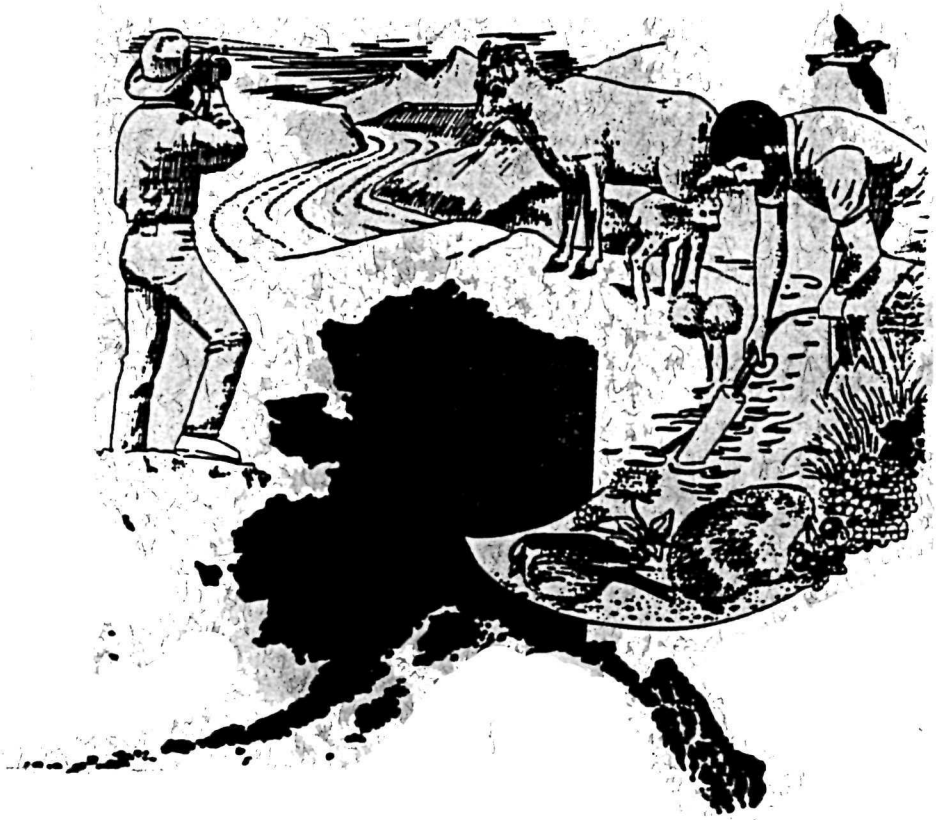
Proceedings of the Chena Hot Springs Workshop January 24-27, 1989, Fairbanks, Alaska

Strategies for Sustained Monitoring in Arctic and Subarctic National Park Service Units and Reserved Areas

Marty Peale, Ross Kavanagh, Dale Taylor, and Charles Slaughter

Natural Resources Report NPS/AR/NRR-93/20



United States Department of the Interior • National Park Service • Alaska Region

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May 1993

National Park Service
Alaska Regional Office
Natural Resource Division
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Anchorage, Alaska 99503-2892

The Chena Hot Springs Workshop

Contents

Appendices / 58

Tables

Figures

Preface

Much has happened since this workshop was held at Chena Hot Springs in 1989. The National Park Service has completed NPS-75, ***Guidelines for Resources Inventory and Monitoring.*** A national committee has been formed to direct this newly established program. Denali National Park and Preserve has been selected, through a competitive process, as one of four national parks nationally for development of a prototype monitoring program. A phased program will have monitoring activities established in all parks by the end of a ten year period. An inventory process will begin this year.

The Chena Hot Springs Workshop was an opportunity for resource management specialists, park and academic scientists, managers, and administrators to discuss where we are in Alaska with an inventory and monitoring process, to examine case studies, and to discuss how we should proceed on these pristine areas of immense size. This document summarizes those discussions.

A summary of park personnel, funding level, number of projects, and number and location of weather stations is included herein. This summary documents the resource management capability of each park in Alaska ten years after it was created or expanded with the passage of the Alaska National Interest Lands Conservation Act in 1980. That the inventory and monitoring program is timely and needed is illustrated by the fact that nearly every park listed **baseline data** as a primary need.

Many people were responsible for making this workshop a success. I especially want to thank Dr. Charles Slaughter, Institute of Northern Forestry, U.S. Forest Service, Fairbanks, who originally suggested the idea and took a lead role in designing and carrying out the project. Regional Director Boyd Evison carried through with his long-time interest in inventory and monitoring by supporting the workshop and participating fully. All attendees are to be congratulated for braving an "Omega Block" frontal system which resulted in temperatures of 50 degrees below zero Fahrenheit and some of the lowest barometric pressures ever recorded over a wide area of Alaska and Canada..

The workshop and this final report were made possible through Cooperative Agreement CA 9700-8-8019 between the University of Alaska Fairbanks and the National Park Service.

Dale Taylor
Special Projects Leader
National Park Service
Alaska Regional Office
Anchorage, Alaska
April 20, 1993

Introduction

Management in any enterprise, be it a dog team, a mass transit system, a red salmon fishery, or a national park, requires information. The management of our national parks and preserves should be based on accurate information about those land units: Where are they? What resources do they embody (the inventory)? How and why do the attributes and resources of these units change over time (the monitoring)?

Scientists and park personnel alike acknowledge that a remarkably wide diversity of conditions characterize arctic and subarctic environments. Nevertheless, those who are charged with studying and managing the resource recognize there may be merit in providing an umbrella framework within which monitoring and related research programs might proceed.

The rationale for inventory and monitoring of physical, biological, and chemical processes and rates in ecosystems and landscapes comes from many quarters. Research in natural resources often includes a strong monitoring component (Likens 1983). The National Science Foundation's Long-Term Ecological Research program (Callahan 1984), which now includes two Alaskan sites, has emphasized the scientific need for properly designed monitoring systems. Current attention to questions of global climatic change and the developing International Geosphere Biosphere Program (Malone and Roederer 1985; ICSU 1985, 1988) has placed strong emphasis on high latitude regions in terms of both sensitivity to change ("early warning systems") and exacerbating change through feedback mechanisms involving sea-ice cover, seasonal snowpack and terrestrial albedo alterations, and Arctic Basin and global circulation patterns. A significant portion of the International Geosphere Biosphere Program focuses on the high latitude regions of North America (Eddy et al. 1988) and stresses the role of long-term monitoring and research.

"... call together experts as needed to get this off to a good start, and ... move ahead with the workshops and meetings necessary for this important beginning."

In 1987, Associate Director for Natural Resources and Research Dr. Eugene Hester and Alaska Regional Director Boyd Evison spearheaded NPS personnel who collaborated with dedicated field researchers from many entities and disciplines to prepare a *Draft Natural Resources Inventory and Monitoring Initiative* (1987). NPS Director Mott encouraged Hester to "call together experts as needed to get this off to a good start" and to "move ahead with the workshops or other meetings necessary for this important beginning."

The Initiative

The National Park Service is in a unique position to provide lands and resources for inventory and monitoring activities. NPS lands have been set aside into perpetuity to preserve and protect specific unique resources. These parks, preserves, monuments, and wild and scenic rivers comprise the "gold standard" against which human activities and impacts are to be measured.

Toward this end, the National Park Service *Draft Natural Resources Inventory and Monitoring Initiative* (1987) established that:

> "It is the policy of the National Park Service to assemble baseline inventory data describing the natural resources under its stewardship, and to monitor those resources forever, [in order] to detect or predict changes that may require intervention, and to provide reference points to which comparisons with other, more altered parts of the home of mankind may be made."

The introductory text of the Initiative states:

> "The National Park Service is responsible for management of natural resources in a manner that conserves them unimpaired for future generations. It is essential, therefore, that park managers know the nature and conditions of the resources under their care, have the means to detect and document changes in those resources, and understand the forces driving those changes. With parks increasingly surrounded by altered environments and experiencing externally caused impacts on park resources, and with growing awareness of the effects of human activities within the parks, natural resource baseline inventories and subsequent monitoring are an essential basis for park management.

"It is essential, therefore, that park managers know the nature and conditions of the resources under their care, have the means to detect and document changes in those resources, and understand the forces driving those changes."

Simply put: To determine appropriate management actions, we must know what resources we hold in trust, how they change over time, and how those changes are related to human activities. Inventory and monitoring are essential to determine our fidelity to, or deviation from, desired resource conditions; to assess the impacts of human influence; to direct management intervention; and to measure the subsequent success or failure of that intervention....

In a very real sense, Inventory and Monitoring may be the most important legacy the Park Service can provide American conservation. Probably no ecosystem on earth remains totally unaffected by modern human activities. However, in a world in which wild places have become few and precious, knowledge of the composition and functioning of relatively unaltered wild systems has likewise

become invaluable. The information collected in this program must underlie any fundamental knowledge of those systems."

Dale Taylor
National Park Service
Alaska Regional Office
Anchorage, Alaska

Workshop Goals and Objectives

In 1988, the National Park Service, Alaska Region, affirmed that management of its units could benefit from a coordinated strategy and philosophy of long-term monitoring. Such a strategy might provide regionwide monitoring objectives and research designs, and in some cases, common field techniques for arctic and subarctic park units and reserved areas.

Toward this end, the Service provided support (RFP-88) for *The Chena Hot Springs Workshop: Strategies for Sustained Monitoring in Arctic and Subarctic National Park Service Units and Reserved Areas.* The workshop focused on terrestrial and freshwater systems and terrestrial/aquatic ecotones, drawing on the experience of federal, state, private, and academic investigators with expertise in a broad spectrum of disciplines, from within and outside the NPS.

"... while each unit is unique, there are significant opportunities for sharing concepts, approaches, and techniques in inventory and monitoring."

Goals

1. To provide a comprehensive framework within which monitoring and related research programs may proceed in the national parks, preserves, and reserved areas of Alaska.

Objectives

1. To summarize existing monitoring programs;
2. To evaluate case studies of successful and unsuccessful monitoring programs, both in Alaska and from other locales;
3. To evaluate NPS monitoring needs and goals for the arctic and subarctic;
4. To examine possible common elements of monitoring and inventory in arctic and subarctic units;
5. To place Alaska NPS needs and goals in a national and circumpolar context of societal and scientific needs; and
6. To draft regionwide guidelines for inventory and monitoring including a strategy for implementation.

Results

The workshop has been successful in meeting the first five of these objectives. **The Workshop in Perspective** reviews concepts, objectives, and applications of those practices on National Park Service units in general and in Alaska specifically and places our work in regional, national, and global contexts. Appendix E summarizes existing monitoring programs in Alaska NPS units. **Case Studies in Inventory and Monitoring** includes the observations of principal investigators from Alaska and various units from across the United States, including Hubbard Brook Experimental Forest in New Hampshire, Channel Islands National Park in California, and H.J. Andrews Experimental Forest in Oregon. Six **Working Group Summaries** document participants' discussions of monitoring needs common to Alaskan park units. They address the following technical areas: air quality and climatology, vegetation, terrestrial fauna, freshwater systems, earth surface processes, and disturbance effects on land use.

While the workshop did not provide adequate time to meet the final objective, it did provide the technical basis for formulation of an implementation strategy for Alaska.

Perhaps equally important, the workshop provided an opportunity for resource managers from all Alaska region NPS units to meet on a common footing, explore common problems, and affirm that while each unit is unique, there are significant opportunities for sharing concepts, approaches, and techniques in inventory and monitoring.

Charles W. Slaughter
Institute of Northern Forestry
U.S. Forest Service
Fairbanks, Alaska

The Chena Hot Springs Workshop

The Workshop in Perspective

Alaska National Park Units

Few places in the world can equal the opportunity and the promise of an inventory and monitoring network offered by National Park Service lands in Alaska. The Alaska National Interest Lands Conservation Act of 1980 (ANILCA) increased the number of national parks, preserves, and monuments in Alaska from five to 23 which embrace an area of 53 million acres.

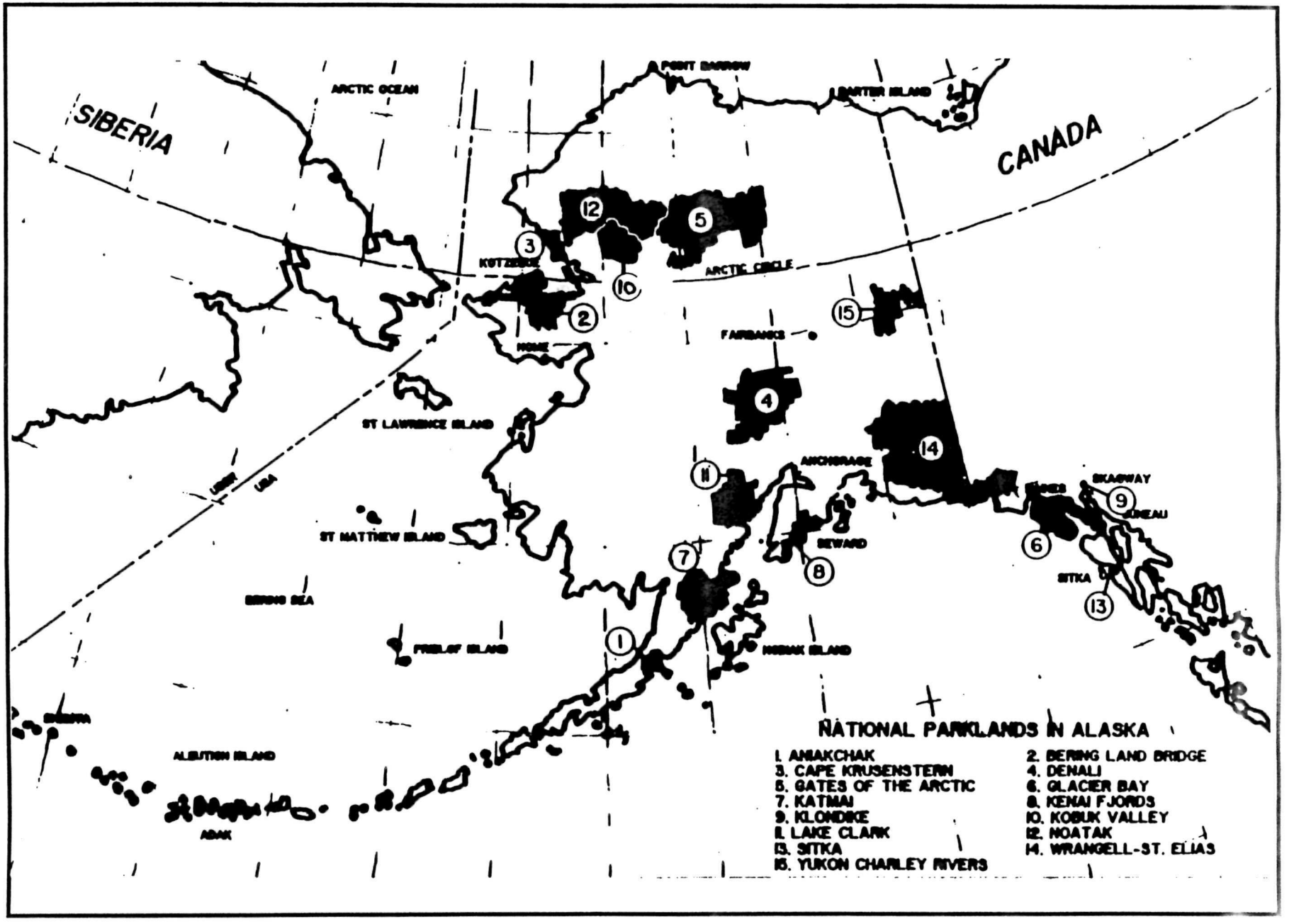
Alaskan NPS units have significant scientific, scenic, historic, cultural, archeological, geologic, wilderness, recreational, and wildlife values and resources. These lands (Figure 1) represent a variety of arctic and subarctic ecosystems, ranging from the mountains of the Brooks Range in Gates of the Arctic National Park; to glacial terrain in Kenai Fjords, Wrangell-St. Elias, Denali, Lake Clark, and Glacier Bay National Parks; from volcanic landscapes in Katmai and Lake Clark National Parks, and Bering Land Bridge and Aniakchak National Preserves; and to pristine watershed systems in Lake Clark and Katmai National Parks and Noatak National Preserve. Unique park ecosystems include the sand dunes of Kobuk Valley National Park and the ancient terrain of the Yukon-Charley Rivers National Preserve. The only NPS lands underlain by permafrost are located in Alaska.

