

**A Study Plan to Inventory Vascular Plants and Vertebrates
in National Park Service Units in Northwestern Alaska**

Bering Land Bridge National Preserve
Cape Krusenstern National Monument
Noatak National Preserve
Kobuk Valley National Park
Gates of the Arctic National Park and Preserve

Target Budget Allocation: \$1.2 million

Submitted to:

National Park Service
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Fort Collins, CO

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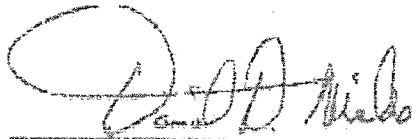
Revised
per Comments from the Servicewide I&M Program Manager

Resubmitted

December 1, 2000

Park Management Approval
Northwest Alaska Network

We, the Superintendents of the Northwest Alaska Network, hereby fully support this inventory of Vertebrates and Vascular Plants Study Plan with the understanding that this information will assist the parks, and network as a whole, in managing natural resources with sound scientific data. We will support this effort to ensure the success of this project.



1/29/01

Superintendent, Gates of the Arctic National Park

Date



1/30/01

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Executive Summary

This document describes a plan for conducting inventories of vascular plants and vertebrates in the 5 National Park Service (NPS) system units in arctic Alaska designated as the Northwest Alaska Network (NWAN). The plan has been revised per comments received from the Servicewide Inventory and Monitoring Program. A signature page, showing superintendent support of this plan, has been added. A network Data Manager for the inventories will be hired, relieving the Inventory Coordinator of those duties. Funding for the Data Manager position was found by foregoing the hiring of a data management technician, postponing the fish inventory until some future date (perhaps with other funding or when monitoring funds become available), and reducing the amount of funding allocated to the small mammal inventory. Allocations among fiscal years were shifted somewhat to reduce the FY02 request and increase the FY04 request.

The 5 NPS units in the NWAN are:

- Bering Land Bridge National Preserve (BELA),
 - Cape Krusenstern National Monument (CAKR),
 - Noatak National Preserve (NOAT),
 - Kobuk Valley National Park (KOVA), and
 - Gates of the Arctic National Park and Preserve (GAAR).
- These units comprise 20.4 million acres of contiguous or nearly contiguous arctic ecosystems at and above the northern limit of treeline. These parks are inaccessible by road, have low to moderate visitation, and are largely wilderness. Consumptive uses of natural resources are specifically allowed for in these units.
- The inventory effort will extend over 4 fiscal years (FY01-FY04). The initial budget allocation to the NWAN was \$1.4 million. Approximately \$200,000 has been spent on pre-inventory steps coordinated through regional contracts. The proposed budget for inventory work described in this study plan is \$1.2 million.
- Inventory effort in the NWAN will focus on improving network-wide knowledge of the presence, distribution and relative abundance of vascular plants, small mammals, and montane-breeding birds. These inventories target the highest priority data gaps identified in the scoping process.
- An *Inventory Coordinator* will be hired to provide logistical coordination and other services needed to administer the projects. The *Inventory Coordinator* will also serve as the Principal Investigator for the Vascular Plant Inventory. A *Data Manager* will also be hired. The budget allocation for support of network operations is \$477,000.
- The **Vascular Plant Inventory** will use experienced Alaskan botanists to visit 60 sites. Half of these sites will be selected using judgment, targeting areas likely to contain undocumented taxa. The other half of the sites will be selected randomly in strata based on landcover or ecoregions. At each site, regardless of how selected, a quantitative plot will also be established. This inventory will be led by a NPS Principal Investigator, to be named. The budget allocation for vascular plant inventory operations is \$290,000 (exclusive of the PI salary).
- The **Small Mammal Inventory** will target shrews, voles and small mustelids. A stratified sampling strategy with ecological sections serving as strata will be used. The same design will be employed in the Central Alaska Network, strengthening the ability of the inventories to describe patterns of distribution and abundance of these species across the tundra and taiga communities that dominate these networks. This inventory will be carried out by a doctoral student at the University of Alaska Fairbanks, working

under the supervision of Dr. Eric Rexstad. The budget allocation for the small mammal inventory is \$257,582.

- Bird inventory work will improve our understanding of the use of NWAN units by **Montane-nesting Birds**. These species are of high international and national conservation concern, and NWAN units may contain high percentages of worldwide populations. Standard point-count methodology will be used, deployed in a systematic design. This inventory will be carried out in cooperation with the USGS-Alaska Biological Science Center, under the supervision of Robert Gill, Project Leader for Shorebird Research. The (NPS) budget allocation for this work is \$212,000. USGS salary contribution to this project is estimated at \$286,000 over the 4-year course of the project.
- These biological inventories are the first systematic effort to document biological diversity of the NWAN parks since their creation in 1980. This opportunity will be used to organize existing information about the biota in these units and lay a solid foundation for future monitoring efforts.

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Introduction

The purpose of this document is to lay out a plan for conducting inventories of vascular plants and vertebrates in the 5 National Park Service (NPS) system units in arctic Alaska designated as the Northwest Alaska Network (NWAN). If approved, this plan will be the basis for allocation of roughly \$1.2 million over the next four fiscal years (FY 01-FY04) for biological inventories in NWAN units. This represents the first significant infusion of funding for comprehensive surveys of plants and animals in these NWAN parks since they were added to the NPS system in 1980.

The funding opportunity for these inventories comes from the Inventory and Monitoring (I&M) Program of the NPS. Established in the early 1990's, the purpose of the I&M Program, is to:

develop scientifically sound information on the current status and long term trends in the composition, structure, and function of park ecosystems, and to determine how well current management practices are sustaining those ecosystems.

The I&M Program is vital to fulfilling the NPS's mission of protecting and preserving the natural resources of the national park system unimpaired for the use and enjoyment of current and future generations.

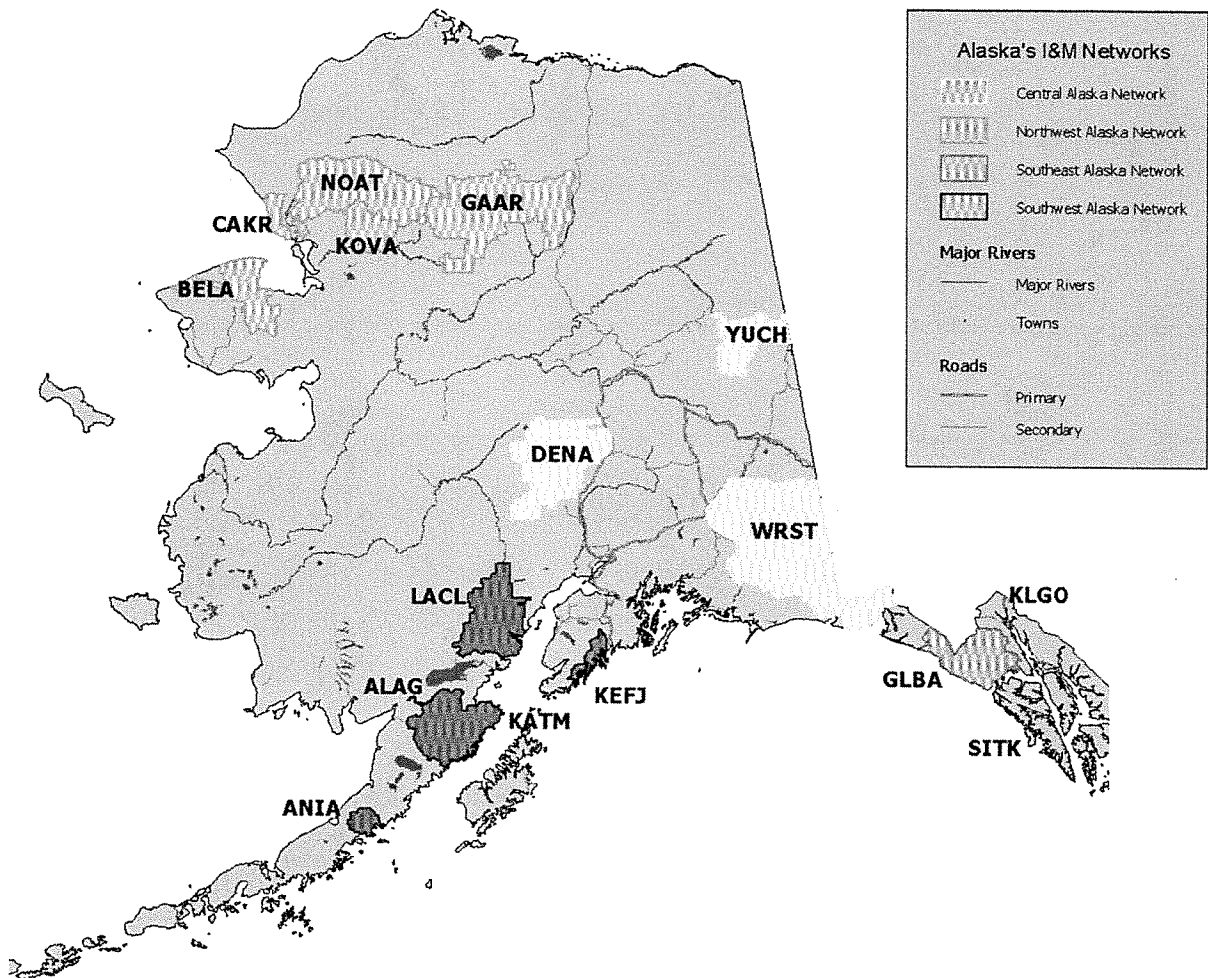
In its first decade, the I&M Program has worked towards the development of basic inventories for each of the 256 park system units with significant natural resources. These inventories include: bibliographies of natural resource-related publications and reports; base cartography, vegetation, soil, and geology maps; water quality surveys; and biological inventories. Inventories of biological resources, focusing initially on vascular plants and vertebrates, were identified as one of the basic inventories. Until recently, however, funding had been sufficient to begin biological inventories in only a few parks.

The lack of scientific information about resources under NPS stewardship has been widely acknowledged as inconsistent with NPS goals and standards, and was addressed by Congress as recently as 1998 with the National Parks Omnibus Management Act. In response, the NPS has launched a nationwide Natural Resource Challenge to revitalize and expand its natural resource program. This effort has increased funding to the I&M Program to facilitate improved baseline and long-term trend data for NPS natural resources. One of the initial components of this effort is the full implementation of the biological inventories portion of the I&M Program.

The goal of the biological inventories is to provide park managers with comprehensive, scientifically-based information about the status of selected biological resources occurring within unit boundaries. To attain this basic goal, the I&M Program has identified 3 objectives:

1. To document, through existing data and targeted field investigations, the occurrence of at least 90% of vertebrate and vascular plant species expected to occur in NPS units.
2. To describe the distribution and relative abundance of species of special concern, such as Threatened and Endangered species, exotics, and other species of special management interest, occurring within unit boundaries.
3. To provide the baseline information needed to develop a monitoring strategy and design tailored to specific park threats and resource issues.

To efficiently and fairly use the funding available for biological inventories, the 256 NPS units with significant natural resources have been organized into 32 biome-based networks. Four networks were established in Alaska, clustering park units that share similar ecological and logistical niches (Figure 1). These networks have been designed to share expertise and infrastructure for both biological inventories and development of long-term ecological monitoring programs. The I&M Program has given each network a



target funding level according to a formula which seeks to allocate available funds equitably among all parks. The I&M Program has also issued guidance to the networks on overall steps in the inventory process, appropriate study designs, expected inventory products, and study plan requirements and review criteria. This study plan was prepared in accordance with these guidelines.

The Northwest Alaska Network

The NWAN (Figure 2) includes five NPS system units:

- Bering Land Bridge National Preserve (BELA),
- Cape Krusenstern National Monument (CAKR),
- Noatak National Preserve (NOAT),
- Kobuk Valley National Park (KOVA), and
- Gates of the Arctic National Park and Preserve (GAAR)

These units comprise 20.4 million acres, representing 25% of all acreage within NPS management in the United States. GAAR, KOVA, and NOAT are contiguous and encompass a large expanse of mostly mountainous arctic ecosystems at the northern limit of treeline. Immediately to the west of these units lie CAKR and BELA which border Kotzebue Sound. BELA and CAKR are similar with respect to their coastal resources and strong biogeographic affinities to the Beringian subcontinent--the former land bridge between North America and Asia. The NWAN park units are not connected to the road system. Much of the NWAN is designated wilderness or proposed wilderness.

All of the NPS units within the NWAN are relatively recent additions to the National Park System. Portions of BELA, CAKR, and GAAR were initially created by presidential proclamation in 1978. All 5 units were re-designated or created with their present boundaries by the Alaska National Interest Lands Conservation Act (ANILCA) in 1980. The recent origin of these remote and difficult-to-access units, coupled with limited natural resource staffing levels, has left the natural resources in these units relatively little-studied. The present biological inventory effort will provide much needed information about natural resources in the NWAN units.

In developing this study plan, existing information about vascular plants and vertebrates has been gathered (with significant help of the Alaska Natural Heritage Program) and reviewed by park staffs and taxonomic experts. In a scoping meeting held in April 2000, inventory priorities for the NWAN units were preliminarily set, based on current knowledge of the occurrence and distribution of taxa in the various taxonomic groups. The result of this meeting was to identify four inventory projects. These projects target vascular plants, small mammals, and montane-nesting birds throughout NWAN units, freshwater fish in BELA, and estuarine fish in BELA and CAKR. The network honed these priorities, as additional data became available over the summer from the Alaska Natural Heritage Program. The network finalized the inventory priorities and allocated the budget among projects in August 2000. Based on review of the draft study plan for these inventories, a decision was made to postpone the fish inventory work to fully fund the data management function for the network.

Guide to the NWAN Biological Inventories Study Plan

This study plan is divided into 5 chapters. In the first chapter, we provide an overview of the network and describe how the NWAN inventory program is organized. The remaining chapters describe specific plans for carrying out the four inventory projects. The topics addressed in each chapter are highlighted below.

- **Chapter 1.—Northwest Alaska Network Overview.** In the first chapter, we provide a network overview—the park units in the network, the current level of knowledge of the vascular plants and vertebrates within NWAN units, the resource protection concerns, how the network will operate, the network's overall I&M goals, and how the immediate network inventory priorities were set. We also

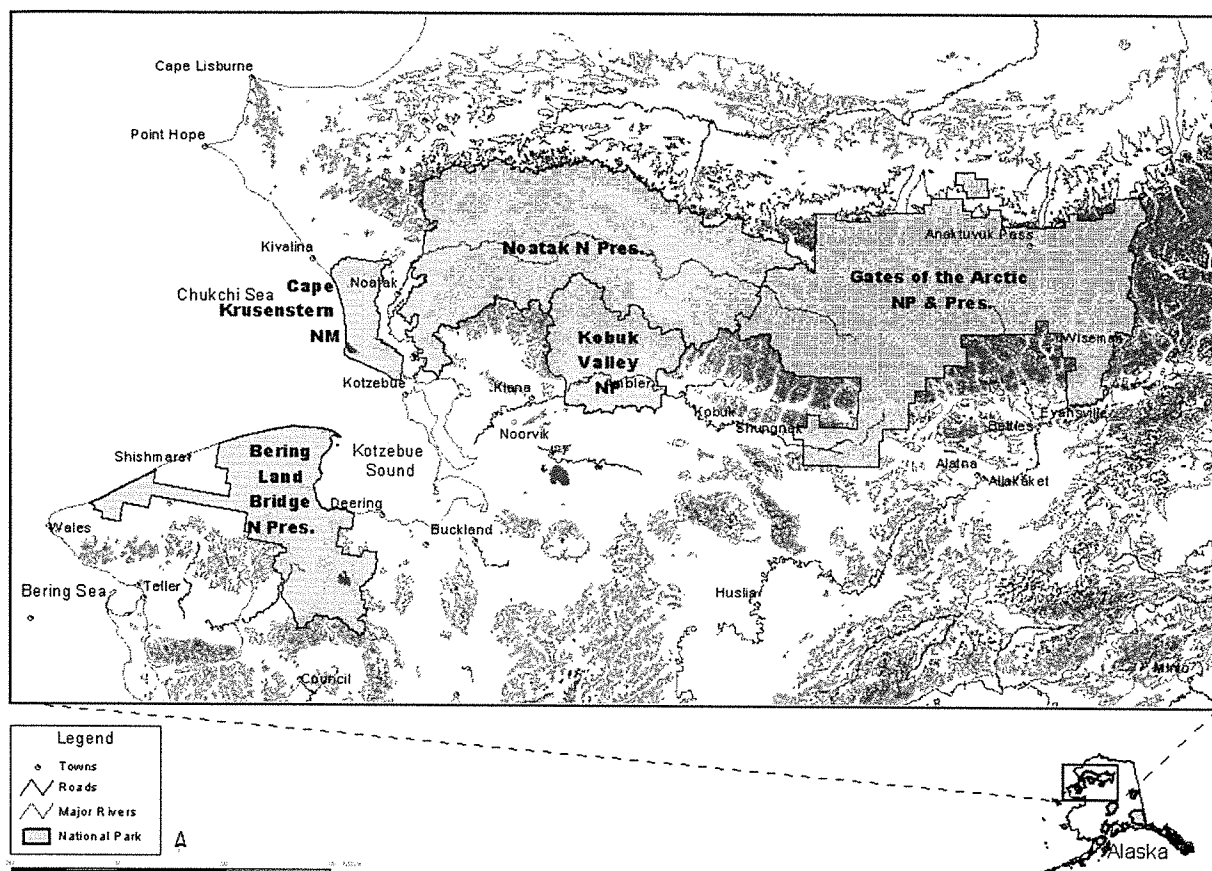


Figure 2. Location of the five National Park System Units included in the Northwest Alaska Network.

identify common design features of the inventories, and review the overall products, budget and milestones of the inventory work.

- **Chapter 2.—Vascular Plant Inventory.** This chapter details the objectives and study design for an inventory and relative abundance assessment of vascular plants in all five NWAN units.
- **Chapter 3.—Small Mammal Inventory.** This chapter details the objectives and study design for an inventory of small mammals in all five NWAN units.
- **Chapter 4.—Montane-nesting Birds Inventory.** This chapter details the objectives of an inventory targeting birds nesting in the montane areas predominant in the NWAN, and discusses the national-level importance of this work for documenting the occurrence of several shorebird species of significant conservation concern.

Following the individual project study plans are two appendices:

- **Appendix A.—Review of Existing Information.** This appendix compiles information on the status of knowledge about each taxa in each NWAN unit. Available literature is referenced, and notes on each taxa from the Preproposal, Scoping Meeting and Alaska Natural Heritage Program’s expected species lists are included.
- **Appendix B.—Species of Special Concern Projects.** The NWAN identified 4 projects targeting species of special concern. These projects address coastal birds, nonvascular plants, fish in springs associated with the Kobuk Dunes, and sheefish (*Stenodus leucichthys*), an important subsistence species. These projects would be considered for funding in future initiatives. In Appendix B, we provide a project description for a recently proposed nonvascular plant inventory in Noatak National Preserve as an example.

Chapter 1 Northwest Alaska Network Overview

In this chapter, we provide an overview of the Northwest Alaska Network and describe how priorities were set for the biological inventories presented in this study plan. We introduce our specific inventory objectives and also address the common design features of the inventories. We then provide an overview of the products, budget, and schedule of the NWAN inventories.

Introducing the Northwest Alaska Network

As previously noted, the Northwest Alaska Network comprises 5 units (Figure 2) added to the NPS system in 1980 under ANILCA. Running west to east, these units are:

- Bering Land Bridge National Preserve (BELA),
- Cape Krusenstern National Monument (CAKR),
- Noatak National Preserve (NOAT),
- Kobuk Valley National Park (KOVA),
- Gates of the Arctic National Park and Preserve (GAAR)

The NWAN parks total more than 20 million acres and comprise 25% of all acreage under NPS management in the United States. GAAR, KOVA, and NOAT are contiguous. These units and their neighboring refuges--Selawik and Koyukuk National Wildlife Refuges--which extend from the southern boundary of KOVA--form one of the largest protected areas on earth. Over 50% of lands within the NWAN units are designated as wilderness or proposed wilderness. With one exception, the NWAN units are roadless. The one exception is the access road linking the Red Dog Mine with its Kotzebue Sound port site. This road--unconnected to Alaska's road system--passes through CAKR. Overall, the NWAN can be characterized as remote, wild lands with significant biological, paleontological, archeological and geological resources. These are the only NPS units located above the arctic circle. Because access is limited and logistically difficult, visitation to NWAN parks is currently moderate to low.

As might be expected by their contiguity, the 5 units that make up the NWAN are ecologically similar. GAAR, KOVA and NOAT straddle the western Brooks Range. Arctic tundra habitats are found on the north side of the range, and spruce taiga foothills are found on the south side of the range. Bering Land Bridge and Cape Krusenstern are also similar with respect to their coastal resources and their location within Beringia--the former landbridge between North American and Asia.

Although the NWAN units include a variety of designation types (i.e., park, preserve, and monument), all the units share a common purpose in their enabling legislation: to protect populations of fish and wildlife and their habitats. For some of the units, protection of specific types of fish and wildlife, and their habitats, are mentioned. For example, protection of marine mammals is specifically mentioned as a purpose of BELA and CAKR. Other species mentioned in enabling legislation of the NWAN units include black bears (*Ursus americanus*), grizzly bears (*Ursus arctos*), moose (*Alces alces*), wolves (*Canis lupus*), Dall sheep (*Ovis dalli*), caribou (*Rangifer tarandus*), waterfowl and raptors. In addition, one of the purposes of BELA is to protect and interpret examples of arctic plant communities, while still allowing for private reindeer grazing.

The species receiving specific mention in enabling legislation for the NWAN units tend to be the more common, charismatic species for which general information about occurrence, distribution and abundance was available when ANILCA was passed. This inventory program provides an important opportunity to develop a more complete picture of the "fish and wildlife" that inhabit the NWAN units and to understand the significance of the NWAN units for species, such as the Bristle-thighed Curlew, whose occurrence within the NWAN was not recognized when the units were created.

As ANILCA conservation system units, another common purpose of the NWAN units relates to protection of continued use of natural resources to allow local, rural residents an opportunity to continue subsistence ways of life. Three of the units (BELA, NOAT and GAAR) are designated as or include lands designated as preserves where sport hunting is allowed. Because these consumptive uses are provided for in the NWAN units, management of natural resources requires understanding of status and trends of harvested populations.

Existing knowledge on vascular plants and vertebrates in NWAN units

In this section, we provide an overview of existing information on the occurrence, distribution and abundance of vascular plants and vertebrates in the NWAN. This overview focuses on justifying our selection of the inventories described in this study plan, as filling the most important data gaps. This overview is based, in part, on Appendix A, where we provide a more detailed review and compendium of existing knowledge for each unit in the NWAN.

Prior to the 1970s, the biological resources of the areas in northwestern Alaska that were to become a part of the NPS system in the form of BELA, CAKR, NOAT, KOVA, and GAAR, had been relatively little studied. In the process of settling Alaska Native land claims (to allow construction of the Trans-Alaska Pipeline System), it became clear that major additions to the federal conservation system would be made. Thus, in the 1970s, multi-disciplinary inventory expeditions to prospective areas for inclusion in the conservation system were mounted. In some cases, these expeditions were conducted to study the areas for their suitability, and in some cases, to generate information needed for environmental documents supporting the additions. Such expeditions were made to the areas that became BELA (Melchior 1979), CAKR and NOAT (Young 1974), KOVA (Melchior 1976) and GAAR (Murray 1974). These efforts resulted in some of the first detailed descriptions of the flora and fauna of these regions. They also resulted in significant collections of plants and small mammals.

Studies of the coastal areas that became part of BELA and CAKR also occurred in the 1970s under NOAA's Outer Continental Shelf Environmental Assessment Program (e.g., Cannon 1977, Schamel et al. 1979) and similarly produced considerable information about the flora and fauna of NWAN coastal areas.

Since their designation as NPS units under ANILCA, a variety of biological studies have occurred in NWAN units that have generated additional information about their flora and fauna. Regional initiatives and pre-impact baseline studies have been a primary source of data. In BELA, several biological projects were funded by a major Beringian Studies program (International Park Program 1989). The construction of the Red Dog mine—the world's largest lead and zinc mine—near the borders of CAKR and NOAT was the impetus for a number of studies in that area (e.g., Dames and Moore 1983, U.S. Environmental Protection Agency 1984, Ballard 1993). In GAAR, the potential for construction of a road from the Ambler mining district to the Dalton Highway resulted in a detailed ecoregional mapping effort (Swanson 1995), combined with a small mammal study (Swanson 1996) in the upper Kobuk River valley. A number of other biological studies have also occurred, targeting specific taxa or locations (see Appendix A).

In completing Step 1 of the biological inventory process (Compilation of Past Data, Fancy 1999), the Alaska Natural Heritage Program has developed expected species lists for vascular plant and vertebrate taxa for each park unit (Alaska Natural Heritage Program 2000). They have also collected verified reports for each taxa for each park unit. Table 1 summarizes this information by taxonomic group for the park units in the NWAN. None of the taxa (except amphibians) have been documented to the desired 90% level within any NWAN unit.

Table 1. Preliminary results of Step 1 of the Biological Inventory Process for National Park Service Units in Northwest Alaska: Comparison of the number of vascular plant and vertebrate species documented to occur in each unit with the number of species expected. Source: Alaska Natural Heritage Program, 2000.

	BELA	CAKR	NOAT	KOVA	GAAR
Vascular Plants					
# species documented	460	186	191	260	427
# species expected, but not yet documented	183	136	376	135	91
total # expected species	643	322	567	395	518
% documented	72%	58%	34%	66%	82%
Amphibians/Reptiles					
# species documented	0	0	0	1	0
# species expected, but not yet documented	0	0	1	0	1
total # expected species	0	0	1	1	1
% documented	N/A	N/A	0%	100%	0%
Freshwater Fish					
# species documented	9	18	22	16	14
# species expected, but not yet documented	16	6	2	6	2
total # expected species	25	24	24	22	16
% documented	36%	75%	92%	72%	88%
Marine Fish					
# species documented	8	8	N/A	N/A	N/A
# species expected, but not yet documented	30	30	N/A	N/A	N/A
total # expected species	38	38	N/A	N/A	N/A
% documented	21%	21%	N/A	N/A	N/A
Mammals					
# species documented	20	11	18	10	24
# species expected, but not yet documented	22	27	18	19	13
total # expected species	42	38	36	29	37
% documented	48%	29%	50%	34%	65%
Birds					
# species documented	132	145	119	116	121
# species expected, but not yet documented	71	64	58	70	33
total # expected species	203	209	177	186	154
% documented	65%	69%	67%	62%	79%

Available information about vascular plants varies among the NWAN units. There have been a considerable number of intensive plant studies in GAAR (e.g., Cooper 1986, 1989; Murray 1974), BELA (Kelso et al. 1997) and the Kobuk Dunes area in KOVA (Mann and Parker 1998). Plants in NOAT and CAKR have received less attention. Extensive studies are entirely lacking except for macrolichens in GAAR (Neitlich and Hasselbach 2000). Landcover maps have been prepared for each unit (Markon and Wesser 1998), but these do not provide information at the vegetation community level.

