United States Department of the Interior

NATIONAL PARK SERVICE
Geographic Information Systems
P.O. Box 25287
Denver, Colorado 80225-0287

IN REPLY REFER TO

N16(472)

September 1, 1992

Memorandum

To: NPS Regional GIS Coordinators

From: Program Analyst, Policy and Planning Branch, GISD

Subject: Draft Guidelines for GIS Park Plans

Attached, for your information and/or comment, is the draft of GIS Park Plan Guidelines (attachment 1). The Park GIS Plan Guidelines are intended to provide a framework for GIS planning while sections of the NPS GIS Sourcebook will contain detailed information relevant to various GIS issues. The draft document has received rigorous, thoughtful review by each GISD Branch. It is hoped that the GIS Park Plan Guidelines will allow for the multitude of variables and considerations unique to each park, while providing strong GIS planning direction.

Throughout the GIS Park Plan Guidelines, the reader is directed to pertinent sections of the NPS GIS Sourcebook for current and detailed information. I have attached a copy of the Sourcebook Outline (attachment 2).

Your review of the draft, and any concerns or comments, will be appreciated. Please return your comments to me by COB September 23, 1992. If you have any questions, I can be contacted at (303) 969-2710.

Donna R. Mahoney

Attachments

cc:
WASO-470-Fenn
WASO-422-Fairchild
DSC-PG-Drews
WASO-270-Chittendon

NPS GIS Sourcebook

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6. Cadastral / survey activities
7. Maintenance
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-DRAFT-

GEOGRAPHIC INFORMATION SYSTEM (GIS)

PARK PLAN GUIDELINES

This document is intended to provide helpful guidance to parks in developing a park-specific geographic information system (GIS) plan. Planning for GIS at a park necessitates involvement of all appropriate divisions in intensive communication and cooperation aimed at understanding the technology, what it can and cannot do, what the park needs are, and what the impacts are on each division's standard operating procedures particularly as they relate to how data are collected, managed, and used. Planning, developing, and implementing a GIS is a team effort at the park level and Servicewide. Both the Region and WASO have significant support roles. In addition, to park personnel, GIS planning must involve coordination and consultation with the Regional GIS Coordinator, Regional Technical Support Center (RTSC) staff (if applicable), and GIS Division (WASO) staff. In order to be effective, adoption of a park GIS program requires commitment at the Superintendent, division management and staff levels. GIS is a new way of thinking about and doing things, a new paradigm.

It is anticipated that each park plan will be as unique as the park for which it is developed. The Park GIS Plan is a dynamic document, subject to change and revision; however, the plan must serve as a solid basis for implementation at any point in time. The Plan itself will function both as a planning document or road map for implementing GIS at the park and as a communication instrument to all those interested in the future of the park.

GIS is the product of good data, software, hardware, and institutional procedures. If any of these four elements are missing, the GIS becomes non-functional. However, GIS technology is complex, high tech, and is continually changing. Implementing the technology also requires considerable expenditures of staff time and funds. All of these factors lead to the conclusion that thorough planning is vital to effectively implement a GIS in a park or Region.

Park GIS Plan Outline

Signature Sheet

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Park GIS Plan

Signature/Cover Sheet

1. Identify park
2. Geographic Information System Plan
3. Signatures (submitted, recommended, concur) and date to include:
   - -Superintendent of park (if node/cluster situation, affiliated park Superintendent's signatures needed also)
   - -park GIS Specialist or Coordinator (if applicable)
   - -Regional GIS Coordinator
   - -Regional Director

Park GIS Plan

Summary

Scope and Objective:

The Summary section of the Park GIS Plan should be written last and presented first. A draft of the GIS Plan should be reviewed by divisions/programs that will be using and/or supporting the GIS to ensure its feasibility and to confirm commitments before preparing the Summary.

The Summary of the Park GIS Plan may be framed in either a cost-benefit analysis derived from the Park GIS Plan feasibility study, and/or to reflect the park's desire to enhance management efficiency and effectiveness. Generally, the Summary might include statements regarding the selection of a GIS system, the implementation time-frame, and identification of resources, to include FTEs (full-time employees) and funding, that will be required.