Because many Alaskan parks and preserves are vast and remote, park values are not well known. While some information is available from ANILCA studies, basic inventories are still badly needed simply to identify resources.

"Monitoring for changes in these extreme systems may not only provide early warning of changes but may also indicate the potential magnitude of those changes."

Our park units may be remote, but they are not immune to man-caused changes. NPS management must meet the mandate of conserving natural resources unimpaired for future generations, while providing for continued subsistence hunting, fishing, and trapping within many units, for sport hunting in national preserves, and for sport fishing in all units. Monitoring is particularly important, as activities allowed within parks such as sport and subsistence hunting, fishing, and some mechanized travel, have the potential to cause significant changes.

Furthermore, man's capacity to alter the environment on a global scale has increased dramatically. Arctic and subarctic environments may be particularly susceptible to global changes, as they are extreme environments located in precisely the northern areas where major climate change is predicted to occur. Monitoring for changes in these extreme systems may not only provide early warning of changes but may also indicate the potential magnitude of those changes.


SIBERIA
CANADA
ARCTIC OCEAN
POINT BARROW
BARTER ISLAND
KOTZEBUE
ARCTIC CIRCLE
NOME
FAIRBANKS
ST LAWRENCE ISLAND
ANCHORAGE
SEWARD
SKAGWAY
JUNEAU
SITKA
ST MATTHEW ISLAND
BERING SEA
PRIBILOF ISLAND
KODIAK ISLAND
ALEUTIAN ISLAND
ADAK
NATIONAL PARKLANDS IN ALASKA
1. ANIAKCHAK
2. BERING LAND BRIDGE
3. CAPE KRUSENSTERN
4. DENALI
5. GATES OF THE ARCTIC
6. GLACIER BAY
7. KATMAI
8. KENAI FJORDS
9. KLONDIKE
10. KOBUK VALLEY
11. LAKE CLARK
12. NOATAK
13. SITKA
14. WRANGELL-ST. ELIAS
15. YUKON CHARLEY RIVERS

For all these reasons, whether we consider Alaska's national parks, monuments, and preserves as unique individual units or portions of a whole system, they are undeniably fertile study areas for monitoring changes on local, regional, and global levels.

Dale Taylor
National Park Service
Alaska Regional Office
Anchorage, Alaska

Alaskan National Parks in the National Perspective

The most serious threats to the National Park Service are ignorance, impatience, macho management, and the acceptance of ignorance. Before delving into these skeletons in the National Park Service closet, however, it might help to explain what the Service, and the system we manage, are supposed to be about.

By passage of the act of August 25, 1916, Congress created the National Park Service to "promote and regulate the use of" federal areas known as national parks, monuments and reservations; "to conserve the scenery, the natural and historic objects, and the wild life therein; and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

"Now, you don't 'conserve ... wild life' and leave it 'unimpaired' without protecting ecosystem integrity."

Now, you don't "conserve ... wild life" and leave it "unimpaired" without protecting ecosystem integrity. Of course, every ecosystem of any real size on earth has been at least somewhat altered by modern, technological humankind. Nevertheless, NPS units are the most extensive ecosystems in America for which the basic purpose is to keep intact their ecological integrity. As such, they have become enormously important (and become more so every day) as benchmark areas. They are a kind of gold standard, even if only 22 carat, by which to judge the effects of human activity on the global ecosystem that is the home of humankind.

In 1988, following a season of extensive fires, the National Fire Panel was called to evaluate fire-management practices on park and wilderness lands. As that Review Team reaffirmed, man is part of nature, but parklands were clearly set aside as places in which wildness, natural conditions as free as possible from techno-human impacts, is a fundamental purpose. So parks are managed to hold these impacts to a minimum, even while providing for "use." The alternative, carried to its logical conclusion, would be a constantly sliding scale in which anything goes and benchmark values are squandered. Where wild naturalness exists, we are obliged to protect it. Where it's been impaired, we must learn how it's been impaired and then manage to compensate for that, if we can.

"Where wild naturalness exists, we are obliged to protect it. Where it's been impaired, we must learn how it's been impaired and then manage to compensate for that, if we can."

As ecosystem managers, the Service has labored for years in ignorance, by and large -- ignorance of exactly what our systems comprise, how their components function, interrelate, and change over time, and how those changes relate to human activities.

We made a good start in George Wright's time, the 1930s, but that fizzled when he was killed in an automobile accident. What comparable scientific vision we have had since then has been regularly frustrated by a lack of understanding on the part of management and a concomitant lack of support, not just in terms of money, but also willingness to provide a good working environment for research in the parks.

Managers have sometimes recognized the need for science on which to base management actions. But we are an impatient lot, and we don't like to be seen as indecisive. This is what I mean as "machismo." The fact is that it often takes more courage to "do nothing" because there isn't enough information than to "do something." Either requires a decision, conscious or otherwise.

"In fact, it is only in the Alaska parks that the Service has its one remaining substantial chance to 'do it right the first time' as managers."

Machismo and, admittedly, necessity born of grossly inadequate funding and/or excessive pressures, have also put us for years in a mode of never getting around to any but the most obvious and immediate management-related research. Nationwide priorities have actually pushed studies to the bottom of the list, if they didn't promise "an answer" within two years and a "solution" by management action in the third year. "Basic research" came to mean anything that didn't make such promises, and it was not only neglected; in some cases it was openly scorned.

You can imagine how much attention this left for inventory and monitoring. Even when it was first thought of, it was shunted aside by managers, because it wouldn't produce "results" soon enough, and by academics (from whom certain amounts of gratis research trickled in with little or no NPS help) because it was unexciting and of no real publication value. We fell into *the habit of accepting ignorance* of the most fundamental facts about the places for which we are responsible.

In just the last three years, some concerted attention has been given to the need for a Servicewide inventory and monitoring program, with consistent goals and methods, and with regional and park programs developed to meet specific needs. This workshop is but one of the tiny handful of efforts generated by the pittance allotted to this cause Servicewide.

This is what we need to develop an inventory and monitoring program: we need to sort out what to measure and upon which components to concentrate our attention. It may be expensive to develop the necessary information base, but it's too often incomprehensibly more expensive to have to go in and try to make things "right" after ill-founded decisions and actions have thrown things badly out of kilter. Inventory and monitoring is our best insurance against accidents and bankruptcy in the future.

The success of this workshop is tremendously important to us. During the days of the d2 [ANILCA] battles, the cry was "this is the last chance to do it right the first time," that is, to create parks and refuges from unspoiled lands. In fact, it is only in the Alaska parks that the Service has its one remaining substantial chance to "do it right the first time" *as managers.*

Boyd Evison
Regional Director
Alaska Region
National Park Service

Alaska National Parks in the Global Perspective

To do a comprehensive job of placing Alaskan parks squarely in the global perspective would take someone with much more knowledge and experience than I have. In all humility, what I wish to do is reinforce what we already know – that Alaska's national park units must rightly be recognized as important and unique in Alaska and in the United States. They should also be perceived and used in the broader context of circumpolar, indeed global, questions and problems.

Time Magazine's January 1989 focus on the planet illustrates the growing awareness of global problems, be they overpopulation, solid waste disposal, or climatic warming.

With regard to climatic change, there is general agreement that polar regions – our front and back yards - - will react earliest and perhaps most dramatically to global warming. The recent University Center for Atmospheric Research document, *Arctic Interactions*, points this out and proposes an arctic focus for initial North American actions in the International Geosphere Biosphere Program (IGBP).

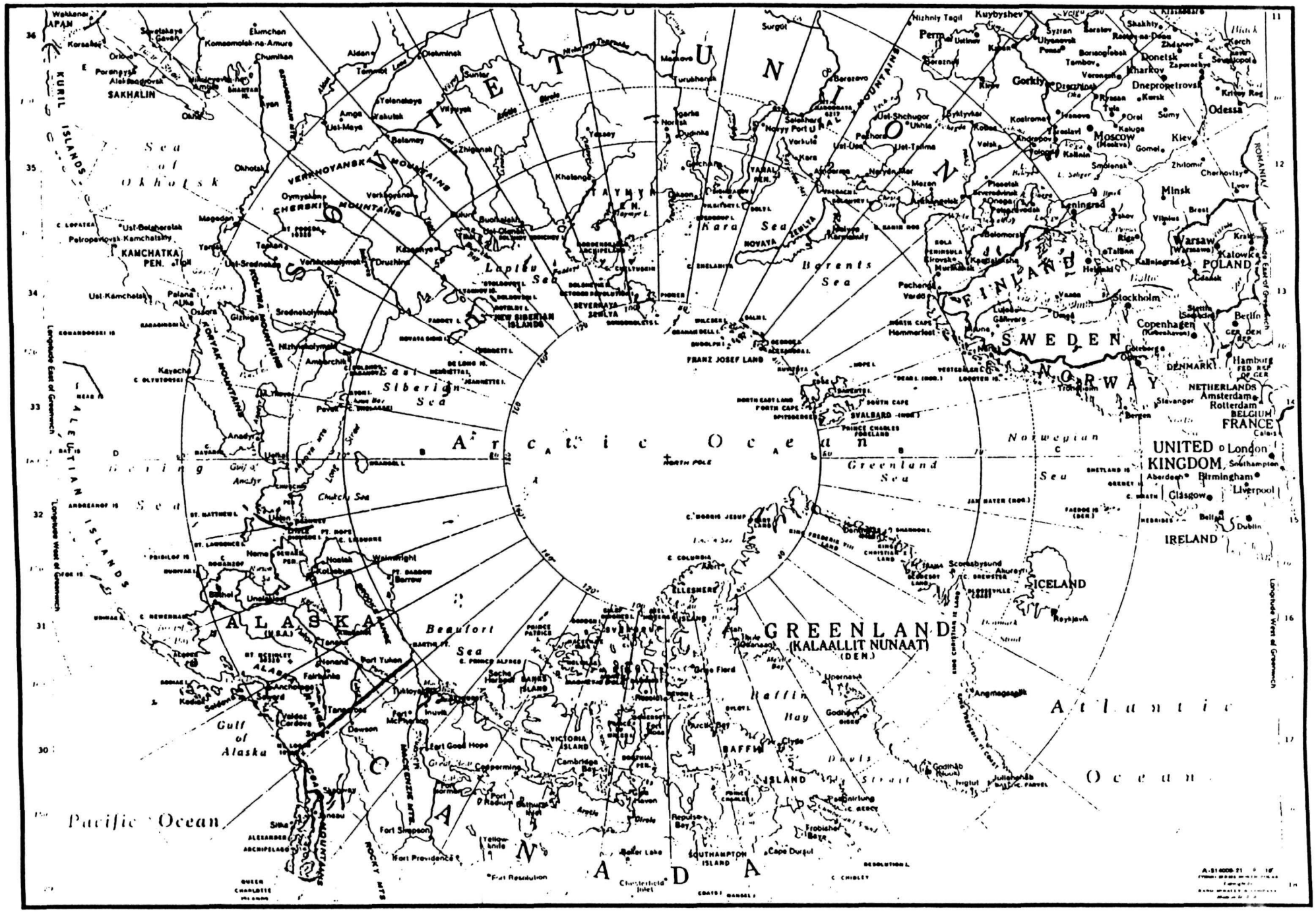
Long-term monitoring, properly designed and executed, is vital to determination of trends in climate, atmospheric and landscape pollution, and ecosystem response. Is there global warming? Is there regional warming? Is there radionucleotide accumulation in plant or animal tissues? Is there a net carbon loss from specific landscapes such as peatlands? If so, how much and how fast, and so what?

You know how many of us view Alaska provincially as the largest state, or in a regional context at the center of our thinking. We refer often enough to "Alaska and our neighbors." A polar map projection provides a different, circumpolar viewpoint (Figure 2) emphasizing that the landscapes, the environmental systems of Alaska, are represented around the pole.

"Is there radionucleotide accumulation in plant or animal tissues? Is there a net carbon loss from specific landscapes such as peatlands? If so, how much and how fast, and so what?"

With this in mind, many of us are now striving for a more adequate understanding, and better stewardship, of these landscapes and ecosystems, through communication and collaboration with scientists and resource managers of these circumpolar lands.

Opportunities for just such cooperation are improving every year. One example is the December 1988 *Conference of Arctic and Nordic Countries on Coordination of Research in the Arctic* in Leningrad, which provided an unprecedented forum for scientists from all northern countries to discuss common problems and opportunities for cooperation.


Arctic Ocean
North Pole
Pacific Ocean
Atlantic Ocean
ALASKA (U.S.A.)
CANADA
GREENLAND (KALAALLIT NUNAAT) (DEN.)
ICELAND
SWEDEN
FINLAND
NORWAY
DENMARK
UNITED KINGDOM
IRELAND
POLAND
NETHERLANDS
BELGIUM
FRANCE
ROMANIA
JAPAN
SAKHALIN
KURIL ISLANDS
KAMCHATKA PEN.
ALEUTIAN ISLANDS
Sea of Okhotsk
Bering Sea
Chukchi Sea
Beaufort Sea
East Siberian Sea
Laptev Sea
Kara Sea
Barents Sea
Greenland Sea
Norwegian Sea
Baffin Bay
Davis Strait
Gulf of Alaska
Lake Superior
Lake Huron
Lake Michigan
Lake Erie
Lake Ontario
Great Bear Lake
Great Slave Lake
Lake Winnipeg
Hudson Bay
Moscow
Leningrad
Kiev
Minsk
Warsaw
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Liverpool
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Kharkov
Dnepropetrovsk
Gorkiy
Kuybyshev
Perm
Sverdlovsk
Tashkent
Alma-Ata
Novosibirsk
Irkutsk
Yakutsk
Khabarovsk
Vladivostok
Anchorage
Fairbanks
Juneau
Sitka
Nome
Point Barrow
Inuvik
Yellowknife
Fort Nelson
Fort Simpson
Fort Providence
Fort Resolution
Fort Good Hope
Coppermine
Cambridge Bay
Resolute
Alert
Eureka
Thule
Godthaab
Angmagssalik
Frobisher Bay
Cape Dyer
Cape Dorset
Pond Inlet
Ellesmere Island
Baffin Island
Victoria Island
Southampton Island
Banks Island
Prince Patrick Island
Prince Charles Island
Franz Josef Land
Novaya Zemlya
Severnaya Zemlya
New Siberian Islands
Svalbard
Jan Mayen
Faeroe Islands
Shetland Is.
Orkney Is.
Hebrides
Verkhoyansk Mountains
Cherskiy Mountains
Kolyma Mountains
Koryak Mountains
Brooks Range
Rocky Mts.
Longitude East of Greenwich
Longitude West of Greenwich

To provide more focus for the general theme that "international cooperation is good," let me summarize three international programs which are relevant to NPS inventory and monitoring in Alaska.

