Study Plan

Development of a Prototype Long-term Ecological Monitoring Program at Denali National Park and Preserve, Alaska

SIS Project#: 5001243

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Executive Summary

This study plan provides an overview of an ongoing research program (SIS# 5001243) of the USGS-Biological Resources Division (BRD), Alaska Biological Science Center, to work with Denali National Park and Preserve to develop a long-term ecological monitoring (LTEM) program.

- This research program, started in 1992, is being developed as a **prototype** for national parks in the subarctic, and is supported by annual funding from a national USGS-BRD *Inventory and Monitoring* program.

- The primary goal of this research effort is to develop a LTEM program that is **ecologically relevant, statistically sound, cost-effective, and relevant to park management concerns**. Because the program is being developed as a prototype, our secondary goal is to pass on lessons learned and contribute to the general knowledge of monitoring program development.

- This study plan sets forth the specific research objectives to be achieved in the FY 98-00 period, focusing on FY 99. This plan provides an explanation of the **budget request for FY 99 of $203.9K**.

- Research in FY 99 will focus on activities that will **help Denali develop measurable objectives related to the broad goals** of the LTEM program. The lack of measurable objectives has confounded development of the program and is the highest priority activity for this year.

- The other research activities that will be undertaken in FY 99 are activities that will further the development of the Denali LTEM program and which make sense to pursue, while measurable objectives are being defined. These activities include:

    1. Continuation of the **development and review process for protocols**, focusing on vegetation, aquatic invertebrates and small mammals.

    2. Continuation of the effort to **integrate data from the LTEM program**.

    3. Development of **basic cost-benefit information** to be incorporated in the program design process;

    4. Continuation of our **evaluation of the existing monitoring effort**.

    5. **Improve internal and external communications** about the LTEM program through development of a web page.

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Introduction

In 1992, the National Park Service (NPS) began to develop prototype long-term ecological monitoring (LTEM) programs in selected parks representing major biogeographic regions within the United States. Denali National Park and Preserve, Alaska, one of the first four parks in the program, was chosen as the testing ground for Alaska parks. Alaska has 23 national parks, covering 21.5 million ha. These parks represent 66% of the total land base of the U.S. National Park system. Thus, lessons learned developing the Denali LTEM program will influence how monitoring is done over a significant proportion of U.S. park lands. Like Denali (2.4 million ha), the Alaska parks encompass vast, roadless areas, and access is a major constraint on park management, including monitoring.

The National Park Service and U.S. Geological Survey, Biological Resources Division (BRD), working as partners, are developing the Denali LTEM program. Scientists from the University of Alaska Fairbanks and ornithologists with two nonprofit organizations, the Alaska Bird Observatory and the Institute for Bird Populations, are also involved. The Denali LTEM program currently includes monitoring of a broad array of attributes, including air and water quality, meteorology, soils, glaciers, fire, and bird (passerine and raptors) and mammal populations. A major aspect of the monitoring program has involved the use of a watershed approach to organize study effort for a mix of abiotic and biotic attributes within a single watershed, Rock Creek (Thorsteinson and Taylor 1997). The linking of intensive studies within a watershed is expected to yield information about ecosystem relationships, a primary goal of the Denali LTEM program. The Rock Creek studies include collection of the typical data sets associated with watershed studies (e.g., atmospheric deposition, water chemistry), but also include collection of data on small mammal and bird populations.

A 1995 review of the Denali LTEM was critical of the program, particularly of the decision to base so much of the monitoring effort in a single watershed. The reviewers recommended the park reconsider their objectives and develop a more appropriate conceptual framework for the program. Park management was also critical of the program, as it had developed up to that point. They were also concerned about the localized nature of the monitoring effort, and because the program neglected critical park resources (such as key wildlife species). In 1996, two workshops focused on identification of anthropogenic and natural stressors to the Denali ecosystem. In 1997, park staff wrote a draft conceptual design document, but the document has yet to be finalized, due in part, to misunderstandings between the park and the BRD about the appropriate conceptual design.

At the beginning of FY 98, the USGS-BRD and Denali National Park and Preserve agreed to continue work to complete development of the LTEM program. The USGS-BRD agreed to a 3-year commitment (FY 98-00) to continue research efforts aimed at getting the program ready for implementation. A joint work plan was written at the beginning of FY 98. The main elements of the FY 98 work plan identified joint efforts with the park to close-out the original protocol development agreements, get data into the data management system, and finalize the conceptual design for the program. The work plan also outlined in broad terms the general elements of the research effort that BRD would lead. The elements to the BRD research program were:

1. **Continued Protocol Development.** To continue research for completion of protocols not yet considered fully operational, specifically soils, aquatic invertebrates, and glaciers.