Although there may be reason to elaborate, a summary statement as concise as that in the following example is adequate:

Example:

"When the Rocky Mountain National Park was established in 1915, many people thought the preservation of the mountainscape in the park and the natural resources were saved. Today, however, problems still exist and impacts are still occurring to the park. The extent of these problems are more diverse today than they were in 1915 and are more difficult to evaluate without a comprehensive system for managing resource information. The lack of such a system will make it difficult to do the timely retrieval and analysis of resource information necessary for sound decision-making. The recent technological advances in computers has enabled the development of computerized mapping systems, and the Geographic Information Systems Division in Lakewood, Colorado has been devoted to assisting parks in automating, interpreting, and setting up Geographic Information Systems. Rocky Mountain National Park recognized the importance of GIS and is devoting time and money over the next five years to fully implement an active GIS program in the park."[1]

I. GIS User Requirements

Scope and Objective:

Define the requirements of a GIS in terms of the desired applications. Thoroughly assess the specific applications needed by management and establish their respective priorities. The identification of applications will point-out themes, or data layers, needed for the GIS. The data layers identified as basic to the park GIS operation constitute the nominal data base. Examples of basic themes in a nominal data base include vegetation, elevation, slope, aspect, roads, hydrography, and boundaries. Careful consideration should be given to text data needed for applications that can incorporated in the GIS.

Park management and research personnel can best address the applications and themes considered to be critical to their respective divisions/programs. The requirements analysis may use several techniques, including workshops, interviews, questionnaires or surveys of managers' current and future applications requirements. Themes in the nominal data bases will emerge through this process, as will a priority for developing digital versions of the various themes. Documents such as the *Regional GIS Plan*, *Information Resource Management Plan*, *Resource Management Plan*, *General Management Plan*, *Statement for Management*, *Outline for Planning Requirements*, *Land Protection Plan*, and *Interpretive Prospectus* should also be useful in providing insight into the types of information that are required by management. The attachment, Information Sources and Planning Guidance, at the end this section, explains these and identifies several other pertinent NPS planning documents.

The GIS User Requirements section of the Park GIS Plan should include an overview that addresses the need for GIS and a detailed appendix that includes applications and themes to be used in the GIS. Following are considerations for, and examples of, overview statements, applications, and themes. For a suggested appendix/table format, see the attached Example Appendix I, GIS User Requirements, at the end of this document.

This part of planning, along with Section II, Current Status, will indicate the themes most urgently and commonly needed and determine data acquisition priorities. As the planning progresses, other factors including data availability and hardware/software costs, will play major roles in designing a GIS.

A. Overview

An overview statement concerning the park's assessment of need for a GIS should briefly cover the anticipated benefits and introduce an appendix to the Park GIS Plan that details applications and themes defined/determined through the above referenced requirements analysis.

Considerations for Overview Statement:

- How does the creation and use of the GIS data base relate to other data management activities in the park? It should be part of a wider effort to coordinate and consolidate all data management activities throughout the park, with cooperators, Region, and other agencies.

▸ How adequate is the present GIS or methods employed for management analysis and decision making? Or how will the planned GIS provide support and information to the park decision-making process?

Overview Example # 1:

"Organ Pipe Cactus National Monument (ORPI) is a national park quality assemblage of biotic and abiotic components of the Arizona Upland and Lower Colorado River Valley sub-divisions of the Sonoran Desert ecosystems. ORPI is an important desert research area, with research projects conducted throughout the "Greater Organ Pipe Ecosystem," which includes ORPI, Tohono O'odham Indian Reservation, Cabeza Prieta National Wildlife Refuge and the Pinacata Region in Sonora, Mexico. As part of its mission, ORPI has established a large scale monitoring program, the Sensitive Ecosystems Program, to help protect its unique resources. The monitoring program generates large quantities of data. ORPI needs a geographic information system (GIS) to efficiently manage and store spatial data generated through this monitoring program. In addition, GIS technology is needed to assist and support other monument programs, including, but not limited to, endangered species management, revegetation efforts, archaeological surveys, road and trail assessments, and search and rescue activities. The uses for GIS transcend all monument divisions, including Natural and Cultural Resource Management, Interpretation, Maintenance, Law Enforcement and Research."[2]

The ORPI GIS Plan includes an application development table that cites specific applications relative to management issues and theme (data layers needed).