The International Hydrological Program Regional Working Group on Northern Research Basins

In 1974, Denmark, Sweden, Finland, Norway, Iceland, USSR, Canada, and the United States established the Northern Research Basins Program (NRB). With the research basin, catchment, or watershed as the unifying concept, the objective was to advance knowledge of northern, high latitude hydrology, with a focus on low order, headwater, stream catchment systems.

This objective has been approached, very deliberately, with a minimum of formal organization. From the first, NRB was planned to maximize direct dialogue among hydrologists, scientists, and practitioners alike, who are actually grappling with northern water resource problems. This has been accomplished through a series of biennial workshops, designed to emphasize the opportunity for direct discussions of hypotheses, research techniques, and field problems; and through symposia designed to provide written accounts on specific items which are shared among all the circumpolar participants. Seven of these meetings have been held to date, with the next to be hosted by Sweden in 1990. The NRB does not administer sites and has not received external funds. It is, in every sense of the words, cooperative, participatory, and successful.

UNESCO-MAB Biosphere Reserve System

"Biosphere Reserve" is an international designation of the UNESCO Man and the Biosphere program (MAB), established in 1971. These reserves are intended to provide multipurpose models of integrated resource conservation, land use, and management, including both research and development.

While over 80% of the biosphere reserves have been created through an "overlay" designation on existing parks or reserved lands, they are not necessarily synonymous with parks, research natural areas, or other land designations. These reserves are not planned as exclusive-use sites or as "lock-ups" of land -- an especially touchy subject in Alaska. Rather they are designed to serve multiple functions, spelled out in the *Action Plan for Biosphere Reserves*. These functions include:

Conservation, by adding a "layer" of international recognition to ecosystems with (ideally) a "core" pristine area surrounded by buffer areas of multiple-resource use and development. This status can be useful in advancing local management goals.

Research and monitoring, by providing protected areas, administratively secure and available for long-term research into natural and managed ecosystems. This function, and particularly the long-term monitoring aspect, is becoming increasingly relevant as global climate change and the International Geosphere Biosphere Program grow in significance.

Education and training, by providing reserves as field laboratories.

Cooperation, by providing a focal point for many disciplines concerned with environmental research and management, and by providing a common ground for scientists, governmental land and resource managers, resource development interests, and indigenous residents, to meet, learn of each others' aims and legitimate concerns, and develop strategies for accommodating these many-faceted concerns. In fact, local participation is a key component in successful biosphere reserve endeavors.

What is perhaps most important to note here is that the biosphere reserve approach has stressed observation of both development and protected "core" areas. This has direct application to some of Alaska's present concerns about inholdings, subsistence use, and "buffer zones" -- zones of influence adjoining park boundaries.

Biosphere reserves have been established throughout the world, in biomes categorized by Udvardy's (1975, 1984) biogeographical system. (That system does not, by the way, provide adequate refinement for the northern boreal and tundra systems.)

Sparse as they are, the existing high latitude reserves do provide a foundation for a circumpolar network of research sites. The six established high latitude reserves include Northeast Greenland National Park, the largest in the world, Northeast Svalbard, and four in Alaska: the Aleutian Islands National Wildlife Refuge, Denali National Park, Noatak National Preserve, and Glacier Bay National Park. Several additional sites are under consideration in northern Canada.

Man and the Biosphere Northern Science Network

The Northern Science Network was established in 1982 as a part of the UNESCO Man and the Biosphere Program. It is intended to address the lack of information (as compared with temperate zones) on environmental and biological processes and responses to man's activities in circumpolar zones. It is also intended to address the need for sharing resources and information among high latitude scientists.

At its March 1988 meeting in Helsinki, participants revised the focus of the program to include the following:

Protected areas and biosphere reserves in northern regions
Birch forest ecosystem studies and subarctic ecotones
Sustainable development in the north
Geosphere/biosphere observatories monitoring social and environmental change in the north

The latter two are new areas of interest for the Network. They reflect growing concern with sustainable development (Weick 1986) and indications of global climate change in circumpolar regions (Lachenbruch and Marshall 1986).

Northern science policy questions have also emerged as an area of concern (Freeman and Slaughter 1986). A common theme among these activities has been concern for the role of local residents and indigenous people in northern research, management, and policy development (Cournoyea 1986; Fenge 1985; Lynge 1986).

Participating states include Canada, Norway, Denmark, Sweden, Finland, Iceland, USSR, USA, and Greenland (the Inuit Circumpolar Conference). In 1988, Finland accepted responsibility for the Network Secretariat, to be established at the new Arctic Center at Rovaniemi on the Arctic Circle.

Conclusion

These three programs are active, "off the shelf," functional programs. They place a common emphasis on scientific research, circumpolar cooperation, and field sites dedicated to sustained research. (They also all place an emphasis on watersheds, but that's a function of my professional bias; this isn't yet a prerequisite for I&M study design.) In addition to these shared goals, each program serves a specific purpose. We would do well to use them more fully, and to improve upon them as appropriate, as we pursue international cooperation in science in the north.

Charles W. Slaughter
U.S. Forest Service
Institute of Northern Forestry
Fairbanks, Alaska

Inventory and Monitoring in Watershed Units

Having broached the subject of watersheds, I'd like to elaborate very briefly. Much of my thinking over the past two decades has been influenced by the philosophy that landscapes considered in terms of catchments, watersheds, or drainage basins comprise discrete and manageable study units for a great many "environmental," natural resource questions.

Let me emphasize the obvious: terrestrial and aquatic systems are inextricably linked in landscape units. What comes into a landscape -- water, nutrients, chemical species, energy -- is stored (perhaps very temporarily) and processed on that landscape. Landscape may be considered a three-dimensional response surface, an interface where physical, chemical, and biological processes affect each other in countless ways and where human activities intersect environmental systems.

"Watersheds are discrete and distributed through all landscapes in hierarchical fashion and so provide a natural framework for the design of field studies."

Watersheds are, of course, discrete and distributed through all landscapes in hierarchical fashion and so provide a natural framework for the design of field studies, such as comparing processes or rates among ecosystem units.

Perhaps equally important, watersheds include and provide ecotones, relatively discrete zones of change in system properties. For instance, terrestrial/freshwater ecotones, sometimes termed phreatic or riparian zones, may be very important to nutrient movement from slope to stream. Also, treeline (both elevational and latitudinal), sometimes referred to as the tundra/taiga ecotone, is one key to understanding response of northern landscapes to climatic change.

For each of these reasons, watersheds are particularly useful for interdisciplinary, coordinated research into terrestrial and freshwater ecosystems around the globe.

Charles W. Slaughter
U.S. Forest Service
Institute of Northern Forestry
Fairbanks, Alaska

Quality Assurance in Inventory and Monitoring

The National Park Service already spends considerable effort in inventory and monitoring. However, the absence of a clear understanding of the objectives behind collection of the data, and in most cases, the absence of a quality assurance program, result in data which do not pass scrutiny.

The primary purpose of quality assurance is to ensure that the data we collect lends credibility to the research effort. While the precautions I will outline today are not unique to inventory and monitoring, they must be considered and executed from the outset of what may become decades of work in this case.

"To identify human-induced change generally requires detecting a significant change in the occurrence of a compound, or magnitude of a process, above that which may be considered to be natural variation. A good quality assurance program can considerably decrease the time (and so the cost) required to detect such change."

One of the purposes of long-term monitoring is to detect human-induced change or stress. Many of the variables we monitor have considerable natural variation or "noise." To identify human-induced change generally requires detecting a significant change in the occurrence of a compound, or magnitude of a process (mechanism), above that which may be considered to be natural variation. A good quality assurance program can considerably decrease the time (and so the cost) required to detect such change.

My intent today is to highlight some of the basic definitions used in quality assurance, to point out the importance of understanding the inventory and monitoring objectives, and to briefly mention the major considerations in: (1) field sampling, (2) field laboratory analysis, and (3) central laboratory procedures which improve quality assurance and quality control (QA/QC).

Definitions

Quality Assurance pertains to the steps we take overall in the systematic process of collecting and managing data to ensure the accuracy, precision, or integrity of the data. Quality assurance encompasses quality control.

Quality Control pertains to the steps we take in study design, in lab or field procedures, to ensure that data meet certain quantifiable standards for accuracy and precision (i.e., +-.05%).

Precision is the degree of mutual agreement among individual measurements made under prescribed conditions with a single test procedure.

Bias is the systematic error due to unrepresentative sampling, instability of samples before analysis (as in plant, soil, and water samples), interference effects, or difficulties with analytical machines.

Accuracy is the total error, which includes random and systematic error (bias).

Quality Assurance/Quality Control Objectives

To Ensure That All Participants Understand the Purposes of the Study. Not knowing the purpose of the study can result in: (1) ignorance of natural sources of variation which could affect the sampling protocol and (2) failure to document circumstances which might contribute to variation in field data. Furthermore, it is often difficult for field workers to maintain enthusiasm over time when they do not understand the purpose of the effort. Failure to understand one's role in the overall project can lead to an inappropriately casual approach to the acquisition of data. This is especially a problem when there is only infrequent communication with other members of the project, such as when collecting data in remote areas.

To Ensure That All Participants Are Committed to the Program. A critical factor in good data collection is the will and interest of the people in the program. This lesson has become clear from the National Atmospheric Deposition Program (NADP), wherein few site operators are compensated for their time in the program. Nevertheless, they strongly believe in the objectives of the program and recognize the importance of their contribution to high data quality. For these reasons, the credibility of this 10-year program remains high. Important factors for maintaining the commitment of personnel include: (1) giving feedback regarding their performance, (2) designing and providing good sampling conditions, and (3) giving recognition for their efforts.

To Be Aware of Existing Protocols. Many investigators and organizations have given considerable thought to procedures used in their inventory and monitoring. While EPA's protocols are designed to address regulations, most others are not. EPA's protocols are, nevertheless, sound, valuable, and usually effective for meeting current quality assurance needs. Programs such as the National Science Foundation (NSF) Long-Term Ecological Research (LTER) Program, the National Atmospheric Deposition Program (NADP), and the National Acid Precipitation Assessment Program (NAPAP) have developed thorough protocols, many of which address long-term inventory and monitoring. The U.S. Geological Survey and the U.S. Forest Service have also done similar work. Researchers initiating inventory and monitoring would do well to consult these protocols as they often reflect many years of field and laboratory experience.

Field Sampling

Be Consistent. We cannot place enough emphasis on the importance of consistency in sampling procedures. While many sources of variation are unknown in field sampling, the best way to minimize them is to use consistent procedures. Consistent time of day, sampling location, and handling before analysis can each contribute considerably to standardization. Variation induced by casual changes in

personnel is especially common in long-term inventory and monitoring. This can be avoided by carefully explaining even the most "trivial" details of how and why sampling has been conducted in the past. When you must implement changes in equipment, run both the new and old units side by side for at least six months to verify that they yield similar results. There are many horror stories about the impact of change in procedures on long-term inventory and monitoring.

Draw on Personal Experience to Detect Variation from "Normal" Conditions. Personnel with extensive inventory and monitoring field experience are hard to find. Observant workers will make mental note of conditions that are other than they would have expected. This is often the only way of identifying unknown sources of natural or procedural variation which may significantly reduce data quality. Documentation of deviation from "normal" conditions, be it in sampling or in natural sources, is critical. In time, such information becomes invaluable to identify new sources of natural variation, and to qualify, or to exclude data.

Note Diurnal Variation and the Importance of Time. Increasingly, ecological processes (mechanisms) are proving to be very sensitive indicators of change, especially in terrestrial ecosystems. Major sources of variation in the rate of natural processes include time of day and season. Document these, and keep the timing of sampling consistent to the maximum extent possible.

Handle Samples Consistently. Most of the significant sources of variation in sample integrity which are associated with time (light, oxygen, temperature, shaking) can be controlled. Use split samples to assess the impact of these factors on sample integrity.

Use Replicates, Splits, and Blanks. Replicates are two or more samples collected under the same field conditions. Splits are two or more samples split from one. Blanks are solutions which contain everything in the sample solution except the analyte. Each of these can play a role in assessing change in sample integrity due to natural factors or from sample handling.

Calibrate Equipment. Most field equipment must be calibrated at least every six months. Late spring and late fall are the generally preferred times. We have found that even older, "proven" field monitoring equipment needs calibration two to four times each year. Calibration must be documented on a database.

Record Data Carefully. Data loggers have improved considerably in reliability over the last five years. Use them for routine variable recording. The recording of critical data, especially in regions with highly variable or extreme weather, should be backed up with older, more proven instrumentation. Data loggers can be downloaded easily in the field, but our experience has been better in the laboratory. Tape recorders are reliable for recording field observations, especially in bad weather. Hand carried data loggers are also convenient. The results from either must be checked when entered, preferably on a computer, in the field lab or office. The person collecting the data should always be responsible for recording it, for only s/he can detect error in a timely manner.

Many database software systems for PCs have methods to detect error. Explore their capacity. Regressions of one field variable against another are very effective tools for detecting data entry errors.

Field Laboratory Analysis

Importance of Consistency. Analyze samples in a field lab only when sample deterioration is likely. Measure the variables that are especially vulnerable to change with time, temperature, etc.

Standards and Working Solutions. Take special care to update these on a regular basis. There is a tendency in field situations to use dated standards and working solutions, because replacements are not readily available. Reference solutions are especially important in such an environment; record calibration results from their use to identify trends/bias.

Working Environment. Any field chemical determinations are much more consistent when sample, solutions, and instruments are working at the same temperature. Cleanliness of glassware and equipment is another major consideration. As a rule, avoid kitchen and living areas if possible because of the large amounts of aerosols and other air contaminants present.

Instrument Calibration. Use the same procedures as in a central laboratory. Use buffers and reference standards, and check samples, when doing any chemical analysis. Recording the results of such checks can give an overall evaluation of the performance of any field lab equipment. Return sensors or probes, as for pH determination, to a central lab at the end of each season for checking against a reference probe. Check them again before returning them to the field for the next season.