2. **Rock Creek Watershed Variables Assessment.** To conduct a critical assessment of variables addressed by pilot studies in the Rock Creek watershed for their power to detect changes or trends, cost and importance to understanding underlying ecosystem processes. To recommend the suite of variables suitable for retention by the LTEM program, and possible expansion to other watersheds. To consider whether Rock Creek is a viable long-term study site.

3. **Begin to address Issues related to Scale.** To 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.

4. **Begin to Address Issues related to Stressors and Critical Park Resources**. To provide functional relationship data needed to implement "stressor" elements of the desired LTEM program. To look at linkages between watershed data and critical park resources, such as population characteristics of key wildlife species.

5. **Conceptual Ecosystem Model**. To develop a conceptual ecosystem model for Denali for use by the LTEM program.

6. **Technical Assistance.** To assist in the development of caribou, wolf, moose and merlin monitoring protocols under ABSC's general technical assistance program.

This study plan, being written at the beginning of the second year of this three year effort, further develops and lays out the rationale for the work that is envisioned to be undertaken by the BRD. The original description of work is modified to reflect our current vision of what is needed by the program.

The Denali LTEM program involves the participation of key staff at Denali National Park and Preserve as well as several Principal Investigators and contractors, whose participation is funded by the BRD. (A list of Denali LTEM contacts is provided as Appendix A.) This study plan is therefore an umbrella document which describes the overall program of the BRD with respect to the prototype Denali LTEM program. Study plans for the separate components of the program have been or are being prepared by the Principal Investigators funded by the BRD. As required per USGS-BRD national policy, all study plans will undergo outside peer review. Peer review of this document was coordinated by the ABSC Branch Chief, Eric Knudsen.1 Peer reviews of study plans for the component study plans will be coordinated by the Principal Investigator, Karen Oakley.

1 Peer reviewers were Dr. David Peterson (USGS-Forest and Rangeland Ecosystem Science Center, Seattle, WA), Dr. Steven Fancy (NPS, Fort Collins, CO), Dr. Mark Udevitz (USGS-Alaska Biological Science Center, Anchorage, AK), and Dr. Larry Basch (NPS-Glacier Bay National Park, Gustavus, AK). Their comments are on file at the USGS-Alaska Biological Science Center. This document is the revised study plan that incorporates their comments.

Goals and Objectives for BRD Work Effort

The overall purpose of this study effort is to work with Denali National Park and Preserve to develop a long-term ecological monitoring program as a prototype for national parks in the subarctic. The primary goal of this joint effort is to develop a program that is ecologically relevant, statistically sound, cost-effective, and relevant to park management concerns.

Because the Denali program is being developed as a prototype, we will also consider how the methods developed at Denali could be applied to other parks and develop mechanisms to pass on lessons learned in the course of developing the program. Silsbee and Peterson (1993) defined a process for development of monitoring programs (see their Figure 1, provided as Appendix B). We will use this process as a guideline for the protocol development process at Denali. We will capture what we learn from the process of Denali LTEM program development and suggest modifications or elaborations of the process that can help expand understanding of long-term monitoring. We can already envision several modifications to this process (see revised Figure 1 in Appendix B). In this way, we intend to meet our second goal of passing on lessons learned at Denali.

The following specific objectives are defined for BRD involvement in the Denali LTEM program development process for the FY 98-00 period, focusing on FY 99. All of the original objectives in the FY 98 work plan are retained (in one form or the other), but are reorganized and rephrased. In addition, three new objectives (1, 2, and 3) are defined to address what we view as high priority needs of the program.

1. **Measurable objectives.** Develop methods for the definition, refinement and prioritization of unambiguous and measurable objectives for strategic, long-term ecological monitoring appropriate for Denali and other national parks in the subarctic. Recommend alternative suites of measurable objectives for Denali.

2. **Develop and test methods.** Develop and test appropriate methodologies for meeting the measurable objectives defined for the Denali LTEM program. Work on specific protocols will focus initially in three areas: vegetation, aquatic invertebrates, and small mammals.

3. **Cost-Benefit.** Incorporate cost-benefit considerations into development of the Denali LTEM program.

4. **Integration.** Continue the effort to integrate data from the LTEM program.

5. **Evaluate the existing monitoring effort.** Determine what elements of the existing LTEM effort fit into the new conceptual framework of measurable objectives and make recommendations for what elements to retain, modify or discard.