Overview Example # 2:

"Since 1988, the lakeshore has been moving from inventory to long-term monitoring. There are currently 16 projects in the monitoring program and an additional 17 needed inventory or monitoring projects are identified by the park's Resources Management Plan (RMP). The data from on-going monitoring projects are entered into the park's data management system. The park's data management system has been under development since 1988. This system is primarily being used to store, query and analyze data collected through the monitoring program, research projects, visitor observations, and visitor use. The majority of data in the system are geographically referenced. This data management system will provide a\the foundation for the textural component of a GIS. The park does not have any computerized mapping capabilities or the ability to conduct multi-layered geographically referenced analyses."[3]

Overview Example # 3:

"...Unfortunately, managers have lacked a comprehensive system with which they could identify resources, assess the cumulative effects, and define the biophysical limits of acceptable change. The importance and extent of these changes are difficult to evaluate and the lack of a comprehensive system precludes timely retrieval and analysis of resource information necessary for sound decision-making." This plan goes on..."The data is spread throughout several divisions in the park"...."Another major hinderance is a lack of pertinent data or data that is not automated or hard to analyze. Park management is finding that sometimes data is out of date, not site- specific, incomplete, or too cumbersome to use. What is needed is a GIS to support research, resource management, interpretation, law enforcement, and maintenance in Rocky Mountain National Park, and provide data to Regional personnel, Denver Service Center personnel, and NPS divisions such as the Water Quality, Air Quality, Geographic Information, and Energy Mining and Minerals"....."GIS can also play an important function in the planning process when writing plans such as Development Concept Plans, General Management Plans, Statement for Management Plans and Land Protection Plans. The data analysis and graphic capabilities will help long-range planning teams along with park staff in developing these critical long-range management documents."[4]

B. Applications:

Identification of management's concerns and responsibilities and the facts that are needed to make decisions and monitor their effects.

Considerations:

▸ What are the intended applications of the GIS? What resource, maintenance, research, operations, or other management problems will the GIS help solve? What GIS products would be derived from GIS analysis?

▸ Which applications are most urgently needed? Establish such priorities with management.

Examples of Applications:

▸ Place park's unique habitats in a regional context.
- Identify and quantify critical habitats for state and/or Federally-identified rare, threatened, endangered, or special interest wildlife species.
- Evaluate habitat condition; potential habitats, home range, monitor population trends, and define migration routes.

▸ Determine search areas for lost visitors; plot point last seen, determine distance buffers based on time, vegetation, elevation, road and trail access.

▸ Analyze the distribution and recovery of white pine, hemlock and yew from logging disturbances.

▸ "Cape Sable Seaside Sparrow (endangered species): A census of this species, which is found only in EVER and southern BICY, was initiated this year. This information will be combined with fire history data to assess the impact of fire on the population size and distribution".[5]

▸ Park's responsibility to surrounding community.
- Develop information necessary to predict smoke dispersal patterns for prescribed and wilderness fires to ascertain impact on surrounding communities and make decisions on burn suppression. Dispersion models are needed to correlate with precipitation, fuel, topography, vegetation, data bases and fire behavior models.

▸ Determine areas within or adjacent to park lands where future development could seriously impact the historic scene.

▸ Select alternative locations for park housing or a new visitor center within the park using standard criteria and help determine the differential impact of the various alternatives.

▸ Provide ready access to resource information needed to determine impacts of park development and maintenance on sensitive natural and cultural resources.

▸ "Relate park's aquatic biota to Lake Superior commercial fishery."[6]

For additional examples of applications, see the *NPS GIS Sourcebook: Applications*.

C. Themes:

Themes are types of data that are mapped and entered into a GIS (e.g., soils, boundaries, vegetation, roads, and archeological sites).

1.) Derived Themes: Thematic data which is produced as a result of a GIS analysis (e.g., aspect and slope are derived from digital elevation data).

2.) Nominal Data Base: Basic set of thematic data that will allow for most types of analyses required by various park managers. See *NPS GIS Sourcebook: Data Issues.*

Considerations:

- What data (themes), at what scales and resolutions, will be needed in the GIS to address the problems cited in the applications?