Special Equipment or Procedural Requirements. Be cautious in the use of new equipment, especially that which is to replace existing monitoring equipment. When upgrading equipment, operate both the old and replacement unit side by side for at least six months.

Field Data Entry and Quality Control Plots. Computer entry of field data provides numerous data checking opportunities. Use of a simple database or spreadsheet with graphics is especially helpful. Regression or X-Y scatter plots of two or more related variables will show outliers which often are the result of data entry error. They can usually be corrected, if the person who collected the data catches the errors at this time. I cannot overemphasize the merit of using a database at this stage. Many accept alphanumeric data. They are excellent tools for noting variation from normal sampling protocols or environmental conditions. Such documentation can be sorted and examined to detect contributions to sample or analytical variation over time.

Sample Storage and Shipment. Storage is often a problem because of lack of space, refrigerated or otherwise. Do not allow vegetation samples to collect dust or be exposed to household aerosols as from cooking. When poor storage conditions exist, give more attention to routine shipping to the central laboratory.

Central Laboratory Procedures

Field Data Entry. Most importantly, submit all field variables with the samples, so that field data can be used in laboratory QA/QC. Make every effort to enter data in a PC ASCII file while in the field.

Sample Storage, Queuing, Sampling Blocks. Queue samples as they arrive so as to standardize the time they remain in the lab before analysis. Arranging samples within blocks, as by type, data, or

concentrations, also helps minimize variation due to possible change in handling or analytical machine operation. When samples from one site are combined with samples from numerous other sites, the advantage of these suggested procedures becomes clear.

External QC Blind Audits. Do not use a laboratory which will not provide and explain its QA/QC report. Labs have ready access to Bureau of Standards reference samples, EPA QA/QC and audit samples, internal check solutions, and their own standards. There are also many recommended formats for QA/QC reports.

Data Transfer. Most central labs are rapidly becoming fully automated, thus minimizing manual data entry errors. However, do not criticize those labs which are only "semi-automated" and using older, often more proven procedures. For example, we have had personal experience showing that the integrators used to analyze analog output from several types of equipment may not give the precision that an older procedure provides. Often large labs are set up with considerable investment in a certain procedure, and updating is not justified economically or in terms of good QA/QC. If a lab uses manual or semi-automated procedures, ask what steps it takes to catch any manual data entry errors. There are specific procedures to do this and the lab should be practicing them.

Laboratory QC Plots and Statistical Analyses. With the availability of statistical and database packages for PCs, detailed QA/QC checks are now available in the lab. These make provision of QA/QC reports to clients much easier. Common methods include scatter plots, especially of analytical results against selected field variables, regression equations between and among related variables, long-term plots of concentration against time, running plots of check samples, and so forth. Databases permit operators to include coding or direct notes about deviation from normal analytical or field conditions. Data collected under such abnormal conditions can now be examined in detail to see if a change in protocol is warranted, or if the data should be discarded.

Merging with External Databases. Essentially, this should not be a major problem today. The major concern is proprietary, that is, what data use rights go with the person or program collecting the data. The person or program must fully understand this before they allow external access to their data. Unfortunately, with demands placed on publishing quantity rather than quality, the unprofessional use and outright theft of data is increasingly common.

Conclusion

To be effective, QA/QC must be integrated into all aspects of the sample collection, analysis, and recording of results. Exercised from the start, good QA/QC has a relatively minor impact on overall project costs. However, improper or poorly instituted QA/QC can result in data lacking credibility. In a long-term project, this represents considerable cost. The constant assessment of data collection, which must be maintained throughout a long-term monitoring program, can be executed only with a well-thought-out QA/QC program.

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The Chena Hot Springs Workshop

Case Studies in Inventory and Monitoring

Gary Davis
Channel Islands National Park, California

Park ecosystems are changing in ways we have never witnessed before, but we lack the historical and contemporary data necessary to clearly define the nature and extent of these changes. Unless we begin now to gather empirical data on the health of park ecosystems, unprecedented changes, subtle at first, may become irreversible and fatal. Alternately, the uncertainty born of our ignorance, or the fear of changing systems which we perceive as naturally static, may induce us to impose unnecessary constraints on human endeavors, or to freeze political action.

A natural resources monitoring program needs to provide information that will reduce uncertainty about system dynamics. What to monitor, and at what level of accuracy, varies from park to park, but the basic reasons for monitoring are universal. They are:

(1) to determine present and future ecosystem health;
(2) to establish empirical limits of resource variation;
(3) to diagnose abnormal conditions in time to mitigate; and
(4) to identify potential agents of abnormal change.

Managers are like family physicians for parks. They monitor ecological health to identify impaired park resources, treat dysfunction, repair damage, and guard against poor health by reducing exposure to dangerous agents (e.g., pollutants). Unfortunately, present knowledge of resource management is roughly equivalent to that of medicine in the 17th Century, when William Harvey was discovering the circulatory system and function of the heart.

While a physician knows what vital signs of a human patient to monitor, ecological vital signs have yet to be identified. Physicians measure parameters such as pulse, blood pressure, temperature, and weight. Comparable measures for ecosystems are unknown.

"Unfortunately, present knowledge of resource management is roughly equivalent to that of medicine in the 17th Century, when William Harvey was discovering the circulatory system and function of the heart."

Physicians can interpret their findings; they can determine present health and project into the near future, because they know the normal (healthy) limits of parameters they monitor. It was long-term research and clinical observation (monitoring) of patients that provided normal values and critical limits of these parameters. For ecosystems, however, normal limits of variation are virtually unknown. Long-term ecological monitoring is the first step in learning how to assess ecosystem health. It is the quickest and

surest way to find the parameters, and limits of variation, that can serve as ecological "vital signs." Monitoring will thereby help us to diagnose impairment and develop treatments.

Design of a long-term monitoring program begins with a conceptual model of the park ecosystem. This model should consist of an exhaustive list of mutually exclusive system components and a description of their relationships. From components such as birds, vascular plants, and water, representative elements (e.g., species and watersheds) are selected and tested for monitoring. The adequacy of existing resource inventories is apparent at this stage. Certainly not all parts of the ecosystem need monitoring, but the list of components should include representatives of all biotic and abiotic resources and the processes by which they interact.

There are several legitimate ways to describe and monitor ecosystem dynamics. Among the more useful for diagnostic monitoring are constituent assessments and biological measures of population dynamics and diversity. Perhaps the simplest approach is to consider plant and animal populations and constituents of air, water, and soils -- the basic components of park ecosystems. Monitoring representative elements of these components will determine the nature and extent of system dynamics sufficiently for management purposes.

Measures of population dynamics also offer a good handle on the challenge of monitoring the biological elements of park ecosystems. This approach is sensitive to a wide variety of environmental conditions, because organisms integrate the effects of influences like predation, competition, and pollution and express their responses to these influences in terms of abundance, distribution, age structure, reproductive effort, and growth rate. Parameters such as age structure and reproduction often reflect subtle, chronic stresses, permit projections of future conditions, and provide early warning of pending problems. Population data is relatively easy to interpret and apply at the systems level. For instance, many management controls operate at the population level, so application of population data to management issues is direct and measurable.

Biodiversity is an important attribute of ecosystems. It functions at many levels: genetic, individual, population, community, and even ecosystem. However, the repeated inventories required to measure and monitor biodiversity are expensive and difficult to conduct. Highly skilled surveyors are necessary to find and identify the elements of diversity. Alone, repeated inventories do not meet the goals of diagnostic monitoring. At the species level, diversity is not very sensitive to environmental stresses and provides only a record of the past. Changes in diversity are also hard to assess, ambiguous to interpret, and difficult to apply to management issues.

Park ecosystems are dynamic. They are confusing and difficult to understand. But we cannot ignore or avoid them; we are part of them. To survive, we must learn to understand the consequences of our collective actions upon them. Monitoring natural resources is the first step in a long process that we must begin soon, or frozen by uncertainty about their dynamics, we will soon lose the interest values of parks.

Wayne Martin
Hubbard Brook Experimental Forest, New Hampshire

Hubbard Brook is a 3200-hectare reserve dedicated to the long-term study of forest and stream ecosystems. The U.S. Forest Service established the area in 1955 as an Experimental Forest Research Station. Because a large number of scientists use the area, we work in the context of established guidelines and rules.

While long-term monitoring was not ever the original goal, it grew out of the work proposed by successful researchers, and it fed upon itself. In other words, successful research programs dictated a long-term monitoring program, not the other way around. The long-term records continue to attract scientists and funding today.

"In other words, successful research programs dictated a long-term monitoring program, not the other way around."

The station maintains long-term records on meteorology, stream flow, snow pack and water equivalent, ground water, precipitation, and chemical input/output. There is a 25-year record of bird and small mammal populations. The reserve also includes one of the most studied lakes in the world.

The reasons for monitoring and the way that things are monitored have changed some over time, but nothing has been dropped. As a result of maintaining long-term records, we have been able to make some very helpful observations. These include the following:

The pH record from 1968-82 shows annual variation around a steady mean. Between 1982 and 1988, however, pH increased. At the same time, SO_2 and cations declined.

I suggest there are three keys to successful long-term monitoring:

(1) Use simple and reliable equipment, so that new people will not have difficulty becoming familiar with it.

(2) Use the same equipment for as long as possible. If new equipment must be introduced, use it simultaneously with the old for a year before the transition is completed.

(3) Maintain continuity. The newest person at Hubbard Brook has been there for twenty years.

Funding constraints present the only "reason" why the National Park Service might arguably not monitor "forever" to verify ecosystem integrity.

Art McKee
H.J. Andrews Experimental Forest, Oregon

The H.J. Andrews Experimental Forest is a 6400-hectare area located at an elevation of 1,400-5,400 feet in steep mountain topography. One third of the area is cut over.

While the experimental forest was established approximately 25 years ago, the Long-Term Ecological Research (LTER) program officially began only ten years ago. Table 1 lists the basic principles and philosophy which guide the research program. Table 2 lists the program's research components.

Like Hubbard Brook, H.J. Andrews has seen its long-term monitoring be defined by the research itself. Forty to sixty scientists are active at any one time. As a foundation for their work, the research station currently monitors meteorology, losses/discharges of all metals, sediment loads, mass movement, sample plots, litter fall, exclosures, log decomposition, energy flow in aquatic systems, seasonal variation in hydrological discharges, young-of-the-year trout, seasonal retention of nutrients, stump decay classes, and mortality patterns (including spatial patterns) on permanent sample plots.

Results from data collection suggest that events, at this location at least, are episodic in the long term and that downstream enrichment from debris has allowed fish populations to increase.

"For this reason, I sometimes refer to 'the invisible present' – to the subtle but significant events that may well be happening at this moment but escaping our detection because of some function of the scale at which we collect data."

Allow me to elaborate on the first point with an example from Lake Mendota in Wisconsin. There, long-term monitoring of ice cover illustrates how our perspective and conclusions shift with an increasingly extensive database. Clearly, one year of data has no meaning. The ten-year record shows that the 1983 ice cover was unusually low, but the 50-year data shows that the '83 data match those of other years. What seems to be a fairly dramatic event within a decade looks simply episodic over a period of half a century. When we proceed to review the 132-year record, we can detect a slight decline in ice cover. (We suspect the El Nino current may be linked.) It is only with more than a century of data that we can detect climatic trends. For this reason, I sometimes refer to "the invisible present" -- to the subtle but significant events that may well be happening at this moment but escaping our detection because of some function of the scale at which we collect data.

What difficulties have we weathered at Andrews? What, if anything, has been wrong with our approach? After an initial period when too little was invested in the research station, too much became available.

TABLE 1

Basic Principles and Philosophy Guiding Long-Term Ecological Research (LTER) Program at H.J. Andrews Experimental Forest

The LTER program will look at important ecological hypotheses and processes that cannot be examined (or resolved) using short-term methods.

The LTER program will use sampling methods that are statistically appropriate to detect change (resolution) or to test hypotheses (replication).

The LTER program will develop and maintain the capability to reduce and analyze data rapidly and provide that data to collaborators.

The H.J. Andrews Experimental Forest will actively promote collaboration with other sites through the design of common experiments, development/selection of common measurement techniques, and exchange of data and personnel.

The LTER program will develop methods to place detailed, site-specific research in a landscape and regional perspective.

The H.J. Andrews Experimental Forest will maintain a basic terrestrial and aquatic measurement program.

TABLE 2

Research Components of Long-Term Ecological Research (LTER) Program at H.J. Andrews Experimental Forest

Changes in composition, structure, and key processes with succession in Douglas fir/Western hemlock forests.

The nature and importance of forest-stream interactions.

Population dynamics of young forest stands as affected by density and nutrient regime.

Long-term impact of early-successional, nitrogen-fixing shrubs on forest soils.

Patterns and rates of log decomposition.

Factors controlling long-term site productivity.

Because we were too optimistic about natural variation, we found that our sample sizes were inadequate.

We have found that the most difficult part of the whole program is setting priorities. And, finally, we have had to concede that not all questions can be answered, regardless of the dollars available.

The suggestions I can offer to you are these:

(1) Keep the activity simple. LTER funds provide for basic research around which other projects are developed.

(2) Routinely reappraise the program, but prevent wildly fluctuating swings regarding what data is collected.

(3) Remember that the H.J. Andrews program did not spring up overnight, but has grown over the course of 25 years. Those who were involved in the beginning tried to keep everything small and simple.

Ian Worley
Glacier Bay National Park, Alaska

There are four principal points I'd like to make today, as I share these slides of Glacier Bay and the monitoring work we're continuing to do in the National Park there. They are these:

(1) Monitoring requires much more anticipation of the future than is customary in scientific work.

(2) The monitoring future should not be a few years or even decades, but should transcend many, many human generations -- spanning at least centuries, if not millennia.

(3) The budgeting of monitoring is entirely different than normal field work and probably cannot come from governmental agencies due to their short-term character; the monitoring at the Cooper-Lawrence plots at Glacier Bay was due to a very small amount of university and Park Service support combined with a significant amount of personal monies.

(4) Monitoring leads to a personal identification of the individual stations; the stations become individualities rather than sample units, each with a developing personality. They may cease to have generality as time goes by.

In 1916, Dr. William S. Cooper established vegetation plots in Glacier Bay National Monument to monitor change following retreat of the glaciers there. Since that time, a handful of scientists, including Dr. Don Lawrence from the University of Minnesota, have monitored those plots, providing one of the longest chronological records in North America.

As individual researchers, we tend to think in time frames that pertain to our careers or our tenure in a particular research region. These are short time frames relative to the ecological and geologic processes we monitor.

"Monitoring ... stations become individualities rather than sample units .... They may cease to have generality as time goes by."

What we are finding in Glacier Bay, as we actually compile the long-term record, is that the successional process we anticipated is not necessarily the process we observe. The successional process at Glacier Bay that we've described in textbooks assumes that what happened at the foot of the glaciers 200 years ago is the process that is occurring at the foot of glaciers there today. We've referred to space and time interchangeably. Today, our data suggest that this is not the case. We suspect that proximity of seed source and the incidence of drought, for instance, alter the pace and course of succession.