6. **Improve Communication.** Develop a web site for the Denali LTEM program to improve communication among the program participants, promote

understanding and visibility of the LTEM program, and promote information transfer and data management.

Methods

Measurable Objectives

Broad goals for the Denali LTEM program have been defined[2], but the measurable objectives related to these goals have not been defined or prioritized. This lack of measurable objectives has significantly confounded development of the conceptual design of the program. There is confusion about what measurable objectives are, why they are important, and how such objectives are defined and prioritized.

Monitoring is the repeated collection of data to meet a purpose. For monitoring to be effective, the broad goals of monitoring must be stepped down to measurable objectives. We will make the general observation that going from "goals" to "measurable objectives" is a difficult and often neglected step. We would add a step to the beginning of the monitoring program development process that shows this step between broad goals and measurable objectives (see revised Fig. 1 in Appendix B). We will develop guidance (i.e., a description of what is involved in that step) that can help park service managers in the process of developing measurable objectives for long-term monitoring. The literature concerning "objectives" development, specific to monitoring, will be reviewed and written guidance developed. This guidance will immediately benefit development of the Denali program, and should also have general applicability to a wider audience of natural resource managers in Alaska, and elsewhere.

We will also experiment with various methods of prioritizing objectives, focusing on the use of a modeling technique known as AHP, the Analytical Hierarchy Process (Saaty 1990). AHP can be applied in any decision making situation, and has great potential in natural resource management. Schmoldt et al. (1994) and Peterson et al. (1994) described their use of AHP at Olympic National Park to prioritize resource management projects. Various software packages (e.g., Expert Choice) are available that make it relatively easy to apply the technique. As a first step, we will use Expert Choice to "reverse engineer" the priorities implied by the current monitoring program. As the various building blocks of the revised program become apparent, we will use AHP to assess whether the new program does indeed match the true priorities of park management.

The prioritization of objectives is important because the available dollars for monitoring will never be enough to fund all the monitoring the park would like to do. The cost information to be developed under the cost-benefit objective (see below) will be used in the AHP.

We will also generate alternative suites of measurable objectives for the Denali LTEM program, for the consideration of the park. The alternatives will be selected to demonstrate the trade-offs between different approaches, depending on the intent of the monitoring. We will also make a

[2]These goals are to (1) improve information for park management decisionmaking, (2) improve ecosystem understanding, (3) participate in national and global monitoring networks.

recommendation about the approach we think Denali should take.

One of the larger issues we are trying to address in developing the Denali LTEM program relates to the selection of appropriate scales of both space and time for monitoring. As suggested by Dave Peterson, we will develop a matrix of appropriate scales of measurement and inference for the various LTEM components, as this work on objectives proceeds. Use of the matrix will alert us to disconnects between scales of measurement and inference for the various components so they can be addressed before we have locked in a design.

The activities under this objective should facilitate the process for Denali staff to define and prioritize measurable objectives for their LTEM program. Once this list of objectives is set, they can be incorporated into the existing Strategic Plan document (Denali National Park and Preserve and Alaska Biological Science Center 1997), allowing that document to finalized.

Defining measurable objectives will also be a major step forward to completion of the conceptual design of the program. However, completion of the conceptual design will require work on topics in addition to measurable objectives. The current design document has incomplete treatments of topics such as study design and other statistical issues, quality assurance and quality control, data management and integration. The BRD and NPS will continue to work on completion of this critical document throughout FY 99. [Note: Due to the delay in hiring the Denali LTEM program manager, work on the conceptual design document will not occur until FY 00. Hopefully, the work of the USGS during FY 99 will make that job easier.]

Develop and Test Methods

The primary function that the BRD has with respect to development of monitoring programs of the Department of Interior bureaus is the development and testing of appropriate methodologies for meeting measurable objectives. Until the measurable objectives for the Denali LTEM program have been defined, we will focus our efforts to develop and test methods in three areas: vegetation, aquatic invertebrates and small mammals.

For the aquatic invertebrate protocol, a new cooperative agreement with Dr. Alexander Milner, University of Alaska Fairbanks, was developed in FY 98. Under this agreement, Dr. Milner will continue his work on using stream invertebrates to monitor the biological productivity of streams. The primary objective of the current work is to look at annual variation in benthic invertebrate communities within the main classes of streams in Denali park. Other objectives include evaluating different sampling techniques (e.g., D nets versus Surber samplers) to find the easiest and cheapest method. The FY 99 work for this agreement was pre-funded in FY 98, so no operational funds are requested in the FY 99 budget.