- What maps or data do/would researchers, resource, maintenance, operations, and other managers use on a routine basis?

- What text data bases would be useful in conjunction with the GIS?

Examples of Themes:

Boundaries
- administrative (NPS, buffer, state forests)
- international, state, county, local, congressional districts
- right-of-way boundaries
- easement boundaries

Topography/Hypsography
- elevation
- slope
- aspect

Hydrography
- streams/rivers
- reservoirs
- watershed
- irrigation ditches
- springs

Soils
- series
- hazardous soils (marine or slumping)

Subsurface
- geology
- bathymetry
- caves

Vegetation
- existing cover type
- habitat types, i.e., potential vegetation
- historic landscape
- exotic plants
- threatened and endangered plant species locations/habitats
- wetlands

Wildlife
- threatened and endangered species locations/habitats
- migration corridors
- calving grounds
- critical habitat

Landuse
- management zones within park
- adjacent zoning
- classification and current use
- in-holdings/status of claims

Maintenance Management
- trail structures
- underground utilities
- mow areas
- transmission lines
    - communication
    - power
- pipelines
    - sewer/water
    - chemical, gas, oil
- road stripes
- bridges
- tunnels
- culverts
- road sign locations

Cultural Resources
- historic areas base map
- archeological sites
- classified structures and properties
- National Register district boundaries and properties
- historic vegetation

Interpretive Activities/Ranger Activities
- sign locations
- visitation statistic and locations
- traffic accidents
- locations of volunteer projects
- interpretive trails
- fire fuels
- historic fires

Transportation
- primary roads
- secondary roads
- 4-wheel drive roads

- trails
- railroads
- bicycle trails
- snow mobile routes

ATTACHMENT #1 Information Sources and Planning Guidance

This attachment identifies and explains several NPS documents that provide planning guidance and insight into the types of information required by management.

NPS Management Policies

Management Policies is the three-part servicewide policy document of the NPS. Recommended procedures for implementing servicewide policy are described in the NPS guideline series. *Management Policies* is available through NPS publication offices or the Government Printing Office (ref: 1990 - 773-038/20013 Region No.8).

NPS-2 Planning Process Guideline

The *Planning Process Guideline* sets forth guidance on the preparation of Park General Management Plans.

- **General Management Plans**
  In compliance with NPS Management Policies, each Park has an approved *General Management Plan (GMP)* that outlines a management concept for the park; establishing a role for the Park within the context of regional trends, plans and issues. The GMP identifies strategies for resolving issues, and gives management objectives, usually within a 15-year period.

- **Statement for Management**
  Each Park has it's own *Statement for Management* that is evaluated every two years and revised as necessary. This document is a compilation of information about the Park's purpose, resources, uses, regional context and considerations, the legislative and administrative requirements for its management, etc. This information is used to identify any issues or problems and to establish management objectives (all of which are included in the *Statement for Management).*

- **Outline of Planning Requirements**

  The *Outline of Planning Requirements* is an analysis of the issues and problems identified in the *Statement for Management*. The Outline is also a programming document that contains a priority listing of studies, surveys, and designs needed by the park to produce an adequate information base for planning and compliance with management policies.

NPS-77 Natural Resources Management Guideline

A comprehensive guideline for all NPS personnel involved with procedural or activity planning, implementation, and evaluation. Each section of *NPS-77* refers the reader to applicable guidelines, procedural directives, technical handbooks, legal requirements and policies regarding NPS management.

Park Resource Management Plans

Park Resource Management Plans identify, and in some cases, prioritize, management objectives. The Plans address present status of resource information, inventory and monitoring needs, activities funding, etc. Some park's plans include specific GIS planning information, and all contain information that is pertinent to the development of a Park GIS Plan.

Regional GIS Plan

In response to a request by the Director, Natural Resources, each NPS region submitted a GIS plan. Regional GIS Plans are designed to assist the Region and parks in establishing their GIS program implementation strategy.