Furthermore, we have recognized that the initially established one-meter-square plots have been too small to accommodate vegetative changes from herbaceous plants to the much larger spruce and hemlock trees.

In Glacier Bay, it is largely because of Dr. Lawrence's extraordinary personal dedication that succeeding generations of researchers have continued to monitor the plots set up nearly 80 years ago. It is not enough for us to count on personal dedication for the maintenance of these records that transcend careers and generations. We must cultivate institutional commitments to long-term monitoring. This calls for the humility to recognize our own limited perspective -- our mortality and ignorance --, but the insight will long outlive us.

Glenn Juday
Research Natural Areas, Alaska

Research Natural Area (RNA) is the principal administrative land use designation used by federal resource management agencies to build a network of sites containing all natural diversity features for scientific and educational use.

A joint federal-state effort to identify such sites in Alaska began in 1977 and planned a system of about 220 sites in the state. Since 1980, when the Alaska National Interest Lands Conservation Act was passed, over 50 RNAs have been established or formally proposed in the land use plans adopted for the new federal resource management units. The National Park Service, however, has chosen not to participate in this effort.

"Alaska ... has possibly the highest terrestrial species diversity of any equivalent latitude in the world."

The search for RNAs to represent specific elements of natural diversity forced some disciplined thinking about diversity issues in Alaska. Alaska is at the low end of the equator-to-pole species diversity gradient, but it has possibly the highest terrestrial species diversity of any equivalent latitude in the world. Explanations include the presence of unglaciated refugia, ocean and shoreline influences, impressive geologic diversity, and Bering Land Bridge influences. Overall, Alaska has some of the most complex and active geology in the world, which is closely linked to biological diversity. As a result, the phrase "natural diversity" is more appropriate than "biological diversity."

Inventory and monitoring projects in Alaska RNAs have involved large (up to one hectare) permanent forest reference stands, complete species inventories, successional study plots, erosion/deposition monitoring, and other projects specifically related to key elements of natural diversity in the given RNA. National parks in Alaska have some outstanding natural diversity resources and a few areas that have been monitored for a substantial amount of time.

Participation of the National Park Service in the statewide RNA program is recommended, so that the research community can have a stable, compatible land base to accompany the substantial investment of research effort represented by a long-term monitoring project. Low cost techniques of monitoring suitable for relatively low frequency visits have been used in Alaska RNAs and should be of use in national park inventory and monitoring in the State.

The Chena Hot Springs Workshop

Working Group Summaries

Air Quality Status

The National Park Service Air Quality Division (AQD) has focused funding and data collection primarily in Class I areas. Denali National Park is the only Class I area in Alaska compared with 156 Class I areas servicewide. Denali NP is an NPS trend site. The air quality monitoring system is a component of the Interagency Monitoring of Protected Visual Environments (IMPROVE) network and the National Atmospheric Deposition Program (NADP). NPS trend sites will be operated indefinitely to monitor servicewide changes in air quality.

The objectives of the IMPROVE network are to: (1) establish present visibility levels, (2) identify sources of existing human-made impairment, and (3) document long-term trends to track progress towards meeting the long-term goal of no human-made impairment of protected areas. The objective of the NADP is to assess the environmental effects of atmospheric deposition through understanding of nationwide distribution of deposition and its chemical composition.

Servicewide Class II areas have not received priority for the AQD limited funding. However, stacked filter units for sampling fine particulates are operating at Bering Land Bridge NP, Gates of the Arctic NP/P, Katmai NP/P, Noatak NP, Wrangell-St. Elias NP/P, and Yukon-Charley Rivers NP. The Aerovironment SFS-500 aerosol sampler was developed by the University of California, Davis. Each site collects samples for a 24-hour period every Wednesday and Saturday throughout the year to establish baseline conditions. Analyses are performed by Crocker Nuclear Laboratory, University of California, Davis and are funded by AQD and the Resource Management Division, Alaska Region. All analytical programs operate under formal third party quality assurance protocols. At a minimum, analytical results are received annually.

One objective of the Air Quality Division strategic plan for gaseous pollutant monitoring was to insure representation of significant ecoregions. As a result of this effort, additional gaseous pollutant monitoring trend stations will be installed at Noatak NP and Wrangell-St. Elias NP/P. One stacked filter unit will be transferred to Glacier Bay NP/P for baseline data collection.

In addition to the trend stations the strategic plan established eight baseline stations. The baseline stations will operate in a NPS unit for five years to establish baseline air quality conditions. Upon completion of the five-year sampling period the station will be moved to another NPS unit. These stations will be placed in both Class I and II areas. The Alaska units will compete for baseline stations.

Recommendations. Analytical results of both the stacked fine filter units and NADP sensors have not been received by the Region and parks in a timely and consistent fashion. The reports usually consist of raw data and data summaries without interpretation. It would be beneficial to all involved if at a minimum an annual report was received that interpreted the data in light of changes throughout the year; made comparisons with other Alaska stations; compared results with previous years, other Alaska stations, and servicewide stations; explained the significance of recorded values; and identified potential ecological concerns or impacts that could occur at current pollutant levels or anticipated future levels.

Workshop participants recognized the value of preparing an Alaska Region Air Quality Management Plan with the assistance of the Alaska Region, AQD, and other air quality management agencies and research scientists to generate recommendations for a regionwide air quality program with associated funding support to achieve mandated protection of air quality resource values. A monitoring program may include but is not limited to the following programs and suggested elements:

Programs: National Atmospheric Deposition Program (NADP)
National Dry Deposition Network
Interagency Monitoring of Protected Visual Environments (IMPROVE)

Sampling for: Ozone
Sulphur Oxides
Trace Elements
Fine Particulates

Climatology Status

Appendix E lists weather stations by park unit, including seasonal, year-round, and Remote Automated Weather Stations (RAWS). Most weather data in NPS units come from RAWS. Nine of the ten RAWS were purchased, installed, and maintained by fire management funds primarily for fire weather data collection. They have typically been operated from June through September.

All existing RAWS are scheduled to be modified for operation throughout the year. In addition to upgrading existing stations, five new RAWS with cold weather modifications have been received and will be installed in Yukon-Charley Rivers NP, Lake Clark NP/P, Kobuk Valley NP, Denali NP/P, and Bering Land Bridge NP. Existing precipitation gauges are reported to be highly inaccurate in windy areas.

Recommendations. The year-round operation of RAWS primarily benefits operations and activities other than fire management. A coordinated program of funding for maintenance and data recovery should be implemented among potential users of climatological data. Daily two pm fire weather observations are archived in the National Fire Weather Library. All weather observations should be archived at the national climatological weather data center for use by resource managers and research scientists.

Programs should be institutionalized to insure that RAWS are properly calibrated and maintained for year-round operation, including timely response to emergency repair needs. Wind shields should be installed around the precipitation sensors in windy areas.

Participants

Brad Cella	NPS, Alaska Regional Office
Doug Kane	University of Alaska Fairbanks
Al Lovaas	NPS, Alaska Regional Office
Kate Roney	NPS, Northwest Areas
Bruce Wiersma	University of Maine, Leader

Vegetation

Goals

1. To document the natural diversity and understand natural variations in vegetative communities of the ecosystems of the national parks in Alaska.

Objectives

1. To develop a hierarchical vegetation classification and apply it in each park;

2. To extensively survey all parks;

3. To develop a species list of flora for each park, including vascular plants, mosses, and lichens;

4. To intensively characterize the states of dominant ecosystems and rates of processes within at least one watershed in each park each year;

5. To intensively monitor sensitive systems;

6. To identify characteristic vegetative communities within the parks;

7. To establish reference plots for intensive, long-term monitoring of characteristic vegetative communities;

8. To establish study sites addressing special topical issues, including service plots for other interests; and

9. To establish rare plant plots selected to monitor population status of uncommon or "sensitive" species.

Status

Plots used historically need to be identified.

Recommendations

1. Reference plots for long-term monitoring of typical vegetative communities should be selected to coordinate with existing installations in Research Natural Areas and Long-Term Ecological Research (LTER) sites.

2. Data for intensive vegetation study plots must include the population of each taxa as well as its distribution, live and dead biomass, and leaf area. Soils data must include profiles, structure, and physical and chemical parameters.

3. Documentation of processes must include production (e.g., litterfall), decomposition, natality/mortality, and disturbance factors.

4. Sampling and monitoring approaches for rare plant plots must be determined by the biology of the individual species.

Participants

Gary Ahlstrand	NPS, Alaska Regional Office
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Terrestrial Fauna

Summary

Participants representing the Alaska Region and four national parks in Alaska drafted a three-part inventory and monitoring (I&M) program for terrestrial fauna in the region. The proposed program includes monitoring of selected species and communities. Objectives differ for each component.

Monitoring of selected species emphasizes the roles which individual species play in ecosystem management. Certain species are sensitive to impacts or harvest. Others have special legal status or are "charismatic" to the public. Others are significant and critical components of ecosystems. Others are rare or restricted in range. Some are, or may be, indicator species which reflect ecological problems unanticipated by managers.

Participants developed a ranking system to guide the objective selection of species to be monitored (Table 3). Criteria included the above-mentioned considerations, the presence of sufficient numbers of a species for accurate and precise monitoring, and the availability of accurate and precise techniques for monitoring each species. The proposed species ranking system may also be useful in determining the monitoring priority of key aquatic fauna within the region.

Community monitoring targets the fauna associated with major types of vegetative communities and is, therefore, very closely tied to the vegetation monitoring program. Monitoring is designed to include all small and medium-sized mammals, birds, and perhaps certain insects.

Substance monitoring is designed to identify and track toxins in the environment. The objective is to monitor known toxins that are likely to be encountered by the fauna of the region (e.g., organochlorines, heavy metals, and radioactive substances), because they may be specific and early indicators of problems where they occur. The general environment and the fauna itself will be sampled. This work is closely linked to the monitoring of air, water, and vegetation quality.

The program must be simple and consistent over the long term. It should be institutionalized into NPS procedures and integrated with other related state and federal efforts. Wherever possible, we must enlist the help of scientists and specialized experts from the National Park Service in and outside of Alaska, other agencies, universities, and any other qualified members of the public.

The many practical problems associated with long-term monitoring include challenging logistics in Alaska, insufficient funding, inconsistent support from the National Park Service, and the difficulty of applying reliable scientific methods in the field.

TABLE 3

Species-Ranking Selection Criteria for Monitoring Program

Each species is given a rank [low of 1 to high of 5] in each category. The separate ranks are summed to assess priority for each species. All other things being equal, the highest-ranking species are incorporated into the monitoring program.

Criteria and Ranking Scale:

	1	2	3	4	5
Population Size	rare				abundant
Legal Status	none				protection
Distribution	worldwide				limited
Harvest	no pressure				high pressure
Value to the Public	low				high
Dominance	low effect				considerable effect
Susceptibility	low				highly vulnerable

Examples:

	Golden Eagle	Red Squirrel	Pine Marten	Swan Sp.
Population Size	3	4	3	3
Legal Status	5	1	1	4
Distribution	2	1	1	1
Harvested	1	2	5	2
Value to the Public	4	2	3	4
Dominance	3	3	2	2
Susceptibility to Impacts	3	2	3	4
Totals:	**21**	**15**	**18**	**20**

Participants

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Freshwater Systems

Objectives

1. To introduce the National Park Service to the concepts and values of inventorying and monitoring its resources;

2. To articulate objectives for monitoring freshwater systems;

3. To identify "vital signs" and the parameters appropriate for monitoring them;

4. To inventory freshwater systems in Alaskan national parks, in order to provide baseline information and a basis for designing a monitoring program; and

5. To design and initiate a stable, long-term monitoring program.

Summary

Workshop participants discussed various parameters that may be important to measure in lakes, streams, and wetlands in Alaskan national parks. Although there was no consensus on a freshwater monitoring program, participants agreed on a few very basic points.

Participants generally agreed that a freshwater water body inventory must be conducted in the national parks in Alaska before specific monitoring plans can be defined. A basic inventory (size, type, number of water bodies, approximate volumes) would provide information to "stratify" and provide a comprehensive picture of the water resources in the parks. The inventory must include basic geographic information gathered from maps, photos, and existing information, as well as an on-the-ground resource level inventory.

Participants also agreed that if parameters are to reflect the character and function of freshwater systems, they must be interdisciplinary and integrated (Table 4).

Participants felt the need to emphasize that repeated inventory does not constitute monitoring.

The principal points of discussion are summarized on the following pages.

TABLE 4

Aquatic Resource Linkages to Other Disciplines

Discipline	Examples
Cultural Studies:	History of Human Activity
Subsistence:	Land Disturbance, Fish Populations, Acid Deposition, and Associated Changes in Stream Chemistry and Soil
Lithology:	Effects on Stream Chemistry
Botany:	Nutrient Input
Forestry:	Fire and Associated Watershed Change
Archaeology:	Time/Depth Strata of Information
Geomorphology:	Sedimentation, Volcanism, Earthquakes
Remote Sensing:	Inventorying, Interpreting, and Calculating Information on Water Resources

Points of Discussion

Defining the System. Basic inventory is a realistic objective for NPS in Alaska today. Such a basic inventory would let NPS know what's there. Consider these questions: What are the objectives of inventory? What are you going to inventory? What are the factors to use in the first step of the inventory process?

Do we include wetlands, groundwater, lakes, and estuaries in these freshwater systems discussions?

We should tally types of aquatic resources (e.g., glacial vs. clearwater; deep vs. shallow; inland vs. coastal; etc.).

Between the basic inventory and the selection of components to monitor, some baseline information should be gathered; this will provide better information in order to select monitoring components.

There is a need to identify "vital signs" in Alaska; we don't know yet what the parameters are.

Inventory work would include basic lake morphometry, which is important to know before lake water chemistry work is initiated.

Freshwater scientists tend to view water as a system, not as separate entities; vegetation is too often viewed as a separate unit and not incorporated into a system orientation.

Selecting Parameters. Are there common parameters that occur among freshwater/saltwater systems that can be used to monitor these systems, such as nutrient transport, primary productivity, nutrient release, decomposition, and water movement?

Physical parameters need to be measured during different seasons, not just in the summer months. Some important physical parameters to consider: rainfall, soil storage (groundwater, permafrost), runoff, snowfall, snowpack, evapotranspiration and evaporation, wind, snow moisture, and surface energy balance.

Permafrost presence or absence affects freshwater systems in Alaska. In designing monitoring plans, we need to tie permafrost into hydrological response.

Eutrophication is a good indicator of the health of lakes and would probably be a reliable indicator for Alaskan lakes; $chlorophyll_a$ would be a dependable parameter.

There is a need to "walk down" through the deductive process in order to have basic information to select monitoring parameters.

See Inventory and Monitoring Flowchart for Water Resources (Figures 3a and 3b).

Monitoring. Select basins that are widely representative because parks are so large; to make this selection, look at soils, vegetation, and factors that will affect aquatic systems.

One can't assume that "now" is "natural"; we must remember that "now" may be altered.

In order to select monitoring parameters, it is necessary to divide the processes and look at the parameters (Figures 3a and 3b). The selection of monitoring components is presented in Figure 3b.