Although the vegetation protocol is considered “operational,” the LTEM vegetation studies have languished without a Principal Investigator in recent years. We therefore established a Cooperative Agreement with the University of Alaska Fairbanks to bring in Dr. Dot Helm as PI for vegetation. Dr. Helm is working with park staff to analyze and report on the existing data and will be preparing an evaluation of the vegetation methods used in Rock Creek. Dr. Helm will also make recommendations about how to modify the vegetation protocol to address changes at broader spatial scales and provide links to other park resources. We have earmarked

$50K to cover her participation and any field work required for testing of methods in FY 99.

The small mammal protocol has been operational for several years, and our main questions concern how the work could be scaled up and whether power and cost issues have been addressed appropriately. Work will continue with Dr. Eric Rexstad at the University of Alaska Fairbanks on these aspects of small mammal monitoring.

Denali park has been developing protocols for detecting changes in populations of key wildlife species, for eventual incorporation into the LTEM program. As these protocols become available, we will assist by coordinating outside peer review and ensuring that the protocols are consistent with the overall standards of the LTEM program.

Cost-Benefit

An important, but often neglected, step in the process of developing monitoring protocols is a consideration of cost. For long-term monitoring programs, cost is an especially important consideration. The chances of the LTEM program continuing for many years will decline if the costs are too high. Factors that can contribute to the perception of high costs include budget crises, changing park leadership, and economic conditions. Thus, an evaluation of the cost effectiveness of implementing a LTEM program is an important part of the development process. One of the final steps in the procedure defined by Silsbee and Peterson (1993) is to determine whether the cost-per-unit of precision and power is acceptable (see Appendix B). To undertake this analysis, basic cost information is necessary. To allow comparison of costs of various elements that might be included in a monitoring program, costs need to be determined in a consistent manner among program elements. To date, cost has not been explicitly considered or evaluated in development of the Denali LTEM program. For most of the Denali protocols, pilot study data have been collected, so data on variation (needed for power calculations) are available, and realistic costs can be determined based on actual experience.

We will work with the Social, Economic, and Institutional Analysis Section (SEIAS) of the Midcontinent Ecological Science Center (MESC) of the BRD to incorporate cost-benefit considerations into the development of the Denali LTEM program. SEIAS is uniquely suited to describe and evaluate the costs of the LTEM protocols. The SEIAS has expertise in economic valuation, decision making, and policy analysis. In particular, evaluation of this type is in the province of economics. The SEIAS employs the only research economists in the BRD. The ABSC will transfer $30K to the MESC for this work.

Integration

The Denali LTEM program has always been defined as an “integrated” watershed approach (Thorsteinson and Taylor 1997). However, no mechanisms are in place for the integration of data sets, and all reporting from the program has thus far been by discrete program elements (e.g., birds, mammals, stream water quality). In FY 98, Research Work Order #81 with the Alaska Cooperative Fish and Wildlife Unit at the University of Alaska Fairbanks was established to work with Dr. Eric Rexstad to begin the process of data integration for the Denali LTEM program. Ed Debevec, a Research Analyst, was hired to take the lead on the integration effort. The purpose of this effort is to use the data collected by the LTEM program to produce an annual

assessment of ecosystem health that can be presented in a timely fashion to park managers, in a format that is easily understood. This integration is expected to prompt the completion of needed data management activities (obviously necessary before the data can be used), and to produce an understanding of "how" integration can best be achieved by a multi-disciplinary program like this. The majority of the FY 99 funds needed for RWO#81 were transferred in FY 98. The $21K requested in FY 98 is the balance needed to fulfill the FY 99 obligation.

Evaluate the Existing Monitoring Effort

Ultimately, we will determine what elements of the existing LTEM effort fit into the new conceptual framework/measurable objectives and make recommendations for what elements to retain, modify or discard. This evaluation will focus on the Rock Creek watershed studies, but will also include the existing monitoring efforts outside of Rock Creek (MAPS, bird point counts, glaciers). Although the final evaluation cannot occur until the measurable objectives have been defined, the cost-benefit and integration elements of this work plan will be collecting information needed for this review process. Thus, work on this objective, leading to recommendations about the monitoring program, will continue throughout the remainder of this phase of work.