Freshwater fish have been relatively well-documented throughout the network with the exception of BELA (Hansen et al. 2000). Studies for fisheries management of the Kobuk and Noatak drainages have provided the majority of this information. Lacking a large commercial or subsistence fishery, BELA never received such attention. Marine and estuarine fishes in the coastal lagoons of BELA and CAKR likewise received little attention as these areas have been outside closely monitored zones of commercial and subsistence harvest.

The low percentages of mammal species documentation is due to the absence of information on smaller species such as shrews, voles, hares, squirrels and smaller mustelids. The occurrence of larger mammal species, such as ungulates and larger predators, is much better known. Because these species are targeted for consumptive uses, they are much better studied.

The avifauna in NWAN units have received a fair amount of attention, however most of the effort has been deployed in more accessible, lower elevation areas.

Natural Resource Protection Concerns of NWAN Parks

Another key piece in deciding how best to deploy inventory efforts hinges on what information is needed to do a better job in protecting park resources. What are the resource protection concerns of the NWAN units and how does the proposed inventory relate to them?

The natural resource protection concerns facing the NWAN units are similar to other Alaskan units in scope and magnitude. These concerns include:

- development within or near NPS boundaries;
- lack of data to effectively manage consumptive use of resources;
- lack of data about fish, wildlife, and plant populations;
- degradation of resources due to proximal (i.e., mining, construction) and remote causes (i.e., global change, circumpolar pollution), and
- exotic, threatened and endangered species management.

The lack of reliable baseline data about rare and endemic vascular plant species is particularly apparent in the NWAN. Many uninventoried areas within these units could contain species of concern, or entire vegetation communities, that are of rare or endemic status and therefore require special management or protection. These vascular plant inventories will assist in closing this data gap.

Mammalian and avian exotics, and species of special concern are also of priority for inventory. The effects of abundant reindeer (domesticated caribou) herds on natural forage species, and on the Western Arctic Caribou Herd remain unknown. Data about the distributions and relative abundance of many avian species, such as the Bristle-thighed Curlew (*Numenius tahitiensis*), Harlequin duck (*Histrionicus histrionicus*), and Steller's eider (*Polysticta stelleri*), are lacking.

For the 2 decades since the creation of these units, consumptive uses of fish, wildlife, and plant resources have occurred on these federal lands without the benefit of comprehensive data about distribution, abundance, or other relevant population demographics. Although some of the large mammal populations have been surveyed regularly, there are a wide variety of fish and wildlife species that sustain continued harvest for which few data are available. The NPS is mandated to continue to provide for subsistence opportunities focused on these resources; but cannot effectively manage for healthy populations without good field data about resource status. Many plants are consumptively used by local residents and little information about these activities or their impacts on the populations is available.

Northwestern Alaska has been insulated from the increase in the Alaskan tourist industry to some extent, primarily due to the difficulty of access in the region. However, human impacts of other sorts do occur and will continue to increase in intensity as regional population and development increase. In order to assess

short and long-term impacts of resource extraction activities and consumptive resource use within and near NPS boundaries, baseline data are necessary.

Local point sources of pollution are not of great immediate concern to the NWAN, although truck accidents on the Red Dog Mine haul road do occasionally occur and are a potential source of impact to park resources in CAKR. Remote sources of pollution are of greater concern. Arctic Haze—a winter pollution phenomenon—occurs consistently throughout the region. Pollutants, most likely from Eurasian sources, become trapped in the stable air mass that hangs over the arctic and extends down into North America and Eurasia, creating Arctic Haze (Shaw 1995). The ecological effects of Arctic Haze are unclear at the present time, but knowing that the pathway for contamination exists underscores the importance of improving our knowledge of these remote areas.

How the Network will Operate

The 4 most westerly units in the NWAN—BELA, CAKR, NOAT, and KOVA—form an administrative cluster (known as “Western Arctic National Parklands” or WEAR) and are managed by staff stationed in two offices: the headquarters office in Kotzebue and a district office in Nome. The fifth unit—GAAR—forms an administrative cluster with Yukon-Charley Rivers National Preserve (YUCH) (part of the Central Alaska Network) and is also managed by staff stationed in two offices: a headquarters office in Fairbanks and a district office in Bettles. Because four of the parks in the NWAN are already operating as an administrative unit, and because of ecological unity of the area, the transition to operating as a network has thus far been straightforward. Existing natural resource personnel in NWAN units are already accustomed to working together.

Inventory work in the Northwest Alaska Network is being coordinated by a group consisting of the Resource Management Division Chiefs [Patty Rost (GAAR), Lois Dalle-Molle (WEAR)], the Network Inventory Lead (Peter Neitlich), GAAR Inventory Lead (Shelli Swanson), and the Alaska Region I&M Coordinator (Sara Wesser). As the network inventory lead, Peter Neitlich also serves as the representative from the Northwest Alaska Network to the I&M Steering Committee for the Alaska Region. These individuals are involved in all major decisions pertaining to inventory priorities, project development, and program oversight. Since all parks/preserves will receive some level of inventory work, they each have a vested interest in seeing that deadlines, reports, and funding transfers occur on schedule.

Because existing natural resource personnel in NWAN parks are few in number (and GAAR staff also work for YUCH), the successful operation of the inventory program within the NWAN will require additional staff for this specific purpose. The Network will therefore hire an *Inventory Coordinator*. We anticipate this position will be filled by a GS-11 biologist in a 4-year term position. This position will:

- Be the main point of contact between NWAN and the Alaska Regional I&M Coordinator;
- Be the main point of contact in communications within the NWAN;
- Be responsible for coordinating logistics among the 4 inventory projects;
- Serve as the Principal Investigator for the Vascular Plant Inventory.

The NWAN will also hire a network inventory *Data Manager*. We anticipate this position will be filled by a GS-11 computer specialist in a 3+ year term position. (We do not think the position will be filled before summer 2001, hence we are requesting only partial funding for FY 2001). The network *Data Manager* will be responsible for overseeing the data management function for the NWAN.

To facilitate recruitment of highly qualified candidates for these network positions, we are keeping the location of the base of operations for the network flexible. Depending on the preferences of the selected individual, the administrative home of the network could be in either Anchorage or Fairbanks. If Anchorage is selected as the base, then the WEAR will provide administrative functions. If Fairbanks is selected, GAAR will provide these services.

Each of the inventories will be supervised by a Principal Investigator. The Principal Investigator is responsible for scientific and administrative oversight of the inventory project, including: drafting the study plan, maintaining communications with the *Inventory Coordinator* and *Data Manager*, managing all administrative aspects of carrying out the inventory work (hiring, training, logistics, compliance, setting up any necessary contracts, etc.), data management, and reporting.

The *Inventory Coordinator* will manage a quality assurance assessment process at the network level. This may be accomplished by annual meetings with park staff, Principal Investigators, and the Regional I&M Coordinator. Products will be reviewed for completeness and accuracy, and reports will be peer reviewed, prior to submission to the regional office. We will ensure that the inventories are accomplished within the guidelines of the servicewide program by coordinating with the Regional I&M Coordinator (Sara Wesser) and the Alaska Region I&M Steering Committee.

Overall Network Goals

This immediate project on vascular plant and vertebrate inventories in NWAN units is significant for bringing the 5 farthest north units in the NPS system together for the purpose of inventory and monitoring. These inventories represent our first opportunity to develop the conceptual framework and administrative systems needed to operate as an I&M network. Thus, while our immediate goal is to accomplish the vertebrate and vascular plant inventories targeted by this specific funding opportunity, we see this as an opportunity to lay the foundation for the development of a strong I&M Program for these park units.

One of the key steps in development of a long-term monitoring program is an ecosystem model. For this, a synthesis of the ecological information available for the parks is required. One of the critical outcomes of this inventory effort will therefore be the development of systems for keeping current with ecological information about NWAN units. This inventory project will help gather the information needed to produce such a synthesis.

Because the NWAN is looking ahead towards monitoring, we have taken a somewhat different approach to the inventories than we might have taken if our only goal was to document the occurrence of 90% of the expected species. Taken literally, this 90% goal would provide a species list, but not much more. A species list alone was judged to have limited value to the protection and management of the NWAN units. We have therefore focused on deploying inventory effort to obtain information on the distribution and relative abundance of species across the landscape. This type of information will help the NWAN units to build the ecological understanding needed to design its monitoring program.

Vascular Plant and Vertebrate Inventory Objectives

In this section, we lay out the specific objectives for the NWAN inventories and the process by which those objectives were set. We also identify the highest priority projects to address species of special concern.

Inventory Objectives and Priority Setting Process

The process of setting the biological inventory objectives for the units in the Northwest Alaska Network began with the preparation of the Alaska Region preproposal (National Park Service 1999). In this document, an initial assessment of the status of knowledge about vascular plants and vertebrates in the NWAN parks was made, relying on general knowledge of park staff. This initial assessment indicated that, generally speaking, more information about birds and large (charismatic) mammals was available than information about plants, small mammals and fish, throughout the NWAN parks.

The process of gathering information about the vascular plants and vertebrates of the NWAN parks continued through the winter of 2000. Under Step 1 of the Biological Inventories process, the Alaska Natural Heritage

Program (ANHP) compiled information to develop species lists for each park, including some indication of the status of each species on the list (i.e., whether its presence was documented or expected). Early versions of the lists developed by the ANHP were available at Biological Inventories Scoping Meeting, held in Anchorage, April 25-27, 2000. A session on each taxonomic group was held during the scoping meeting where park staff and invited taxonomic experts considered whether 90% of the expected species had been documented for each park. Summaries of the percentages arrived at, and of the deliberations of the NWAN participants were published in Hanson (2000:12-16, and Appendix D).

The ANHP work on expected species defined the main gaps in our general level of understanding of these taxonomic groups within NWAN units. These gaps included: small mammals and vascular plants for all parks in the network; freshwater fish in BELA; estuarine fish in the coastal lagoons of BELA and CAKR. Another important gap concerned the use of the alpine and montane areas so common in NWAN units for breeding by shorebirds such as the Bristle-thighed Curlew, and passerines. Based on regional and national assessments, these montane-nesting birds, particularly the shorebirds, are of high conservation concern, and NWAN units may well support large percentages of the breeding populations.

Immediately following the April scoping meeting, Peter Neitlich, NWAN Network Lead, drafted specific objectives for each of the priorities established at the scoping meeting. These objectives (see below) were circulated amongst the NWAN team for review and comment.

**Biological Inventory Objectives
of the
Northwest Alaska Network**

1. Determine the presence, distribution and relative abundance of **small mammals** in all 5 NWAN parks.
2. Determine the presence and relative abundance of **vascular plants** in all 5 NWAN parks.
3. Determine the presence and relative abundance of **marine/estuarine fish in coastal lagoons** in CAKR and BELA.
4. Determine the presence, distribution and estimated abundance of nesting **montane-nesting birds** across the Brooks Range and other alpine areas of all 5 NWAN parks.
5. Determine the presence, distribution and relative abundance of **freshwater fish** in BELA.

NWAN team members met again on August 22, 2000, to solidify the objectives, allocate dollars to the projects, assign Principal Investigators and develop a strategy for writing this study plan. At this meeting, the group determined that the two fish objectives would best be organized as a single project. Thus, the outcome of the priority setting process was that there would be 4 projects, each with a designated Principal Investigator. The allocation of funds among the 4 projects was based roughly on the relative priorities for these inventories of each park within the network.

During the review of the draft study plan, it was recommended that the network hire a Data Manager. To fund this position, the network decided to postpone commencement of the fish inventory project, to reduce the amount of funding allocated to the small mammal inventory, and to forgo hiring of a data management technician.

Species of Special Concern Projects

At the referenced Biological Inventories Scoping meeting for Alaska parks, each network also discussed projects to address what were called “Species of Special Concern.” The purpose of these discussions was to identify the highest priority inventory projects for attention, once the goal of documenting the occurrence of 90% of expected species was met for all taxa and all parks in the network. The identified “species of special concern” projects for the NWAN units were summarized in Hanson et al. 2000.

The network decided that funding for this biological inventory effort would not extend far enough to address these species of special concern projects. A short list of the highest priority projects were prepared (see box below). We intended to include short project descriptions for each of these projects in Appendix B. We have included an existing project description for a recently-proposed nonvascular plant inventory in Noatak National Preserve as an example.

Species of Special Concern Projects of the Northwest Alaska Network

1. **To determine the presence, distribution and relative abundance of sensitive coastal bird species in BELA and CAKR.** Species of primary concern are: Spectacled Eider (*Somateria fischeri*), Common Eider (*Somateria mollissima*) and Steller’s Eider (*Polysticta stelleri*), Arctic Loon (*Gavia arctica*), Yellow-billed Loon (*Gavia adamsii*), Aleutian Tern (*Sterna aleutica*).
2. **To determine the presence and relative abundance of nonvascular plants.** Presence will be assessed as a combination of LTEM plots established to detect trends in nonvascular resources, and habitat-based searches. Note: some of this may be achieved as a synergy with other projects in the current inventory effort, and as determined by availability of existing staff.
3. **To search for the presence of fish species at the springs of the Kobuk Dunes (KOVA).** If taxa are found, key parameters will be: full complement of taxonomic diversity, relative abundance of each species, habitat associations of taxa.
4. **Determine Sheefish early life history (GAAR, KOVA).** Sheefish (*Stenodus leucichthys*) is an important species for commercial, sport, and subsistence fisheries in KOVA and GAAR. Because of conflicting uses, additional information on their distribution, abundance and early life history is a priority.

Project Design Considerations

Although the NWAN biological inventories will be conducted as 3 fairly autonomous projects, their designs will have common features related to sampling design, data management and handling of voucher specimens. Our discussions and decisions related to these common design features of the projects are summarized below.

Sampling Design Considerations

Guidance from the Servicewide I&M Program is strongly weighted towards use of sampling frameworks allowing inferences to be made across larger areas than those sampled (Fancy 2000). We have followed this guidance to the maximum extent possible in each inventory. However, we have not been able to achieve a single sampling framework that would serve the inventory needs of all taxa. The small mammal inventory comes the closest to this ideal, with sampling effort allocated among strata based on the section-level of physiographically-based ecoregions. The montane-nesting bird inventory uses a statistically-rigorous design but must necessarily target higher elevation areas used by these species to achieve its objectives. The vascular plant inventory will use targeted surveys in addition to randomly-placed surveys and plots in strata based on land-cover or ecoregions.

Ecoregions mapping to support the stratified designs to be used in the vascular plant, small mammal and montane-nesting bird inventories is underway managed by the Alaska Region, Inventory and Monitoring Program.¹ This mapping effort uses available information, such as bedrock and surficial geology maps, Landsat Thematic Mapper Imagery, and color infrared photography to delineate ecoregions to the section level. The ecoregions are based on a synthesis of physiography, lithology and surficial geology features. Mapping for BELA has been contracted to Torre Jorgenson, of ABR Inc., and is nearly complete. Dave Swanson has been hired to complete the mapping for the remaining NWAN units. This work is scheduled for completion in spring 2001, in time to allow sample sites for the NWAN inventories to be selected.

In addition to documenting the occurrence of vertebrate and vascular plant species, a secondary purpose of species inventories is to develop insight into species-habitat associations, to facilitate ecosystem understanding. We will require that standard habitat attributes be collected for all vertebrate and vascular plant inventories. This will provide a common context for species inventories and will facilitate the integration of species occurrence data across habitats and taxa. We are still developing the list of specific attributes for which data will be collected. We will use Viereck et al. (1992) to describe the general vegetation at each site where inventory data are collected.

Another important feature of our designs is that we will try to estimate how close we come to documenting the number of species that actually occur. We will use the expected species lists being developed by the ANHP as one method of determining whether we have achieved the 90% goal. However, because of the inherent difficulties in developing these expected species lists, we feel it is important to have an independent measure of the number of species that occur (Soberon and Llorente 1993). Keating et al. (1998) concluded that the negative binomial estimator of Efron and Thisted (1976) was the most robust across a range of community structures and sampling regimes. We will use this or other estimators to determine how effective our sampling has been in detecting species.

Data Management

This inventory project represents a significant opportunity to gather and organize information about the biological resources of the NWAN units. Solid data management is a vital component of this effort. The *Data Manager* will be responsible for preparing and implementing a data management plan for the NWAN inventory effort. This plan will be consistent with existing guidance from the Servicewide Inventory and

¹ This ecoregions mapping effort is part of Step 3 (Habitat Delineation) of the Biological Inventory process (Fancy 1999). Mapping for the Alaska networks is being funded separately by the NPS I&M Program.

Monitoring Program (National Park Service 1997) and related information, such as the Data Management Protocol for the Denali Long-term Ecological Monitoring Program (Denali National Park and Preserve 1997, Oakley and Boudreau 2000).

The costs of data management are estimated to be from 25-30% of the total cost of an inventory or monitoring project (Graber et al. 1993, Fancy 1999, Mulder et al. 1999). When such costs are not properly budgeted for, data management can be short-changed. Each project has identified and budgeted for personnel responsible for data management at the project level. As noted, at the network level, the *Data Manager* will be responsible for overseeing data management functions. This network level function is important for ensuring that the information input into the national-level databases is consistent. It is also important for ensuring that the inventory projects are compatible and lead to functioning databases that link with the existing GIS Theme Managers for Alaska parks. We estimate that about 29% of our budget will be dedicated to specific data management functions.

Table 2. Amounts allocated to support data management for biological inventories in the Northwest Alaska Network over the entire project (FY01-FY04)

	Amount Allocated for Data Management
Network Operations	
Data Manager	186.0
Equipment/Supplies	20.0
Inventory Projects	
Vascular Plants	45.0
Small Mammals	43.5
Montane-nesting Shorebirds	48.6
Total for Data Management	343.1
Total Budget	1,200.0
Percentage of Total Budget	29%

A standard practice of good data management is to determine the uses of the data and to develop the structure of the database around the uses of the data prior to data collection. In this vein, one of the first priorities of each project in this first year is to develop the structure of their Microsoft Access database. As much as possible, similar structures and naming conventions will be used, to facilitate using the information in an integrated fashion. We will build relatedness among data sets through standardized field forms, site and event codes, and habitat measures. We will use the Database Template or similar design to ensure data can be related across inventories and be readily incorporated into existing GIS Theme Managers for each NWAN unit. Each Principal Investigator will be required to develop databases consistent with this overall design. In addition, each Principal Investigator is responsible for assuring field activities are well-documented and facilitating accurate implementation of sample methods and collection of complete data.

During the data handling phase, data management activities will focus on: 1) designing tools for data entry that reduce transcription errors; 2) independently verifying data transcription; and 3) developing data error-trapping techniques. Again, each Principal Investigator is responsible for these tasks.

Archiving and dissemination of the inventory data will be accomplished as follows: The *Data Manager* will be responsible for incorporating inventory data into the servicewide databases either by ensuring that Principal Investigators accomplish the task, by including the task in a scope of work or by personally entering the data. If contractors are used, a quality assurance procedure will be included (i.e. verify random sample of data.) In addition, final reports and manuscripts regarding the inventory will be entered into NRBib and each dataset will be recorded in the Dataset Catalog. Original field data sheets will be stored by the Network Lead,

with a copy stored at the park. A website will be developed at the regional or network level. Copies of digital data, metadata, reports and summaries will be posted to the website and distributed on CD to the parks, Regional I&M Coordinator, and Servicewide I&M Coordinator.

All inventories will be required to produce ArcInfo or ArcView datasets compatible with the GIS Theme Manager. Specifications for GIS datasets will be provided to each Principal Investigator who will be responsible for ensuring the completeness and accuracy of submitted products. The Network Lead will work with the Alaska Support Office GIS Team and the Regional I&M Coordinator to incorporate new GIS and appropriate tabular data into existing GIS Theme Managers for each NWAN unit.

On the project level, principal investigators will be responsible for hiring and training skilled personnel for their specific inventories. Periodic checks on data collection procedures and accuracy will be conducted to ensure data quality and consistency. Changes needed or incorporated in study design, data collection, or methods will be recorded and evaluated annually.

Voucher Specimens

Voucher specimens will be collected as necessary to document currently undocumented species within the network. The greatest volume of vouchers is expected for the vascular plant and small mammal inventories. Voucher specimens will also be collected for the freshwater and estuarine fish. Bird specimens will not generally be collected as a part of this project. The exact methods of collecting, processing, cataloging and storing vouchers is described in detail in the project descriptions for each taxa. We provide a synopsis here.

All specimens collected as part of the NWAN biological inventories will be stored at the University of Alaska Museum. A cooperative agreement between the Alaska Region I&M program is in place under which the arrangements will be formalized. Each of the Alaska Networks will contribute funds to the agreements, in proportion to the number of specimens to be archived. All voucher information will be entered in the Automated National Cataloging System (ANCS+) and the NPSpecies database.

As noted, curation of all plant specimens will be handled by cooperative agreement with the University of Alaska Museum Herbarium. Herbarium professional staff will supervise work-study students based at the Museum to handle the mounting of specimens, at a cost of \$2-\$3 per specimen, including printing labels, mounting and filing. The NWAN Principal Investigator for the vascular plant project will be primarily responsible for specimen determination, data entry and transfer to Museum personnel for label preparation. There will be a separate line-item for supplies required for specimen curation. In addition, herbarium personnel will provide determination and specimen-review quality control. The Vascular Plant Inventory project has allocated \$10K as its contribution to the cooperative agreement with the museum for curation support.

Similarly, curation of all small mammals will be handled by cooperative agreement with the University of Alaska Museum. Heart, liver, kidney and muscle tissue from each captured animal will be frozen in liquid nitrogen, and these tissues will be archived at the museum. Project personnel will put up as many specimens as possible in the field (up to 20 per species). Remaining specimens will be preserved in ethanol for identification and archival at the museum. Processing costs for mammals preserved in this way are \$860/100 specimens. Based on the number of mammals expected to be trapped each field season (100/site/crew), the Small Mammal Inventory project has allocated \$10,000 to the museum for curation support for each year of the project, for a total curation budget of \$30,000.

As noted previously, no collections of bird specimens are planned. Curation of any bird specimens found or collected opportunistically will be handled through the existing cooperative relationship between the investigators and the museum.

Network Products

Required Servicewide Program Products

The National Program has identified 4 types of products that are required. These are: (1) annual progress reports, (2) a final report, (3), ArcView GIS themes to be added to existing GIS Theme Managers, and Microsoft Access databases, and (4) updates of biological databases maintained by the I&M Program and other NPS Servicewide databases (i.e., ANCS+). The NWAN strategy for completing these products is described below:

Annual Progress Reports.--An *Annual Progress Report* for the NWAN biological inventory studies will be completed each year under the direction of the NWAN Coordinator. The Principal Investigator for each of the 4 NWAN inventory projects will be responsible for providing a statement of progress to be included in the *Annual Progress Report* for the network. The *Annual Progress Report* will be completed in a timely fashion after the end of the field season. The focus will be to report on progress toward completion of the inventory goal, rather than on analysis of data. The *Annual Progress Report* will be completed according to the following schedule:

December 1	Drafts of project progress reports due to <i>Inventory Coordinator</i>
December 15	Draft Annual Report completed for internal network review, and for review by the Alaska I&M Regional Coordinator
January 15	NWAN Biological Inventories Annual Progress Report submitted to WASO

Final Reports.—A *Final Report* summarizing the findings for the entire inventory effort will be produced. We will also require a *Final Report* for each of the 4 inventory projects to be undertaken by the NWAN. These *Final Reports* will be completed at the conclusion of each inventory. As for the *Annual Progress Reports*, submission to WASO will be coordinated through the Alaska Region I&M Coordinator.

Data Products: ArcView and Access.--As mentioned above in our discussion of data management for the inventories as a whole, each inventory will develop a Microsoft Access database for storage and display of the data. A data dictionary will be created to promote the use of standardized fields and codes among the inventory projects. All projects will use GPS technology to ensure consistent and accurate geographic referencing for all observation and collection sites. The databases will be linked to GIS Theme Managers for the NWAN units to allow graphical display of the new themes generated by this inventory work. Federal Geographic Data Committee (FGDC)-compliant metadata will be developed for all geospatial data.

NPS Servicewide Database Updates.--The national I&M Program maintains the following NPS Servicewide biological databases:

- NPSpecies, a database of documented species occurrences in each park;
- NRBib, a database of bibliographic citations related to natural resources for each park;
- the Dataset Catalog, a database of data sets collected in each park.

Another NPS Servicewide database that will be added to by these inventories is:

- ANCS+, the Automated National Catalog System, a database of park museum collections,

Although these are separate databases, they are interrelated. For example, voucher specimens entered into ANCS+ are imported into NPSSpecies. Any publications documenting the occurrence of a vascular plant or vertebrate species in a park unit needs to be entered into NRBib.

The process of updating these databases with information produced by the NWAN biological inventory effort will be as follows.

- The Principal Investigator for each of the 4 projects will be responsible for keeping track of what information needs to be added to the national databases.
- The Principal Investigator will be responsible for submitting information to the NWAN *Data Manager* for entry into the national databases.

Other Products of the NWAN Biological Inventories

Other specific project products to be produced by these inventories are outlined in their respective chapters. Of note are the following:

- The vascular plant inventories for all Alaska park networks will join efforts to produce a plant data browser and updated species distribution maps. These maps will, in effect, provide an update of Hulten (1968), which represents the current source of distribution and status information for Alaska's vascular plants.
- The small mammal inventory data will be made available in georeferenced format on the web.
- Doctoral dissertation on the small mammal inventory, and related publications in the peer-reviewed literature.

Another important type of product from the inventories will be the production of various products for the public. Development of these products will occur in consultation with the public affairs officers and interpretative division staffs of the NWAN units. Types of products may include the posting of material on park web sites, posters, public lectures, school visits, brochures, or briefing fact sheets.

Network Budget

The national allocation to NWAN parks for these biological inventories was \$1,437,470. In Alaska, costs of starting up the Biological Inventories program (including Steps 1, 2 and 3) were shared amongst the 4 networks in Alaska. The NWAN share of these costs was \$198,676. The remaining allocation to be spent on NWAN inventories is therefore \$1,238,794; this is the number we used for planning NWAN inventories. Table 3 provides an overview of the NWAN biological inventories budget.

Table 3. Overview of Northwest Alaska Network FY 2001-FY2004 budget for biological inventories.

	FY 2001	FY 2002	FY 2003	FY 2004	Total
Network Operations					
<i>Inventory Coordinator</i> /Plant PI	50,625	67,500	67,500	67,500	253,125
<i>Data Manager</i>	13,290	57,592	57,592	57,592	186,066
Equipment/Supplies	5,000	5,000	5,000	5,000	20,000
Logistics Support	6,000	6,000	6,000		18,000
subtotal--network	74,915	136,092	136,092	130,092	477,191
Inventory Projects					
Vascular Plants	127,396	127,396	0	36,003	290,795
Small Mammals	69,283	83,370	70,829	23,100	257,582
Montane-nesting Shorebirds	65,589	62,811	62,227	21,373	212,000
subtotal--inventories	273,268	273,577	133,056	80,476	760,377
Network Total	348,183	409,669	269,148	210,568	1,237,568

Specific information on the budgets of each inventory project is provided in the individual project statements. Each project is working on the assumption that no field work will occur in Year 4 (FY 2004), and the major endeavor in that year will be on reporting.