NPS Information Resources Management (IRM) Long-Term Plan

The Paperwork Reduction Act (44 U.S.C) requires each Federal agency to annually develop and revise a 5-year plan for meeting the agency's information technology needs. Pursuant to the Act, OMB Circular A-130 further requires agencies to establish multi-year strategic plans for acquiring and operating information technology to satisfy program and mission needs, and to support agency budget requests. The DOI Manual (Part 375 DM 4) describes procedures the NPS must follow to implement IRM strategic planning.

The NPS Long-Term IRM Plan's planning process requires that the regions/parks identify and include in the current Plan, any application system developed or purchased for implementation.

Authority for coordinating IRM in the NPS is assigned to the Chief of the Information and Data Systems Division. Information Management (IM) Coordinators assist in annual IRM planning in all 10 NPS regions and are responsible for IRM programs under each Associate Director. Per the IRM Long-Term Plan, B.4.2, "In 1990, authority for IRM review of individual computer procurement was delegated to IM Coordinators, as long as the requirements are reflected in the *NPS Long-Term IRM Plan*, comply with NPS ADP Standards, and do not exceed dollar thresholds documented in the DOI Departmental Manual."

NPS ADP Standards Manual (released 6/84; revised 11/90)

The *NPS ADP Standards Manual* provides policies and procedures for the effective development and management of information and other ADP resources, and promotes the compatibility of information and computer processes. Sections of the Standards Manual address GIS database development, operating system software, and application software; policies and procedures for data standardization, etc.

NPS-62 Acquisition Guideline

This guideline consolidates NPS acquisition policy and procedural guidance into a single document. It implements and supplements the Federal Acquisition Regulation (FAR) and the Department of the Interior Acquisition Regulations (DIAR) as well as other Federal and agency-specific requirements.

While *NPS-62* addresses a wide range of acquisition-related topics, several sections are directly applicable to GIS planning (i.e., ADP acquisition and Reporting Requirements).

NPS-75 Standards and Guidelines for Natural Resources Inventory and Monitoring (in draft)

Intended as an implementation guideline, *NPS-75* outlines strategic considerations needed to rank Inventory and Monitoring (I&M) needs, standardize recording techniques, test model systems, bring all parks to a high level of resource awareness, and develop a framework to synthesize I&M information over large spatial and temporal scales.

II. Current Status

Scope and Objective:

The next, time-consuming, but essential step in planning for a GIS involves locating, evaluating, and preparing for use, existing and usually disparate data.

If the park does not currently have a GIS, briefly address the considerations below.

For parks with an existing GIS, describe data (formats, scales, etc.), personnel, software and hardware that constitute the park's present GIS. If the park has large quantities of hardware, software, and data, the incorporation of an inventory appendix into the GIS Plan is suggested (See attached Example Appendix II, Data Inventory, at the end of this document).

Considerations:

- What data does the park possess or access (i.e., Region, other agency, Cooperative Park Study Unit (CPSU), universities, local/state)?

- What are the current forms (analog or digital), types (text, map, raster, vector, point), and formats (e.g., numbers, paper, mylar, GRASS, Atlas GIS, dBASE, etc.) of these data? Are they linked somehow to a location? What are their current scales and resolutions?

- How are the data organized in the park? Are they integrated or easily integrateable?

- What are the routine applications, or uses made, of the data and who uses it (e.g., resource management, researchers, maintenance, operations, and/or planners)?
- Who is providing staff support and how much (number of personnel and types of positions such as administrative or technical)?

- What type(s) of software and hardware is the park currently using to analyze geographic data?

- What are the physical configuration and organizational location of the present GIS (e.g., consolidated by offices through a network; stand-alone park-specific, node/cluster, Region, CPSU, or other administrative arrangement).

- What is the current staffing situation regarding resource information management in the park?

Example # 1:

"Statement of Current Conditions

The park has a considerable amount of data from studies conducted within the park. Much of this data would be very valuable in a GIS, but most is not currently in a useable format. These data include information from mammal, bird, reptile and amphibian inventories; vegetation studies; rare plant surveys; fire history studies; cultural resources inventories; geomorphology studies; and aquatic studies.... Digitized data is scarce for the Pictured Rocks area....

Currently no fewer than 40 project statements in the draft PIRO Resource Management Plan (1992) are directly related to GIS or would benefit from having a system in which to place data.

