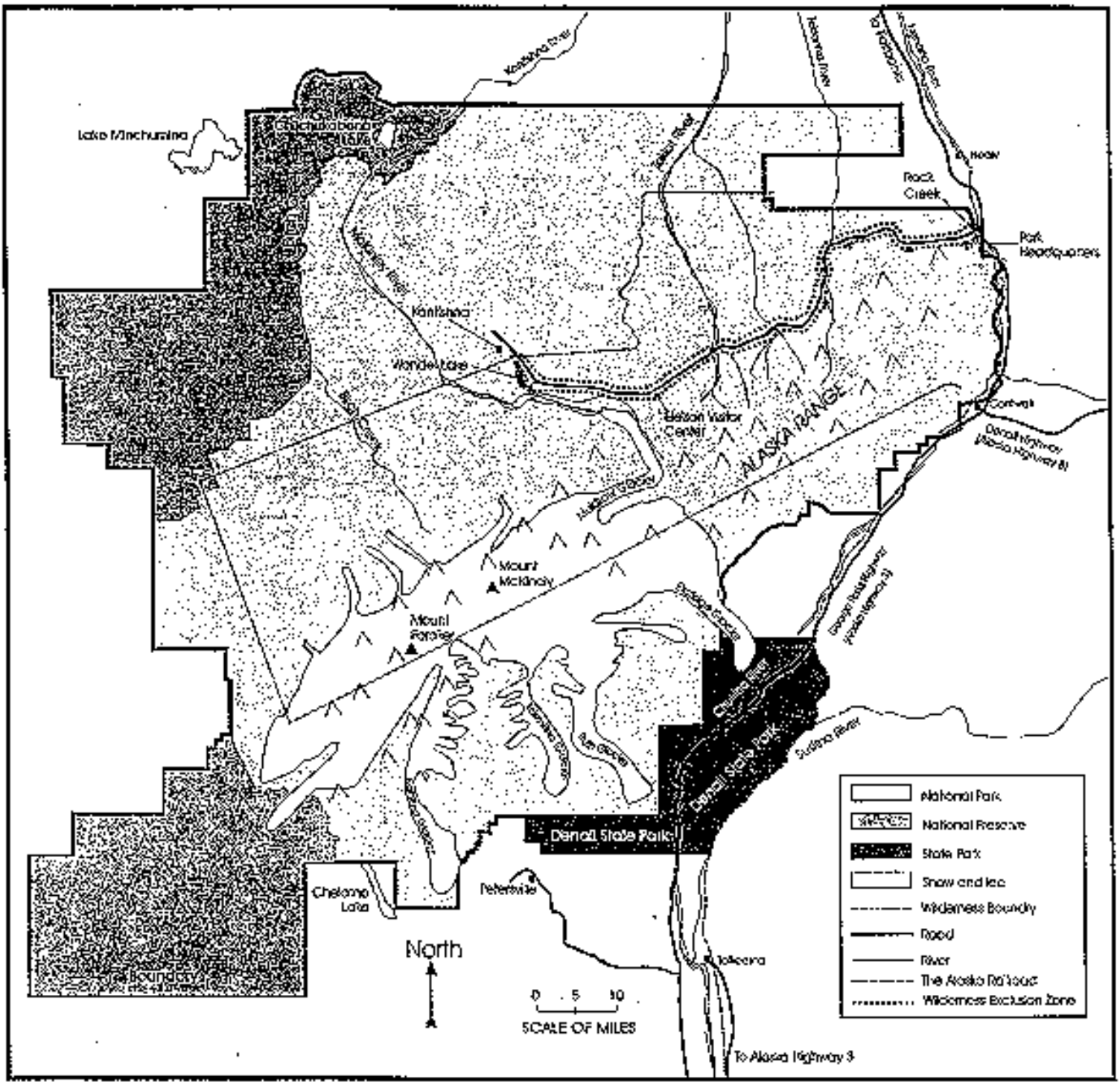
RESOURCE ATTRIBUTE	START DATE	PHASE	PROTOCOL STATUS	FINAL PROTOCOL[A]
Meteorology				
Micro-Met. Network	1993	Transition	Peer Reviewed Draft[L]	1999
Meso-Met. Network	1992	Transition	Peer Reviewed Draft[L]	1999
National Weather Service	*1925*	*Operational*	*Network Handbook*[I]	*1998*
Meteorological Network	1985	Operational	Network Handbook[I]	1998
Snow Course Surveys	*1991*	*Operational*	*Network Handbook*[I]	*1998*
Air Resources Networks			*Peer Reviewed Draft*[I]	
Wet Deposition (NADP[2])	*1980*	*Operational*	*Network Handbook*[I]	*1998*
Particulates (IMPROVE[3])	*1986*	*Operational*	*Network Handbook*[I]	*1998*
Ozone	*1987*	*Operational*	*Network Handbook*[I]	*1998*
Dry Deposition (NDDN[4])	*1997*	*Transition*	*Network Handbook*	*1998*
UV-B	*1997*	*Transition*	*Network Handbook*	*1998*
Water Resources				
Water Chemistry/Hydrology	1992	Transition	Peer Reviewed Draft	1999
Benthic Macroinvertebrates	1992	Development	Peer Reviewed Draft	2000
Soils				
Soils Inventory	1992	Operational	Not Applicable	NA
Soils Processes	1993	Development	Draft in Progress	2000
Soils/Water Interactions	1994	Development	Draft in Progress	2000
Glaciers				
Benchmark Network	1996	Transition	Peer Reviewed Draft	1998
Secondary Network	1991	Development	Draft in Progress	2000
Wildland Fire				
Fire Mapping	1982	Operational	Not Applicable	NA
Vegetation				
Plant Communities	1992	Transition	Peer Reviewed Draft	1999