The Network Operations budget reflects the hiring of an *Inventory Coordinator* who serves all coordination functions. This individual will also be the Principal Investigator for the Vascular Plant Inventory. A *Data Manager* will also be hired to oversee the data management function. \$20K has been allocated to equipment and supplies needed for data management, and \$18K has been allocated to logistic support. These latter dollars are intended as a cushion to meet the exigencies of operating in the remote environment of NWAN units.

Timeline

Key milestones in the NWAN biological inventories process are identified below by fiscal year. FY 2001 is a critical year in terms of getting the inventories started, with such one-time activities as hiring the *Inventory Coordinator* and completing the ecoregions mapping needed to stratify field work. In FY 2002 and FY 2003, the project should be in a full implementation mode. FY 2004 is reserved for production of products, including final reports, databases, GIS layers, and for synthesis among the inventory efforts. We are targeting completion by September 30, 2004. However, past experience suggests that completion of all reports and required data products will not occur until the next fiscal year. The *Inventory Coordinator* will be responsible for completing the inventories within funding and time constraints.

FY 2001

- Submit Study Plan to WASO
- Receive Funding.
- Hire *Inventory Coordinator* and *Data Manager*.

- Project PIs Plan Summer 2001 field work, including: planning meeting to brief all I&M personnel on the respective scope and objectives of each inventory and to coordinate field operations.
- Get ecoregions map for use in stratification.
- Provisional Field Work Schedule:

	BELA	CAKR	NOAT	KOVA	GAAR
Vascular Plants			X	X	X
Small Mammals					X
Birds	X	X	X		

FY 2002

- *Annual Progress Report* (for FY 2001) to WASO by January 15, 2002
- Plan Summer 2002 field work
- Provisional Field Work Schedule

	BELA	CAKR	NOAT	KOVA	GAAR
Vascular Plants	X	X			
Small Mammals			X	X	X
Birds			X	X	X

FY 2003

- *Annual Progress Report* (for FY 2002) to WASO by January 15, 2003
- Plan Summer 2003 field work
- Provisional Field Work Schedule

	BELA	CAKR	NOAT	KOVA	GAAR
Vascular Plants	X	X	X	X	
Small Mammals	X	X			
Birds				X	X

FY 2004

- *Annual Progress Report* (for FY 2003) to WASO by January 15, 2004.
- Data analysis and writing (no field work)
- Update Servicewide databases
- *Final Reports* for the network and for each inventory to WASO by September 30, 2004

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Chapter 2 Vascular Plant Inventory

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Introduction

Covering approximately 21 million acres of remote, roadless land in Alaska's western arctic, little of the Northwest Alaska Network (NWAN) has been visited by botanists. Mechanized access to the majority of the network's land is extremely costly because of the distances involved and is generally limited to helicopter and fixed-wing planes on floats. Accessing the terrain beyond a drop-off point typically requires days to weeks of cross-country hiking over difficult terrain. As expected with these constraints, recent examination of documented and expected vascular plant species in network parks (Table 4) revealed fairly low percentages of documented species, compared to the number of expected species (Alaska Natural Heritage Program 2000).

Levels of past work on vascular plants vary considerably across the network. Both Gates of the Arctic National Park and Preserve (GAAR) and Bering Land Bridge National Preserve (BELA) have benefited from comprehensive plant inventory efforts in small areas of these units (e.g., Murray 1974, Kelso et al. 1987). Noatak National Preserve (NOAT), Kobuk Valley National Park (KOVA) and Cape Krusenstern National Monument (CAKR) have received only low intensities of survey effort. Quantitative data on network plant communities are mostly lacking except for a few intensive studies in small areas (e.g., Cooper 1983, Christiansen 1988). Remote sensing landcover maps have been completed for all network parks (Markon and Wesser 1998), but few community composition data were gathered for these products.

Table 4. Number of vascular plant taxa present and expected in National Park Units of the Northwest Alaska Network. Species numbers were determined by compilation of verified vouchered specimens and high quality data sources. Source: Alaska Natural Heritage Program (2000).

	BELA	CAKR	NOAT	KOVA	GAAR
Vascular Plants					
# species documented	460	186	191	260	427
# species expected, but not yet documented	183	136	376	135	91
total # expected species	643	322	567	395	518
% documented	72%	58%	34%	66%	82%

At the April 2000 Biological Inventories Scoping Meeting held in Anchorage, it was immediately clear that gathering additional information on vascular plants was going to be a high priority for at least 3 of Alaska's 4 inventory and monitoring networks. To help formulate study plans for these vascular plant inventories in the large, remote parks of Alaska, a regional team of park service and university botanical experts was formed. The members of this team (the Alaska Region I&M Plant Working Group) met and corresponded over a period of several months to develop a recommended approach for the inventories. The group had many discussions about selecting inventory sites based on judgment versus a sampling approach. For several reasons, the group recommended that most, if not all, of the vascular plant inventory effort should be deployed using a reconnaissance methodology targeting sites predicted to provide the most information about species not yet documented (Alaska Region I&M Plant Working Group 2000). The reasons for this recommendation include the nature of Alaska's vegetation, where expansive low diversity plant communities are interspersed with pockets of high diversity. Because of the impetus to document as many species as possible (i.e., 90% of the expected species), efforts must be made to target these diverse hot spots for investigation.

The Alaska Region I&M Plant Working Group did not reach a consensus on whether to recommend quantitative vegetation sampling. Most of the group's members believed that the principal goal of floristic inventory was all that was achievable given the size of our parks and the high cost of access. However, the

group also recognized the importance of quantitative methods of inventorying plants to allow inference to wider areas and to lay the foundation for future monitoring. Thus, in the Central Alaska Network, the vascular plant inventory will include comparison of results in species capture from reconnaissance sites and from a subset of sites from a systematic grid established to monitor vegetation change in Denali. In the Northwest Alaska Network, we will investigate the species capture abilities of the targeted reconnaissance method by also visiting sites selected at random, and by investing about 20% of our effort in plot-based work.

The project described below will attempt to gather network-wide data on plant communities to quantify the relative abundance of plant taxa at a variety of spatial scales and provide a preliminary assessment of patterns of plant diversity on a landscape-level. As in any large, remote area, detailed floristic inventory usually requires iterative efforts extending beyond the scope of any one project (Hulten 1968). The vascular plant inventory proposed will fill in large data gaps and allow us to target remaining gaps strategically in successive efforts.

This project plan contains the following elements:

- background information on the general environment of the Northwest Alaska park units relating to vegetation;
- a review of prior work on vascular plants in this region;
- goals and objectives of the inventory;
- sampling design and methods for the inventory;
- descriptions of the expected products;
- a budget, project timeline, and explanation of park contributions to the project.

Background

NWAN Environment

NWAN's five park units encompass a large, contiguous area near the arctic circle (between 65° and 68° N latitude) and are situated within the low arctic plant community province (Hulten 1968, Thomson 1984). The major physiographic features in the network are the east-west trending mountain systems comprising the central and western Brooks Range. Seventeen million acres of land in GAAR, NOAT and KOVA straddle these mountains, with elevations ranging from 0 to 2500 m. The continental divide traces a sinuous path through the network, dividing arctic plain, interior and oceanic climates, and physiographic regions. The Brooks Range is composed predominantly of calcareous formations of mid-Paleozoic age with two inset granitic batholiths which are exposed in the spires of the Arrigetch and Igikpak formations (Ellis et al. 1981). Two of the network parks lie just beyond the reach of the western Brooks Range. CAKR is a coastal plain ecosystem with extensive lagoons, wetlands, coastline and low-lying foothills. BELA, the network's southernmost park, lies on the Seward Peninsula just south of the arctic circle (Figure 2), and is comprised of low, rolling hills, lava beds from fissure volcanoes, and a large coastal plain dotted with expansive permafrost thaw lakes and wetlands.

The mean annual temperature at low elevation (ca. 200 m) on the south side of the Brooks Range is approximately -11°C and is colder but unknown at higher elevations (Owenby and Ezell 1992). The mean summer and winter temperatures in the three Brooks Range park units are approximately 13°C and -25°C respectively. Mean annual precipitation is approximately 350 mm, ranging from 280 mm to 480 mm. Mean summer temperatures and winter temperatures are approximately 3-4° colder and precipitation is lighter (ca. 250 mm mean annual) on the north slope of the Brooks Range. The western area of the network on the NW side of the continental divide is influenced by western Alaska's oceanic climate and receives somewhat higher precipitation than the interior or arctic climatic zones. Summer temperatures are lower in the most maritime areas, leading to an exclusion of boreal forest (Viereck et al. 1992).

Vegetation in the network consists primarily of arctic and alpine tundras, boreal forest, wetlands, and shrub thickets. Boreal forests occur in the southern fringes of the Brooks Range parks where the higher summer temperatures of a continental climate allow for growth of trees. Boreal forests include stands of pure white spruce (*Picea glauca*), mixed white spruce-paper birch (*Betula papyrifera*), pioneering stands of pure paper birch, spruce-lichen woodlands, black spruce (*Picea mariana*)-dwarf shrub-bryophyte-lichen muskeg, closed alder (*Alnus crispa*) thickets and scattered groves of black cottonwood (*Populus trichocarpa*) and aspen (*Populus tremuloides*) (Viereck et al. 1992). Shrub thickets consist of low and high willows (*Salix* spp.) in riparian and wetland habitats. Tundras include *Eriophorum* tussock tundras, low to mid-elevation ericaceous dwarf shrub-lichen-bryophyte tundras, alpine (*Dryas*- or *Cassiope*-lichen) tundras, moist low elevation peatlands (*Carex* spp. et al.) and sparsely vegetated-lichen fellfields and talus. Wetlands include vast areas of tussock tundras over permafrost and oligotrophic fens. Elevationally, the plant communities can be roughly classed as follows: <200 m (boreal forest south of continental divide; lower elevation tundras, peatlands, wetlands throughout); 200-750 m (arctic tundras, mesic forb meadows, peatlands); 750 – 1500 m (alpine tundras and fellfields); >1500 m (high alpine communities including fellfields, talus, rock). The network lies primarily within the continuous permafrost zone, with only KOVA containing large stretches of boreal forest over discontinuous permafrost (Pielou 1996). Permafrost-free soils occur in the other four parks only along riparian corridors and over shallow bedrock.

Previous Work on Vascular Plants of NWAN Units

Bering Land Bridge National Preserve.--A high-level team of American and Russian botanists conducted extensive surveys of BELA during their 1992-4 work on the Seward Peninsula, documenting hundreds of vascular and nonvascular species (Kelso et al. 1997). This work provides the bulk of documented, vouchered data in this park unit. Little comprehensive work has been done on plant communities of the Seward Peninsula. Some descriptive work on salt marshes has been done by Hanson (1953), on frost-disturbed ground by Hopkins and Sigafos (1951), on fire communities by Racine (1981), and on community structure important to bird populations by Kessel (1989). Additional discussion of Seward Peninsula vegetation can be found in reports by Racine and Anderson (1974), Melchior (1979), and the National Park Service (1985). The most comprehensive treatment is that of Swanson et al. (1985) whose choice of ecological sites were based on their suitability as reindeer range. Their work is, unfortunately, not comparable to the Alaskan vegetation classification proposed by Viereck et al (1992). FirePro crews surveyed numerous plots in the park, but with extremely limited species capture in plots, often <5 species (National Park Service 1999). Markon and Wesser's (1997) landcover map provides excellent discrimination of plant cover types but with no ancillary community composition data.

Cape Krusenstern National Monument.--The only formal report of plants from CAKR is the NPS Flora/Fauna database listing 12 species (National Park Service 1991). A recent search of University of Alaska Museum Herbarium (referred to hereafter as ALA²) revealed 43 documented records. Most of these specimens were collected by Dr. Steve Young during the pre-ANILCA expedition to the Noatak River basin (Young 1974). ANCS+ records revealed approximately 130 other records of unknown origin. The bulk of the 58% of attainment of documented species relative to expected is therefore of undocumented origin. A landcover map has been produced (Markon and Wesser 1998), but with minimal ground truthing. Approximately 50 Firepro vegetation plots exist (National Park Service 1999), but the data from these plots typically only provide records of the dominant species.

Noatak National Preserve.--Young (1974) collected the vast majority of voucher specimens from NOAT that are cataloged in ALA (2000) during his assessments of the area prior to national park status in the early 1970's. These specimens form the basis for the currently documented list in NOAT, although some past data

² "ALA" is the official acronym given to the University of Alaska Museum Herbarium in the list of the world's herbaria published by the International Association for Plant Taxonomy (Holmgren, P. K., N. H. Holmgren, and L. C. Barnett. 1990. *Index Herbariorum Part I: The Herbaria of the World*. New York Botanical Garden, Bronx, NY. 693 pp.

awaits investigation for inclusion in documented records. For example, Craighead et al. (1988) documented 305 plant species in NOAT in the process of mapping and classifying vegetation with satellite imagery. Obtaining both taxonomic and classificatory results from this project may help NOAT attain a much higher present/expected taxa ratio than it currently shows. Several theses and other research projects have addressed specific vegetation issues in NOAT (e.g., treeline change: Rowland 1997; floodplain-permafrost-treeline dynamics: Arians 1997), but without vegetation reconnaissance or characterization. Markon and Wesser's (1998) landcover map provides excellent discrimination of plant cover types but with no accompanying vegetation classification or statistical characterization.

Kobuk Valley National Park.--Parker (1997), Mann and Parker 1997), Racine (1976), and Hunt (1997) provide the bulk of currently documented plant species for KOVA in ALA (2000). Racine (1976) provided a baseline survey of the flora and vegetation used in the assessment efforts leading to the creation of this park in 1976. A modest amount of quantitative characterization plots were conducted for this effort. Lipkin (1985) provided a detailed assessment of the status and trends of the state-listed rare species *Oxytropis kobukensis*, an endemic to the dune fields in KOVA. He is scheduled to repeat this assessment in 2001 and provide population estimates for continued monitoring of this taxon. Parker provided a comprehensive taxonomic inventory of the Greater Kobuk Sand Dunes based on several site visits between 1996-9, and has provided several lists subsequent to her 1997 floristic descriptions of dune community types. Markon and Wesser's landcover map (1998) provides excellent discrimination of plant cover types but with no accompanying vegetation classification or statistical characterization. Other than Racine's limited study, no classification or vegetation characterization has been done in KOVA.

Gates of the Arctic National Park.--A greater amount of plant inventory has been conducted at GAAR than elsewhere in the network. The most comprehensive treatments in GAAR were Cooper's late 1970's plant classification work in the Arrigetch Creek Valley (Cooper 1983, 1986, 1989) based on over 200 releves including all vascular and nonvascular taxa. Eminent Alaskan botanists David and Barbara Murray made a substantial two-month collection effort (Murray 1974) on the Alatna and Killik drainages, documenting hundreds of vascular and nonvascular taxa. Christiansen (1988) provided a post-fire recovery vegetation sequence spanning 125 years for the boreal forest in the Walker Lake area. This effort resulted in a large volume of vascular and nonvascular collections and plots. Neitlich and Hasselbach (1996) inventoried vascular and nonvascular plants in the vicinity of Walker Lake, documenting approximately 350 vascular plant and lichen species. The National Park Service recently completed a landcover map for GAAR (Helt et al. 1999) based on remote sensing with very limited ground-truthing. FirePro crews surveyed numerous plots in the park, but with extremely limited species capture in plots, often <5 species (National Park Service 1999). Although GAAR's flora is the best known of all network parks, 91 taxa remain expected, and no park-wide or ecological strata-based classification studies have been conducted.

Goal and Objectives

The goal of this inventory project is to improve our understanding of the distribution and abundance of vascular plant species in NWAN units using a sampling design suited to expansive areas with minimal access. This goal will be achieved through the following objectives:

1. Document the occurrence of 90% of the vascular plant species expected to occur in each park unit by surveying targeted and randomly chosen habitats and communities.
2. Describe the relative abundance of each species at spatial scales ranging from plant community to network, collecting data in accordance with regional protocols allowing for Alaska-wide estimation.
3. Lay the foundation for future efforts in monitoring plants/habitats of special concern and lichen communities.

4. Compare the species-capture ability of judgment-based versus stratified-random biodiversity sampling and determine the habitat characteristics associated with elevated diversity “hotspots”.
5. Gather a vouchered set of specimens of each species for research and park uses and populate national and local databases with taxonomic and accompanying data.

Methods

The following sections describe our study design (focusing on site selection and allocation of effort), field methods, data analysis, data management, vouchering and curation.

Study Design

The vascular plant inventory in NWAN units will employ two widely-used approaches to plant inventory:

1. Floristic reconnaissance for vascular plant species and communities using:
 - a. judgment-based site selection (40% of field time, 30 sites anticipated).
 - b. stratified-random site selection based on landcover or ecoregional strata (40% of field time, 30 sites anticipated).
2. Fixed-area plot network arrayed in stratified-random design within major landcover or ecoregional strata (20% of field time, 60 plots anticipated)

In designing this study we attempt to balance NWAN’s competing needs for biodiversity data from sparsely-represented and patchily-distributed plant species, and abundance and distribution data with network-wide inference. Effective management for biodiversity requires that inventories be conducted with a high level of taxonomic rigor, have adequate spatial coverage, include detailed examination of special communities, and have enough analytic power to place results in the context of regional floristics. Management of large areas facing potential threats (e.g., mining, roads, acid deposition, grazing) requires knowledge of the relative abundance and distribution of species of concern, as well as the composition and diversity of the vegetation at a variety of spatial scales. To meet these divergent goals, this inventory will use a combination of targeted reconnaissance surveys, randomly chosen reconnaissance surveys (stratified-random design), and permanent fixed-area plots associated with both targeted and randomly chosen sites.

The bulk of the arctic lands are occupied by high-dominance, low-diversity plant communities, and elevated diversity generally occurs in small pockets in the landscape (Pielou 1996). There are a large number of plant communities in the network overall, but many of these occupy a small minority of the land area. The primary goal of attaining 90% of expected species requires that:

1. a sampling of all likely special habitats occurs, and
2. plots are efficiently distributed within a large number of plant communities in the network, many of which occupy small areas.

Random sampling without stratification would be most likely to result in the selection of sites offering this regional backdrop of low diversity and high dominance by a few plants. We have chosen to stratify (probably by plant community—see below) our randomly chosen sites to ensure that plants will be sampled across the greatest spectrum of community diversity possible. For details of the sample site selection process, see headings immediately following.

Several beneficial by-products are anticipated from this study design. First, by installing permanent vegetation plots, we will provide a sampling framework and a vegetation data set for intended network monitoring of nonvascular plants facing pollution and grazing threats. Second, as inventory will be an ongoing effort, comparison of judgment-chosen and randomly selected reconnaissance sites will provide an independent assessment of these two sampling approaches. Third, we hope to evaluate the extent to which elevated diversity “hotspots” surpass regional diversity levels and the set of environmental variables associated with these special communities.

Based on a consideration of the logistical realities of working in the remote NWAN units and the budget for this project, we anticipate that we can visit 60 sites as a part of this inventory (see later section “Logistical Considerations and Assumptions Used in Developing the Project Budget” for how we reached this number of sites). Reaching these 60 sites will require 2 2-person crews working over two summers with significant amounts of support by fixed-wing planes and helicopters. We describe our site selection procedure in the following section.

Selection Process for Reconnaissance Sites

Targeted Sites.--Habitat characteristics of expected species, species of special concern, habitats of special concern and suspected diversity hotspots will be evaluated. An unranked pool of targeted landscape units will be identified via analysis using key criteria such as:

- regionally unique geological or geomorphological features;
- communities or habitats of biological concern;
- likely habitats of expected species and rare plants, as indicated by regional floras (e.g., Hulten 1968) and museum records (ALA 2000);
- under-represented plant communities and previously unsurveyed areas (ALA 2000);
- minimum sample unit (SU) allocation to each landcover stratum;
- logistical feasibility (e.g., access means, cost);
- potential of certain types of sites to maximize species and communities encountered (e.g., ecotones, high gradient areas)

Site selection criteria will then be weighted, and the targeted survey sites in the pool will be ranked. These will be delineated as a spatial layer. Fifty percent of the total number of anticipated sites (i.e., most likely 50% of 60 sites) will be selected from the top of the ranked list. In ranking the sites to be visited, we will heavily weight habitats deemed to be of high priority, rare taxa considered to be of special concern, and taxa that are underrepresented.

During the expert review phase, scoping meetings and Alaska Region I&M Plant Working Group meetings, consensus emerged on the following high priority reconnaissance habitats in the network:

- *BELA* – marshes, coastal/strand systems, aquatics, Ear Mountain area
- *CAKR* – Coastal plain, Brooks Range foothills, bird perches and other nutrient enrichment areas
- *KOVA* – Alpine areas, especially the Jade Mountains and karst formations
- *NOAT* – Areas of unusual geology, especially siliceous or granitic bedrock
- *GAAR* – Hot springs and perennial springs, dunes, mud boil tundra features, disjunct and unsurveyed Castle Mountain section, NE corner of preserve (Oolah Lake vicinity)
- *Network-wide* – Aquatic systems hosting aquatic plants

We will also target rare taxa of special concern. Several taxa in NWAN parks have been given special status by the Alaska Natural Heritage Program (2000) due to endemism or low population levels. Taxa of special concern include: *Coriospermum ocotense*, *Aster yukonensis*, *Oxytropis kobukensis* (especially white morph), *Oxytropis arctica* var. *barnebyana*, *Gentiana detonsa*, *Rumex krausii*, *Ranunculus auricomis*, *Lupinus*

kuschei, *Douglasia beringensis*, *Beckwithia glacialis*, and *Artemesia globularia* var. *lutea* (Carolyn Parker, Rob Lipkin and David Murray, pers. comm.). Preliminary assessments of populations of these taxa encountered will provide the basis for a determination of whether follow-up monitoring is warranted.

Analysis of the expected species lists suggests that the families hosting the greatest undocumented diversity are Cyperaceae (Sedges), Poaceae (Grasses), Brassicaceae (Mustards), Asteraceae (Composite), and Caryophyllaceae (Pink). The concentration of missing taxa in these most difficult families suggests that the goal of documenting 90% of expected species will require a high-level of field expertise.

Randomly-selected Sites.--The random selection of the remaining 50% of sample sites will proceed as follows: A determination will be made as to the appropriate method and hierarchical level of landscape stratification. Likely candidates are combined groups of landcover classes (Markon and Wesser 1998); or ecoregion provinces (Nowacki et al. 2000). A dense grid-cell approach of identifying potential sampling locations (Fancy 2000) will then be applied to the entire park. The starting point for this base grid will be randomly selected. Using a constrained stratified-random design that allocates equal numbers of sample units to each landscape stratum, grid cells will be chosen at random from strata until appropriate sample sizes are reached. Decisions on the level of landscape classification used for strata will await final products from Step 3 (landscape stratification) of the inventory process.

In choosing landscape strata for stratified-random designs, the use of vegetation or landcover maps has been generally discouraged (Fancy 2000) because of the likelihood that vegetation will shift over time. Stratification based on physical features has been advocated as a more stable long-term approach. In spite of caveats, we favor stratification by grouped landcover classes as we think this best targets natural variation in plant habitats. Since this project is designed primarily as an inventory effort, it is critical to identify units most likely to contain different sorts of plant communities. While any given ecoregion province, section or subsection contains up to 12-20 landcover classes (Markon and Wesser 1998), each landcover class is unique and is likely to contain a distinctly different set of plants than all other landcover classes. Stratification by ecoregions would mimic the problems presented by simple random sampling above, in that the widespread, low-diversity communities represent most of the area in any given province or section.

Allocation of stratified sample units proportionally to strata size has also been advocated (Fancy 2000), but was rejected for similar reasons. Allocation of stratified-random sample units in proportion to landcover strata size would again result in over-sampling of the high-dominance/low-diversity communities of the largest landcover strata (e.g., dwarf low scrub, tussock tundra), while at the same time neglecting the under-surveyed strata that are likely to host large numbers of expected species. If our primary questions concerned monitoring the trends or documenting the habitats in the majority of lands—rather than inventorying the greatest number of species—we would certainly consider proportional allocation (or even simple random sampling). An inventory requires, however, that sampling occur where different types of taxa are most likely to occur. If we decide for other reasons to stratify based on physical features or ecoregions (which are primarily physically-based, e.g., Nowacki et al. 2000), we will attempt to attain sample adequacy in landcover classes by making this a weighting factor in the targeted site pool selection.

Selection Process for Plot Sites

As noted earlier, we will expend roughly 20% of our field crew effort in quantitative assessments (typically, 3 hours by one crew during a 2-day site visit with two crews). Fixed-area vegetation survey plots will be installed at each site selected for reconnaissance. In sites selected by judgment criteria, plots will be randomly located within the community of interest. At randomly chosen sites, plots will be located at random within the appropriate landcover class in the grid cell selected. In order to retain the balanced allocation of sample units to strata, strict rejection criteria will be developed to avoid sampling in mismatched landcover pixels. A backup pool of randomly chosen sites in the appropriate landcover class will be chosen. In the case of mismatching or locations comprised of more than one landcover type, the location will be rejected and a backup location will be used.

If landscape stratification occurs by ecoregion rather than landcover type, then we will post-stratify by landcover types. We may also consider sample unit allocation strategies that allocate plots to landcover classes as equitably as possible (e.g., heavier weighting of judgment sites in under-represented landcover types). Plot data will be analyzed annually to determine variability within landscape strata and projected sample adequacy by stratum. The hierarchical level of stratification and/or sample unit allocation may be adjusted in following field seasons based on past season's results.

Field Methodology

Field Methods at Reconnaissance Sites.--The basic survey will provide abundance and frequency categories for all species encountered at each site, a comprehensive list of taxa in target community type(s), and trends in the distribution of species of concern with respect to site characteristics. Site locations will be mapped on an aerial photo, USGS topographic map and a georeferenced with GPS. The routes surveyed will be mapped and georeferenced. A description of the site will be recorded and significant landforms and communities described. Sites will be photographed on the ground and, when possible, from the air. Communities, notable plants & unique landforms will also be photographed.

As the survey is conducted new communities encountered will be recorded on the community data sheet and a species list compiled. The following data are recorded on the community data sheet: Viereck vegetation type to level 4 (Viereck et. al. 1992), slope, aspect, elevation, topographic position, wind, moisture, soil types, parent material, cover classes of life forms and bare ground, dominant species by life forms and a description of the community. A species list is compiled, and the communities in which each species occurs is recorded.

Specimens are collected for taxa that are: new to the park, species of concern (rare, endemic, disjunct, invasive) or not identifiable in the field. As time permits, a more complete voucher collection for the site is acquired focusing on species that are unique to particular communities or ecoregions. Collections are only made if the population is large enough to support removal of individuals and will follow the collecting protocol of Parker and Murray (1992). Duplicate collections will be made when possible, one for NPS and one for the ALA.

Collection data will include: latitude and longitude (NAD27, decimal degrees); slope, aspect, elevation, topographic position, associated landforms, associated species, Viereck vegetation class, substrate, soil moisture, soil type, drainage, parent material, cover class and frequency class, notes on characters not preserved well, associated photo number, phenology and ecological observations. For species of concern the size of the population and area surveyed is to be included.

A list of species for Alaska for which genetic material has been requested from ALA will be compiled by ALA. Material will be collected and held in silica gel for genetic analysis. Material will be sent to the University of Alaska Fairbanks Museum (ALA) for storage or forwarding to the requesting investigators.