Improve Communications

We will develop a "temporary" web site for the Denali LTEM development program to improve internal and external communications. The web site should improve understanding and visibility of the program and promote data management. Currently, there is a lack of understanding of what the Denali LTEM program is doing and what data are being produced. The lack of readily available information about the program contributes to the poor regard in which the program is generally held. We will attack this problem by developing a web site to explain the main components of the program and show and serve the data sets as they become available from the Principal Investigators. We feel this is an immediate need that should not wait until the park's official web page for the LTEM program is up and running. We do not propose to be the permanent server of information about the program, but rather to help get some of the building blocks together that can be easily transferred to the park's web site once the park has staff to devote to the task. The web site will be utilitarian, focusing initially on serving general information about the program and frequently requested data sets, such as the National Weather Service records from park headquarters, which date back to the 1920s.

This objective will require the cooperation of the PIs in contributing data sets, metadata, photographs, and descriptions of their work. Existing agreements with all PIs require the timely production of data and metadata. We will use a contractor (WEST, Inc.) to conduct intermediate steps in data management related to database design, quality assurance and quality control, and metadata documentation. We will hire a MIS student (GS-3 Computer Clerk) to work under the supervision of the Alaska Biological Science Center IRM Manager to build the web pages. We will work closely with the Public Information Officer of Denali National Park and Preserve, and the LTEM Data Manager, to ensure that the resulting web pages are consistent with NPS standards and to facilitate a seamless transfer to the park.

Budget

For FY 99, we are requesting a total budget of **$203.9K** to support BRD operations relative to the Denali LTEM program. The breakdown of the proposed budget is as follows:

Salaries (temporary)

GS-3 (.5 FTE) Computer Clerk (web page)	8.4[3]
GS-9 (.5 FTE) Botanist (vegetation)	20.0[4]

Contracts

Dr. Eric Rexstad (integration)	56.0[5]
Dr. Dot Helm (vegetation)	50.0[6]
Dr. Sandy Milner (stream invertebrates)	0.0[7]
WEST, Inc. (statistics)	25.0[8]
Midcontinent Ecological Science Center (cost)	30.0[9]

3. This position will work on developing the Denali LTEM web site. The position will be filled by a University of Alaska Anchorage MIS (Management Information Systems) student, working half-time, starting in January 1999. Costs are estimated at GS-3, 20-hours a pay period, 20 pay periods.

4. This position is currently filled by Carl Roland and is located at Denali National Park and Preserve. This position is responsible for collection of vegetation data for the LTEM program during the field season and that half of the position is funded by NPS. To establish some continuity in the vegetation component of the program and to ensure that data collected during the previous 6 years are analyzed, BRD is funding half of the position for FY 99. (The funds will be transferred to the park through an existing interagency agreement.) The BRD-funded PI for vegetation (Dr. Dot Helm) would have hired someone to analyze the prior data to meet the objectives of her cooperative agreement with BRD. Funding the LTEM botanist at Denali to conduct this work was cost-effective and considered beneficial to the development of the program as a whole by providing some continuity for the vegetation study.

5. Research Work Order #81 with Dr. Eric Rexstad at the University of Alaska Fairbanks, Alaska Fish and Wildlife Cooperative Research Unit, was established in FY 98, to continue small mammal sampling, to develop options for sampling small mammals at larger spatial scales, and to lead the effort to integrate data from the LTEM program. Ed Debevec, a Research Analyst, has been hired to work on the integration effort. Most of the FY 99 budget for the RWO #81was pre-funded in FY 98.

6. A Cooperative Agreement with Dr. Dot Helm, University of Alaska Fairbanks, was established in FY 98 to evaluate the existing vegetation protocol for Denali LTEM and make recommendations. Dr. Helm will be submitting a study plan for FY 99 field work in the spring. The requested $50K will cover her continued participation and any field testing of new vegetation protocols in FY 99.

7. A Cooperative Agreement with Dr. Sandy Milner, University of Alaska Fairbanks, was established in FY 98 to continue development of an aquatic biomonitoring protocol for Denali LTEM. The FY 99 work was pre-funded in FY 98, thus no additional funds are requested in FY 99.

8. WEST, Inc. is a consulting firm specializing in statistical reviews, data management and other biological research services. WEST, Inc. will provide statistical reviews of all Denali LTEM-related study plans and protocols.

9. The Social, Economic, and Institutional Analysis Section (SEIAS) of the Midcontinent Ecological Science Center (MESC) of the USGS-BRD will describe and evaluate the costs of the Denali LTEM program, leading to development of methods for incorporating cost analysis into the development of monitoring protocols. The majority of the work will be performed by Lynne Caughlan, an economist with the SEIAS.