The charge of this working group is to define components in a monitoring system and to define an objective; ask why do you want to monitor?

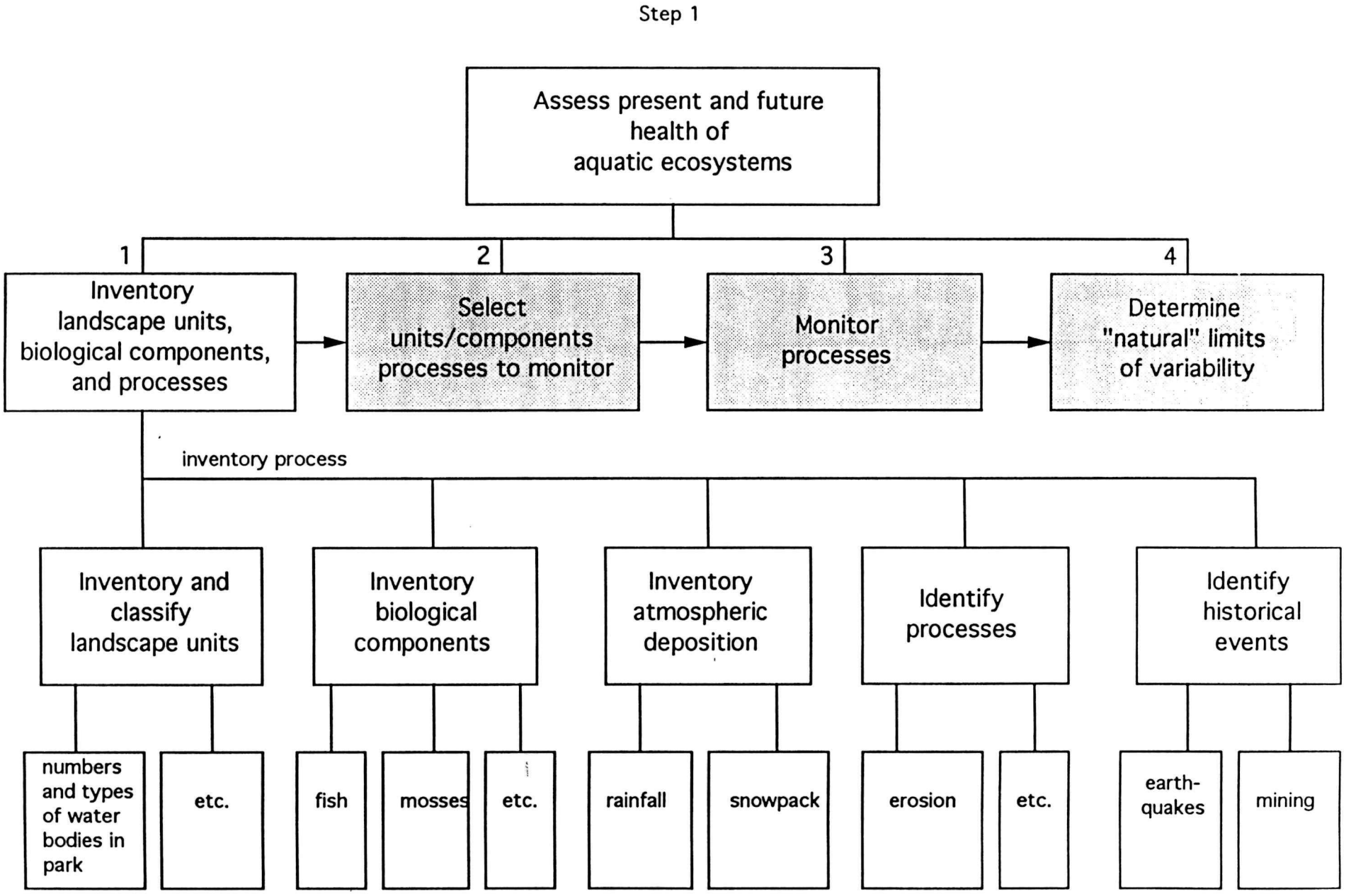
The primary concern for aquatic resources is threats that have been identified already (e.g., concern for Wild and Scenic River status and the preservation of the wild, natural element). The Charley and Tlikakila Rivers are two of the few Wild Rivers in the U.S. located entirely within a park; there is a need for baseline information.

Resource managers have monitoring concerns that tie to threats because of lack of staff and funding; right now, it's difficult to think beyond immediate threats.

The NPS in Alaska should use a stratified inventory process and then select monitoring components appropriate for individual parks. This park level approach will address regional and global concerns if:

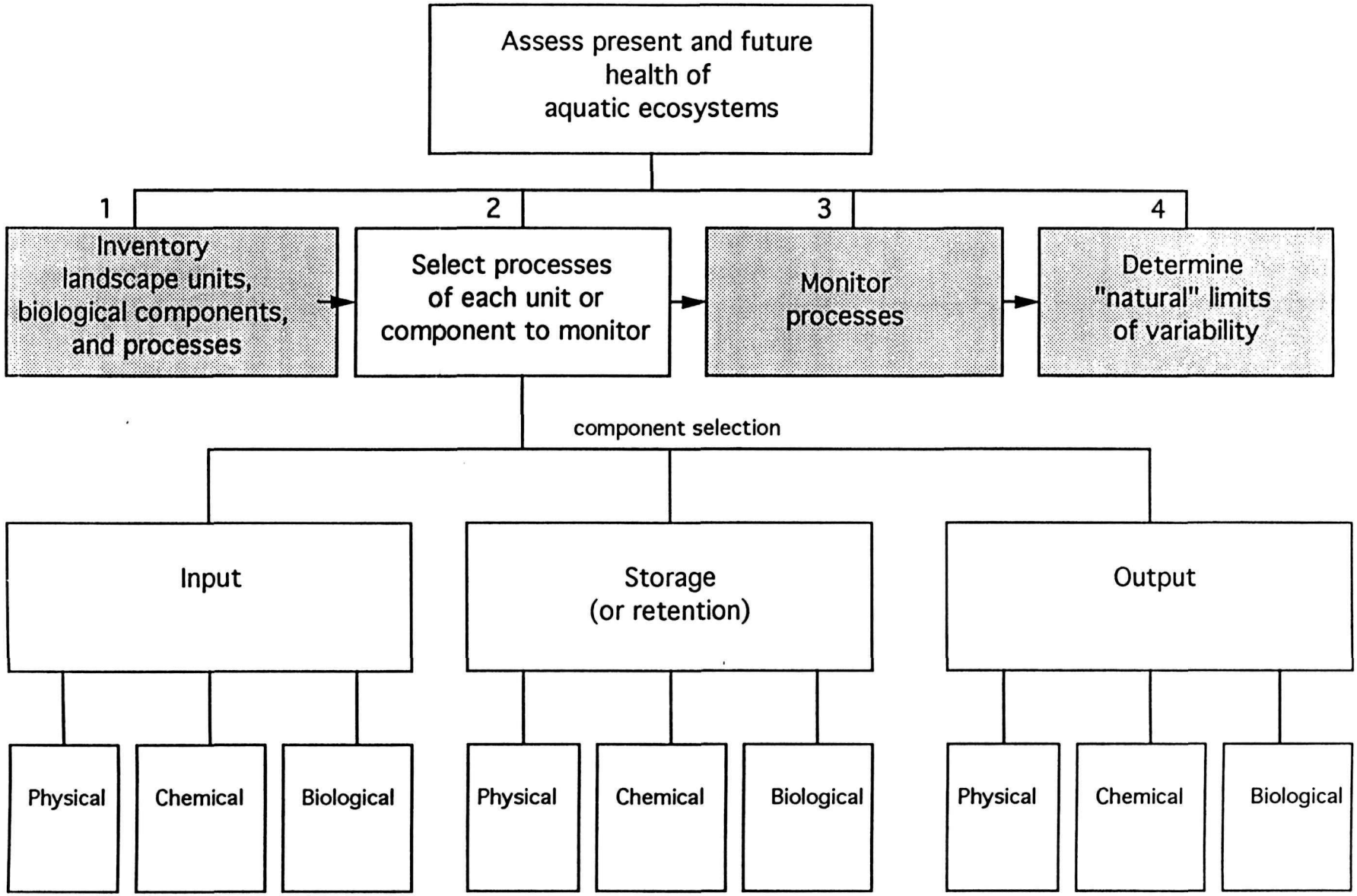
Figure 3a

Inventory and Monitoring Flowchart for Water Resources



This figure is excerpted from the water-resources I&M prototype drafted by Nancy Drum of the NPS Water Resources Division in Ft. Collins, Colorado. It serves as the basis of the I&M program in Katmai National Park and Preserve.

Figure 3b
Inventory and Monitoring Flowchart for Water Resources
Step 2: Component selection



This flowchart is excerpted from the water-resources I&M prototype drafted by Nancy Drum of the NPS Water Resources Division in Ft. Collins, Colorado. It serves as the basis of the I&M program in Katmai National Park and Preserve.

(1) the data management system is well designed before the project even begins;
(2) the appropriate monitoring components are selected; and
(3) a quality assurance program is established and adhered to.

(General group consensus was not reached on this approach).

A few key park units could be used to focus on global research concepts.

How will work be divided between private and government sectors? The U.S. Geological Survey, University of Alaska, and other agencies provide good basic water resource monitoring given appropriate funding.

Long-term monitoring will continue only if management and Congress can see benefits. It doesn't matter if the program starts off backed by good intentions; it will wither if there are no applications.

Acquaint the National Park Service with inventory and monitoring; emphasize why it is important and useful; sell the concept to the institution.

Stability and continuity of personnel are important aspects of a monitoring program; the program should be designed to continue uninterrupted despite changes in resource managers.

A stable program will bring in other money and other researchers; the program will grow upon itself, as Hubbard Brook research has grown.

Lake Monitoring Parameters. Participants reached no consensus on lake monitoring parameters. The list of possibilities presented below is quite broad in scope.

Inputs:
Rainfall and Snowfall
Air Temperature
Wind Speed and Direction
Radiation
Inflow Discharge
Inflow Temperature

Storage:
% Light Transmission Through Water Column Stage
Conductivity/Total Dissolved Solids
Temperature Profiles
Oxygen Profiles
Alkalinity
Anions (SO_4-NO_3-Cl)
Cations (Ca-Mg-K-Na)
Total Nitrogen/Total Phosphorus
Color
Dissolved Organic Carbon
pH (If Technique Can Be Determined to be Robust)
Turbidity/Secchi Disk
Sediment Trap Algae
Chlorophyll$_a$

Fish Population Dynamics
Zooplankton
Waterfowl (During Molt)

Outputs: Outflow Discharge
Gases (H_2S, CH_4, N_2)

Why not use lake water temperature instead of radiation or light penetration? Temperature alone will not accurately reflect light available for photosynthetic growth.

Carefully consider the frequency of sampling and sampling depth in lakes; we need to sample for monitoring purposes (before any known threat); sample 2-4 times per year for monitoring, trying to catch seasonal changes and mixing.

Surface sediment concentration of diatoms and protista may not be an appropriate monitoring technique due to extensive time for analyses; other lake parameters might be better (e.g., chlorophyll$_a$ in the water column).

Contaminant concentrations in fish tissues are not reliable parameters to monitor in Alaskan lakes; instead monitor fish population dynamics.

Waterfowl was suggested as a lake monitoring parameter in Alaska. However, the terrestrial study group may have already outlined a waterfowl monitoring strategy. Fish-eating raptors would not be a reliable lake monitoring parameter in Alaska (general group comments).

Stream Monitoring Parameters. Participants developed a short list of stream monitoring parameters but did not reach consensus on priorities for use in monitoring. Among the parameters are:

Carbon, Phosphorus, Nitrogen (Dissolved Inorganic and Organic, Particulate Organic)
Taxa List (Macroinvertebrates, Benthic Algae)
Conductivity
Discharge

Participants identified several parameters that could be measured before, during, or after suspected impacts. These are benthic sediments, coliform, *Giardia*, in situ biomonitoring, and stream morphometry.

The "storage" process is not a valuable parameter due to extreme variability and changing inputs. In addition, certain storage parameters are too specific for a general stream monitoring program. Storage parameters, such as coliform bacteria, address a specific resource threat and do not meet the goal for a stream monitoring program (general group discussion).

Are stream morphometry and stream channel structure important monitoring parameters? In general, participants felt that these parameters were not a high monitoring priority. They may, however, be an important element in some specific cases (e.g., changes in glacial river structure).

Are suspended sediments an important issue or simply an inventory parameter? Glacial sediment loads may be an important monitoring parameter in some cases. Aquatic invertebrates would be a better parameter, however, as the presence of invertebrates reflects general stream conditions, while sediment load is highly variable.

Wetland Monitoring Parameters. All participants concurred that, while wetlands are an important water resource element, they are difficult to monitor. We must keep in mind, particularly in the case of wetlands, that all hydrological components, including permafrost, aufeis, groundwater, surface water, etc., are interrelated. Very little information exists to guide this portion of monitoring work. Participants generated these possible parameters:

Inputs:	Same Parameters Identified for Lakes and Streams (Dependent on Type of Wetland) Balance of Surface/Groundwater
Storage:	Areal Extent Stage Waterfowl
Outputs:	(No Decisions Drawn for This Category)

Areal extent of wetlands may be an important parameter to measure, as it may reflect loss of wetland habitat over time (general discussion).

Natural flood and drought will increase or decrease wetland areal extent and must be noted in monitoring.

Global warming may change wetland extent; for this reason, areal wetlands may be an important indicator.

Natural succession of wetlands to terrestrial habitat would cause a decrease in areal wetlands; fire would also affect areal extent of wetlands over time (general discussion).

Aufeis may be an important wetlands parameter to measure as an indicator of fish overwintering habitat.

Long-term simple stage monitoring and limited water quality monitoring could provide some information on changes in wetlands over time. Areal extent and long-term stage readings might be a good combination of factors for monitoring.

We should invest a significant amount of time on a basic wetlands inventory; then design a monitoring program for the gross classification of wetlands.

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Earth Surface Processes

Philosophy

Geological inventories identify the major earth features in the parks. Earth surface process inventories focus on features such as glaciers, volcanoes, avalanches, large earth slides, geologic strata, soils series, and associated processes that shape landforms. These must be mapped and monitored.

Many earth features and processes in national parks in Alaska are unique. Unlike most other ecosystem components, most of these are not threatened by human activity; rather, they often pose hazards to people. Volcanic eruptions, earthquakes, tsunamis, avalanches, and falling ice serve as examples. A long-term effort is required, although the periodicity of monitoring may be years. Significant geological hazards and features undergoing rapid change would require regular monitoring.

The inventory and monitoring effort on earth surface processes should be done in cooperation with outside assistance from the USGS, Soil Conservation Service, and other scientists. The work should be accomplished with minimum-tool and minimum-impact techniques. Some geologic research will, however, be temporarily disruptive to the landscape.