Plot Methods.--We are currently evaluating several plot methodologies, including Forest Health Monitoring vegetation plots (Busing et al. 2000), Modified-Whittaker plots (Stohlgren 1995), and 0.1 ha circular plot releve. The releve technique has been widely used in Alaska for vegetation classification (e.g., Viereck 1992, Hasselbach 1995), and we currently favor this technique for its simplicity and utility for subsequent lichen sampling and monitoring.

We estimate that 75% of the plant species in our network are nonvascular. Lichens, in particular, face a wide range of threats such as new sources of regional air pollution, reindeer grazing, acidification, and Arctic Haze (AMAP 1998, Neitlich 2000) and are the highest plant priority in the network. Since network monitoring is much more likely to focus on lichens and bryophytes (which are excluded from this national inventory initiative) than vascular plants, we are currently favoring the simple 0.1 ha releve. FHM is scheduled to sample vegetation statewide from 2002-2004. Were we to use their method, we would add considerably to

the power of our dataset. This method is generally more time-consuming and complex than advised for the purposes of inventory alone, however. A final decision will hinge partly on how well simple relevés may be integrated with FHM data, and partly on cost-benefit trade-offs. Regardless of the plot type chosen, plot sampling will lay the foundation for subsequent lichen sampling which will be conducted using these same plots.

Data to be collected on the plot will consist of standard vegetation metrics as outlined in Busing et al. (2000). This includes: cover class ratings for each species in two vertical strata, 0-2 ft and >2 ft; cover class ratings by grouped life forms (e.g., trees, tall shrubs, dwarf shrubs, graminoids, herbs, mosses, lichens); % cover of dominant lichens and bryophytes; 5 prism point counts for basal area of trees >10 cm dbh; cover ratings for a broad suite of terrestrial characteristics (e.g., rocks in different size classes, soil, standing water, duff); and standard environmental variables such as geographic coordinates (with estimated position error), slope, aspect, elevation, depth to permafrost (within soil probe reach), depth of major soil horizons (probe only), soil texture and pH, and bedrock type. If multi-scale plots are conducted, data will be gathered in each subplot and soil measurements done at plot center.

Plots will be permanently marked with iron rebar covered with a white PVC pipe, tagged with a 2 in aluminum tag. The plot stake will be at plot center, and buried as deeply as possible. In GAAR, the marker will be buried just below the ground surface. Metal detectors will be needed to relocate the plot center exactly. Plot center will be recorded with PLGR-level accuracy.

Regional Standardization.--In March of 2001, all of the members of I&M plant inventory projects in the Alaska Region will meet to fine-tune inventory protocols that have been used throughout the Alaska region (e.g., Roland, 1999). The goal of this meeting is to adopt a methodology that can then be applied throughout the region, thereby allowing for inference about relative abundance on the level of NPS lands statewide. Common database structures and a unified data dictionary and set of field forms will be developed prior to the field season. Consultation will also be sought with the small mammals and birds projects to explore the option of common variables collected by each project for potential use in monitoring efforts.

Attainment of 90% Species Capture.--A key question in this inventory is, How do we know when 90% of expected species has been achieved? The answer to this question is critical at all phases of the project from planning to interim data analysis to project conclusion. One often-discussed option is to compare the project's species list with a purportedly more complete species list derived from either: a) a spatial coverage which buffers the network lands by a certain distance, or b) expert opinion. Because of the high number of taxa involved and the inherent uncertainty of making extrapolations about poorly known taxa (in poorly known parks), our Step 1 plant lists were derived using a 50 mi buffer around network parks. Species input into this model came from ALA's database.

The buffering model of assessment is a good operational "best-guess" model for project planning, but may fall short for interim and final assessments. Several other models based on species capture per unit effort or area address this question using data from *within* the network rather than from *outside* of it. Two common models of total species estimation for vegetation are island-biogeography species area models (Conner and McCoy 1979, Conner et al. 1983) and jackknife estimators of species richness (Palmer 1990, 1991, 1995). Island biogeography models are used for sample units of unequal size (e.g., meander surveys) while jackknife estimators are used for sample units of equal size (e.g., plots). Both of these models will be considered in determining the overall attainment level of this project on interim and final bases.

Data Analysis

Data analysis will focus on species, community, network and regional levels. Key among the results will be:

- Occurrence and distribution of species as spatial data layer.

- Relative abundance of each species by plant cover type, ecoregion, park and network.
- Trends in the distribution of species with respect to site and community characteristics.
- Regional cooperation for generation of updated statewide distribution maps for taxa of greatest need (e.g., for groups which have undergone significant taxonomic revision, species of special concern).
- Floristic analysis including composition of the flora by life form, family and genera; biogeography of the flora including endemism and other forms of rarity; and distribution of rare taxa by site characteristics.

In addition to the standard products anticipated from this study design, we also envision several beneficial by-products. These emerge from the our inclusion of both random and judgment sites and plots and feature:

- Comparison of randomly chosen versus judgment chosen sites, helping us answer the question: "How should future inventory be designed in this arctic network?"
- Diversity and compositional gradients of special (judgment) communities compared to randomly chosen sites; and
- Characteristics and compositional gradients of diversity "hotspots" (e.g., Neitlich and McCune 1997) compared to lower diversity sites.

At 21 million acres, NWAN land holdings represent 25% of the land in the National Park System. Only approximately 60 sites will be visited in this inventory, 30 of which will be randomly located. Statistically describing the vegetation of 10-15 landscape strata (e.g., 15 plant cover classes in Markon and Wesser 1998), some covering millions of acres, is therefore not feasible given the mixed objectives of this study. To supplement our dataset, we will examine high-quality past datasets from intensive ecological studies such as Cooper (1983), Christiansen (1988), Craighead et al (1988) and Swanson (1985). If plot density is high enough in landscape strata (e.g., with the addition of other datasets), it may be feasible to analyze the patterns of species richness across landscape strata, community gradients across landscape strata and their relationship to environmental variables, and compositional variability within strata. If compatible with our methods and intended analyses, we may also conduct an exploratory community classification analysis of the combined datasets to lay the foundation for future vegetation classification and mapping efforts.

Statistical analyses will include: logistic regression to identify habitats and environmental characteristics most likely to predict presence-absence of different taxa; multivariate community techniques in PC-ORD (species-area curves, multi-response permutation procedures, ordination, cluster, matrix variability summary *per* McCune 1999) to assess environmental variables associated with diversity hotspots; and standard univariate statistics (e.g., descriptive statistics, ANOVA, regression in SYSTAT 9.0) for general analysis.

Data Management

Network-level databases will be created in FY 01 to store taxonomic, community and spatial data with metadata in accordance with FGDC standards. The Plant Inventory PI will be responsible for insuring that structures are suitable for intended analyses and interchanges. Databases will be designed for inter-compatibility with other databases including those administered by Alaska's other networks, ALA, and the service-wide NPS inventory program.

The primary relational databases that will be created and/or populated include:

Network

- *Reconnaissance data.* Species, communities, environmental and spatial variables. Data fields will be compatible for import into ANCS+ for NPS curation and into ALA's database for label preparation.
- *Plot data.* Species, environmental and spatial variables.
- *Biogeographical data.* Biogeographical and ecological attributes for floristic analysis.
- *Supplementary spatial datasets.* Notable species will have distributions digitized from known references and ALA data exported so that distribution maps can be prepared. Survey routes will be digitized from aerial photos and maps.
- *QA data.* QA data will be store the raw and summarized QA results from each field season, providing for error estimates of the data by year.
- *Common variables.* If common variables are adopted for plants, small mammals, and birds, a shared database will be created to house inputs from each project.

National

- *NPSpecies.* NPSpecies will be populated with data from ALA, representing a fully vouchered, verified collection. PI will ensure that any currently non-vouchered NPSpecies entries are substituted with vouchered entries.
- *Dataset Catalog.* To be populated with all products in year 4.
- *ANCS+.* Collection data to be imported for NPS cataloging.
- *NRBib.* To be populated with additional references on plants in the NWAN units found during the course of the project.

Electronic data will be archived on high-quality CD's, at the Alaska Region Support Office and on the GIS servers at each park cluster headquarters. File formats for each database will include ASCII delimited text, Excel and MS Access 2000. The PI will supervise these projects, and will be responsible for hiring biotechnicians to help with the work. Biotechnician funds have been allocated annually and on a network-wide basis in FY 04 for data management and reporting. Annual data collection in network databases will be entered by biotechnicians after field work and identification is complete.

Specimen Determination and Vouchering

Specimens will be sorted, examined and preliminarily determined by the botanists who collected them. Collections will be sent to ALA where determinations will be finalized and difficult taxa determined and reviewed by the Museum staff. As needed, specimens will be sent out to genus or family-level authorities by ALA for determination. We estimate that 4000 specimens per season would be collected by two teams of botanists in the network.

A cooperative agreement has been initiated with ALA for this work. We anticipate each network contributing to this agreement annually in proportion to the amount of specimens that will need to be curated. Specimens to be stored at ALA and those to go to park herbaria will be mounted and prepared at ALA. Data for collections will be imported into ALA's database so that labels can be prepared, as overseen by ALA's data manager. Silica gel and tissue samples will also be curated and stored at ALA for future analysis.

Rare plant sighting forms with maps will be completed for species with an AKNHP state rank of 3 or higher, and provided to AKNHP.

Project Curation

Specimens returned to parks from ALA will be filed and accessioned with catalog ledgers updated. Arrangements will be made for long-term loans of primary specimens at ALA, where it will be of benefit to the entire research community.

Hardcopy data and photographs will be copied, with originals archived at Western Arctic National Parklands Headquarters (Kotzebue) and duplicates residing at Gates of the Arctic Headquarters and project files. Slides will be labeled, sorted and filed by site and species. Select site and species slides will be scanned for use in the data browser. At the end of the project, data sheets, field notes, maps, slides and all associated project files will be accessioned by park and items cataloged.

Products

A substantial NPS General Technical Report is planned with two major sections—one treating floristics and another on vegetation. The floristic section will document survey objectives, methods and results including: a floristic analysis by park, network and/or region; annotated species lists by park; distribution of species of concern; trends in site characteristics of species of concern; relative abundance of each species at a variety of spatial scales; species lists by site and abundance categories; habitats or areas requiring further survey work; species requiring population level assessment; research questions; evaluation of the applicability of judgment sampling schemes; and management recommendations for the inventory and monitoring of the network's flora.

The vegetation section will report on: patterns of species richness on scales from community to network; characteristics of high-diversity communities; predictive estimation of species richness by species area models (forming an independent test of inventory adequacy); and the potential for regional vegetation characterization via linked NPS, FHM and intensive study datasets.

Several manuscripts will be submitted to peer-reviewed journals documenting the distribution of taxa new to the state, noteworthy taxonomic finds, and a distillation of community patterns.

The Alaska Region I&M Plant Working Group placed a high priority on the following regional products. Each network has agreed to contribute to these projects, and products would focus on the entire Alaska region. The Central Alaska Network will contribute eight months of their term botanist's time to the completion of these projects in year four.

- a. A site data browser will be developed which will document site characteristics, the species and communities present, the notable plants present and be hotlinked to site photos.
- b. Alaska-Yukon and park distribution maps for notable taxa will be prepared.
- c. A species data browser will be developed for species of concern that will include Alaska-Yukon distribution maps, status, habitat characteristics, collection data and will be linked to species photos and descriptions.

In review, this inventory will result in the following specific products:

1. A report documenting survey and plot-based results, including an annotated species list of all taxa and geographic and habitat attributes.
2. Publications of notable finds in peer-reviewed outlets.
3. Populated databases including local databases, NRBib, NPSpecies and ANCS+.
4. Additional GIS layers for inclusion in each park's GIS Theme Manager.
5. Curated set of voucher specimens for ALA with duplicates in park herbaria.

6. Repository of DNA material of species of concern for use in clarifying taxonomic relationships.
7. A site data browser to retrieve localities by taxa and to view site photos and characteristics.
8. A sensitive species data browser documenting sensitive areas for plants including taxa and habitat characteristics
9. Current distribution maps for selected species (species of concern, notable taxa).

Timeline

The following timetable is proposed for the plant inventory:

FY 01

November 2000	Advertise <i>Inventory Coordinator</i> /Plant PI/Data Manager vacancy
December 2000	Begin pre-inventory steps
January 2001 February 2001	Advertise biotechnician positions, with hiring by March Hire <i>Inventory Coordinator</i> /Plant PI
March 2001	Begin landscape stratification via target sample points and develop grid methodology for randomized locations; lead botanists begin to develop list of targeted sites;
May 2001	Biotechnicians begin work in mid-May.
June – early August 2001	Field work in NOAT, CAKR, BELA
Late-August to September 2001	Data entry, specimen identification, project curation

FY 02

October 2001 – May 2002	Specimen identification, specimen curation and cataloging, data cleanup, biogeographic attributing, analysis of year 1 plot distribution for statistical coverage and variability within strata, year 2 plot selection.
January 2001 June – August 2002	Advertise biotechnician positions, with hiring by March Field work in GAAR, NOAT, KOVA
Late-August to September, 2002	Data entry, specimen identification, project curation

FY 03

October 2002 – May 2003	Specimen identification, specimen curation and cataloging, data cleanup, biogeographic attribution, analysis of year 2 plot distribution for statistical coverage and variability within strata, year 3 plot selection.
June – August 2003	Additional ONPS-funded surveys in CAKR, NOAT, KOVA, BELA

Late-August to
September, 2003

Data entry, specimen identification, project curation

FY 04

October 2002 – May 2004

Specimen identification, specimen curation and cataloging, data cleanup, biogeographic attribution. Final data cleanup, consolidation and analysis. Population of network and national databases. Production of final products and publications. Project and data archiving.

September 2004

Submission of peer-reviewed manuscripts for publication and distribution of spatial datasets and browsers.

Park Contributions, Coordination and Logistical Support

As soon as funding is approved for FY 01, NWAN will hire an Inventory Coordinator who will also serve as plant inventory Principal Investigator and network data manager. This position will supervise plant biotechnicians in FY 01 and 02, and a data management technician in FY 01-FY 04. Supervision for this position will be provided either by the Chief of Resource Management of YUGA or WEAR. In order to attract highly skilled applicants, the position is to be located in Anchorage or Fairbanks, rather than Nome or Kotzebue.

In order to help conserve our transportation budget, we hope to rely heavily on the park plane and pilot for fixed-wing transportation. Although fixed-wing access represents a minority of costs, use of NPS resources would save us up to \$8,000 in OAS charges as currently planned. Current budgeting is based on more costly charter flights because of a history of difficulty scheduling the park plane, although we've been assured that some compromises can be achieved.

In FY 03, NPS will contribute a short field season of vegetation work to augment the data gathered in FY 01 and FY 02 with I&M funding. The WEAR FY 01-05 GPRA plan (WEAR 2000) contains the goal of "conducting field surveys to provide new data on locations of rare and understudied nonvascular taxa." As vascular and nonvascular plot work may be done together, this goal provides the basis for allocation of funds to complement the I&M initiative, contingent upon continuing support by the Ecology program manager, the Chief of Resource Management and the Superintendent. We envision FY 03 to be used to fill in any major holes in floristic or vegetation sampling identified as high priorities in FY 01-02.

WEAR and YUGA will also contribute substantially to the project in the form of field/logistical support and data management/analysis support. The park clusters will offer project participants the use of bunkhouses in Kotzebue, Nome, and Bettles, remote cabin use in all park units, field survey equipment including GPS, GIS support, and computers and supplies for data management. Office support (space, administrative actions, etc.) for the *Inventory Coordinator/Plant Inventory PI/data manager* will be provided from base operating funds.

Logistical Considerations and Assumptions Used in Developing the Project Budget

With the exception of one short gravel road through a corner of CAKR, none of the network's parks contain roads. There are also few airstrips in the parks. Access to sampling sites will be provided primarily by a combination of fixed-wing airplanes on floats, helicopters, and collapsible boats which can be transported by air. Supercubs with balloon tires may be able to help with resupply flights or ferrying crews using several flights if there are accessible gravel bars in an area. While helicopters provide the greatest flexibility of access, the cost of providing a contract ship for the entire survey is slightly beyond our means. The following general model is therefore proposed:

Two crews will be deployed. Each crew will have one lead botanist and one biotechnician. Lead botanists will be contracted for the full field season. Biotechnicians will stay a month beyond the field season to assist with data entry and project curation.

Each survey trip will be staged in 10 day blocks followed by 4 days off. Access in and out of the field (Days 1 and 10) will be provided via 2 flights of a Cessna 185 or 206 fixed-wing airplane on floats. Drop-off and pick-ups will therefore be staged at accessible lakes or rivers. (In GAAR, one Beaver flight on floats may replace the 2 Cessna flights elsewhere for additional cost savings.) During the middle days of the survey (Days 3 to 8), access will be provided primarily by helicopter. On Day 8, the helicopter will drop crews off near an area which will then be accessible via float plane on Day 10.

Our total OAS budget for flight access is approximately \$54,000 per season. If not enough proximate survey sites prove accessible by float planes, we may need to shorten trips by 1-2 days and hire a helicopter on a 30 day contract (ca. \$50,000), recouping some costs from other projects by sharing logistics. Fixed-wing accessible sites may then be visited in tandem at the end of the season. We have budgeted for a limited sharing of helicopter costs (\$6,000/season, or 2 flight days/season) with the small mammals inventory during their late July and August sampling window, regardless of our ultimate logistical arrangement.

An average of 2 days is required per site for an adequate survey using two skilled botanists. Actual time needs may range from a few hours to several days, depending on access and the diversity of community types at the site. NWAN's survey window is approximately eight weeks--from the last week of June to the second week of August. To be efficient, the project will follow phenology, starting with south-facing ridges early, transitioning to uplands, alpine and lowlands mid-season, and ending with wetlands in August. To accommodate a schedule of 10 days on - 4 days off, approximately 40 working days remain during this window. Allowing for lost time due to weather, we have budgeted three 10 day trips for two crews. With two teams in the field, we have estimated that approximately 30 sites per year will be covered during the first two years, a total of 60 sites. During the third year, which will be sponsored by NPS to meet GPRA goals out of operating funds, we expect to survey an additional 5-10 sites; if logistical linkages can be made with the small mammals project during year 3, this number could increase slightly.

Budget**Table 5.** Proposed FY01-FY04 budget for the vascular plant inventory in the Northwest Alaska Network.

	FY 01	FY 02	FY 03	FY 04	Total	Notes
Personnel						
Principal Investigator	***	***	***	***	***	Paid out of <i>Inventory Coordinator</i> fund
Biologist GS-9	0	0	0	6,784	6,784	ANCS+ and NPSpecies Data Import/Entry (4 pp)
Bio. Technician GS-7 (2)	21,504	21,504	0	0	43,008	Field Work and pre/post field work data entry
Bio. Technician GS-5				5,400	5,400	Project Curation (4 pp)
Subtotal Personnel	21,504	21,504	0	12,184	55,192	
Equipment and Supplies						
Miscellaneous	1,750	1,750			3,500	Dry suits for aquatic sampling, film, field supplies
Subtotal Equipment/Supplies					3,500	
Travel						
Commercial Air	3,000	3,000			6,000	2 trips/year Kotzebue-Anchorage or Fairbanks
OAS						
Helicopter	37,445	37,445			74,890	12 6-hour flight-days/season
Fixed-wing	16,800	16,800			33,600	16 3-hour RT flights on floats/season
Per Diem (field work)	1,330	1,330			2,660	
Invitational Travel	2,070	2,070			4,140	Dr. John Sanderson/Phil Caswell
Subtotal Travel	60,645	60,645	0	0	121,290	
Services						
UA Museum						
Botanist (Parker)	10,481	10,481			20,962	Includes overhead
Specimen Identification	15,528	15,528			31,056	Includes overhead
ALA Curation	5,000	5,000			10,000	Includes overhead
Alaska Natural Heritage Program						
Botanist (Lipkin)	12,488	12,488			24,976	Includes overhead
Regional Products				15,000	15,000	
Publications				8,818	8,818	
subtotal Services	43,497	43,497	0	23,818	110,812	
TOTAL	127,396	127,396	0	36,002	290,794	

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Resumes of Principal Investigators and Key Coworkers

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Robert Lipkin has been the principal botanist at the Alaska Natural Heritage Program since 1989. He has a B.A. degree from the State University of New York at Albany (1974), and a M.S degree from the University of Alaska Fairbanks (1983), where his thesis work focused on the systematics and ecology of the arctic grass genus *Dupontia*. His principal focus has been the vascular flora of Alaska and the arctic, and he has conducted numerous floristic surveys, often targeting rare and sensitive plants throughout Alaska and in other arctic regions, including Canada and Russia. He has considerable floristic survey experience within and near the NWAN units, including several seasons in Kobuk Valley National Park and Bering Land Bridge National Preserve.

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Chapter 3 Small Mammal Inventory

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Introduction

The current mammalian fauna of Alaska includes 108 species (Jarrell et al. 1998), of which 73 species are primarily terrestrial, and 35 species are primarily marine. As a general rule, there is abundant and detailed information about the occurrence, distribution, abundance, food habits, life histories, etc. for the larger of these terrestrial mammal species: the ungulates (moose, caribou, Dall sheep) and their main predators (wolves, grizzly bears). Less well known are the smaller terrestrial mammals: the shrews, voles, mice, weasels and other mustelids, squirrels, hares, and bats.

At the April 2000 Scoping Meeting for biological inventories in Alaska parks, participants found that knowledge about the occurrence of these small mammal species was fragmentary or absent for most park units. Because these species are important ecologically, acquiring basic information about their occurrence, distribution and abundance was given a high priority. This conclusion was reached for 3 of the 4 Alaska Networks, including the NWAN.

Review of the number of mammal species expected to occur in each NWAN unit revealed that only 29 to 65% of the expected species have yet been documented (Table 7). These undocumented species are mainly small mammals.

Table 7. Number of mammal species expected to occur in National Park System units in Northwest Alaska: Comparison of the number currently documented to the number expected but not yet documented. Source: Alaska Natural Heritage Program (2000).

	BELA	CAKR	NOAT	KOVA	GAAR
# species documented	20	11	18	10	24
# species expected, but not yet documented	22	27	18	19	13
total # expected species	42	38	36	29	37
% documented	48%	29%	50%	34%	65%

Early descriptions of the mammal fauna of Northwest Alaska come from Quay (1951), Rausch (1951), and Pruitt (1966). Over the years, a fair amount of small mammal trapping has occurred in areas that are now part of the NWAN units. Dean and Chesemore (1974) reported on snap trapping in grids in the Baird and Schwatka Mountains at several sites now within NOAT and GAAR. The pre-ANILCA, multi-disciplinary expeditions to the areas that became BELA (Melchior 1979), NOAT (Gardner 1974), and KOVA (Melchior 1976) included small mammal trapping, as did baseline studies prior to construction of the Red Dog Mine (Erickson and Hettinger 1983), which borders CAKR and NOAT. Douglass (1984) studied small mammal abundance on trapping grids in a variety of habitats in the DeLong Mountains. In the early 1990s, small mammal trapping has occurred in BELA as part of general biological inventories (Harris 1988, Welp and Beymer 1989, Welp and Sowl 1990, Ross et al. 1993), and Swanson (1996) reported on small mammal abundances in black spruce seral stages in GAAR. Most recently (2000), the University of Alaska Museum collected small mammal specimens from sites in CAKR, NOAT and KOVA as part of a Beringia study funded by the National Science Foundation (Dr. J.A. Cook, University of Alaska Museum, pers. comm., see also <http://arctos.museum.uaf.edu:8080/projects/bcp/index.html>)

Most of these prior studies in the NWAN region have used snap trapping or live trapping methods targeting the smaller small mammals, i.e., voles and mice, and to some extent, shrews. Some work on medium-sized mammals has also occurred. Difolco (1999) has studied hares, and Golden (1988) and Swanson (1992) have reported on furbearers. However, the dominant source of existing information on small mammals within the NWAN units is heavily weighted towards the smaller mammals susceptible to being captured by museum specials or Sherman traps. Hence, species such as shrews, small mustelids, hares, and squirrels have not been studied.

In this project, we plan to sample small mammal occurrence in a design that will reveal patterns in occurrence in broad ecological regions. The Central Alaska Network, which includes Denali National Park and Preserve, Yukon-Charley Rivers National Preserve and Wrangell-St. Elias National Park and Preserve, has similar needs and objectives with respect to small mammal information, and the two networks will use identical designs to strengthen the application of the data collected. The Southwest Alaska Network will also consider the use of these methods.

Goals and Objectives

The goals of this project are to improve our knowledge of the occurrence, distribution and abundance of small mammal species in National Park System units in northwest Alaska and to make that information readily accessible to park managers and others. These goals will be met through the following objectives:

- 1) Document the occurrence, distribution, and relative abundance of small mammal species in the Northwest Alaska Network;
- 2) Examine associations between small mammal distribution and habitat characteristics;
- 3) Collect voucher specimens of each captured species for accessioning within the University of Alaska Museum system for both research and NPS uses;
- 4) Design a small mammal inventory sampling scheme that will allow inferences about small mammals in unsampled areas to be made and provide a framework for long-term monitoring; and
- 5) Enter small mammal data into park and national databases.

Methods

The study design and field methods for this inventory were developed in conjunction with John Burch, Wildlife Biologist with GAAR-YUCH, who is the Principal Investigator for the small mammal inventory in the Central Alaska Network. The two networks encompass similar tundra and taiga habitats, and the use of common design and methods will facilitate regional application of the results.

Sampling Strategy

The overall sampling framework will be based on the latitude-longitude grid. ArcView software will be used to randomly select points constrained to specific strata. The scale of the sampling universe will be at 2 strata levels: ecological sections (Cleland et. al. 1997) and subsections (currently being defined by T. Jorgenson for BELA and by D. Swanson, for CAKR, NOAT, KOVA and GAAR). These strata levels (based on geology, landforms, soils, vegetation, etc.) are tiered; multiple subsections comprise each section. Strata will be further refined by excluding from sampling those areas above 1,500 meters or covered by glaciers (although these criteria are unlikely to be met in NWAN).

Probability-proportional-to-size sampling will be employed to allocate sampling sites among strata. Replicate sites will be placed within each ecosection to assess variability in abundance not only between but also within ecosections. At least 3 sites will be randomly selected within each section. A constrained randomization will be employed, ensuring that no more than one sample site occurs within a subsection. This attempts to capture a maximum of heterogeneity within ecosections with a minimum of replicates.

Topographic maps and prior knowledge of the area from park staff will be used to evaluate the feasibility of small mammal trapping at the randomly selected sites. Given the instance where a site is unsuitable (i.e., steep, rugged, inaccessible), the closest site within a 1-km radius will be selected. If there are no favorable

sites within 1 km, that site will be abandoned and the next alternative site will be selected. Questionable sites may be evaluated with a fixed-wing overflight, which may be incorporated into other park projects such as aerial radio telemetry or law enforcement patrols.

Field Methods

Small mammal trapping will be conducted from early August through mid September when small mammal populations are highest and the probabilities for detecting rare species are greatest. Sites will be selected using a stratified random design as explained above. Given funding limitations, only 6-8 trapping sites can be sampled in each park. The Principal Investigator will work with park resource management staff to ensure that ecological units/areas of particular management concern are identified and sampled during the project..