Data entry (bibliography)	2.5[10]
Travel	
International conference	2.5[11]
Denali (8 person-trips)	4.0[12]
Fairbanks (2 trips)	.5[13]
Fort Collins (1 trip)	2.5[14]
Equipment	
Computer	2.5[15]
TOTAL	**203.9**

10. A small contract will be issued to speed the process of entering monitoring references into a bibliographic database. This database will be served on the web site.

11. Travel to the North American Science Symposium: Towards a Unified Framework for Inventorying and Monitoring Forest Ecosystem Resources in Guadalajara, Mexico, November 1-6, 1998, to present a paper.

12. Budgeting for 8 person-trips to Denali for the ABSC Principal Investigator, Branch Chief, and other BRD staff, to confer with park staff.

13. Budgeting for 2 trips to Fairbanks for the ABSC Principal Investigator, to confer with PIs at UAF.

14. Budgeting for 1 trip to the Fort Collins, Colorado, area to confer with staff at the Midcontinent Ecological Science Center ,WEST, Inc., NPS national program staff, or staff at Colorado State University.

15. New computer for ABSC Principal Investigator, so the old one can be passed on to the Computer Clerk for web site development.

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Appendix A

Denali National Park & Preserve
Long-term Ecological Monitoring Program

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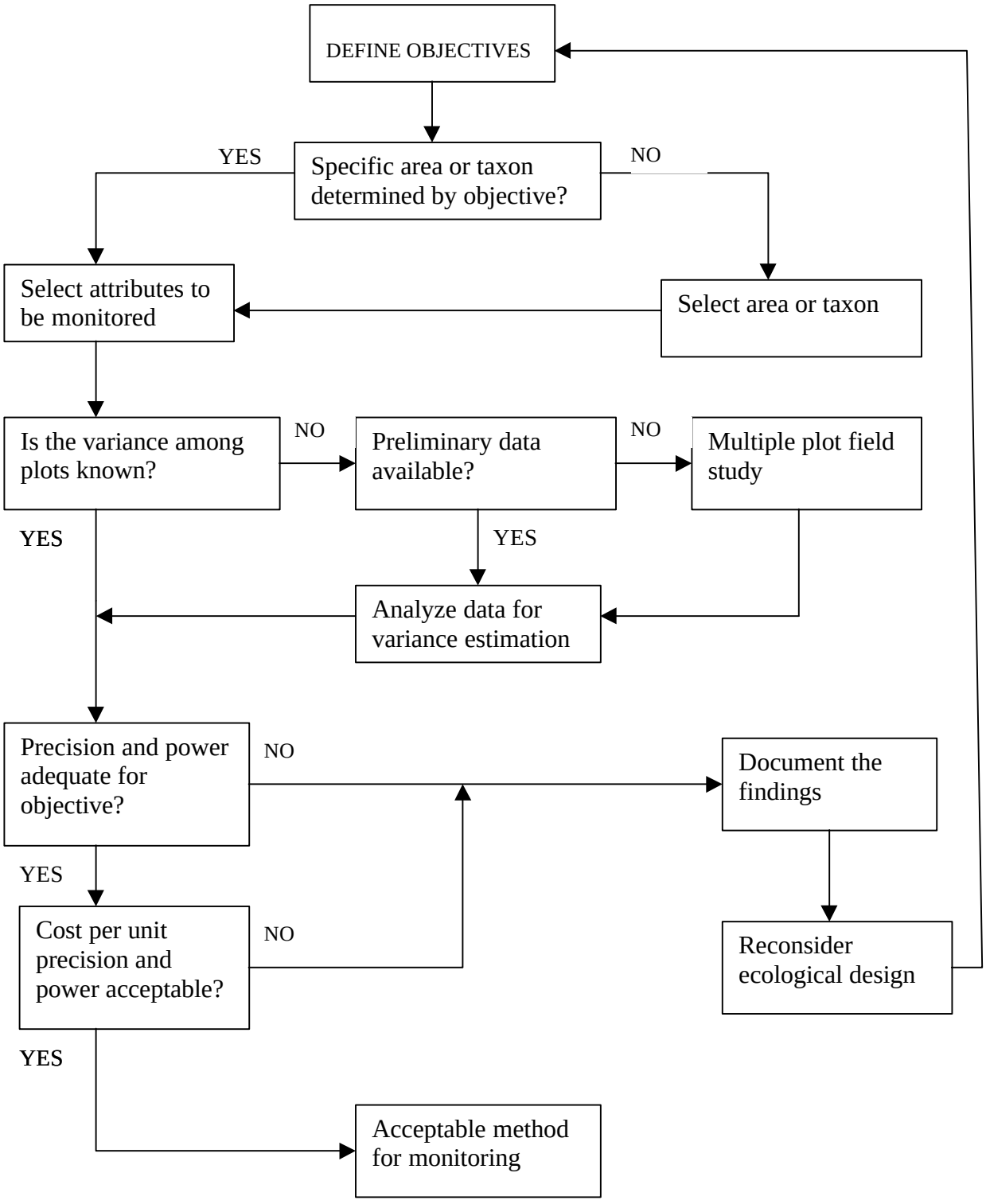
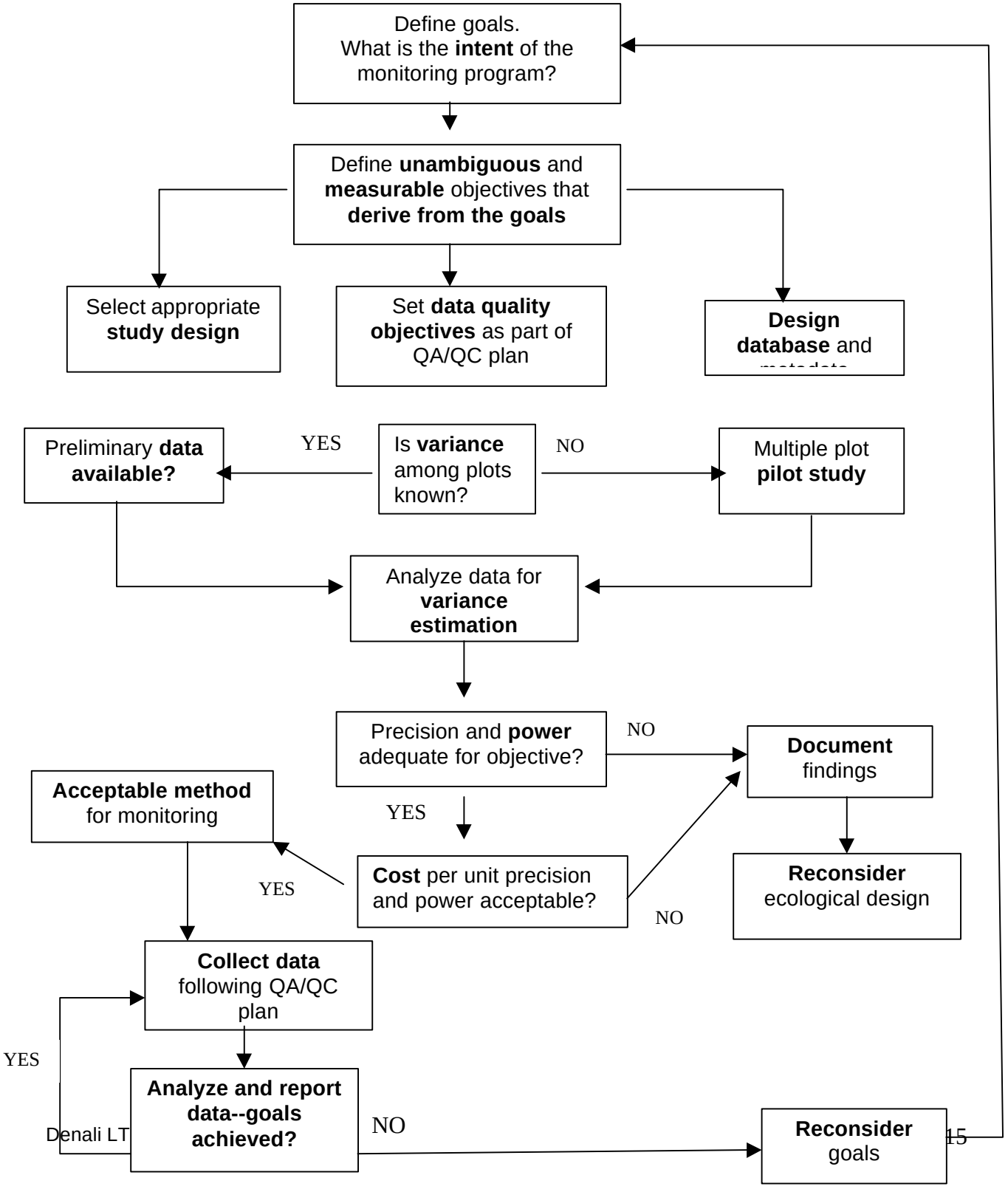
Appendix B

Figure 1 from Silsbee and Peterson (1993).