Goals

1. To document earth processes that drive change on and near surfaces of national parks in Alaska.

Objectives

1. To establish baseline information on earth features and processes in Alaska national parks by inventorying historic data sets of geologic/soils features and processes from large to small scales;

2. To identify significant gaps in geologic/soils knowledge and formulate a plan to complete baseline inventories; and

3. To identify important features and processes to monitor change over time using various techniques, particularly remote sensing coupled with a Geographic Information System.

Methods

Rely upon remote sensing, including aerial and ground photography, as a primary tool for the inventory and monitoring of landforms and earth surface processes. Repeat imagery will be most helpful for monitoring.

Ground truth all remotely sensed data.

Use stratigraphic measurements to document and monitor profiles of atmosphere, snow, soils, and rock.

Example:

Landform: Glacier

Why measure the glacier? Glaciers comprise major features, attract visitors, and require interpretation in many national parks in Alaska. Over 70% of all the glaciers in the U.S. lie in national parks. They can be helpful indicators of climatic change since they integrate changes in temperature and precipitation. Their presence controls and drives nearby ecosystems, and they are the major form of freshwater storage on the globe. Runoff from some glaciers affects water rights considerations.

What can be easily measured about a glacier that has some value? Terminus position and profiles, both longitudinal and cross sectional.

How should glaciers be monitored? Satellite imagery and photographs from air and land. Watch for unusual features and activity such as badly broken ice surfaces and surges.

Strategy

1. Develop a list of experts in the field regarding Inventory and Monitoring (I&M) of various landforms and earth processes.

2. Develop questions for resource experts on I&M systems:

   a) Can the work and expense be justified?
   b) Is the project relatively inexpensive?
   c) Can minimally trained staff repeat the work with accuracy?
   d) Does the work tie in with other disciplines (i.e., meteorology)?
   e) Are studies designed to give pertinent clues to resource changes?

3. Contact experts to elicit I&M needs and potential research. Use person-to-person surveys whenever possible. Written questionnaires and inquiries must be followed up with personal contact if used at all. Otherwise, a serious response is unlikely.

4. Develop long-range I&M goals that are compatible with MAB and other global I&M priorities.

5. Seek peer review of I&M Plan and research project statements by a large group with expertise.

6. Develop a resource list of individuals and references for superintendents and resource managers at each park (Appendix F).

7. Have historic and existing data sets interpreted by geologists or other specialists.

8. Establish computer data search linkages for National Park Service personnel.

9. Develop thorough reference lists and collections for each park unit in Alaska with bibliography and image indexes.

10. Develop manuals for resource managers that detail methods and protocols for I&M. Standardize methods for establishing baselines and monitoring resources that are repeatable and comparable to work elsewhere.

Special Concerns

Outside review of National Park Service research, inventorying, and monitoring is healthy and badly needed. NPS research and I&M funding generally overlook geomorphologic resources and processes since they are rarely threatened. These resources have far-reaching implications and therefore should not be ignored. The I&M system in Alaska NPS should comprehend all natural resources including geologic/geomorphic resources, as well as the biological component.

Participants

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Jeanne Schaaf	NPS, Alaska Regional Office
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John Yarie	University of Alaska Fairbanks

Objectives

1. To conduct long-term monitoring of the "naturalness" of ecosystems. (Some group members felt that the terms "health" or "wildness" were more appropriate than "naturalness.");

2. To define the structure and processes of natural regimes;

3. To establish a historical baseline;

4. To focus on critical areas, which are:

   (a) those more easily disturbed and/or less resilient; and/or
   (b) those with special ecological importance (e.g., endangered species);

5. To avoid disturbances which may serve as "trigger factors" to destabilize the system, by evaluating cumulative, synergistic, and novel impacts; and

6. To define interfaces with other monitoring and research programs.

Strategies

Order and importance are not rigorously addressed in the following list of strategies:

1. Determine areal extent of disturbance, extending beyond the park boundaries where appropriate, particularly in biosphere reserves.

2. Understand and map cyclic disturbances such as fire. Define the temporal nature of disturbance, including seasonality and duration.

3. Evaluate the intensity of disturbance and the resilience of the ecosystem.

4. Identify functions to be monitored (e.g., vegetation, thermal stability, nutrients).

5. Identify management options, including prevention, mitigation, amelioration, and/or restoration.

Human Disturbance

Participants first listed the types of human disturbance in our parks which may require long-term monitoring. We excluded human disturbance types that we felt would be covered in other groups. Our list included:

Placer Mines
Roads (Dust, etc.)
Runways
Facilities
Visitor Impact (Trails, etc.)
Mechanized Transportation (ATVs, etc.)
Timber Harvest
Noise (Aircraft, Boats, etc.)

Example: We focused on one type of disturbance, ATV trails, to help us work on methodology. The following list of methods is presented in the order discussed:

1. Determine areal extent of disturbance from aerial photos and select control areas.
2. Ground truth selectively.
3. Establish monitoring interval.
4. Evaluate historical baseline -- time of trail use, frequency, etc.
5. Measure effects on vegetation, soils (including thermal regime), water quality, and wildlife use.
6. Select study sites (including baseline), plans, and intervals.
7. Evaluate priorities, importance, urgency.
8. Integrate GIS data, etc.

Natural Disturbance

We discussed and prepared a list of natural disturbances that occur in our parks such as fire, erosion and deposition, glaciers, and frost action. There was some discussion as to whether our group should address all disturbances or focus on just human disturbance. We discussed the importance of natural disturbance as an analog to human disturbance. For example, knowledge of the rate and direction of natural riparian succession would provide a reference point for evaluation of the factors limiting succession on placer mine spoils.

Methodology

After discussing methods for one type of disturbance, we continued to develop general methods for long-term monitoring of human disturbance:

Aerial Extent:	Satellite photos (GIS data) Aerial photos (various levels) Ground photos
Historical Baseline:	Literature Archive photos Interviews Site visits
Effects:	Identify both overall and site specific goals

	Identify variables to be monitored Select study sites, sampling methods, and sampling interval Link with overall regime of disturbance
Evaluation:	Internal and external review, within and between parks Evaluate objectives and whether methodology addresses them
Intervention:	Prevent, ameliorate, or restore disturbance

Periodic review and coordination must be both internal and external.

Products

Management maps
Report on monitoring, database
Management applications
- Permit review
- Permit review strategies
- Alternatives, guidelines

Environmental technologies
Research topics
Expert testimony
Information for interpretive programs

Example: Our group then worked through the methodology again for a specific type of disturbance, subsistence timber harvest for cabins and firewood, and came up with the following approach:

Baseline Inventory: Present
- Existing vegetation and commercial timber from GIS data, ground sampling, and reference stands
- Habitat use
- Water quality
- Endangered species
- Slope, aspect, etc.

Baseline Inventory: Historical
- Permit records, inventory of old cuts, interviews
- Literature

Monitoring Impacts
- Determine location, timing, extent, access, and harvest method for proposed timber harvest

Effects to Evaluate
- Localized bark beetle outbreaks
- Windthrow

Regeneration potential
Probable rate and direction of succession
Endangered species
Visual quality
Special habitat considerations

Cumulative Impact
Percent of plant community type lost on a regional basis

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The Chena Hot Springs Workshop

Appendices

Appendix A
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Appendix B
H.J. Andrews Sample Study Design

Sample Measurement Program for Long-Term Ecological Research (LTER):

Research Component #1:

Changes in Composition, Structure, and Key Processes with Succession in Upland Douglas Fir/Western Hemlock Forests at H.J. Andrews Experimental Research Forest

Parameter/Process Interval	Sampling Interval	Scale: Plot/Stand	Watershed
Plant composition/diversity	6-7 yrs	x	x
Vascular plant biomass	6-7 yrs	x	x
Leaf area	6-7 yrs	x	x
Woody debris (standing and down)	6-7 yrs	x	x
Tree growth	6-7 yrs	x	x
Tree mortality	1 yr	x	x
Input of coarse debris	1 yr	x	x
Litterfall	3 wks	x	
Decomposition[1]	variable	x	
Canopy closure	3-5 yrs	x	
Seedfall	2/yr	x	
Soil chemistry	5-10 yrs	x	x
Invertebrate composition/ diversity	4/yr every 5 yrs	x	
Vertebrate composition/ diversity	2/yr every 5 yrs	x	x

[1]Primarily Handled in LTER Component # 5

Appendix C
Water Resources Inventory and Monitoring Prototype

(Please refer to flowcharts in Freshwater Systems section.)

I. Background Information.
   A. Compile background information including present water resources program.
      1. Perform literature search.
      2. Miles of stream by Rosgen classification and by water use class (both designated and actual).
      3. Acres of surface water by use class.
      4. Volume summaries (acre feet; acre feet/year).
      5. Watershed delineations.
      6. Spring and well locations (yields, if available).
      7. Important ground water resources.
      8. Basic water quality.
      9. Ecoregion and associated reference water quality standards.
      10. Identify in-park pollution sources and summarize potential constituents and issue by watershed.
         a. Landfills.
         b. Underground tanks.
         c. Vegetation cover condition (erosion condition).
         d. Roads.
         e. Facilities.
         f. Sewage disposal lagoons.
         g. Production wells.
         h. Parking lots.
         i. Visitor use.
         j. Others.
      11. Identify out-of-park pollution sources, with emphasis on upstream land uses. (Summarize potential issues and constituents by watershed.)
         a. Agricultural.
         b. Industrial.
         c. Municipal.
         d. Forestry, grazing.
         e. Mining.
         f. Hazardous materials sites.
         g. Oil and gas fields.
         h. Acid rain.
         i. Others.
      12. Develop a list of constituent concerns, applicable water bodies, and likely mode/period of contamination.
      13. Interview local people to gain knowledge about the area.
      14. Review data from nearby sites not in the park and compare data for frequency of sampling, constituents, discharge, drainage area, etc.

B. Form objectives.
   1. Evaluate background data within and near park.
   2. Evaluate pollution sources and potential area of impact.
   3. Evaluate list of constituent concerns, applicable water bodies, and likely mode/period of contamination.

II. Inventory and Monitoring.
   A. Design an ideal sampling program.
      1. Characterize sampling schemes from objectives.
         a. Synoptic or baseline sampling (inventory).
            i. Occurrence and spatial distribution of broad array of water quality constituents.
            ii. Single water quality measurements representing a single hydrologic condition at many sites during a brief period of time.
         b. Fixed station sampling (inventory).
            i. Describe temporal variation and frequency of occurrence of selected water quality constituents.
            ii. Limited time period sampling: 1-2 years.
         c. Intensive studies of selected reaches or focused on critical issues (monitoring).
            i. Long-term monitoring designed around a hypothesis to detect change in condition.
      2. Develop site list.
      3. Develop constituent list.
      4. Develop an experimental design to determine sampling frequency.
      5. Determine laboratory analyses.
      6. Prioritize hypotheses and objectives.
   B. Review resource availability, constraints, and other considerations.
      1. Person power.
      2. Budget.
      3. Policy requirements.
      4. Consistency with existing data.
      5. Quality assurance/quality control at laboratories and with data collection and analysis.
      6. Statistical validity.
   C. Design modified feasible sampling program given constraints.
   D. Design data management system.
   E. Implement modified sampling program and data management system.
   F. Prepare interpretive report.

Appendix D
Inventory and Monitoring Questionnaire, NPS, Alaska

Return to Dale Taylor,
Alaska Regional Office
by December 15, 1988

Park name:

When was the unit established?

How many acres in the unit(s) (i.e., preserve/park)?

How many FTEs on the resource staff?

Research staff?

How large is the research/resource staff to be in the future?

How much money was available for 1988 projects in the park?

List 1988 projects. (Include all contracted, cooperative, volunteer, or other projects being conducted in the park.)

Do you maintain a list of park project reports that are separate from the Regional Office Natural Resources Report Series?

(If so, is a list available? A summary of the Natural Resources Report Series is being prepared by park unit and subject matter.)

Do you maintain climatic records?

What is the location of weather stations? (Include all RAWS data stations.)

What are your immediate inventory and monitoring needs?

Appendix E
Inventory and Monitoring Survey Results

Appendix D includes the following information:

Summary data from inventory and monitoring survey, NPS, Alaska.

Projects, weather stations, and inventory and monitoring needs by park:

Aniakchak National Preserve
Bering Land Bridge National Preserve
Denali National Park and Preserve
Gates of the Arctic National Park and Preserve
Glacier Bay National Park and Preserve
Katmai National Park and Preserve
Kenai Fjords National Park
Klondike Gold Rush National Historical Park
Lake Clark National Park and Preserve
Northwest Areas
Wrangell-St. Elias National Park and Preserve
Yukon-Charley Rivers National Preserve

TABLE 5

Summary of Inventory and Monitoring Survey, NPS, Alaska
12/20/89

Park Name	Date Established	Acres (mm)	FTEs *	Research Positions	Planned Positions **	Funding 1988 (m$)	Projects 1988	Weather Stations
Aniakchak	12/80	0.6	1	0	0[1]	95.0	3	0
Bering Land Bridge	12/80	2.7	1	0	5	146.5	9	0
Denali	2/17	6.03	6	0	6	890.0	26	3
Gates of the Arctic	12/80	8.4	3	0	7	331.0	12	3
Glacier Bay	2/25	3.3	1	0	5	125.0	5	1
Katmai	9/18	4.2	1	0	6	85.0	2	2
Kenai Fjords	12/80	0.58	1	0	3	0	5	4
Klondike Gold Rush	6/76	0.01	0	0	1	0	0	0
Lake Clark	12/80	3.65	2	0	6	289.5	17	1
Northwest Areas[2]	12/80	9.0	3	0	6	247.6	15	6
Wrangell-St. Elias	12/80	13.0	2	0	7	237.0	11	2
Yukon-Charley	12/80	2.2	1	0	5	114.0	6	2
Totals		**53.6**	**22**	**0**	**57**	**2,561.0**	**111**	**24**

*Resource Manager Positions
**Combined Research and Resource Manager Positions
[1]Combined with Katmai
[2]Cape Krusenstern, Kobuk Valley, and Noatak combined as Northwest Areas

Aniakchak National Preserve

600,000 acres

Projects

1. Surprise Lake limnological study
2. Black Lakes bear study
3. Aniakchak Caldera fisheries survey

Weather Stations

None

Inventory and Monitoring Needs

1. Baseline data
2. Furbearer populations

Bering Land Bridge National Preserve

2,700,000 acres

Projects

1. Baseline survey
2. Remote weather station installation
3. Curatorial equipment acquisition
4. Reindeer tracking
5. Serpentine Hot Springs water quality monitoring
6. Geomorphology studies of coastal processes (independent research)
7. Paleobotanical study of thaw lakes (independent research)
8. Revegetation of disturbed tundra

Weather Stations

None

Inventory and Monitoring Needs

1. Baseline data
2. Stream monitoring station on Humboldt Creek (mining related)
3. Expanded vegetation monitoring
4. Waterfowl and seabird censuses
5. Base funding for field operations