Removal trapping techniques employing museum special snap traps, funnel pit fall traps, and conibear traps will be used. The first 2 trap types target voles and shrews and the latter type targets weasels. Traps will be set in 2 configurations: a 100 x 100m grid of trap stations (to estimate species abundance) and 2 trap loops (to sample species diversity). The grid will consist of 100 stations set 10 meters apart. Each station will have 2 traps (2 museum specials; or 1 museum special and 1 pitfall). One conibear will be set between each station. A total of 250 traps will be set for the grid. The grid will be checked twice daily, as recommended for removal trapping.

The 2 trap loops will cover 2 km each, radiating out in opposite directions from the grid, with trap stations set every 200 meters (100 total trap stations per loop). Three traps (2 museum specials and 1 pitfall) will be set at each station. Due to the odor of captured weasels, conibears will be placed between stations to prevent shrews and voles from avoiding the area. A total of 600 traps will be set for both loops. GPS locations and flagging will be used to relocate trap sites. Traps will be checked once per day on the loops. Trapping loops will facilitate targeted sampling in different habitats in the grid vicinity and increase our ability to document the species diversity within the ecological subsection and section.

Habitat will be classified for each area (grid and loop) to level III of Viereck's Alaska Vegetation Classification (Viereck et al. 1992), and vegetation canopy cover, percent canopy composition, slope, aspect, and elevation will be recorded. Additional site specific habitat characteristics will be measured at each trap station. Plant cover will be estimated in a 2m radius around the trap station. Meteorological conditions will also be monitored during the sampling session using temperature and precipitation dataloggers from Onset Systems Inc.

Data Analysis and Management

Data will be captured on palmtop computer at the trap location, and transferred to permanent specimen labels in field camp via label writers. The data will concurrently be stored in a database for subsequent estimation of abundance and richness.

Estimation of absolute abundance on the 1ha grids will be assessed using the generalized removal models of Otis et al. (1978), as implemented in program CAPTURE (Rexstad and Burnham 1992) along with program MARK (White and Burnham 1999).

Species richness at the section (strata) level will be estimated using the community-level generalization of capture-recapture estimators, in which replicate sites constitute 'occasions,' and species constitute 'individuals.' Based on the estimated detection probabilities of species, the estimated number of species in a section can be computed. This technique can also be employed to estimate the number of species in a park unit. This sampling/analytical framework lays the foundation for subsequent estimation of species turnover rate, should successive monitoring sampling be undertaken in the future (Boulinier et al. 1998, Nichols et al. 1998).

Habitat characterization data collected on each plot will be used to develop habitat association models via methods of logistic regression (Hosmer and Lemeshow 1989) or classification and regression trees (Breiman et al. 1984). At a more coarse level of resolution, species occurrence can also be predicted by ecological section, given this is the stratification mechanism employed in the sampling design.

Vouchering and Genetic Sampling

All captured specimens will be collected for some form of vouchers. Animal care and use standards will be adhered to for euthanasia of live specimens. Halothane on cotton ball in a closed plastic jar with the small mammal will be used for euthanasia. Heart, liver, kidney and muscle tissue will be frozen in liquid nitrogen for each animal captured for archive at the UA museum. Study skins will be made in the field for as many specimens as time allows, for all species up to a maximum of 20 skins per species. All other specimens will be labeled, gutted and placed in large plastic Nalgene ethanol carboys for later identification and archiving at the UA museum. The estimated number of specimens to be collected over the planned course of this project is 2,400 (100 specimens per site x 4 sites x 2 crews x 3 years).

Products

Annual Reports and a Final Report will be produced according to the schedule described in the Network Overview (see Chapter 1). Other products will include:

- MS Access database of all data;
- ArcView themes showing small mammal distribution and relative abundance;
- Updates to NRBib, NPSpecies, ANCS+, and the Dataset Catalog.

In addition, a wealth of information will be available from the vouchered specimens, and the material stored in the frozen tissue collection. Specimens, along with data derived from them will be archived at the University of Alaska Museum for use by future researchers.

Data collection protocols will be documented, and archived along with georeferenced data on mammalian encounters, habitat characterization, and meteorological phenomena. A convenient and effective way of having this archive readily-accessible is to place it on the web. We have used this medium to good effect in the mammalian component of the long-term ecological monitoring program in Denali National Park and Preserve (<http://mercury.bio.uaa.edu/~edebevec.staff/denali-sites>).

A student dissertation and publications derived from the dissertation, are also expected from this project. The subject of that thesis may involve modeling species:habitat relationships, biogeography, or molecular investigations from the database resulting from field collections.

Project Timeline

FY 2001

October 2000-June 2001

- Obtain GIS-based products needed to define sampling areas.
- Finalize sampling design (determine accessibility, select sampling sites).
- Develop data base structures and establish data management strategy.
- Outline data analysis procedures.
- Arrange logistics for first field season (locate access points, assure Office of Aircraft Services [OAS] training and charter requirements in place.
- Coordinate with staff in NWAN regarding logistics and site selection

July-August 2001

- Train field technicians (museum procedures and species identification, appropriate safety courses such as CPR, Wilderness First Aid, boat safety, aircraft safety, bear safety and firearms training)
- Conduct surveys in Gates of the Arctic National Park.

September 2001

- Enter and summarize data.
- Prepare progress report.

FY 2002

October 2001-April 2002

- Data analysis.
- Refine study plan as needed
- Plan logistics for upcoming field season.

July-August 2002

- Train field assistants.
- Conduct surveys of Noatak National Preserve, Kobuk Valley National Park, and Gates of the Arctic National Park and Preserve.

September 2002

- Enter and summarize data.
- Write progress report.

FY 2003

October 2002-April 2003

- Data analysis.

July-August 2003

- Train field assistants.
- Conduct surveys of Cape Krusenstern National Monument and Bering Land Bridge National Preserve.

September 2003

- Enter and summarize data.
- Write progress report.

FY 2004

October 2003-December 2003

- Continue data analysis.
- Continue write-up.

January 2004

- Provide NPS with final report.
- Provide NPS with the final data sets of mammalian species inventory and abundance and habitat characterizations.

- Provide NPS with archived data (sampling design, survey protocol, location of all sampling sites, voucher results).

Park Contribution, Coordination, and Logistical Support

Where feasible NPS will assist with in-place logistics and project support. Examples include:

- Use of NPS aircraft (at reimbursable OAS rates) to transport survey crews to and from sites.
- Use of NPS boats and vehicles.
- Use of NPS remote facilities (ranger cabins if scheduling allows).
- Use of NPS bunkhouse and facilities in Kotzebue, Nome, Bettles, Anaktuvuk Pass, and Marion Creek.
- Use of NPS pilots and knowledgeable staff and cooperators to assess potential access sites throughout NWAN Parks.
- Use of field equipment (e.g., radios, bear-proof containers, first aid kits, tents).
- Access to GIS themes of NWAN Parks (DEM models, landcover).
- Assistance in developing NPS-compatible database structures.

Shared logistics with other NPS Inventory and Monitoring studies throughout NWAN Parks could be mutually beneficial. Within the temporal framework of proposed small mammal inventories in each park (August), personnel working on other taxonomic groups (plants and fish) will be accommodated on a space-available basis. Conversely, personnel from the small mammal inventory effort may want to accompany (on a space-available basis) other disciplines to collect ancillary data or assess sampling sites scheduled to be visited at future dates. With appropriate training and if time allows, small mammal personnel will be available to assist with data collection for I&M efforts on other taxonomic groups (e. g., plant surveys and collections and fish collections). Prior to any field work it would be beneficial to have all I&M personnel briefed on the respective scope and objectives of each taxonomic group's planned efforts within NWAN Parks.

Budget

Table 8. Proposed FY01-FY04 budget for the small mammal inventory in the Northwest Alaska Network.

	FY 01	FY 02	FY 03	FY 04	Total
Personnel					
Ph.D Student	18,000	18,000	18,000	18,000	72,000
Field assistant (2)	6,510	6,510	6,510		19,530
Volunteer (2)	1,680	1,680	1,680		5,040
Subtotal Personnel	26,190	26,190	26,190	18,000	96,570
Equipment and Supplies					
Traps	8,500	1,000	1,000		10,500
Ethanol, Liquid nitrogen	400	400	400		1,200
Field Computers, Dataloggers	7,600				7,600
GPS, Rangefinder	1,000				1,000
Field Equipment	2,895				2,895
Food	1,800	1,800	1,800		5,400
Subtotal Equipment/Supplies	22,195	3,200	3,200	0	28,595
Travel					
Commercial Air	5,000	5,000	5,000	3,000	18,000
OAS	6,000	35,000	20,000	0	61,000
Subtotal Travel	11,000	40,000	25,000	3,000	79,000
Services					
Vouchering (UA Museum)	3959	6041	10,000	10,000	30,000
DIRECT COSTS	59,385	79,390	64,390	31,000	234,165
INDIRECT COSTS (10%)	5,939	7,939	6,439	3,100	23,417
TOTAL	69,283	83,370	70,829	34,100	257,582

The small mammal inventory will be conducted via a Research Work Order with the Alaska Cooperative Fish and Wildlife Research Unit at the University of Alaska Fairbanks.

Justification:

o Salary

This includes stipend and tuition for a PhD-level student working at the Univ. of Alaska Fairbanks on a research assistantship, funded through the research work order process of the USGS/BRD cooperative fish and wildlife research unit (along with the 10% indirect cost associated with this budget item). Additional annual salaries are provided for 2 technicians for 6 weeks. Perdiem costs are also included for 2 volunteers for 6 weeks. This staffing level provides for 2 field crews.

o Equipment and Supplies

Each field crew will be equipped with 2 GPS units, 2 palmtop computers, a laptop, and a rangefinder for data recording and grid placement. Each camp will be equipped with carboys for ethanol storage, and a liquid nitrogen tank. Each camp will deploy 400 snap traps, 200 pitfall traps, and 50 conibear traps. These must be purchased in FY01. FY02 and FY03 expenditures will be for consumables (ethanol and liquid nitrogen) along with replacement of 5% of the traps due to attrition. We also budget for purchase of some field equipment (tents), and food.

o Travel

This is an estimated cost of commercial airfare for 2 volunteers coming from the lower 48/year along with commercial airfare between Fairbanks and Kotzebue and/or Bettles. Without knowing the locations of the sampling locations in each park, it becomes difficult to calculate transportation costs to those locations. However, these calculations were conducted with the following premises:

- GAAR (2.9 million hectares) would be sampled in FY01 using fixed-wing aircraft,
- BELA and CAKR (1.2 million hectares) would be sampled in FY02 using rotary aircraft,
- KOVA and NOAT (3.3 million hectares) would be sampled in FY03 using rotary aircraft,
- Salary allocation would allow crews to conduct sampling for ~4 weeks/year, sampling 4 sites each per year,
- Aircraft would initially deposit crews at sites, move crews between sites 3 times/year, and bring crews back to the duty station,
- 3 weather days/year would be allocated for rotary aircraft on-call,
- Round-trip rotary aircraft time Kotzebue-BELA-CAKR is 5 hours for each crew transfer,
- Round-trip rotary aircraft time Kotzebue-KOVA-NOAT is 9 hours for each crew transfer,
- Round-trip fixed-wing aircraft time Bettles-GAAR is 2 hours for each crew transfer

o Vouchering

The University of Alaska Museum will process specimens preserved in ethanol in the field. The processing cost (http://www.uaf.edu/museum/mammal/Procedures_Manual/costs.html) is ~\$860/100 specimens. We estimate that 100 specimens will be collected per sampling site per year, hence sampling 4 sites/year/crew (see below) results in the expenditure of \$8600. An additional \$1400 per year during the data collection phase is included for additional support from UA-Museum staff.

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Resumes of Principal Investigators and Key Coworkers

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Rexstad has been conducting research on small mammals in Alaska since 1992. He and his students have studied small mammals in Denali National Park and Preserve, Yukon-Charley National Preserve, Koyukuk/Nowitna National Wildlife Refuge, Kanuti National Wildlife Refuge, Copper Basin ecosystem, and the Bonanza Creek LTER sites. He has consulted with state and federal agencies within the state, and nationally on study design and analytical issues associated with population dynamics and biodiversity issues. Rexstad will serve as Principal Investigator for this project.

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Chapter 4 Montane-nesting Birds Inventory

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Introduction

The Alaska National Interest Lands Conservation Act (ANILCA) of 1980 substantially increased the amount of land administered in Alaska by the National Park Service (NPS). In northwest Alaska alone five new units were established: Cape Krusenstern National Monument, Noatak National Preserve, Bering Land Bridge National Preserve, Gates of the Arctic National Park and Preserve, and Kobuk Valley National Park. The smallest, Cape Krusenstern, is 2,670 km² (660,000 acres) in size while the largest, Gates of the Arctic, encompasses almost 34,000 km² (8.4 million acres). In total the five units of the Northwest Area Network (NWAN) of Parks comprise almost 81,000 km² (20.4 million acres), or 5% of Alaska's land area.

Over this vast landscape occurs a diversity of habitats, geologic features, and climatic conditions that are probably unequalled elsewhere in Alaska in an area of comparable size. The most prominent landscape feature throughout the NWAN units is mountains. These begin as rolling hills along the Chukchi Sea coast and become progressively higher and more rugged farther inland. Indeed, Gates of the Arctic National Park and Preserve is almost entirely montane with only a small fraction of the land, mostly intermountain valleys, below 600 m above-sea-level (ASL). The majority of the landscape, including countless ridgelines and peaks occurs above 1,500 m.

The landcover of the region is also quite varied. The upland regions usually begin in the open low willow-sedge tundra zone, but these lower landscapes are also a mixture of sedge-willow and wet sedge meadow tundra, especially on south-facing slopes. With progressive elevation (or latitude) the montane vegetative communities transition to dwarf shrub, mountain heath, and *Dryas*-lichen tundras (Vioreck et al. 1992). Most high ridgelines and mountains in the central Brooks Range are often bare or sparsely covered with vegetation.

Information on the occurrence of birds within Alaska NPS units is generally good with particular exception of the NWAN Parks. All five NWAN units are suspected of hosting between 150 and 200 species of birds, but for only one unit, Gates of the Arctic, have more than 80% of the species been adequately documented; for the other four units only between 60 and 70% of the species have been documented. For a landscape so dominated by mountains as are NWAN Parks, surprisingly little is known about the montane-related avifauna, especially for the larger parks. Information from relatively small portions of NWAN Parks and elsewhere in Alaska, points to the importance of montane areas as nesting habitat for particular assemblages of birds, most notably several medium- to large-sized shorebirds and several passerine species. For shorebirds like Pacific Golden-Plover (*Pluvialis fulva*), American Golden-Plover (*P. dominica*), Bristle-thighed Curlew (*Numenius tahitiensis*), Surfbird (*Aphriza virgata*), Red Knot (*Calidris canutus*), and Wandering Tattler (*Heteroscelus incanus*), nesting is restricted almost exclusively to montane areas. For others, such as Whimbrel (*Numenius phaeopus*) and Bar-tailed Godwit (*Limosa lapponica*), nesting can range from the upland transition zone to high mountain areas. The suite of passerine species in the montane-zone of NWAN Parks also exhibits a wide range of habitat preferences, ranging from Horned Lark (*Eremophila alpestris*), Northern Wheatear (*Oenanthe oenanthe*), and American Pipit (*Anthus rubescens*) that occur mostly in high, mostly rocky alpine areas to Bluethroat (*Luscinia svecica*), Yellow Wagtail (*Motacilla flava*), and several species of sparrows that reside mostly in lower elevation shrub habitats.

Several features about shorebird and passerine species stand out in terms of knowledge of their occurrence in NWAN Parks and their status as species of concern vis-à-vis regional, national, and global populations of individual species. For instance, about half (1,500 pairs) of the world's population of Bristle-thighed Curlews nests among mountains of the west-central Seward Peninsula, including portions of the Bering Land Bridge National Preserve (Gill et al. 1990). A smaller, yet unknown portion of the population is suspected of nesting in mountains of Cape Krusenstern National Monument (Gill et al. 1996). Two other species, the Wandering Tattler and Pacific Golden-Plover, have similar restricted ranges and small population sizes within Alaska, probably numbering fewer than 20,000 individual plovers and maybe half that many tattlers. The latter may constitute as much as 75% of the species' entire population (ASWG 2000). The population of the Pacific race of the Bar-tailed Godwit (*L. l. baueri*) numbers about 100,000 birds (Gill and McCaffery 1999). In the

southern portion of its range on the Yukon Delta it nests over wet sedge meadows, but farther north it nests primarily in upland habitats, especially on the Seward Peninsula, in the western Baird and DeLong mountains, and over the north slope of the central Brooks Range (McCaffery and Gill in press, R. Gill and T. Swem pers. obs.). Indeed, the highest known nesting densities for the population have been reported from Cape Krusenstern National Monument (Gill et al. 1996). The Surfbird is another species restricted entirely to montane habitats during nesting. Probably 75% of the entire population of about 70,000 birds occurs in Alaska, most distributed throughout southcentral Alaska, but also throughout the mountains of eastern Norton Sound and the Seward Peninsula (Senner and McCaffery 1997, Brown et al. 2000). Isolated observations have documented nesting at several locations in the Brooks Range, including in Noatak National Preserve and Gates of the Arctic National Park and Preserve (Senner and McCaffery 1997, Paul McKee pers. comm.).

Recent regional and national shorebird conservation planning efforts (ASWG 2000, Brown et al. 2000) have identified certain shorebird species and habitats as being of high conservation concern, primarily due to documented or perceived population declines and/or restricted distributions. In Alaska 14 such species have been identified. Six of them nest in montane regions, including Pacific Golden-Plover, Wandering Tattler, Whimbrel, Bristle-thighed Curlew, Bar-tailed Godwit, and Surfbird. At the national level this same suite of species has been ranked similarly high, all assigned conservation prioritization scores of 4 on a scale of 1 to 5 (Brown et al. 2000).

Despite the obvious importance of NWAN Parks to regional, national, and international populations of montane-nesting birds, particularly shorebirds, information on species distribution and abundance is limited or non-existent for most geographic areas of the parks – the exceptions being Bering Land Bridge National Preserve and selected portions of Cape Krusenstern National Monument. Information from Cape Krusenstern may be applicable to nearby portions of Noatak National Preserve, but unlikely so for the vast amount of land in NWAN units farther east.

To determine the status of montane-nesting birds occurring in NWAN Parks a large-scale, habitat-based inventory and monitoring program should be established. Data generated from such a program will provide baseline information on the distribution and abundance of birds and provide the basis for which a more rigorous monitoring program can be developed.

Goals and Objectives

The goal of this project is to document the occurrence of 90% of the species of montane-breeding birds present in NWAN Parks using a repeatable, scientifically-valid sampling design suited to expansive areas having minimal access. This goal will be achieved through the following objectives:

1. Collect and summarize all existing information on the distribution and abundance of all avian species occurring on upland habitats in NWAN Parks.
2. Obtain geographic data layers needed to characterize elevation, slope, seasonal green-up, and habitat (vegetation and hydrology).
3. For each species determine associations between distribution and abundance and habitat characteristics, particularly for shorebirds and passerine species occurring on upland areas during the breeding season; project this information to obtain park-wide assessments of distribution and abundance.

Methods

Study Area

The study will encompass all five NWAN Parks (Bering Land Bridge National Preserve, Cape Krusenstern National Monument, Noatak National Preserve, Gates of the Arctic National Park and Preserve, and Kobuk Valley National Park). Work will focus on the four most northern parks with work on Bering Land Bridge occurring only as needed to supplement the comparatively extensive body of existing information from that unit.

Sampling Strategy

Sampling areas for shorebirds will be selected using a systematic sampling design with random start. Each park will be overlain with a dense GIS-generated sampling grid that will be offset a random distance and direction (Overton 1993). The sampling universe will be determined through digital elevation and terrain (DEM) coverage with a lower bound of about 150 m (ASL) and an upper bound encompassing all snow-free areas during the prenesting and early-nesting periods as determined by AVHRR data. Sampling areas will be accessed primarily by helicopter but also by boat and fixed-wing aircraft when possible. The proportion of the sampling area within each park that will be inaccessible due to logistical, monetary, or safety constraints will be estimated after consulting with pilots and others familiar with the areas.

The number of samples required to detect at least 90% of the estimated number of montane-nesting bird species occurring in each park will be estimated from data gathered on the Seward Peninsula during an earlier study (Gill et al. 1996a, b). The step size for the selection of sample areas will be determined as a function of sample size needed and the expected proportion of inaccessible sites (Fancy 2000: Design # 1, Terrestrial Systems; T. McDonald pers. comm.). All possible sampling points will be systematically ordered, a starting point will be randomly chosen, and systematic samples will be selected with the computed step size. Inaccessible points will be excluded from the sample.

Each grid point will serve as an anchor for a set of two 12-point transects laid out across elevational gradients. Points along transects will be spaced 500 m apart; legs of transects will be spaced at least one drainage and no less than 1.5 km apart.

Birds will be sampled with point-transect methodology (Buckland et al. 1993) using protocols developed for the USGS Shorebird Project in earlier surveys of montane- and upland-nesting shorebirds. At each point on the transect all birds detected during a 10-minute period will be recorded. At the start of each survey, the following will be recorded: GPS location, elevation, slope, date, time, observer, wind speed, wind direction, precipitation, percent cloud cover, air temperature, snow cover, and habitat within 250 m of the point. For each detection of a bird the following will be recorded: elapsed time, species, number of individuals, behavior, vocalizations, radial distance from the census point, and microhabitat with which the bird is associated. Habitat will be classified using the systems of Viereck et al. (1992) and NWAN, where available.

To maximize detection of individuals, surveys will be conducted during the early breeding season when courtship displays and vocalizations are at their peak. In Bering Land Bridge National Preserve this usually occurs during the last week of May and the first week of June. Farther north in Cape Krusenstern National Monument, western Noatak Preserve, and Kobuk Valley National Park these events peak about a week to 10 days later. The chronology of birds using Gates of the Arctic National Park and Preserve is unknown but, given its size, elevational gradients, and diversity of habitats, surveys will likely have to be conducted over a three- to four-week-long period.

Data Analysis and Management

Efficiency of the inventory will be determined after the first field season using the program CAPTURE (Rexstad and Burnham 1991) to examine species that nest within each park. Sampling effort will be adjusted, if necessary to detect at least 90% of the estimated number of montane-nesting bird species occurring in each park. The density (with 90% confidence interval) of each species will be estimated for each vegetation type and for each sampling area as a whole by analyzing the distance data to develop detectability functions (Buckland et al. 1993). Time of day and season will be included as covariates.

Logistic regression will be used to estimate the probability of detecting a species at any location in the study area. A resource selection probability function (Manly et al. 1993) will be constructed by comparing characteristics of the sample points that are used or unused by each species. The presence or absence of the species will be the dependent variable and habitat and topographic characteristics around the point will be used as explanatory variables. Because the points will be selected in a systematic random fashion, it will be assumed that the sampling fractions of used and unused points are equal and that probability function can be estimated. For those variables for which information is available on park-wide GIS, resource selection probability functions will be developed by comparing points used by each species with a randomly selected sample of points available in the study area. Maps depicting presence/absence data at sample points will be developed for each species. Predicted distributions maps for each species with sufficient data will be constructed for each park using elevation and terrain data.

Data sheets will be copied and stored at two locations: Shorebird Project of the USGS Alaska Biological Science Center, Anchorage, and NPS, NWAN Headquarters, Kotzebue, Alaska. Data will be entered promptly in Microsoft Access and Excel. Geographic data will be recorded directly from GPS units.

A GIS specialist will prepare metadata materials to insure compliance with FGDC standards and compatibility with NPS service-wide biological databases maintained by the Inventory and Monitoring Program.

Quality Assessment/Quality Control

Field staff will be trained in: 1) identification of shorebirds through sight and vocalizations, 2) distance estimation from a fixed point, 3) GPS training/orienteering, 4) identification and classification of vegetation, and 5) safety training. Those responsible for identifying birds must be proficient at identifying calls, songs, and plumages of Alaska shorebirds; song and call identification will be tested using BirdMaster software with the Alaska Bird Song CD. Field training sessions for identifying birds, songs, and distance to birds will also occur prior to the survey. Those collecting vegetation information will be responsible for identifying the major tree, shrub, and herb species common to the parks. This knowledge will also be tested prior to actual field work.

Vouchering and Genetic Sampling

The PIs for this effort recognize the importance of and justification for vouchering scientific data, including collection of whole specimens and/or tissues. However, the rigid time-constraints involved with the proposed sampling protocol will allow for only the most rudimentary vouchering of samples. For all rare or previously undetected species we will document occurrence through detailed notes and photographs, including GPS location data. Final results will identify population centers and range boundaries whereby focused voucher-sampling efforts can be conducted in the future. Any dead birds and/or bird parts that we find will be salvaged and sent to the University of Alaska Museum, Fairbanks.

Products

Both interim and final products will be produced from information collected during the study. These include but are not limited to:

- Spatial data layer linked to landcover.
- Spatial data layer linked to abundance.
- Spatial data layer documenting critical areas for species of management concern.
- Annotated species lists linked to geographic and habitat attributes.
- Archived data on census protocol and location of sampling units.
- Annual and Final reports.
- Publications in peer-reviewed outlets.

Project Timeline

FY2000

September 2000

Complete study plan.

FY2000-2001

October 2000-April 2001

Contract for GIS-based products needed to define sampling areas.

- Finalize sampling design (delineate montane areas, determine necessary sample sizes, determine accessibility, select sampling sites).
- Develop data base structures and establish data management strategy.
- Outline data analysis procedures.
- Arrange logistics for first field season (locate access points, assure Office of Aircraft Services [OAS] training and charter requirements in place.
- Hire technician(s) for procurement and maintenance of field equipment and initial data entry

April-June 2001

- Train field technicians (voice recognition, hearing test, appropriate safety courses such as CPR, Wilderness First Aid, boat safety, aircraft safety, bear safety and firearms training)
- Conduct surveys of Cape Krusenstern National Monument, Noatak National Preserve (in part), and Bering Land Bridge National Preserve (in part).

July-September 2001

- Enter and summarize data.
- Prepare progress report.
- Write annotated species accounts for all birds detected in sampled units of NWAN Parks.

FY2002

October 2001-April 2002

- Data analysis.
- Refine study plan as needed
- Plan logistics for upcoming field season.

April-June 2002

- Train field assistants.

- Conduct surveys of Noatak National Preserve (in part), Kobuk Valley National Park (in part), and Gates of the Arctic National Park and Preserve (in part).

July-September 2002

- Enter and summarize data.
- Write progress report.
- Write annotated species accounts for all birds detected in sampled units of NWAN Parks.

FY2003

October 2002-April 2003

- Data analysis.

April-June 2003

- Train field assistants.
- Conduct additional surveys of Kobuk Valley National Park and Gates of the Arctic National Park, and other units that require additional sampling.

July-September 2003

- Enter and summarize data.
- Write progress report.
- Write annotated species accounts for all birds detected in sampled units of NWAN Parks.

FY2004

October 2003-December 2003

- Continue data analysis.
- Continue write-up.

January 2004

- Provide NPS with final report.
- Provide NPS with the final data sets of shorebird abundance and landcover associations to be used in creating spatial data layers.
- Provide NPS with archived data (sampling design, survey protocol, location of all sampling sites, survey routes, and point counts).