This plan will address only the development of the nominal GIS database and those themes which can be easily addressed at this time. Other data sets, their development, purchase or digitization, will be addressed separately in the park Resource Management Plan (RMP) under the specific section applicable to the data theme...A database management system is critically needed at Pictured Rocks. The amount of existing park data and the new data that will be coming into the park as it becomes involved with GIS require organization. It is important that PIRO designs and implements an effective database management system to facilitate the use, storage, and cataloging of resource management data. This needs to be done before PIRO ventures too far into GIS"[7]

Example #2:

"The GIS at the SAMO has developed into an operational project by acquiring data hardware as funds became available. In the early stages of development (1982) the Resource Management Division worked independently to identify the data base structure and resource themes necessary for input into the system. The park was able to acquire a Tektronix graphics terminal and the WASO/GIS Division assisted the park to arrange access to a CDC Cyber mainframe computer located at California State University, Northridge. Both SAGIS and MANAGE software were used for GIS applications through this arrangement. Eventually the GIS operations progressed to an AT microcomputer using the UNIX operating system and a Bernoulli 20 MB mass storage device. This local operating capability enabled the park to operate its GIS independently of telecommunications problems and maintain data base integrity by having internal control over the resource maps. Data input into the GIS for selected NPS sites, by park personnel using SAGIS software, has included fire history maps, land-use information, soils, geology, vegetation, rare plant locations, mountain lion sightings, critical wildlife habitat areas, and property boundaries. With this data, applications have included wildfire potential maps, vegetated areas that have not burned in over 20 years, protection zones for sensitive resources in riparian communities and (using a CDC Cyber) interpolation or rainfall zones."[8]

Using an appendix format, this plan details what data the park currently has, some of which is used in their GIS. The appendix lists the known existing data and their condition, scale and format (i.e., digital and mapped in-house, acquired but not formatted, tabular, etc.).

Example # 3:

"In 1989, the park acquired the foundations of a GIS system. It is a PC-based system utilizing EPPL7 software, which was developed and is supported by the Land Management Information Center (LMIC), St. Paul, Minnesota. EPPL7 is compatible with the NPS standard GIS software program (GRASS), as well as with programs used by adjacent NPS areas, the Minnesota and Wisconsin DNR's, and the U.S. Fish and Wildlife Service. The present park GIS system does not have dedicated hardware or staffing, and many information gaps in the data library remain."

"The present park GIS system is a PC-based system in raster format utilizing EPPL7. On-line data files consist primarily of applicable Minnesota state theme information in the ML-MIS 100 (100 m2 scale) format."[9]

This plan details present on-line GIS data files. The author states that applications have thus far been limited due to disorganized and varied forms (including maps of varying scales) of data, and limited hardware and staffing.

III. GIS Implementation Strategies

Scope and Objective:

While the GIS planning steps in sections I and II have been accomplished in sequence, in this section they will occur in parallel and will overlap. GIS Implementation Strategies will include Data Base Design and Collection, System Design, System Support, and the park's GIS Implementation Schedule.

The Regional GIS Coordinator should be consulted and involved in the Park GIS Plan preparation at this juncture. GIS implementation experience is essential to plan tasks and estimate the time and resource requirements for each task.

At this stage, important park applications have been analyzed and the theme priorities or common objectives have been established. What remains is to determine specific data, software, and hardware and to research cost-effective means of bringing about the GIS implementation. The *NPS GIS Sourcebook: Data Issues, Hardware and Software Issues, Applications, Institutional Issues, and Associated Technologies* will be helpful in implementation planning.

The following sub-sections may be presented in either text or table format, or a combination of both. See the following attachments at the end of this document: Example Appendix III, GIS Data Collection and Acquisition, Example Appendix IV, Park Boundaries Map, and Example Appendix V, Implementation Schedule.

A. Data Base Design and Collection

The data base design develops specifications to create and maintain the park's GIS data base. The characteristics of the GIS data base design include contents, specifications, relationships, and sources of data. Data on-hand, as well as that to be acquired through suppliers or other agencies, must be thoroughly evaluated to verify the availability of the required data and the accuracy, completeness, and/or suitability for digitizing. Data is the greatest long term cost of a GIS, but it is the raison-d'être of the GIS.