Table 1 Continued.

RESOURCE ATTRIBUTE	START DATE	PHASE	PROTOCOL STATUS	FINAL PROTOCOL[A]
Land Birds				
Productivity and Survival[5]	*1992*	*Transition*	*Peer Reviewed Draft*	*1999*
Point Count Surveys	1992	Transition	Peer Reviewed Draft	1999
Breeding Bird Surveys	*1984*	*Operational*	*USFWS Protocol*	*1998*
Raptors				
Golden Eagles	1981	Transition	None	1999
Merlin	1983	Transition	Draft	1998
Small Mammals				
Microtines	1992	Transition	Peer Reviewed Draft	1999
Ungulates				
Caribou	1976[6]	Operational	None	1998
Moose	1976[6]	Transition	None	2000
Dall Sheep	1974[6]	Transition	None	2000
Large Carnivores				
Wolves	1970[6]	Operational	None	1998
Bears	1990[6]	Development	None	1999

[A]Dates listed represent approximate year of protocol finalization. Assessment during preceding years may remove the attribute from the program or add other attributes.
[1]Peer reviewed drafts for overall network include standard handbooks
[2]National Atmospheric Deposition Program
[3]Interagency Monitoring of Protected Visual Environments
[4]National Dry Deposition Network
[5]Monitoring Avian Productivity and Survivorship (MAPS)
[6]Starting dates for consistent monitoring efforts; surveys at irregular intervals or surveys using different methods were carried out prior to these starting dates


Longterm Monitoring Sites
Rock Creek Watershed
Denali National Park and Preserve
Legend
Buildings
Trails
Resource Monitoring Sites
Air Quality
Bird Point Count
Hydrology
MAPS
Met/Veg
Meteorology
Small Mammal
Snow Course
Vegetation
Water Quality
Watershed Boundary
400 0 400 800 Meters
Tundra
Rock Creek
Upper Ridge
Riparian
Treeline
Rock Creek East
Rock Riparian
Rock Forest
Permafrost
East Hines Creek
Rock Creek West
Air Quality
Permafrost



Location in Alaska

PARK/REGION

Denali National Park and Preserve

U.S. Department of the Interior • National Park Service