Park Contribution, Coordination, and Logistical Support

Where feasible NPS will assist with in-place logistics and project support. Examples include:

- Use of NPS aircraft (at reimbursable OAS rates) to transport survey crews to and from sites.
- Use of NPS boats and vehicles.
- Use of NPS remote facilities (ranger cabins if scheduling allows).
- Use of NPS bunkhouse and facilities in Kotzebue, Nome, Bettles, and Marion Creek.
- Use of NPS pilots and knowledgeable staff and cooperators to assess potential access sites throughout NWAN Parks.
- Use of field equipment (e.g., radios, bear-proof containers, first aid kits, tents).
- Access to GIS themes of NWAN Parks (DEM models, landcover).
- Assistance in developing NPS-compatible database structures.

Shared logistics with other NPS Inventory and Monitoring studies throughout NWAN Parks could be mutually beneficial. Within the temporal framework of proposed shorebird inventories in each park (late May to late June), personnel working on other taxonomic groups (plants and small mammals) will be accommodated on a space-available basis. Conversely, personnel from the shorebird I&M effort may want to accompany (on a space-available basis) other I&M disciplines to collect ancillary data or assess sampling

sites scheduled to be visited at future dates. With appropriate training and if time allows, shorebird personnel will be available to assist with data collection for I&M efforts on other taxonomic groups (e. g., plant surveys and collections and small mammal trapping). Prior to any field work it would be beneficial to have all I&M personnel briefed on the respective scope and objectives of each taxonomic group's planned efforts within NWAN Parks.

Budget

Table 9. Proposed FY01-FY04 budget for the montane-nesting bird inventory in the Northwest Alaska Network.

	FY01	FY02	FY03	FY04	TOTAL
Personnel					
Principal Investigator (Gill)	*	*	*	*	*
Co-PI (Tibbitts)	*	*	*	*	*
Collaborator (Handel)	*	*	*	*	*
GS-05 Biological Technicians	7,052	7,200	7,400	4,000	25,652
GS-09 GIS-Database Manager	11,899	12,100	12,300	12,300	48,599
GS-07 Graphics Preparation				5,073	5,073
Equipment and Supplies					
GPS Units (6 @ \$200)	1,200				1,200
USGS Maps/aerial photos/mylars	1,000				1,000
Misc. field equipment/food	3,000	1,600	2,500		7,100
Aircraft (OAS)					
Helicopter (Bell 206L-1)					
Wet rate/hour \$685	20,495	22,055	18,125		60,675
Availability @\$850/day	8,500	10,200	8,500		27,200
Fixed-wing (C206)					
Wet rate/hour \$300		2,400	6,000		8,400
Travel and Per Diem					
Commercial to Kotzebue	4,848	3,636	606		9,090
8 RT @ \$606 each					
Commercial to Fairbanks	525	525	2,096		3,146
2 RT @ \$262 each					
Commercial to Anchorage	2,000	2,200	2,400		6,600
4 RT @ \$500 each					
Commercial Fairbanks to Bettles			1,295		1,295
Per Diem	2,070	2,400	2,500		6,970
TOTAL	62,589	64,316	63,722	21,373	212,000

*USGS-Alaska Biological Science Center scientists. Salary covered by USGS base funds.

Justification:

- Salary

This includes about 7.0 pay periods (PP) of GS-5 Biological Technician time per annum for field work for years FY01-03 and 3.5 PP for assistance with report preparation during FY04. In addition, a GS-9 position will be funded at 6.5 PP per annum to assist with database development and management. During the final year of the effort a GS-7 position will be funded for 4 PP to assist with graphics preparation for the final report. Salaries for the PI (GS-14) and Co-PI (GS-11) will be covered by USGS base funds in amounts of about \$30,000 (7 PP) and \$23,000 (10 PP), respectively, per annum during FY01-03. During the final year of the study (FY04) these figures are expected to at

least double because of increased time needed for data analyses and write-up. Additional USGS base funds (6 PP, 21,000) will be contributed through collaborative work by C. Handel (GS-13) during FY03-04. Staffing for field work will be supplemented by use of volunteers.

- Equipment and Supplies

Each person in the three, two-person field crews will be equipped with a GPS unit and each crew will have a VHF radio, palmtop environmental data recorder, and site-appropriate maps, images, and census forms. Each crew, when deployed to a specific site, will have gear and food necessary for extended stay.

- Aircraft (OAS)

The preliminary plan is to survey all NWAN parks using both fixed-wing and helicopter support, beginning in FY01 with Cape Krusenstern National Monument and portions of Noatak National Preserve. In FY02, the remainder of Noatak National Preserve and portions of Kobuk Valley National Park and Gates of the Arctic National Park and Preserve will be surveyed. The remainder of the latter two parks will be surveyed during FY03. We anticipate about 10-12 days of dedicated helicopter support will be required during each of the three field seasons. In the second and third years of the study an additional 8-20 hours of fixed-wing aircraft support is planned, this primarily for work in Gates of the Arctic National Park and Preserve. In all years, aircraft will deploy three, two-person teams to selected survey sites and then pick them up and move them to additional sites, either that same day or following one or more overnight stays at particular sites. Because optimal timing of surveys in most areas is coincidental with breakup, it is highly likely that crew deployment will depend on mostly helicopter support. However, since this is also the period when other human activities in montane areas are least likely to occur, we anticipate minimum disruption from such operations.

4. Travel

Outlined travel entails 1) getting survey personnel (salaried and volunteers) to and from survey sites, including travel from areas outside Alaska, and 2) travel of Project PIs to NWAN Parks to work with staff and coordinate logistics for planned surveys.

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Resumes of Principal Investigators and Key Coworkers

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Robert Gill has been U.S. Department of Interior project leader for shorebird research in Alaska since 1976. He has extensive experience in design and implementation of field studies throughout the state. These range from short-term, site-specific studies of occurrence to long-term, range-wide assessments of status and size of populations. A major aspect of this work since the late 1980s has involved assessments of the distribution and population size of shorebirds identified at both the state and national levels as species of high conservation concern. Included in this effort have been studies of montane-nesting shorebirds on the Seward Peninsula (including Bering Land Bridge National Preserve) and eastern Norton Sound (1988-1992, 1999-2000), surveys of montane-nesting shorebirds in Cape Krusenstern National Monument (1996), studies of breeding biology of montane-nesting shorebirds in Lake Clark National Park and Preserve (1997-1999), and several assessments of shorebird use of Chukchi Sea, Bering Sea, and Gulf of Alaska estuaries (1976-present). Most recently (1997-2000) Gill helped develop the U.S. Shorebird Conservation Plan by chairing the Plan's research and monitoring working group and currently serves a Vice-chair of the U.S. Shorebird Plan Council. Gill earned both Bachelor's and Master of Science degrees through the Avian Biology Laboratory, San Jose State University. He has authored over 80 peer-reviewed publications. Gill will serve as Principal Investigator for this effort.

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Lee Tibbitts has worked on shorebird projects at the Alaska Biological Science Center since 1988. She has extensive experience censusing shorebirds in a variety of habitats and areas throughout Alaska. She participated in a comprehensive assessment of the status of Bristle-thighed Curlews (1988-1992, 1999-2000) on the Seward Peninsula and in the Nulato Hills. She coordinated censuses of migrant shorebirds on the Alaska Peninsula (1993) and organized the ground-based component of a study of shorebird seasonal use of Cook Inlet (1997-1999). She participated in all phases of a multi-year study (1988-1994) of Bristle-thighed Curlew breeding ecology and population demographics and, more recently (1996-2000), conducted studies of the breeding ecology and foraging behavior of yellowlegs. Lee earned a Bachelor's of Science degree from the University of Oregon and a Master of Science degree from Humboldt State University. She will serve as Assistant Project Leader for this effort.

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Colleen Handel has been involved in Department of Interior research in Alaska since 1975, primarily on behavior and ecology of shorebirds and since 1992 on landbird research. Her current focus involves developing integrated, regional monitoring programs for landbirds. Between 1989 and 1993 and 1999-2000 she was a Principal Investigator on the Bristle-thighed Curlew project with primary responsibility for the design and analysis of data for a study on breeding distribution and population assessment. She earned a Bachelor's degree from Harvard University and a Master of Science degree from the University of California, Davis. She has recently completed academic requirements for a Doctoral program in Ecology at UC, Davis, and is writing her dissertation. She has authored over 25 refereed publications. Colleen will provide guidance on study design and data analyses.

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Appendix A. Review of Existing Information

In this appendix, we take a first step towards synthesizing available information on vascular plants and vertebrates in the 5 park units that comprise the Northwest Alaska Network. This review of existing information is an important part of the inventory process. To set priorities for the inventories, it was necessary to identify where the data gaps were. To identify the data gaps, it was necessary to identify what was already known. Within the time and funding constraints of this study plan development process, a complete literature review by taxa and park unit was not possible. But, we have taken a first step by compiling and briefly reviewing the information we had access to in the process of developing this study plan.

For each park unit, we first present general information (e.g., date created, size, purposes). We then turn to a consideration of the available information on each taxa in each park. For each taxa, we present a short synopsis based on the following:

- Best professional judgment of park staff on the relative level of knowledge as included in the preproposal (NPS 2000);
- the evaluation of the percentage of known taxa made by the assembled park and taxa specialists at the April scoping meeting (i.e., best professional judgement of a large group, including experts with statewide knowledge) (Hanson 2000);
- the Alaska Natural Heritage Program's expected species lists (based on searches of literature, ANSC+.....) (ANHP 2000);
- review of the scope of relevant literature citations currently in NRBib (current through 1995);
- review of the scope of relevant literature citations currently at the Alaska Resources Library and Information System (ARLIS) and in searchable databases accessible through ARLIS (e.g., Wildlife Worldwide, Fish and Fisheries, Arctic and Antarctic, LaserCat) (current through mid-2000).
- very limited reviews of primary literature.

Each synopsis is followed by a list of relevant citations from NRBib, Alaska Natural Heritage Program work, and other sources. Additional sources of relevant citations may be found in:

Alaska Natural Heritage Program. 1992. A bibliography of biological resource information for Northwest Alaska Areas. Noatak National Preserve, Cape Krusenstern National Monument, Kobuk Valley National Park. With emphasis on rare species and critical habitats.

Bering Land Bridge National Preserve

Established: 1980, under ANILCA.

Size: 1.15 million hectares (2,457,000 acres)

Purposes:

- Protect and interpret examples of arctic plant communities, volcanic lava flows, ash explosions, coastal formations, and other geologic processes;
- Protect habitat for internationally significant populations of migratory birds;
- Provide for archeological and paleontological study, in cooperation with Native Alaskans, of the process of plant and animal migration between North America and the Asian Continent;
- Protect habitat for, and populations of fish and wildlife including, marine mammals, brown/grizzly bears, moose, and wolves;
- Continue reindeer grazing use;
- Provide for outdoor recreation and environmental education activities at Serpentine Hot Springs

Resources Management Plan:

The Resources Management Plan for BELA is in draft form. This plan identifies completion of baseline inventories as a high priority. It also identifies a backlog in natural resource collection cataloging as an important need. Natural resource protection concerns identified in the draft plan that specifically relate to these biological inventories include: management of reindeer grazing, fire management, assessment of coastal resources, assessment of fisheries and furbearer populations, and site management at Serpentine Hot Springs.

Vascular Plants:

Among the five park units in NWAN, the vascular flora of BELA appears to be the most well-known. This was the initial assessment of park staff as reported in the Preproposal, which was supported by experts at the Scoping Meeting. The collective wisdom there was that >90% of expected species were documented for all categories of plants (trees, shrubs, forbs, graminoids, aquatics). The ANHP assessment was slightly less optimistic. Their list included 643 vascular plant species for BELA, of which 72% were documented.

The reasons that the vegetation of the BELA has received relatively more study than the other parks in the NWAN most likely relate to its relative accessibility and to its being a part of Beringia. The Seward Peninsula has long been an attractive location for a variety of geological, paleontological, and botanical studies related to understanding the connection between the Asian and North American continents. Thus, there have been quite a lot of collecting as indicated by the over 1000 specimens in the ALA. Because of human use of much of the northern Seward Peninsula for reindeer herding, there have been a number of vegetational studies related to the reindeer range questions. The pre-ANILCA studies of the area added to our understanding of the flora. Another wave of studies related to Beringian Heritage occurred in the early 1990s, adding further information. Although considerable information appears to be available on the vascular flora of the BLA, that information has not yet been organized to produce a checklist or to identify rare taxa, or taxa of concern (such as due to reindeer grazing).

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Amphibians:

No known occurrences.

Fish:

The Preproposal, Scoping Meeting and ANHP efforts all pointed out a lack of basic information about fish presence and distribution within BELA. The ANHP identified 25 freshwater species with 9 documented. They generated a list of 38 marine species with 8 documented. The ANHP noted the following:

. . . Most fish identified for this park are known to be in the region but little park specific information exists for fish observations . . . This park has probably the most need for a better documented fish inventory.

Information on fish presence in BELA appears to come mainly from reconnaissance type trips to specific locations or from incidental observations by biologists working on other taxa. While there has been considerable work on freshwater and marine/coastal fish in the region by the Alaska Department of Fish and Game, and others, very little of that work has occurred within the bounds of BELA.

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Birds:

The birds of the Seward Peninsula, including BELA, are comparatively well-known. Kessel's (1989) book provides annotated species account for the birds of the Seward Peninsula based on many years field work by herself and others, and extensive literature review (through the late 1980s--the date of publication). Kessel also had experience within BELA. (e.g., Kessel and Gibson 1979). Cape Espenberg, within BELA, is the site of a long-term study of coastal birds by Doug Schamel and Diane Tracy, which began in the days of NOAA's OCSEAP program. A variety of other OCSEAP studies also included work in the coastal areas of BELA. Other studies have documented populations and ecology of selected groups (e.g., falcons, waterfowl, shorebirds).

At the Scoping Meeting, the group estimated that > 90% of expected bird species in BELA had been documented. The ANHP came up with a list of 203 expected species with 132 species documented, for a much lower percentage of documented species--65%. However, scrutiny of these expected but not yet documented species shows that there are many species that are pelagic (open ocean) birds that would not normally be expected in coastal habitats of BELA, and other species that would be considered accidental.

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Mammals:

Participants in the Scoping Meeting agreed that the occurrence of larger mammals (including ungulates, large and small predators) in BELA was well-documented. Documentation of the occurrence of small mammals, including shrews, microtines, squirrels and hares, was estimated to be around 30% of the number of expected species. The ANHP developed a mammal list of 42 expected species, with only about half of the species documented. However, the ANHP list included marine mammal species that would likely not occur within BELA coastal lagoons (i.e., whales). The terrestrial mammal species that have not been documented within BELA include tundra shrew, arctic fox, gray wolf (rare on the Seward Peninsula), wolverine, river otter, ermine, mink, beaver, snowshoe hare.

The literature supports the assessment that the occurrence of larger mammals in BELA is relatively well-known while the occurrence of smaller terrestrial mammals is less well-known. There have been numerous studies addressing reindeer, muskoxen, moose and grizzly bears. Some studies of birds have also collected information on mammals (e.g., Roseneau's studies of gyrfalcon food habits). Because of the importance of this area for paleontological work, it appears that the Pleistocene mammals of the Seward Peninsula are better known than the present day mammals. The OCSEAP studies of the 1970s probably contain much of the available information about marine mammals occurring along the BELA coast and a more thorough search of those reports would be fruitful. The relatively recent biological inventory work done at BELA (Harris 1988,

Welp and Beymer 1989, Welp and Sowl 1990) included small mammal trapping, but only a limited number of sites were visited.

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Cape Krusenstern National Monument

Established: 1980, under ANILCA

Size: 560,000 acres

Purposes:

- Protect and interpret a series of archeological sites depicting every known cultural period in arctic Alaska;
- Provide for scientific study of the process of human population of the area from the Asian Continent;
- Preserve and interpret evidence of prehistoric and historic Native cultures, in cooperation with Native Alaskans;
- Protect habitat for seals and other marine mammals;
- Protect habitat for and populations of birds, and other wildlife, and fish;
- Protect the viability of subsistence resources.

Resources Management Plan:

The Resources Management Plan for CAKR has been drafted but not finalized. This plan identifies expansion of baseline inventories as a high priority. Natural resource protection concerns identified in the draft plan that specifically relate to these biological inventories include: fire management, managing the effects of the Red Dog mine transportation corridor (including reclamation of material sites), assessment of coastal resources, assessment of fisheries and furbearers, and surveys of bird habitats and populations.

Vascular Plants:

In the Preproposal, the flora of CAKR was reported as the least documented of the units in the NWAN. It was noted that existing records were limited to just a few species and that there were few herbarium specimens. Scoping meeting participants echoed this sentiment, rating the level of documentation as <90% for all groups of vascular plants. The ANHP developed an expected species list of 322 species, of which 60% were currently documented.

The pre-ANILCA expedition to the Noatak river region included at least one field site in the area that is now CAKR. It appears that some plant collections were made by Stephen Young in this area. These may be some of the only collections for CAKR. The literature concerning vegetation in the CAKR area seems to contain primarily general references about regional vegetation.

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- Hopkins, D. M. and others, eds. 1982. Paleoeecology of Beringia. New York: Academic Press; 489 pp. (Wenner-Gren Foundation for Anthropological Research Symposium; v. 81).
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Amphibians:

No information available.

Fish:

The Preproposal simply noted that no information on fishes of CAKR was available. Participants at the scoping meeting felt that the freshwater and anadromous species present in CAKR were known at the 50-60% level. The marine species present in CAKR coastal lagoons were less well-known (rated at <50% of expected species documented). The ANHP expected species list for freshwater/anadromous fish in CAKR included 24 species, with 18 of those documented. Their list of marine fish included 38 species with only 8 species documented.

A review of the literature suggests that little sampling for fish presence has occurred within CAKR. The results of the sampling that has occurred appears to be buried in gray literature reports that will take additional time to ferret out. Some sampling of freshwater streams may have occurred along the road corridor for the Red Dog Mine, but most of the freshwater work for the Red Dog Mine has focused on the Wulik River drainage, just outside of the CAKR boundaries. Some of the lagoons at the northern extent of CAKR were also sampled during the planning for the Red Dog Mine. Some lagoons may also have been sampled during the OCSEAP program, but additional review of the literature is needed to find the actual data.

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Blaylock, William M. and Jonathan P. Houghton. 1983. In: Dames and Moore. 1983. *Supplement to Environmental baseline studies, Red Dog Project*. Cominco Alaska, Inc.

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Lindsey, C.C. and J.D. McPhail. 1986. *Zoogeography of fishes of the Yukon and Mackenzie Basins*. Pp. 639-674, In: Hocutt, C.H. and E.O. Wiley (eds.). *Zoogeography of North American freshwater fishes*. John Wiley & Sons, New York.

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Birds:

In the preproposal, park staff were able to rattle off a long list of bird projects in CAKR, including recent (1991-1993) monitoring of shorebird and waterfowl use at Krusenstern Lagoon (Schroeder 1996), a recent NRPP project looking at nest-site characteristics and habitat selection of shorebirds breeding in Northwest Alaska, an existing Breeding Bird Survey route along the Red Dog Mine road (which crosses the northern section of CAKR leading from the mine to its Chukchi Sea port site), a Neotropical Migrant/Landbird Monitoring Route, and a recent Bristle-thighed curlew survey (Gill et al. 1996). The preproposal also notes the existence of a bird checklist for CAKR. Participants at the Scoping Meeting ratified this analysis, concluding that more than 90% of expected species had been documented.

The AHNPP expected species list included 209 expected species for CAKR, with 145 species documented (30% expected but not yet documented). These expected but not yet documented species included a number of pelagic and taiga species whose presence at CAKR is arguable. The expected species list also included a number of species known to occur in the broader Kotzebue Sound region but which may or may not be reasonable to expect to occur within the restricted area of CAKR. Thus, the discrepancy in the evaluations appear to revolve around how the expected species list was developed, rather than on what the true situation is.

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Bartonek, J. and S. Sealy. 1975. *Distribution and status of marine birds breeding along the coast of the Chukchi and Bering Sea.*

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- Manuwal, D. A. 1978. *Avian diversity and habitat selection in the Noatak Valley, Brooks Range, Alaska. Murrelet, 58: 42-56.*
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Mammals:

The Preproposal noted the occurrence of muskoxen composition and abundance surveys within CAKR, but stated that no mammals checklist was available. At the Scoping Meeting, participants concluded that ungulates and predators were well-known, but that small mammals were not (rated as 25-30% of expected species were documented). The ANHP expected species list included 38 species, of which only 11 species were documented. Missing species included voles and small mustelids as well as some marine species (whales, seals). Studies of mammals in the vicinity of CAKR are mainly related to larger mammals, such as grizzly bear, muskoxen, and caribou.

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Noatak National Preserve

Established: 1980, under ANILCA

Size: 6,460,000 acres

Purposes:

- Maintain the environmental integrity of the Noatak River and adjacent uplands to assure the continuation of geological and biological processes, unimpaired by adverse human activity;
- Protect habitat for, and populations of, fish and wildlife, including but not limited to caribou, grizzly bears, Dall sheep, moose, wolves, and for waterfowl, raptors, and other species of birds;
- Protect archeological resources;
- Provide opportunities for scientific research.

Resources Management Plan:

The Resources Management Plan for NOAT has been drafted but not finalized. This plan identifies baseline inventories as their highest natural resources priority. The plan identifies the following specific inventory projects as important: complete vegetation survey, complete plant species survey of the boreal forest, and riparian zones, identify and map exotic plant species, and survey small mammal populations and develop species lists and distribution maps. Compilation of natural history collections and updating the collections database is also identified as a high priority.

Vascular Plants:

The Preproposal noted that information on vascular plants in NOAT was scant. The Preproposal also noted that Young (1974) recorded 400+ vascular plant species, but that NPS records showed only 185 species present in the park (including some herbarium specimens). At the Scoping Meeting, the participants felt that documentation of vascular plant species present in NOAT was probably greater than 90%. This finding contrasts sharply with the ANHP list. ANHP found 567 expected species with only 33% being documented.

A review of the available literature relative to NOAT plants suggests that the ANHP list, showing the majority of expected species as undocumented, is realistic. Other than the work by Young in the pre-ANILCA expedition, visits by botanists for the specific purpose of looking at plants do not seem to have occurred, and little collecting has occurred. Even the work by Young was aimed at describing the main types of associations present. Most of the information about the vegetation of NOAT seems to come from other scientists (geologists or biologists), and developing their own descriptions of the vegetation to relate to their own observations of, for example, surficial geology, animal distributions, fires. These descriptions would typically note the dominant plants occurring. It is interesting that we seem to have regional scale information about the vegetation of NOAT but no detailed information about the plants. It appears that we are missing a solid set of work by bonafide botanists that would give a complete picture of the flora.

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Amphibians:

No information available.

Fish:

In the Preproposal, a variety of fishery related studies in the Noatak region were mentioned, including two recent University of Alaska Fairbanks master's thesis projects on dolly varden (Cappiello 1995; Foy 1996), lake species assessments in the early 1980s, the Sikusilaq Springs hatchery overview in early 1980s, and aerial arctic char surveys by the Alaska Department of Fish and Game (Fred Decicco, ADF&G). At the scoping meeting, the group agreed that occurrence of fish species in NOAT was at or above the 90% level. The ANHP confirmed this assessment. The estimated that the total number of expected fish species was 24, with 22 of these species already document. The only 2 missing species were coho salmon and rainbow smelt.

A review of available literature confirms the prior analyses. The Noatak River is a major river whose fishery resources are important to local residents, hence fishes in the Noatak have received a fair amount of study.

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Birds:

In the preproposal, the presence of neotropical migrant data from a mist-netting station (Monitoring Avian Productivity and Abundance program) in NOAT was noted. Also noted were prior Noatak River Raptor Surveys. A bird checklist is available. At the Scoping Meeting, the group agreed that at least 90% of the expected species had been documented. The AHNP included 177 species on its expected species list, of which 119 species were considered to be documented (67%). Based on the available literature, the Noatak and other rivers appear to have been the primary access corridors for the ornithological explorations of NOAT.

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Mammals:

In the Preproposal, a long list of NOAT mammal studies was referenced, including: a moose population demography study; wolverine population demography study; brown bear studies related to the Red Dog Mine; Dall sheep movement study (Ayres-M.S. Berkley); Dall sheep surveys-Baird/Delong Mtns, 1986-Present; abundance and demography of dall sheep in the Baird Mountains, Noatak National Preserve, Alaska (NRPP 2000-2003); Kelly River-Small Mammal Trapping –Dwight Bradshaw/Lee Anne Ayres.

At the Scoping Meeting, the group felt that existing information about smaller mammals, including shrews, voles, hares, and squirrels was inadequate (<30% documented) for all parks, including NOAT. The ungulates larger predators, and smaller predators were rated at >90% documented. The expected species list developed by the ANHP for NOAT includes 36 species, of which 18 species are currently documented to occur (50% documented). The expected but not yet documented species include mainly the shrews, smaller predators, and rodents.

Available literature on NOAT mammals focuses on the ecology of the larger mammals. A fair amount of small mammal trapping has occurred also (e.g., Dean and Chesemore 1974, Gardner 1974).

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Kobuk Valley National Park

Established: 1980

Size: 1,710,000 acres

Purposes:

- Maintain the environmental integrity of the natural features of the Kobuk River Valley, including the Kobuk, Salmon, and other rivers, the boreal forest, and Great Kobuk Sand Dunes, in an undeveloped state;
- Protect and interpret, in cooperation with Native Alaskans, archeological sites associated with Native cultures;
- Protect migration routes for the Arctic caribou herd;
- Protect habitat for, and populations of, fish and wildlife including but not limited to caribou, moose, black and grizzly bears, wolves, and waterfowl;
- Protect the viability of subsistence resources.

Vascular Plants:

The Preproposal included the following information about KOVA vascular plants: "One area of intensive study (Greater Kobuk Dunes), other areas less well known. Two state-listed rare plants: *Oxytropis kobukensis* (Lipkin 1985) and *Aster yukonensis* (Hunt 1997, Parker 1997). Several data sources exist (Mann and Parker 1997, Melchior 1976, Melchior and Racine 1976, Parker 1997); checklist not compiled; minimum of 182 species known from herbarium records."

Notes from the Scoping Meeting indicate that the group felt that the vascular flora of KOVA was relatively well-known (relative to other portions of NWAN). The overall rating was 65% of expected species were documented, with forbs, graminoids, aquatics and non-flowering herbs being the least well-known. In discussing species of special concern, the status of *Oxytropis* (a rare endemic plant) was noted; also the need for inventory work in alpine areas, including the Jade Mountains. The expected species list developed by the ANHP includes 395 species, of which 260 are currently documented (66%).

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Amphibians:

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Fish:

The Preproposal noted the occurrence of an Upper Kobuk sheefish project. In the Scoping Meeting, the group felt that anadromous and freshwater fish were documented to the 70% level. The expected species list developed by the AHNP included 22 expected species, with 16 species documented (72%). A review of the available literature suggests that fish in KOVA are less well-known than in NOAT. Most of the prior work has been conducted by the Alaska Department of Fish and Game relative to commercial and subsistence fisheries. The pre-ANILCA expedition of Melchior (1976) included some fish inventory work in KOVA, and reviewed the literature existing at that time.