Considerations:

- Based on theme need identification made in section I, what data and data attributes will be needed for planning and decision-making on a routine basis?

- What data is lacking for high priority applications?

- What text data will your GIS include?

- What type of surveys or geodetic control networks are present and applicable to the GIS?

- What data is accessible to the park that can be assembled and consolidated into a GIS which will provide commonly needed themes for all park staff?

- What geographic coordinate system will be used for the GIS (e.g., UTM, Lat. Long., other?)

- Of the data needed, what is obtainable or procurable in a digital form, and from whom? What are the associated costs?

- What data currently in an analog form will need to be digitized? What are the associated costs and who will do the digitizing/scanning?

- What are the project boundaries for data acquisition and digitizing?

- Will data be exchanged with a CPSU, another park, Regional office, or other state, local government or land management agency? How will common classification standards and data exchange be accomplished?

- If data needs to be created, what is the most appropriate and cost effective method for obtaining (e.g., image processing, photo interpretation, field survey)?

1). Data Acquisition (external and internal coordination)

Using the park's identification of needed themes and subsequent data inventory, strategies for planning data collection and GIS conversion will emerge. Contact other agencies, such as the U.S. Geological Survey, Soil Conservation Service, U.S. Forest Service, Fish and Wildlife Service, state and local agencies, and universities to determine if they have mapped or digital data on your area of interest. Certain themes, such as elevation, hydrography, transportation, boundaries, soils, and wetlands may already exist in digital form and be available from other agencies. Examine the potential of various types and resolutions of remotely sensed imagery such as Landsat and SPOT. If higher resolution in required, consider aircraft MSS or Video Imagery.

Data that cannot be located/converted to the GIS, can be acquired and digitized or scanned by contractors, accomplished in-house, or in cooperation with others.

2). Text Data

GIS's are not normally complete without textual information on the spatial data that they contain. It is best to store this information in a relational data base, or DBMS (Data Base Management System). Some GIS software systems allow for the creation of internal DBMSs that directly couple to the spatial data that they process. Others have no such provision and require the use of an external DBMS. During this stage of planning, it is wise to identify how required textual data will be tied into, and used with, mapped data, so that the appropriate steps to couple the two data sets together can be taken.

3). Data Base Boundary(ies)

The project boundary will circumscribe the geographic area(s) for which data will be collected and digitized (see example Appendix V, Park Boundaries Map[10]). The establishment of the boundary and associated environs should encompass future needs; it will be more expensive and difficult to expand the boundary and collect new data at a later date. On the other hand, do not make the data base boundary bigger than necessary, because the volume of data generally increases as the square of the linear distance involved. The rationale for selecting the data base boundary should be documented.

It is recommended that a map be prepared outlining the data base boundary and also indicating USGS 1:24,000 quadrangle maps incorporated within the boundary. Considerable digital data is produced and distributed on a quadrangle sheet basis.

It is possible to have several project boundaries within a data base boundary, such as a particular watershed, or an area of special interest. Most general data would cover the park and environs but some themes might be desired for only an area of special interest. These boundaries should be described in relationship to data acquisition, text data, scale, and resolution.

4). Scale and Resolution

Select an accurate base map or series of base maps to serve as a reference template for most source manuscripts. Selected areas can have a more or less detailed map base (e.g., regional setting data base or detailed archeological site), which is integrated into the parkwide GIS data base. The scale chosen will depend on the existing data, that which is available through local jurisdictions, and desired resolution and scale for proposed applications.

GISD recommends a map scale of 1:24,000 (1" = 2000'), 7.5-minute, as an adequate level of detail for most parks; however the scale to be used must be determined by the individual needs of the park. The 15-minute (1:62,500-scale), 30- x 60-minute (1:100,000-scale) series, and orthophotoquads (digital or analog) also make excellent base maps.

Resolution relates to the amount of detail contained within a data set, whether vector or raster. In vector data files, it relates to the minimum mapping unit for the map, which may or may not be scale-dependent. For example, at 1:24,000 scale, the minimum mapping unit could be about one acre or larger (e.g., 5-acre, 10-acre, etc.) depending on the desired level of detail of information. Whereas is raster data, the resolution is fixed by the original source cell size (e.g., 1Km, 80m, 30m, 10m). The range is literally centimeters to kilometers for resource data, depending on the data capture method.