6,028,091 acres

Projects

1. Wolf study (cooperative)
2. Caribou studies (2)
3. Moose ecology study (cooperative)
4. Moose survey
5. Moose behavior study (cooperative)
6. Dall sheep survey
7. Dall sheep lambing habitat study (cooperative)
8. Merlin status study (cooperative)
9. Raptor inventory and monitoring
10. Road traffic effects on wildlife
11. Air quality monitoring
12. Stream chemistry study (cooperative)
13. Native plant revegetation materials development
14. Demography of willow study (cooperative)
15. Fire ecology study
16. Cottonwood disease study (cooperative)
17. Toklat River gravel replacement rate study (cooperative)
18. Kantishna Hills sensitive plant survey
19. Kantishna Hills weather monitoring
20. Kantishna Hills streamflow monitoring
21. Kantishna Hills small mammal study
22. Kantishna Hills revegetation survey
23. Mined area restoration (two locations)
24. Bear-human conflict study

Weather Stations

1. Headquarters (year round)
2. McKinley River RAWS (summer only)
3. Kantishna Hills

Inventory and Monitoring Needs

1. Baseline data
2. Road traffic impacts on wildlife
3. Wildlife population trends
4. Merlin pesticide levels
5. Air pollution effects on vegetation (future)
6. Natural and man-made climate change effect on flora and fauna
7. Reclamation and revegetation of mined areas and effects on drainage

8,400,000 acres

Projects

1. Wolf study
2. Furbearer study
3 Lake fish study
4. Firepro
5. Human impacts inventory
6. Raptor inventory
7. Water quality baseline survey
8. ATV and 106 compliance survey
9. Walker Lake water chemistry monitoring
10. Park plant survey
11. Air quality monitoring

Weather Stations

1. Norutak Lake RAWS station
2. Bettles flight service
3. Anaktuvuk Pass remote (air temperature most of the time)

Inventory and Monitoring Needs

1. Monitor raptor populations
2. Better methods for inventory and monitoring of large mammals
3. Establish a realistic program for annual monitoring to obtain baseline data

Glacier Bay National Park and Preserve

3,330,000 acres

Projects

1. Humpback whale study
2. Campsite impacts survey
3. Beardslee Island marine bird/marine mammal study
4. Selected large mammal surveys

Weather Stations

1. Bartlett Cove

Inventory and Monitoring Needs

1. Continue and upgrade existing projects
2. More emphasis on marine ecosystems
3. Weather stations placed in systematic fashion

Katmai National Park and Preserve

4,200,000 acres

Projects

1. Sociological study at Brooks Camp
2. Bear behavior study (cooperative)

Weather Stations

1. Brooks Camp
2. King Salmon

Inventory and Monitoring Needs

1. Baseline data
2. Furbearers

Kenai Fjords National Park

580,000 acres

Projects

1. USGS rock sampling for mapping
2. Camera monitoring of Exit Glacier (NPS/VIP)
3. Goat activity budget (NPS/VIP)
4. Eagle nest survey of coastline (NPS/VIP)
5. Campsite inventory of coastline (NPS/VIP)

Weather Stations

1. Exit Glacier (new year-round snow survey)
2. Aialik Bay (summer only)
3. Nuka Bay
4. Nuka River (SCS snow survey)

Inventory and Monitoring Needs

1. Baseline data
2. Glacier baseline data
3. Black bears at Exit Glacier
4. Plant succession at Exit Glacier
5. Mountain goat population monitoring
6. Vegetation inventory and mapping of entire park

Klondike Gold Rush National Historical Park

13,191 acres

Projects

1. Currently all are cultural resource projects, so none are listed

Weather Stations

None

Inventory and Monitoring Needs

1. Basic inventory

3,653,000 acres

Projects

1. Firepro
2. Tazimina River fish study
3. Socio-cultural study
4. Herbarium collection
5. Campsite evaluation
6. Mulchatna caribou study
7. Moose survey
8. Bald eagle survey
9. Dristen Creek water monitoring
10. Glaciers monitoring
11. Red salmon fisheries study
12. Salmon genetics study
13. Stony River airstrip rehabilitation
14. Salmon escapement study
15. Water baseline study
16. Salmon subsistence survey
17. Historical resource use survey

Weather Stations

1. Stony River drainage (RAWS)

Inventory and Monitoring Needs

1. Baseline data
2. Information on species used consumptively: subsistence and sport -- fisheries, caribou, moose, sheep, bear, wolf, wolverine, fox, lynx, martin, beaver
3. Timber and water surveys
4. Priorities: wolf, wolverine, martin, fox, bear, beaver

9,000,000 acres

Projects

1. Grizzly study (cooperative)
2. Wolf study (cooperative)
3. Noatak River raptor survey
4. Vegetation measures
5. Small mammal survey
6. Coastal waterfowl survey (cooperative)
7. Post-breeding bird transect
8. Tundra swan survey (cooperative)
9. Lepidoptera survey (cooperative)
10. Dall sheep trends study (cooperative)
11. Caribou census (cooperative)
12. Caribou collaring study (cooperative)
13. Eli River fire recovery monitoring
14. Air quality monitoring
15. Red Dog Mine water quality monitoring
16. Cape Krusenstern Geographical Information Systems (GIS) vegetation survey

Weather Stations

1. Kelly River (Raws, partial year-round)
2. Makpik (RAWS, partial year-round)
3. Kotzebue (year-round)
4. Ambler (year-round)
5. Kivalina (year-round)
6. Red Dog Mine (new, year-round)

Inventory and Monitoring Needs

1. Integrated inventory and monitoring program for obtaining baseline data

13,000,000 acres

Projects

1. Hubbard Glacier study (cooperative)
2. Forestry/grazing study
3. Fisheries study (cooperative)
4. Firepro
5. Hazardous wastes survey
6. Database management
7. Gravel pit survey
8. Bison habitat survey
9. Wildlife surveys
10. Mentasta and Chisana caribou study (cooperative)
11. Air quality

Weather Stations

1. Klawasi (west flank of Mt. Drum)
2. Chisana townsite
3. May Creek ranger station

Inventory and Monitoring Needs

1. Baseline data
2. Coastal zone succession -- retreating glaciers
3. Coastal zone old growth communities
4. Coastal zone ecology -- Oily Lake and Samovar Hills
5. Interior old growth white and black spruce
6. Alpine ecosystems

2,200,000 acres

Projects

1. Forty-mile caribou study (cooperative)
2. Fish survey (cooperative)
3. Firepro
4. Air particulate sampling
5. Yukon River water monitoring (informal agreement with Environment Canada)
6. Peregrine falcon banding study (cooperative)

Weather Stations

1. Ben Creek airstrip (RAWS)
2. Eagle fire weather (summer only)

Inventory and Monitoring Needs

1. Baseline studies
2. Peregrine falcon monitoring (preserve-wide)
3. Rare and endangered plant species survey
4. Fire ecology long-term studies
5. Small mammal survey
6. Placer mine disturbance inventory

Appendix F
Partial List of Earth Process Experts

Avalanches

Doug Fessler and Jill Fredston, Alaska Mountain Safety Instructor, Anchorage
Gail March, Fairbanks
Ed LaChapelle, McCarthy and UW

Beach Geomorphology

Dave Hopkins, UAF
Willie Weeks, CRREL/UAF (Ice dynamics)

Geomorphology

Dave Hopkins, UAF
Robert Thorsen, U. Conn.

Glaciology

Austin Post, USGS, retired
Larry Mayo, USGS, Fairbanks
Will Harrison, Geophysical Institute, UAF
Dennis Trabant, USGS, Fairbanks
Charlie Raymond, UW
Bob Krimmel, USGS, Tacoma

Fire History

Les Viereck, INF/UAF
Gary Ahlstrand, ARO
Charlie Van Wagner, U. Alberta, Edmonton

Hazards

Dick Reiger, DGGS

Landslides

Doug Swanson, Forest Sciences Lab, Juneau
Roy Sidle, Forest Sciences Lab, Juneau
George Plafker, USGS

Meteorology

NWS
Sue Anne Boling, Geophysical Institute, UAF

Permafrost

Troy Pewe, Arizona State U.
Tom Ostercamp, Geophysical Institute, UAF
Art Lachenbruch, USGS, Menlo Park

Physical Oceanography

Bruce Wing, NMFS, Juneau
Tom Royer, Institute of Marine Sciences, UAF

Soils

Keith VanCleve, UAF
Ted Dyrness, INF/UAF
Chin Lu Ping, Palmer Agriculture and Forest Experimental Station, UAF
Bernard Borman, USFS, Juneau
Ugolini, Dept. Forestry, UW

Stream Geomorphology

Roy Sidle, USFS, Logan UT
Charlie Collins, CRREL, Fairbanks
Ed Chaco, CRREL, Fairbanks
Jerry Niebler, NWS, Anchorage (Flood Forecast)
Doug Kane, Institute of Water Resources, UAF
Bob Carlson, Institute of Water Resources, UAF
Ross Powell, Ohio State U. (Tidewater glacier discharge)

Tectonics

Dave Stone, Geophysical Institute, UAF

Seismic Studies (Earthquakes)

John Davies, State Seismologist, Geophysical Institute, UAF
Peter Ward, USGS, Menlo Park

Snow Accumulation

George Clagget, SCS, Anchorage
Matthew Sturm, CRREL, Fairbanks
Ted Fathauer, NWS, Fairbanks
Mickewisz, NWS, Anchorage

Volcanoes

Jergen Kienle, Geophysical Institute, UAF
Tom Miller, USGS, Anchorage
John Power, Volcano Observatory, Vancouver, WA
Jim Beget, Tephra Library, UAF
Carl Benson, Geophysical Institute, UAF (Mt. Wrangell)

Attachment G
Workshop Participants

Gary Ahlstrand	Alaska Regional Office
Judy Alderson	Gates of the Arctic National Park and Preserve
Leanne Ayres	Northwest Areas
Mike Britten	Gates of the Arctic National Park and Preserve
Brad Cella	Alaska Regional Office
Charlie Collins	University of Alaska Fairbanks
Bruce Connery	Wrangell-St. Elias National Park and Preserve
John Dalle-Molle	Denali National Park and Preserve
Gary Davis	Channel Islands National Park, California
Roseanne Densmore	Denali National Park and Preserve
Nancy Deschu	Alaska Regional Office
Boyd Evison	Alaska Regional Office
Jessie Ford	U.S. Environmental Protection Agency
Russ Galipeau	Wrangell-St. Elias National Park and Preserve
Margie Galipeau	Wrangell-St. Elias National Park and Preserve
Carl Gureke	Klondike Gold Rush National Historical Park
Paul Haertel	Alaska Regional Office
Rich Harris	Bering Land Bridge National Preserve
Jerry Hilgert	University of Alaska Fairbanks
Larry Johnson	University of Alaska Fairbanks
Glenn Juday	University of Alaska Fairbanks
Doug Kane	University of Alaska Fairbanks
Ross Kavanagh	Alaska Regional Office
Penny Knuckles	Yukon-Charley Rivers National Preserve
Gene Hester	Washington, D.C. Office
Dave Klein	University of Alaska Fairbanks
Jim LaBau	U.S. Forest Service, Alaska
Jacqueline LaPerriere	University of Alaska Fairbanks
Al Lovaas	Alaska Regional Office
Wayne Martin	Hubbard Brook Experimental Forest, New Hampshire
Pat McClanahan	Alaska Regional Office
Janice Meldrum	Katmai National Park and Preserve
Art McKee	H.J. Andrews Experimental Forest, Oregon
Julie Michaelson	Alaska Regional Office
Ed Murphy	University of Alaska Fairbanks
Dianne Osborne	Alaska Regional Office
Mark Oswood	University of Alaska Fairbanks
Bud Rice	Kenai Fjords National Park
Kate Roney	Northwest Areas
Jeanne Schaaf	Alaska Regional Office
Chuck Slaughter	University of Alaska Fairbanks
Robert Stottlemyer	Michigan Technological University

Greg Streveler	Glacier Bay National Park and Preserve
Matthew Sturm	University of Alaska Fairbanks
Dale Taylor	Alaska Regional Office
Hollis Twitchell	Lake Clark National Park and Preserve
Pam Twitchell	Lake Clark National Park and Preserve
Steve Ulvi	Yukon-Charley Rivers National Preserve
Gary Vequist	Alaska Regional Office
Bruce Wiersma	University of Maine
Ian Worley	University of Vermont
John Yarie	University of Alaska Fairbanks
Jenny Zimmerman	Alaska Regional Office

Attachment H
Chena Hot Springs Workshop Agenda

Location: **Chena Hot Springs, Alaska**

Dates: **January 24-27, 1989**

Welcome and Introductions: Tuesday Evening, January 24

Gene Hester, Associate Director, Natural Resources, NPS, Washington, D.C.
Inventory and Monitoring from the Washington, D.C. Perspective

Chuck Slaughter, Institute of Northern Forestry and MAB VIII Director
Alaska National Parks in the Global Perspective

Presentations: Wednesday, January 25

Boyd Evison, Regional Director, NPS, Alaska
Keynote Address (25 minutes)

Dr. Wayne Martin, Hubbard Brook Experimental Forest, New Hampshire
Long-Term Watershed Monitoring (30 minutes)

Art McKee, H.J. Andrews Experimental Forest, Oregon
Long-Term Forest Monitoring (30 minutes)

Gary Davis, Channel Islands National Park, California
Establishing Long-Term Monitoring Programs: Problems and Successes (30 minutes)

Ian Worley, Glacier Bay National Park and Preserve, Alaska
Vegetation Plot Monitoring: Problems and Successes (the longest recorded use of plots in the nation) (30 minutes)

Jim LaBau, U.S. Forest Service, Alaska
U.S. Forest Service Inventory Approaches (30 minutes)

Glenn Juday, Research Natural Areas Coordinator, USA
Research Natural Area Inventory Techniques (20 minutes)

Dale Taylor, NPS, Alaska Regional Office
Unique Problems and Requirements of Inventory and Monitoring Work in Alaskan Parks (30 minutes)

Needs in Each Park: Small-group discussion

What are the common elements in each park unit? Each park has provided an information questionnaire on current inventory and monitoring activities, and its needs for the future.

Common Elements and Needs in Each Park: Summary plenary session

Dinner

Bruce Wiersma, University of Maine
Integration Approaches: How are all these things linked together?
(60 minutes)

Working Group Sessions: Thursday, January 26

Air Quality and Climatology
Leader: Wiersma

Earth Surface Processes: Soils and Permafrost
Leader: Yarie
Special expertise: Hopkins, Strum, Collins

Freshwater Systems: Lakes and Streams
Streams Leader: Slaughter
Streams Special Expertise: Oswood, Stottlemyer, Ford, Hilgert, Pierce
Lakes Leader: LaPerriere

Vegetation/Productivity
Leader: Juday
Special Expertise: McKee, Worley, LaBau

Terrestrial Fauna
Leader: Klein
Special Expertise: Murphy (vertebrates), Werner and McClain (invertebrates)

Disturbance Effects and Land Use
Leader: Johnson

Presentations and Summaries: Friday, January 27

Working Group Reports from Thursday sessions (15 minutes each)

Robert Stottlemyer
Quality Assurance/Quality Control (30 minutes)

Gary Ahlstrand
Archiving/Data Base Management: The Place of GIS

Summary and Dismissal

As the nation's principal conservation agency, the Department of Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-110 May 1993