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- Lindsey, C.C. and J.D. McPhail. 1986. *Zoogeography of fishes of the Yukon and Mackenzie Basins. Pp. 639-674, In: Hocutt, C.H. and E.O. Wiley (eds.). Zoogeography of North American freshwater fishes. John Wiley & Sons, New York.*
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- McPhail, J.D. and C. C. Lindsey. 1970. *Freshwater fishes of northwestern Canada and Alaska. Bulletin (Fisheries Research Board of Canada) ; no. 173. Ottawa : Fisheries Research Board of Canada : available by mail from the Queen's Printer, 1970. 381 p.*
- U.S. National Park Service. 1986. *Kobuk Valley National Park : general management plan, land protection plan, wilderness suitability review. Review copy April. Anchorage, AK. 223 pp.*

Birds:

The Preproposal noted that there are Neotropical Migrant/MAPS Banding Station data from KOVA, and that a bird checklist is available. At the Scoping Meeting, the group felt that KOVA birds were documented at the >90% level. The ANHP expected species list included 186 species, of which 116 were currently documented (62%).

- Brown, R., R. Jandt, Dame, and McGuire. 1991. *Alaska waterfowl production survey. Unpublished survey data sent from H. M. Hankins, Kobuk District Manager, Bureau of Land Management to R. Harris, National Park Service, Nome, AK.*
- GAAR-checklist. 1974. *Birds of the Brooks Range—a checklist. Pages 581-601 in Proposed Gates of the Arctic National Park, Alaska. Prepared by Alaska Planning Group. USDOI. October 1974. Appendix D.*
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- Jones, K. and A. Jones. 1974. *Observations from Onion Portage during Fall – Spring 1965. In Dean, F. C. and D. L. Chesemore. Studies of birds and mammals in the Baird and Schwatka Mountains, Alaska. Biological Papers of the University of Alaska, Number 15. 82 pp.*
- Kotzebue Basin Bird Checklist.
- KOVA Bird Checklist. *Kobuk Valley National Park bird checklist documentation and information sources.*
- KOVA-checklist. 1974. *Checklist of Birds from the Kotzebue Sound-Selawik Region. Pages 510-517 in Proposed Selawik National Wildlife Refuge, Alaska. Prepared by Alaska Planning Group. USDOI. December 1974. Appendix A.*
- Mauwal, D. A. 1975. *The status of the bluethroat (Luscinia svecica) in North America. The Murrelet 56: 5-8.*
- McLenegan, S.B. 1889. *Exploration of the Kowak River, Alaska: Ornithological Notes. Pp. 109-125 IN M.A. Healy, Report of the cruise of the revenue marine steamer Corwin in the Arctic Ocean in the year 1884. GPO, Washington.*

- Melchior, H. R., R. K. Whitten, and R. T. Shideler. 1976. *Vertebrates of the proposed Kobuk Valley National Monument- Birds*. Pages 154-164 in *Biological survey of the proposed Kobuk Valley National Monument final report*. National Park Service contract CX-9000-3-0136, Alaska Cooperative Park Studies Unit. Biology and Reserve Management Program. University of Alaska Fairbanks.
- Melchior, H.R., K.R. Whitten, and R.T. Shideler. 1976. *Vertebrates of the proposed Kobuk Valley National Monument*. Pp. 140-203 in Melchior, Herbert R., ed. 1976. *Biological survey of the proposed Kobuk Valley National Monument. Final report*. Fairbanks, AK: University of Alaska. Alaska Cooperative Park Studies Unit; 215 pp.
- Northwest Alaska Areas (NWAA) Bird Checklist 1996. Northwest Alaska Areas; A Checklist to the bird of Kobuk Valley National Park. Northwest Alaska Areas National Park Service Kotzebue Alaska.
- NPS. 1990. *Field notes from unidentified ranger while near Onion Creek*.
- Selawik NWR Bird Checklist. *Birds of Selawik National Wildlife Refuge*. USFWS. Kotzebue, Alaska.
- Townsend, C. H. 1887. *List of the Midsummer Birds of the Kowak River, northern Alaska*. Auk 4: 11-13.
- Townsend, C.H. 1887. *Notes on the natural history and ethnology of northern Alaska*. Pp. 81-96 IN M.A. Healy, *Report of the cruise of the Revenue Marine Steamer Corwin in the Arctic Ocean in 1885*. GPO, Washington, D.C.
- University of Alaska Museum 1996. *Summary database of the UAM ornithology collection*. Last update 7/19/96. Internet site: <http://www.uaf.edu/museum/bird/index.html>

Mammals:

The Preproposal noted the following mammal studies in KOVA: Onion Portage Caribou Radiocollaring/Blood Serum Collection; Salmon River Moose Abundance Survey; Selawik NWR/KOVA Wolf Demography Study (NRPP project) 1989-1991. At the Scoping Meeting, the group felt that all but the smaller mammals were known at the >90% level. The ANHP included 29 species on its expected species list, with only 10 species currently documented (34%).

- Dean, F.C. and D.L. Chesemore. 1974. *Studies of birds and mammals in the Baird and Schwatka Mountains, Alaska*. Biol. Paper Univ. of Alaska, No. 15. Fairbanks, AK. 80 p.
- Manville, R.H. and S.P. Young. 1965. *Distribution of Alaskan Mammals*. Bureau of Sports Fisheries and Wildlife. Washington D.C. 76p.
- Melchior, H.R. 1976. *Biological survey of the proposed Kobuk Valley National Monument*. Final report CX-9000-3-0136, CO#3. Alaska Cooperative Park Studies Unit. University of Alaska, Fairbanks, AK.
- Melchior, H.R., K.R. Whitten, and R.T. Shideler. 1976. *Vertebrates of the proposed Kobuk Valley National Monument*. Pp. 140-203 in Melchior, Herbert R., ed. 1976. *Biological survey of the proposed Kobuk Valley National Monument. Final report*. Fairbanks, AK: University of Alaska. Alaska Cooperative Park Studies Unit; 215 pp.
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Gates of the Arctic National Park and Preserve

Established: 1980, under ANILCA

Size: 7,052,000 acres

Purposes:

- Maintain the wild and undeveloped character of the area, including opportunities for visitors to experience solitude, and the natural environmental integrity and scenic beauty of the mountains, forelands, rivers, lakes, and other natural features;
- Provide continued opportunities including reasonable access for mountain climbing, mountaineering, and other wilderness recreational activities;
- Protect habitat for and populations of fish and wildlife, including, but not limited to, caribou, grizzly bears, Dall sheep, moose, wolves, and raptorial birds.

Vascular Plants:

The Preproposal included the following information about vascular plants in GAAR: "Herbarium collection at the Bettles Ranger Station containing plants collected through FIREPRO and other small, localized inventory expeditions to unique ecological sites (Reed River Hot Springs, Killik Sand dunes, Kugrak Hotsprings, etc.); verification status is unknown. 369 species have been vouchered according to the ANCS database. Inventories for species of concern *Aster yukonensis* conducted on 3 southern rivers. Vascular plants identified and inventoried in the Kobuk Preserve Unit and Anaktuvuk Pass area in conjunction with an ecological mapping project and ATV impact study. An incomplete annotated plant list is available."

At the Scoping Meeting, the group noted that for all taxa other than trees and shrubs, less than 90% of expected species had been documented. The Alaska Natural Heritage Program included 518 species on its expected species list for GAAR, of which 427 species were currently documented (82%). A review of the available literature indicates that a fair number of site specific vegetation studies have occurred in GAAR.

- Ahlstrand, G.M., S.E. Cantor, S.E., and C.H. Racine. 1988. Effects of all-terrain vehicle use in the vicinity of Anaktuvuk Pass, Gates of the Arctic National Park, Alaska : I. Study of established, recovery, and new trail segments. Anchorage, AK: U.S. National Park Service. Alaska Region; 63 leaves (Natural Resources Final Report; v. AR-88/01).*
- Auerbach, N.A. 1992. Effects of road and dust disturbance in minerotrophic and acidic tundra ecosystems, northern Alaska: M.S. thesis. University of Colorado; 253 leaves.*
- Brown, Jerry and Berg, Richard L., eds. 1980. Environmental engineering and ecological baseline investigations along the Yukon River-Prudhoe Bay Haul Road. Hanover, NH: U.S. Army Cold Regions Research and Engineering Laboratory; 187 pp (CRREL Report; v. 80-19).*
- Brubaker, L.B., H.L. Garfinkel, and M.E. Edwards. 1982. A new look at vegetation change in the central Brooks Range, Alaska. within: Markgraf, Vera; Brubaker, Linda B., and Chernicoff, Stan E. Character and Timing of Rapid Environmental and Climatic Changes : 7th Biennial American Quaternary Association National Conference, Seattle, WA, June 28-30, 1982. Abstracts; 1982; p. 77.*
- Brubaker, L.B., H.L. Garfinkel, and M.E. Edwards. 1983. A Late Wisconsin and Holocene vegetation history*

- from the central Brooks Range : implications for Alaskan palaeoecology. *Quaternary Research* 20:194-214.
- Christiansen, J.S. 1988. *A spruce-lichen woodland in northern Alaska: post-fire regeneration and community dynamics*. M.S. Thesis, University of Washington, Seattle.
- Cooper, D.J. 1986. *The Arrigetch Peaks region of the central Brooks Range, Alaska : ecosystems and human use*. within: Lucas, Robert C., comp. *Proceedings--National Wilderness Research Conference : Current Research*, Fort Collins, CO, July 23-26, 1985. Ogden, UT: U.S. Forest Service. Intermountain Research Station; [1986]; pp. 94-99. ([General Technical Report; v. 212]).
- Cooper, D.J. 1986. *Arctic-alpine tundra vegetation of the Arrigetch Creek valley, Brooks Range, Alaska*. *Phytocoenologia* 14(4):467-555.
- Cooper, D.J. 1989. *Geographical and ecological relationships of the arctic-alpine vascular flora and vegetation, Arrigetch Peaks region, central Brooks Range, Alaska*. *Journal of Biogeography* 16(3):279-295.
- Cooper, D.J. 1983. *Arctic-alpine tundra ecosystems of the Arrigetch Creek valley, central Brooks Range, Alaska: Ph.D. thesis*. University of Colorado. 2 vols.
- Densmore, D. 1980. *Vegetation and forest dynamics of the upper Dietrich River valley, Alaska*. 183 leaves.
- Garfinkel, H.L. 1979. *Climate-growth relationships in white spruce (*Picea glauca* [Moench] Voss) in the south central Brooks Range of Alaska: M.S. thesis*. University of Washington. 104 leaves.
- Goldstein, G.H. 1981. *Ecophysiological and demographic studies of white spruce (*Picea glauca* (Moench) Voss) at treeline in the central Brooks Range of Alaska*. [Seattle, WA]: Ph.D. thesis. University of Washington; 193 leaves, missing [14] leaves of plates.
- Horton, D.G. and B.M Murray. 1976. *Encalypta brevipes and E. mutica, gymnostomous species new to North America*. *The Bryologist* 79:321-331.
- Link, S.O. and T.H. Nash. 1984. *An analysis of an arctic lichen community with respect to slope on silicious rocks at Anaktuvuk Pass, Alaska*. *Bryologist* 87(2):162-166.
- Lyon, J.G. and T.L. George. 1979. *Vegetation mapping in the Gates of the Arctic National Park*. within: *American Society of Photogrammetry. Proceedings of the 45th Annual Meeting, Falls Church, VA, March 18-March 24, 1979*. Washington, DC; pp. 483-497.
- Moser, T.J., T.H. Thomas, and J.W. Thomson. *Lichens of Anaktuvuk Pass, Alaska, with emphasis on the impact of caribou grazing*. *Bryologist* 82(3):393-408.
- Murray, B.M. 1974. *Catalog of bryophytes and lichens of the central Brooks Range, Alaska : a literature review*. [Fairbanks, AK]: University of Alaska Museum; 46 leaves.
- Murray, D.F. 1974. *Notes on the botany at selected localities in the Alatna and Killik river valleys, central Brooks Range, Alaska : final report*. Fairbanks, AK: University of Alaska. [Alaska Cooperative Park Studies Unit]; 218 leaves (Gates of the Arctic Vegetation Study).
- Murray, David F. and Lipkin, Robert. 1987. *Candidate threatened and endangered plants of Alaska with comments on other rare plants*. Fairbanks, AK: University of Alaska Museum; [76] pp.
- Murray, D.F., B.M. Murray, and A.W. Johnson. 1977. *Bryophytes and lichens : Pt. 4 of Botanical reconnaissance of the Yukon River - Prudhoe Bay Haul Road, 15-28 July 1976. Final report to the Cold Regions Research and Engineering Laboratory*. Fairbanks, AK: [Not for publication.] Institute

- of Arctic Biology and Museum. University of Alaska; 1977;[98] pp.
- Odasz, A.M. 1983. *Vegetation patterns at the treelimit ecotone in the upper Alatna River drainage of the central Brooks Range, Alaska*: Ph.D. thesis. University of Colorado; 224 leaves and map.
- Odasz, A.M. 1986. *Distributions of 40 rare vascular plants in the Alatna River drainage of the central Brooks Range, Alaska*. Northwest Science 60(2):104-107.
- Racine, C.H. and L.A. Johnson. 1988. *Effects of all-terrain vehicle traffic on tundra terrain near Anaktuvuk Pass, Alaska*. [Hanover, NH]: U.S. Army Cold Regions Research and Engineering Laboratory; 12 pp (Special Report; v. 88-17).
- Rieger, S., D.B. Schoephorster, and C.E. Furbush. 1979. *Exploratory soil survey of Alaska*: U.S. Soil Conservation Service; 213 pp. and folded maps.
- Shea, K.E. 1994. *An analysis of low altitude color and color infrared aerial photography as a tool for monitoring human impact site changes at Gates of the Arctic National Park and Preserve*: M.S. thesis. University of Wisconsin-Madison; 357 leaves.
- Short, S. K., J.T. Andrews, and P.J. Webber. 1986. *Pollen, vegetation, and climate relationships along the Dalton Highway, Alaska, U.S.A. : a basis for Holocene paleoecological and paleoclimatic studies*. Arctic and Alpine Research 18(1):57-72.
- Stephenson, R.O. 1974. *Characteristics of wolf den sites. Final report*. Juneau, AK: Alaska Dept. of Fish and Game. Div. of Game; 24 pp (Federal Aid in Wildlife Restoration; v. Projects W-17-2, W-17-3, W-17-4, W-17-5 and W-17-6, Job 14.6R).
- Swanson, D. K. 1995. *Landscape ecosystems of the Kobuk Preserve Unit : Gates of the Arctic National Park, Alaska*. Anchorage, AK: U.S. National Park Service. Alaska Regional Office; 291 pp (Technical Report; v. NPS/ARRNR/NRTR-95/22).
- Swanson, D.K. 1996. *Fruticose lichen distribution in the Kobuk Preserve Unit, Gates of the Arctic National Park, Alaska*. Technical Report NPS/AFA RNR/NRTR-96/28. 22 pp.
- U.S. National Park Service. 1982. *Gates of the Arctic: Reed River Hot Springs : special report*. [Anchorage?, AK]; 1982;[19] leaves.
- U.S. National Park Service. 1992. *Alaska Regional Office. Final legislative environmental impact statement on all-terrain vehicles for subsistence use in Gates of the Arctic National Park and Preserve, Alaska*. [Anchorage, AK];447 pp.
- U.S. National Park Service. 1991. *Alaska Regional Office. Div. of Cultural Resources. Flora of Alaska national parks*. Rev ed. Anchorage, AK; 1 vol.
- Ugolini, F.C. and others. 1981. *Pedological, isotopic, and geochemical investigations of the soils at the boreal forest and alpine tundra transition in northern Alaska*. Soil Science 131(6):359-374.
- Van Alstine, N.E. 1988. *Human impact site inventory : Gates of the Arctic National Park and Preserve : status report*: U.S. National Park Service. Alaska Region.; 10 pp. and appendix (Natural Resources Survey and Inventory Report; v. AR-88/18).
- Van Alstine, N.E., T. Gasbarro, and G. Sampson. 1986. *Walker Lake firewood survey, Gates of the Arctic National Park and Preserve - 1986*: U.S. National Park Service. Alaska Region; 30 pp.(Natural Resources Final Report; v. AR-86/16).
- Van Alstine, N.E., T. Gasbarro, and G. Sampson. 1987. *Walker Lake birch study, Gates of the Arctic National*

Park and Preserve - summer 1987: U.S. National Park Service. Alaska Region.; 18 pp.(Natural Resources Final Report; v. AR-87/).

Wiggins, I.L. and D.G. MacVicar. 1958. Notes on the plants in the vicinity of Chandler Lake, Alaska. Contributions From the Dudley Herbarium 5(3):69-95.

Amphibians:

Only wood frogs (*Rana sylvatica*) are known to exist in GAAR; distribution is unknown.

Fish:

The Preproposal included the following information about fishes in GAAR: "Population surveys for lake trout (Walker Lake), lake trout and arctic char (Chandler Lake system), and sheefish (Kobuk River). No checklist available."

At the Scoping Meeting, the group agreed that the occurrence of fish species was documented for GAAR. At the next level of concern, would be more specific information about sheefish and arctic char. The Expected Species list for GAAR developed by the Alaska Natural Heritage Program included 16 species, of which 14 were documented (88%).

Adams, F.J. 1990. Population characteristics of lake trout in Walker Lake, Gates of the Arctic National Park and Preserve, Alaska. M.S. thesis. University of Alaska, Fairbanks, AK. 139 leaves.

*Alt, Kenneth T. 1987. Review of sheefish (*Stenodus leucichthys*) studies in Alaska. Fishery Manuscript 3. Alaska Dept. of Fish and Game. Div. of Sport Fish. Juneau, AK. 69 pp.*

Bendock, T.N. 1979. Inventory and cataloging of arctic area waters. Alaska Department of Fish and Game. Annual Performance Report 1978-1979. Juneau, Alaska.

Bendock, Terrence N. 1981. Inventory and cataloging of arctic area waters. In: Alaska Dept. of Fish and Game. Div. of Sport Fish, Inventory and Cataloging Vol. 22. July 1, 1980-June 30, 1981. Federal Aid in Fish Restoration and Anadromous Fish Studies. Study No. G-I, Job No. G-I-I. Juneau, AK. 34 pp.

Bendock, T. and J. Burr. 1985. Catalog of North Slope lake and stream surveys. Dept. of Fish and Game, Sport Fish Division. Fairbanks, Alaska. 33pp.

Bendock, T.N. and J. Burr. 1985. Freshwater fish distributions in the central Arctic coastal plain (Topagoruk River to Ikpikpuk River). Alaska Dept. of Fish and Game, Sport Fish Division. Fairbanks, Alaska.

DeCicco, Alfred L. 1985. Inventory and cataloging of sport fish and sport fish waters of western Alaska with emphasis on arctic char life history studies. Annual performance report. Completion report. Pages 41-134 In: Alaska Dept. of Fish and Game. Div. of Sport Fish, Federal Aid in Fish Restoration and Anadromous Fish Studies. Vol. 26. Inventory and cataloging. Study G-I-P-A.

Georgette, S. and H.B. Loon. 1990. Subsistence and sport fishing of sheefish on the Upper Kobuk River, Alaska. Division of Subsistence, Alaska Department of Fish and Game, Technical Paper No. 175. 37 pp.

Johnson, R.R. and K.D. Troyer. 1994. Survey of lake trout and arctic char in Walker Lake, Gates of the Arctic National Park and Preserve, 1987-1989. U.S. Fish and Wildlife Service, Fairbanks Fishery Resource Office.

- Lindsey, C.C. and J.D. McPhail. 1986. Zoogeography of fishes of the Yukon and Mackenzie Basins. Pp. 639-674, In: Hocutt, C.H. and E.O. Wiley (eds.). Zoogeography of North American freshwater fishes. John Wiley & Sons, New York.
- Netch, N.F. 1975. Fishery resources of waters along the route of the Trans-Alaska Pipeline between Yukon River and Atigun Pass in North Central Alaska. U.S. Fish and Wildlife Service, Resource Publ. 124, Anchorage, AK.
- Troyer, K.D. and R.R. Johnson. 1994. Survey of lake trout and arctic char in the Chandler Lake system, Gates of the Arctic National Park and Preserve, 1987 and 1989. U.S. Fish and Wildlife Service, Fairbanks Fishery Resource Office.
- U.S. National Park Service. 1986. Gates of the Arctic National Park and Preserve, Alaska : general management plan, land protection plan, wilderness suitability review. [Anchorage, AK?]. 301 pp.

Birds:

The Preproposal included the following information about birds in GAAR: "19 raptor inventories conducted on major rivers between 1985 and 1991; raptor observations and nest records maintained in a database since 1989. Off-road point count transects conducted yearly at 3 sites. Checklist available and references 145 species."

At the Scoping Meeting, the group agreed that the goal of documenting 90% of expected species was most likely already met, but considerable bird study was still desirable. The Alaska Natural Heritage Program expected species list included 154 species, of which 121 species were documented (79%).

- Amaral, M and C. Gardner. 1986. A survey for cliff-nesting birds of prey along the Noatak River, Alaska. U.S. Fish and Wildlife Service, Enhancement Endangered Species, Anchorage, Alaska.
- Campbell, J. 1968. Birds of Chandler Lake, Brooks Range, Alaska. *The Murrelet* 49:16-23.
- Campbell, J. 1969. The owls of the central Brooks Range, Alaska. *Auk* 86: 565-568.
- Dean, F. C. and D. L. Chesemore. 1974. Studies of birds and mammals in the Baird and Schwatka Mountains, Alaska. *Biological Papers of the University of Alaska*, 15: 80 pp.
- Difolco, D. 1996. 1996 Neotropical Migratory bird surveys Gates of Arctic National Park and Preserve. GAAR-96-01. National Park Service, Fairbanks, Alaska.
- Faber, K. 1992. Study Report: Breeding waterfowl survey, Gates of the Arctic National Park and Preserve. GAAR-92-002. October 1992. U.S. National. Park Service, Fairbanks, Alaska.
- GAAR-checklist. 1974. Birds of the Brooks Range – a checklist. Pages 581-601 in *Proposed Gates of the Arctic National Park, Alaska*. Prepared by Alaska Planning Group. USDOl.
- Garber, C. 1987. Itkillik River raptor survey Gates of Arctic National Park and Preserve, Alaska. National Park Service, Gates of the Arctic National Park and Preserve, Fairbanks, Alaska.
- Garber, C. 1989. A survey for cliff nesting birds of prey of the north fork of the Koyukuk River in Gates of Arctic National Park and Preserve Alaska, 6 July to 18 July 1989. National Park Service, Gates of the Arctic National Park and Preserve, Fairbanks, Alaska.
- Irving, L. 1960. Birds of Anaktuvuk Pass, Kobuk, and Old Crow: a study in arctic adaptation. *USNM Bull.* 217: 245-261.

- Kessel, B. and T. J. Cade. 1958. *Birds of the Colville River northern Alaska*. F. C. Dean (ed.). *Biological Papers of the University of Alaska*: 2.
- Kline, N. and V. Brown. 1986. *Itkillik River raptor survey Gates of Arctic National Park and Preserve Alaska, 18 June-13 July, 1986*. National Park Service *Gates of the Arctic National Park and Preserve*, Fairbanks, Alaska.
- Manuwal, D. A. 1978. *Avian diversity and habitat selection in the Noatak Valley, Brooks Range, Alaska*. *Murrelet*, 58: 42-56.
- O'Neale, J. and O'Neale, J. 1993. *Dalton Highway bird observations, June – Sept. 1993*.
- Price, D. 1985. *1985 Alatna river raptor survey*.
- Summer Bird List. 1991. *Summer bird list and sighting areas. Gates of the Arctic National Park and Preserve, Alaska*.
- Summer Bird List. 1992. *Summer bird list and sighting areas. Gates of the Arctic National Park and Preserve, Alaska*.
- Summer Bird List. 1993. *Summer bird list and sighting areas. Gates of the Arctic National Park and Preserve, Alaska*.
- Swanson, D. 1995. *Landscape ecosystems of the Kobuk Preserve Unit, Gates of the Arctic National Park, Alaska*. Technical Report NPS/ARRNR/NRTR-95/22. Prepared by USDA, Natural Resources Conservation Service. National Park Service, Anchorage, Alaska.
- Swanson, S. 1998. *1998 Bird off-road point count surveys and analysis of species richness data, 1993-1998. Gates of the Arctic National Park and Preserve*. GAAR-98-06. National Park Service, Fairbanks, Alaska.
- Swanson, S. 1997. *Avian Productivity in Tundra Riparian Shrub Habitats near Anaktuvuk Pass, Alaska. Gates of the Arctic National Park and Preserve*. GAAR-97-004. National Park Service, Fairbanks, Alaska.
- Swanson, S. A. 1991. *Raptor surveys Gates of the Arctic National Park and Preserve*. GAAR-91-0001. National Park Service, Fairbanks, Alaska.
- University of Alaska Museum 1996. *Summary database of the UAM ornithology collection*. Last update 7/19/96. Internet site: <http://www.uaf.edu/museum/bird/index.html>.

Mammals:

The Preproposal included the following information about mammals in GAAR: “Periodic counts at specific locations for moose, Dall sheep, muskox, and wolves. No abundance information for black bears, brown bears or caribou. State harvest summaries available for furbearers (lynx, river otter, beaver, wolverine, and wolf) from specific areas in the park used by trappers. State harvest records for brown bears, moose, and Dall sheep are available. Negligible information on marten, river otter, red fox, mink, muskrat, least weasel, or marmot distributions or abundance. Microtines inventoried and vouchered at 4 sites on the Kobuk River; 2 voucher specimens collected from the Castle Mountain Unit. Snowshoe hare density information available from the Wiseman vicinity on the eastern edge of the park. No checklist available.”

At the Scoping Meeting, the group felt that small mammals and small predators were the groups most in need of further documentation. The expected species list developed by the Alaska Natural Heritage Program included 37 species, of which 24 were currently documented (65%).