Appendix B continued

Suggested framework of an adaptive monitoring program, incorporating additional steps related to the definition of goals and measurable objectives, data management, and quality assurance/quality control. Original framework from Silsbee and Peterson (1993) and Hinds (1984). Modifications incorporate concepts from various authors (see list following pages).



Selected references incorporated in "suggested framework for an adaptive monitoring program"[16]

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Study Design and General Statistical Issues

see Overton and Stehman (1995), Rose and Smith (1992) and Soballe (1998), above. Also,

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[16]The framework and associated list of references is not complete. I am continuing to develop it as my understanding of the ecological monitoring literature grows, and with experience at Denali. Presenting this framework in this study plan is intended to show how general knowledge of monitoring program development processes gained through our work at Denali will be captured. Also, although the references are listed here under separate "headings," there are important relationships between goals, objectives, study design, quality assurance/quality control and data management. These relationships will eventually be expanded upon in a written companion to the "framework."

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Power Analysis

(A mere sampling of the voluminous literature on this topic . . .)

Fairweather, P.G. 1991. Statistical power and design requirements for environmental monitoring. Australian Journal of Marine and Freshwater Research 42:555-567.

Gerrodette, T. 1987. A power analysis for detecting trends. Ecology 68(5):1364-1372.

Green, R.H. 1989. Power analysis and practical strategies for environmental monitoring. Environmental Research 50:195-205.

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Osenberg, C.W., R.J. Schmitt, S.J. Holbrook, K.E. Abu-Saba, and A.R. Flegal. 1994. Detection of environmental impacts: natural variability, effect size, and power analysis. Ecological Applications 4(1):16-30.

Steidl, R.J., J.P. Hayes, and E. Schauber. 1997. Statistical power analysis in wildlife research. Journal of Wildlife Management 61:270-279.

See also the following web pages:
http://www.mp1-pwrc.usgs.gov/powcase/primer.html
http://www.mp2-pwrc.usgs.gov/ampCV/powcase/powrefs.cfm

Quality Assurance and Quality Control

ANSI/ASQC (American National Standards Institute/American Society for Quality Control). 1994. American National Standard. Specifications and guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs. ANSI/ASQC E4-1994. American Society for Quality Control, Milwaukee, WI.

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Appendix C

Deliverables, Due Dates, and Status

For existing contract work funded by USGS-BRD related to development of the Denali Long-term Ecological Monitoring Program (contracts put in place during FY 98) Updated July 9, 1999.

Product	Responsible Party	Status
September 30, 1998		
Preliminary statistical evaluation of Denali LTEM program.	Lyman McDonald, Trent McDonald	Completed.
Cost-benefit issues and use of AHP in design of Denali LTEM program	Dana Hoag	Completed.
October 30, 1998		
Data and metadata for 1992-1997 small mammal field work	Eric Rexstad	Recieved.
December 15, 1998		
Annual report on FY98 activities suitable for NPS annual administrative report, data, and updated metadata for small mammals.	Eric Rexstad	Recieved.
Annual report on FY98 activities suitable for NPS annual administrative report for vegetation.	Dot Helm (in conjunction with Carl Roland).	Received.
December 31, 1998		
Study Plan for future stream invertebrate work	Sandy Milner	Received.
Annual report on FY98 activities suitable for NPS annual administrative report	Sandy Milner	Received.
Data and metadata for prior stream invertebrate work	Sandy Milner	Received.
Final report (Thesis) on terrestrial-aquatic interface	Chien-lu Ping (Lisa Popovics)	Draft received

Data and metadata for terrestrial-aquatic interface	Chien-lu Ping (Lisa Popovics)	
January 15, 1999		
Draft study plan for geographic extension of small mammal sampling to additional watersheds	Eric Rexstad	Received
February 15, 1999		
Draft study plan for synthesis and integration work, including list of proposed manuscripts.	Eric Rexstad	Received
Phase I report on vegetation.	Dot Helm	Received
March 15, 1999		
Draft report on power and cost considerations relevant to small mammal monitoring	Eric Rexstad	Received
Data and metadata for 1998 stream invertebrate work	Sandy Milner	
Data and metadata for tree ring study	Glenn Juday	Received
March 31, 1999		
Initial variables assessment report	Sandy Milner	Received
Report from Rock Creek Tree ring study	Glenn Juday	Prelim. Report received
April 15, 1999		
Study plan and budget for any proposed field work in 1999 and 2000 related to vegetation.	Dot Helm	Received