- Adams, L.G. 1988. Dall sheep survey, Gates of the Arctic National Park and Preserve, Alaska. 1987. Nat. Res. Survey and Inventory Rep. AR-88/15. National Park Service, Anchorage, AK. 46 pp.
- Brubaker, R. 1998. Progress report, 1998: Sheep work in Gates of the Arctic National Park, October 21, 1998. U.S. National Park Service. Fairbanks, AK. 25 p.
- Brubaker, R. and K. Whitten. 1998. 1996 Dall Sheep (*Ovis dalli dalli*) Survey, Gates of the Arctic National Park and Preserve, Alaska. Technical Report NPS/AR/NRTR-98/35.
- Dale, B. W., L. G. Adams, and R. T. Bowyer. 1989. The influence of late winter caribou distribution on wolf predation in Gates of the Arctic National Park and Preserve, Alaska, Progress report, Dec 1989. U.S. National Park Service, Anchorage, AK.
- Dale, B.W. et al. 1995. Winter wolf predation in a multiple ungulate prey system, Gates of the Arctic National Park, Alaska. pp. 223-230 IN Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, Edmonton.
- Dean, F.C. and D.L. Chesemore. 1974. Studies of birds and mammals in the Baird and Schwaika Mountains, Alaska. Biol. Paper Univ. of Alaska, No. 15. Fairbanks, AK. 80 p.
- Difolco, D.L. 1999. Snowshoe hare abundance in the Wiseman area of Gate of the Arctic National Park and Preserve. Third annual study and summary report GAAR-99-03. U. S. National Park Service. Fairbanks, AK.
- Faber, K. 1992. Dall sheep survey-trip report. Gates of the Arctic National Park and Preserve, Alaska. National Park Service, Fairbanks, AK. 3 pp.
- Golden, H.N. 1988. Distribution and relative abundance, population characteristics, and harvest of furbearers in Gates of the Arctic National Park and Preserve. Final Report NRFR AR-8808. U. S. National Park Service. Anchorage, AK. 33 p.
- Manville, R.H. and S. P. Young. 1965. Distribution of Alaskan Mammals. Bureau of Sports Fisheries and Wildlife. Washington D.C. 76p.
- Morgan, S.O. 1990. Annual report of survey-inventory activities. Vol. XX, Park XIV, Furbearers. ADF&G Fed. Aid in Wildl. Rest. Progr. Rep., Project W-23-2. Study 7.0, Juneau, AK 238 pp.
- Murphy, E. and D.F. Murray. 1973. Notes on mammals of the Central Brooks Range.
- Noatak Joint Patrol 90-11. 1990. Backcountry trip report from Park Service personnel from both Gate of the Arctic and Noatak. Muskox sighting at confluence with Tunukuchiak River in Gates of the Arctic. U. S. National Park Service.
- Rausch, R. 1951. Notes on the Nunamuit Eskimo and mammals of Anaktuvuk Pass region, Brooks Range, Alaska. Arctic 4(3):147-195.
- Reynolds, H.V. III. 1989. Grizzly bear population ecology in the Western Brooks Range, Alaska, NOAT, October 1989. Natural Resources Progress Report AR-89/08. U.S. National Park Service, Anchorage, AK.
- Singer, F.J. 1984. Aerial Dall Sheep Count, 1982, 1983, 1984, Gates of the Arctic National Park and Preserve, Nat. Res. Survey and Inventory Rep. AR-84-2. National Park Service, Anchorage, AK. 20 pp.
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Appendix B. Species of Special Concern Project Descriptions

Inventory and Monitoring of Nonvascular Resources in Noatak National Preserve

Note: The following is an example of a proposal submitted in one park to address lichen inventory and monitoring needs. The same type of project is needed in each park in the network. This would result in a considerably larger and more costly undertaking than that which is proposed.

RMP Project Codes:

NOAT-N-102.000 (Conduct Baseline Inventories of Natural Resources)

NOAT-N-102.101 (Complete Vegetation Survey of NOAT)

NOAT-N-102.110 (Complete Plant Species Survey of Boreal Forest)

NOAT-N-102.201 (Complete Survey of Cryptogamic Species in NOAT)

RMP Priority: 1,2,3,5

NPS Project Manager: Peter Neitlich, Botanist

Collaborators: Dr. Bruce McCune, Professor of Botany, Oregon State University

Recommended Funding: Biological Resource Management Division (BRMD)

Requested BRMD Budget: \$50,000

Service-wide Issues: N20 Lack of Basic Data: Insufficient Understanding of Park Ecosystems and Threats to Them

ABSTRACT

The plant communities of the 6.5 million acre Noatak National Preserve (NOAT) are dominated in diversity by nonvascular species which have yet to be enumerated. Studies in Gates of the Arctic National Park have shown that as many as 75% of the flora is nonvascular. Currently known nonvascular taxa in NOAT are thought to represent approximately 10% of the likely flora in NOAT. This gap in baseline data presents major management challenges including the lack of knowledge of what is at risk and the inability to describe the risk level at multiple scales for affected taxa and habitats of special concern. This study will provide a parkwide inventory and status assessment for each nonvascular taxon, and will collect a baseline lichen community monitoring data layer compatible with other statewide and national efforts.

PROBLEM STATEMENT

Northwestern Alaska's lichens and bryophytes are likely to represent 75% of the region's flora (Hulten 1968, Thomson 1984, Neitlich and Hasselbach 1998, NPFlora 1989, Steere 1978) and play key ecological roles which are assumed by vascular plants in more temperate latitudes. These plants constitute a conspicuous, typically co-dominant portion of the biomass (Viereck et al. 1992, Swanson et al. 1985) and account for numerous dominant classes in large-scale aerial and satellite landcover maps (Markon and Wesser 1985, Swanson et al. 1985, Markon and Wesser 1998) and vegetation classifications (Shepard 1995, TNC 1999, Viereck et al. 1992). Formal lichen and bryophyte work has yet to occur in the 6.5 million acre Noatak National Preserve (NOAT). However, research at adjacent park units Gates of the Arctic National Park and Preserve (Neitlich

and Hasselbach 1998) and Bering Land Bridge National Preserve (Romanenko et al. 1997) suggests that approximately 5-10% of the nonvascular plants likely to inhabit NOAT have ever been documented. The National Park Services Inventory and Monitoring Program (Fancy 1999, Wesser et al. 1999) is currently beginning to assemble data on vascular plants in WEAR's four units, but will not address the floristic component which represents these parks' greatest diversity. Nonvascular inventory and monitoring is required by the first, second, third, and fifth RMP projects in NOAT.

Key among the ecological roles of Alaskan arctic lichens and bryophytes are forage, other wildlife uses and nitrogen fixation. Lichens represent the primary winter forage for caribou, reindeer and northern flying squirrels, and serve as a major food source for many other large and small mammals (e.g., muskoxen, Dall sheep, ground squirrels; Sharnoff and Rosentreter 1998). An adult caribou typically consumes 5-6 kg/day of lichens during winter (Boertje 1984). Lichens represent an exclusive food source for large numbers of arthropods (Neitlich 1993) and provide myriad other arctic wildlife uses including dwelling habitat for arthropods, nesting materials for mammals and birds, and antibiotic nest additives for birds. Lichens also contribute a small but significant quantity of fixed nitrogen to the region's nutrient-poor, low-productivity ecosystems (Gunther 1989).

The lichens are an extremely fragile part of the flora in NOAT and face a considerable range of threats including arctic haze, snowmachine-use, visitor impacts in popular areas, and the potential for bioaccumulation of heavy metals and radioactive fallout via forage lichens (Swanson and Barker 1992, NPS 1986, Ford and Vlasova 1996). Recovery rates following stand-replacing disturbances (e.g., fire, overgrazing) have ranged from 120 to 250 years for the regeneration of late-successional lichen communities rich in forage species, depending largely on climate, moisture regime, soil type and other factors (Christiansen 1988, Swanson 1996, Black and Bliss 1978). Unfortunately, studies addressing the recovery, conservation or dynamics of lichen communities (e.g., Swanson et al. 1985) have seldom taken stock of the full complement of lichen biodiversity and have based findings instead on the recovery of a limited number of dominant, field-identifiable species.

In NOAT, as in most of the North American arctic, ecological data focusing on lichen biodiversity are lacking, and floristic data are sparse in coverage (Thomson 1984, Cooper 1983). Many lower 48 states have Natural Heritage Program lists of lichen species and communities of concern, but such a list has yet to be developed in Alaska (AKNHP 1999). National Park species databases (NPS 1989, NPS 1997) and the NPLichen (Wetmore and Bennett 1999) database contain only a minute fraction of the lichen flora likely to be in NPS arctic park units. In NOAT, for example, only 35 species of nonvascular plants are listed, while expected species are likely to comprise upwards of 700. There is thus an acute need in Alaska's arctic for detailed inventory, development of sensitive species lists, and taxonomically-thorough applied research in lichen community ecology. In the few instances in which comprehensive species lists have been developed, lack of a statewide database has hampered efforts by resource managers to assess the significance of potential impacts. Management actions to protect lichen communities have been extremely few (e.g., NPS 1996) and impaired by lack of basic data.

MEASURABLE RESULTS

This project provides resource managers with data needed to assess impacts to nonvascular species and habitats of special concern with respect to affected taxa. Managers concerned with potential visitor impacts to the Noatak would have an excellent idea of the potential risk for nonvascular

plants in communities of concern facing river-based human impact sites. Equally, future study of impacted areas would be able to place the threats to affected nonvascular taxa in perspective of park-wide and global distribution and relative abundance. This data would fill in a critical gap given that so many of the plant communities in WEAR are nonvascular dominated or have large nonvascular components.

These data would also serve as key information to enable the generation of a statewide database with cooperation from USFS and the UAF Museum. Peer-reviewed journal and database submissions will also assist the scientific community at large in understanding the abundance and distribution of arctic taxa, and the major community gradients in arctic Alaska's nonvascular communities.

Methodology

A. Inventory and Status Assessment

Comprehensive macrolichen and bryophyte inventory will be initiated at NOAT. Standard NPS inventory steps from the I&M program will be followed including: 1) compilation of past data, 2) verification of unconfirmed reports and presumed misidentifications, 3) generation of lists of taxa expected to be found in each park unit, 4) agreement on park-specific objectives for nonvascular data gaps and communities of special concern, 5) designing sampling strategy according to standard nonvascular field practices and access concerns, 6) field survey, 7) specimen identification in collaboration with UAF Museum and taxonomists, and 8) generation of databases and population of NPSpecies and ANCS databases with appropriate data. Following national I&M protocols, these inventories will attempt to document 90% of the macrolichen species expected to occur in NOAT. Given funding constraints, a less ambitious goal of documenting 50% of the expected bryophytes will be adopted.

Status assessment will follow the methodology in Neitlich and Hasselbach (1998) used in Gates of the Arctic National Park, thereby allowing for a regional assessment consistent with the Northwest Alaska I&M network's regional scale. Each taxon will be rated in a series of nested abundance detection plots measuring abundance and frequency. These data, in concert with locational data obtained from the final database, will allow parkwide ratings of each taxon as abundant, common, occasional, and uncommon. Taxa will also be placed in regional and statewide contexts through compilation of existing databases (e.g., University of Alaska-Fairbanks, GAAR) floras (e.g., Thomson 1984) and lists in professional journals (e.g., Talbot et al. 1992, Geiser et al. 1994).

A set of museum vouchers will be created for both the University of Alaska-Fairbanks (ALA) and the NOAT herbarium.

B. Community Gradient Analysis and Long Term Monitoring

Long-term monitoring of lichen communities will be initiated with a series of approximately 30 permanent plots. The first step of long term monitoring is detection of major community gradients and their association with primary landscape variables. Gradient detection and long-term monitoring will be accomplished with national lichen biomonitoring protocols (Tallent-Halsell 1994) which have recently been adapted for Alaska.

Collaboration will be continued with the USDA/Forest Service and Denali National Park to finalize Alaska-specific protocols for long-term lichen community monitoring already implemented

nationally by the USDA/Forest Service-Forest Health Monitoring (FHM) Program and under testing by Denali LTEM. The FHM sampling grid is a 60 x 60 km point grid covering the entire country on all ownerships. On a national level, sampling is currently focused on epiphytes. The Alaska program is currently beta testing methods which will also include terrestrial strata. These methods will form the basis of the community work that will complement the basic inventory.

In the adapted FHM methods, each lichen species present on a 0.4 ha plot is vouchered and rated according to the following scale: 1) 1-3 thalli present; 2) 4-10 thalli present; 3) >10 thalli, but less than 25% cover; 4) >25% cover. Plot-level environmental data is taken including location, collection data, basal area of trees and shrubs >5 cm by category, slope, aspect, elevation, and proximity to disturbances and/or pollution sources. Disturbance data will be gathered as determined by specific park needs, and will probably include visitor use impacts and arctic haze.

The community dataset of plots x species will be analyzed with multivariate tools for detection of major community gradients and correlation of these gradients to landscape variables. Procedures will include ordination (NMS; Kruskal 1964), cluster analysis, and multi-response permutation procedures (Mielke 1984) using the software PC-ORD (McCune and Mefford 1999). Faithfulness of species to broad habitat groups (in terms of presence and abundance) will be analyzed via indicator species analysis (Dufrene and Legendre 1997). Multi-species group membership patterns will also be assessed by the procedures above.

OBJECTIVES

1. To document 90% of the expected macrolichen species in NOAT, and to rate each species in parkwide abundance and frequency.
2. To document 50% of the expected bryophyte species in NOAT
3. To describe basic lichen community patterns and their relationship to major landscape variables
4. To establish baseline long term lichen monitoring plots using standard FHM/LTEM protocols that will allow these plots to be included in statewide and national efforts.

Products

1. Curated voucher specimen set for UAF Museum with duplicate set for WEAR herbarium.
2. Peer reviewed journal article with comprehensive list of lichens and bryophytes in NOAT and status assessment for each taxon. Status assessment will include parkwide and regional relative abundance for each, as well as specific conservation concerns.
3. Database of taxa and population of NPSpecies database with appropriate taxa.
4. Spatial data layer (ArcView 3.2) of lichen collection locations, plots and taxa.
5. Baseline dataset for lichen community monitoring, interfaceable with Denali, USFS and other long term ecological monitoring datasets.

6. General Technical Report detailing lichen community trends and correlations for NOAT.
Budget

ITEM	A. FUNDING SOURCE		
	NPS/BRMD	Other	WEAR
<u>Salaries</u>			
1 GS-11 lichen ecologist (0.4 FTE)			26,000
Backfill for 1 GS-11 lichen ecologist (0.4 FTE)	26,000		
1 VIP bryologist (inc. inv. travel)	6,500		
2 months of collaborative researcher salary		8,000	
2 VIP lichenologists (\$19/day x 30 days)	1140		
C. Travel			
Invitational Travel for 2 VIP lichenologists	4,000		
5 Fixed Wing Flight RT's	6,000		
Per Diem (30 days x 20)	600		
D. Equipment and Supplies			
2 PLGRs	5,760		
Total to NPS (non WEAR/ONPS)	50,000		
Total Project Cost	84,000		

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NATURAL RESOURCES PROJECT RANKING CRITERIA

1. Significance of the Resource or Issue to the Park: How important is the resource or issue to the park involved, relative to it's other resources and issues?

Inventory and monitoring of nonvascular plants is a top resource management priority for NOAT. Four of the five of the RMP's top projects include this element, and one of these projects cites such work exclusively. These projects are:

1. NOAT-N-102.000 (Conduct Baseline Inventories of Natural Resources)
2. NOAT-N-102.101 (Complete Vegetation Survey of NOAT)
3. NOAT-N-102.110 (Complete Plant Species Survey of Boreal Forest)
5. NOAT-N-102.201 (Complete Survey of Cryptogamic Species in NOAT)

In addition, the Western Arctic National Parkland Inventory and Monitoring priority list (Wesser et al. 1999) cites nonvascular plant I&M as the park's top floristic priority.

Among the mandates contained in the enabling legislation for NOAT are to maintain the "natural environmental integrity" of the resource, and to "mitigate anthropogenic sources of vegetation impact." Managers are responsible for

identifying and protecting rare plant populations within parks. Unfortunately, park staff currently lack the data and expertise to perform these tasks with regard to lichens and bryophytes, which are thought to represent 75% of the region's flora.

2. Severity of Resource Threat, Problem, or Need(s):

The major threats faced by NOAT's extensive communities of nonvascular plants are caused by recreation and global pollution sources such as arctic haze. The Noatak River is one of the most popular float rivers in the arctic, and WEAR began to monitor the human impacts along this corridor in 1999. Degradation is visible as denuding of vegetation in heavily visited areas. This funding will permit the study of taxa and communities affected or at risk along the Noatak.

Arctic haze includes the sulphur and nitrogen-based pollutants implicated in extensive lichen decline in moderately to heavily polluted areas in Russia and Scandinavia (Toemmervik et al. 1991). The majority of these pollutants originate in industries in central Eurasia where environmental controls are few and the sulfur content of coal is high. Because S and N point sources are few in Alaska, impacts to arctic lichen communities are likely to occur on the scale of a few decades. NPS air resources and LTEM staff are currently planning a lichen biomonitoring program to gather baseline data prior to anticipated declines. Baseline lichen community data from NOAT will represent the first such data for Alaska and will be gathered with FHM protocols to complement FHM, NPS-air, and NPS-LTEM sampling planned for 2001-5.

3. Problem definition and information base: How well is the problem defined?

This project directly addresses NOAT's lack of nonvascular plant data, a primary problem for resource management. Although a few incidental lichen and bryophyte collections have been obtained from NOAT, no formal surveys or community work has ever been undertaken. NPFlora (NPS 1989) documents approximately 35 species of lichens and mosses in ANCS+, but even these are likely to contain a large number of misidentifications (Neitlich and Hasselbach 1998), and the true number of nonvascular species present is likely to approach 700 (Thomson 1984, Thomson 1998, Steere 1978). Protection and species monitoring efforts are currently impossible due to the lack of basic inventory, community description and identification of habitats of special concern. Inventory and establishment of lichen LT biomonitoring will lay the foundation for a variety of future efforts in species conservation and air quality bioeffects assessment.

4. Feasibility: (Weighting Factor = X3)

The objectives of this project are fourfold: 1) to document 90% of the expected macrolichen species in NOAT; 2) to document 50% of the expected bryophyte species in NOAT; 3) to describe basic lichen community patterns and their relationship to major landscape variables; and 4) to establish baseline long term lichen monitoring plots using standard FHM/LTEM protocols that will allow these plots to be included in statewide and national efforts. Methodologies will follow successful past efforts for nonvascular inventory (Neitlich and Hasselbach 1998) and monitoring (Tallent-Halsell 1994). The project's manager has an advanced degree in nonvascular botany and a decade of experience with Alaska's nonvascular flora. The project's main collaborator, Dr. Bruce McCune of Oregon State University, is widely recognized as a leading authority on lichen floristics and ecology.

The time frame is as follows:

October - June, 2001

Phase 1: Generation of expected species lists, agreement on park-specific objectives and priorities, preparation of cooperative agreements, design of sampling strategy.

July - August, 2001

Phase 2: field work

August, 2001 - April, 2002

Phase 3: specimen identification, generation of databases and population of NPSpecies and ANCS databases, analysis of community data, preparation of general technical reports and manuscripts for professional journals.

5. Problem resolution: Will the proposed use of funds contribute directly to decisions or actions that, when implemented, will meaningfully resolve a management issue? (Weighting Factor = X3)

Data on the presence, rarity and distribution of nonvascular taxa will fill the basic data gap currently impeding scientific management of vegetation. First, comprehensive inventory of nonvascular resources in NOAT complements analogous efforts in GAAR, and will enable managers to place resource degradation into regional perspective. Second, these data will help resource managers to comply with the mandates of the Endangered Species Act by allowing assessment of species for candidate status. Many nonvascular taxa are thought to be threatened or endangered but few have been made candidate species due to lack of data. Third, the Alaska Natural Heritage Program seeks to develop a list of sensitive/rare nonvascular plants in order to enable species tracking as currently done for vascular plants and vertebrates. Interpark and interagency data will be combined to populate such a database. The NPS Alaska Region as a whole would benefit tremendously from such a list, as it would allow for interpretation of otherwise obtuse species lists. A combined NOAT/GAAR/BELA database would provide a vast amount of arctic data to these statewide efforts. These efforts, therefore, will assist not only the park, but the Alaska Region in attaining scientific management of vegetation.

6. Transferability: How widely will the project protocols or results be useful?

The results of this study will be disseminated to assist with at least five professional efforts:

1. The taxonomically-verified database generated by this project will provide high quality data to be used by the Alaska Natural Heritage Program to develop statewide nonvascular species tracking lists. While many other states' natural heritage programs maintain such lists for lichens and mosses, ANHP is currently limited to vascular plants due to insufficient (and insufficiently organized) data. This is a great gap in regional conservation efforts.
2. Reports will assist NPS, USFWS, BLM, and USFS in Alaska to provide a broader context for distribution of taxa in adjacent and regional areas.
3. Results will be shared with the Alaska Rare Plant Working Group, which may then pursue needed management actions.
4. Peer-reviewed articles will be of interest to the broader scientific community concerned with the distribution, conservation and ecology of nonvascular plants.

7. Cost effectiveness: Given problem statement and proposed methodology, are cost estimates realistic and commensurate with the results to be produced?

This proposal is extremely cost effective for three reasons:

1. The project will be completed using NPS, volunteer and collaborating university botanists. In this way we will avoid costly overheads normally associated with contracts to outside specialists.
2. Eighty percent of this project is dedicated to salary, with only 20% to travel. This is rare in Alaska projects. Field work will be prolonged to minimize the number of trips needed, and orchestrated for maximum efficiency of inventory effort. No helicopters will be used.
3. BRMP funds will cover 60% of project funds, with 31% coming from WEAR (ONPS) and 9% from collaborators. BRMP therefore achieves a large amount of results from a project in which interest is high enough to attract high outside input.

The methodologies outlined above were achieved with nearly identical cost-breakdown for a successful \$50,000 "Expedition into the Parks" lichen project in GAAR funded by Canon, USA, Inc. (Neitlich and Hasselbach 1998).

Project Support: What resources (including in-kind contributions) are the park, region or other partner(s) willing to commit to this project? A detailed description of total project costs, including contributions is required.

Forty percent of the project costs will derive from other NPS and collaborator contributions. Broken down, these are 31% from WEAR (ONPS) and 9% from collaborating faculty. Contributions from other sources are made in the form of salary.

*Gates of the Arctic National Park and Preserve
Yukon-Charley Rivers National Preserve*

Minimum Requirement Decision Guide For Wilderness Lands

This is an *interim* guide to ensure that we adequately evaluate and minimize impacts to wilderness character prior to completing a comprehensive Wilderness Stewardship/Backcountry Management Plan in 2004. Revised February 2002. We expect to replace this process with a very similar one designed by the Carhart Wilderness Training Center and endorsed by the 4 wilderness stewardship agencies.

Introduction

Simply designating a wilderness or formally finding lands suitable for inclusion in the National Wilderness Preservation System does not assure its preservation. This guide is provided to assist managers in making appropriate decisions about administrative and research activities in wilderness. The guidance comes from the Wilderness Act, NPS Reference Manual #41 *Wilderness Preservation and Management* (July 1999), specific park enabling legislation, and the collective experience of 35 years of wilderness management in America.

A clear understanding and appreciation of the purposes and definitions contained in the 1964 Wilderness Act are necessary when evaluating proposed management actions in wilderness. Section 4 (c) of the Act states:

"except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act (including measures required in emergencies involving the health and safety of persons within the area), there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area."

In the above language, Congress acknowledged that even though certain activities are prohibited, there are times when exceptions to these prohibitions will need to be made for effective administration of the area. However, it is clear that the wilderness management agencies should not view the language in Section 4 (c) as blanket approval to conduct projects or allow activities without an analysis of (1) whether the project or activity is necessary to meet the minimum requirements for the administration of the area, and (2) which tool or method should be used to complete the project that results in the least impact to the physical resource or wilderness values.

Thus, managers must give appropriate consideration to the aesthetic values of wilderness as well as the physical resource. These factors take precedence over cost or convenience in determining the minimum requirement. By policy, clearly articulated in RM #41 *Wilderness Preservation and Management*, NPS managers must ensure that wilderness areas "are given supplemental and permanent protection beyond that normally afforded

other backcountry resources” in park units. The effect of the Wilderness Act is to unambiguously place an additional layer of protection on wilderness areas within the National Park System. Some statutory provisions of the Alaska National Interest Lands Conservation Act of 1980 may modify or supercede the Wilderness Act.

The Wilderness Act intended, and NPS policy provides for, management activities and scientific use of wilderness areas. The paramount scientific value of wilderness derives from its undisturbed conditions. Because undisturbed natural areas are increasingly rare, wilderness areas often provide unique opportunities for scientific investigation. Scientific activities are encouraged in wilderness, provided that the knowledge gained will help to preserve wilderness character.

The determination as to whether or not an action has an adverse impact on wilderness must consider both the physical resources within wilderness, and wilderness character and values. These characteristics and values include: the wilderness’s primeval character and influence, the preservation of natural conditions (including the lack of man-made noises), cultural resource values, the assurance of outstanding opportunities for solitude, the assurance that the public will be provided with a primitive and unconfined type of recreational experience, and the assurance that wilderness will be preserved and used in an unimpaired condition.

Wilderness contains scientific, educational, and historical properties that are also cultural resources. There has been extensive prior human use in most areas now designated as wilderness, resulting in archeological sites, historic structures, cultural landscapes and associated features, objects, and traditional cultural properties that are contributing elements to wilderness. It is important to recognize that laws, such as the National Historic Preservation Act (NHPA), Archeological Resources Protection Act (ARPA), American Indian Religious Freedom Act (AIRFA) and the Native American Graves Protection and Repatriation Act (NAGPRA), as well as others, intended to preserve our cultural heritage, are applicable in wilderness. National Park Service managers are responsible for maintaining an affirmative cultural resource management program in wilderness. Cultural resource management tasks within wilderness are the same as those elsewhere, but these sites must additionally be treated in a manner that preserves other wilderness resources and character. Measures to protect and inventory cultural resources in wilderness must comply with the Wilderness Act provisions on access and use of the minimum requirement concept.

For the purpose of applying these requirements, by NPS policy the term "wilderness" includes the categories of “suitable,” “study areas,” “proposed,” “recommended,” and “designated.” By policy we are required to manage these areas so as to maintain their suitability until such time as Congress takes action.

Who Needs to Use this Guide?

All projects or activities designed to take place *within* designated or suitable wilderness areas encompassed by Gates of the Arctic National Park and Preserve or Yukon-Charley Rivers National Preserve must be passed through this minimum requirement decision

guide and if necessary, the accompanying minimum tool analysis. If the project or proposal takes place *outside* of wilderness areas, this minimum requirement decision process does not apply. If the project takes place *partially* in wilderness, then only those aspects of the project occurring within or immediately adjacent to those lands should be considered and analyzed in this minimum requirement/ minimum tool decision process.

How to Use This Guide

This guide is not a NEPA document, decision document, or policy, but rather a series of self-explanatory worksheets designed to assist you in thinking through and/or documenting your analysis. The worksheets lead the wilderness manager or project leader through a series of questions to provoke careful evaluation about the necessity of conducting the proposed project in wilderness and the most appropriate tools to use. This document will serve as the administrative record for this analysis.

The Superintendent may authorize any of the generally prohibited activities or uses listed in Sec. 4(c) of the Wilderness Act if they are determined to be the minimum required to do the job and meet management objectives.

When evaluating proposed projects or activities on wilderness lands, follow these steps:

1. Complete a "minimum requirement" analysis, worksheets part A and B, for all proposed projects or activities. This step should not be used to justify use of motorized equipment or mechanical transport, but to describe and evaluate the objectives / results of the proposed project so that a decision can be made as to whether the project is appropriate and necessary in wilderness. Do not address the methods needed to carry out the project here, rather consider only ultimate goals.
2. Complete a "minimum tool" analysis for the project. This is where methods are evaluated. This analysis can follow the attached worksheet or, if not, should at least address the same points. If the analysis shows a justifiable need for motorized equipment, it is important to have this analysis in writing to provide to the official(s) who can authorize the use of mechanical transport or motorized equipment in wilderness. For some units, this analysis may become an integral part of an environmental analysis required to document a decision to use motorized equipment.

See Reference Manual #41 for complete guidance for interpretation of NPS wilderness preservation and management policies.