In some cases, use of specially-prepared base maps may be preferred. This is perfectly acceptable, if the maps have been prepared to national map accuracy standards of horizontal and vertical positional accuracy.

5). GPS (Global Positioning System)

Global positioning is a high interest, rapidly expanding GIS-associated technology involving many resource fields with current in fire management, law enforcement, trail management, and natural and cultural resource mapping. GPS is a technology which allows a single user to easily, rapidly, and precisely locate a geographical position (e.g., northing, easting, elevation) in the field. Locational data collected via satellite transmission can be entered directly into a GIS data base and associated with descriptive attribute data.

GPS is NOT an off-the-shelf measurement tool, if accuracy better than 100 meters is the goal. Education and technological awareness are critical and must be planned for in addition to the basic acquisition of hardware and software.

Interagency cooperation on base station locations and data sharing should be investigated in the GIS planning process if GPS is to be used. Coordination with the Regional GIS Coordinator, RTSC and/or GISD is encouraged to address pertinent GPS concerns and to reflect the current status of the technology. The locations of base stations in the conterminous U.S. provide nearly saturated coverage. Most likely, a park can obtain correctional data from an existing station through local cooperation. Further base station purchases in the NPS would probably be a duplication of effort; buying communication links to existing base stations or purchasing rovers and supporting software would be a better use of funds. Current GPS guidance can be found in the *Associated Technologies* chapter of the *NPS GIS Sourcebook*.

Considerations:

- Does the park need a GPS to collect locational information about non-mapped resources?
- Does the park need to acquire a GPS or can it access one by other means?
- What is the required accuracy for the park's applications?
- What are the base station availabilities for the park?
- What are the necessary steps in sharing base station data with another agency?

6). Metadata

Metadata is information about a data set. Spatial metadata includes information on: origin, format, geometry, spatial domain, classification, lineage, definitions, and quality. Metadata can be created to document data during a data transfer, to document processing steps and file lineage, and/or to use in spatial data catalogs or indexes. Although data documentation is often ignored or neglected, anyone who has ever inherited data from someone else will quickly grasp the importance of documenting geographic data sets. The GIS Plan needs to address what information is to be collected about a data set, and how it is to be organized and stored (e.g., within the cell history file in GRASS, within dBASE, etc.). See the *NPS GIS Sourcebook: Data Issues* for more information on metadata.

The Spatial Data Transfer Standard (SDTS) is a new (1992) Federal Information Processing Standard (FIPS 173) for the transfer of digital spatial data. This means that SDTS will serve as the national spatial data transfer mechanism for all U.S. Federal agencies. Subsets of the SDTS for specific data types, such as vector data with topology, are currently being developed and tested. Part 2 of SDTS is a Spatial Data Register containing just over 200 defined standard terms. This list will be enlarged as USGS will be establishing a method for dynamic updating. It is expected to serve as a standardized terminology list for Federally created spatial data.

There are two areas within a SDTS format transfer which address metadata - "global information modules" and the "data quality report". These provide a flexible framework for metadata, but do not establish any rigorous guidelines. The National Mapping Division of USGS will be defining a metadata standard to be adopted and implemented in coordination with SDTS. The Federal Geographic Data Committee is also attempting to establish several standard thematic classification schemes. The use of standard classification or naming schemes for GIS data is strongly recommended. Contact your Regional GIS Coordinator, RTSC, or GISD to address data classification and coding scheme issues.

Considerations:

- How will park comply with SDTS metadata requirements?
- How will compliance be attained for existing data?
- What software will be used?
- How will metadata be shared with NPS offices and others?

7). Archiving

As part of the commitment to maintain a GIS system, data must be periodically archived. OMB Circular A-130 (revised) requires all Federal agencies producing data to manage that data over time and provide for its dissemination. Frequency of archiving will depend on the rate at which data is added or changed. Archiving should be done locally at the GIS site, as well as sending periodic updates of the entire GIS data base to a regional center and/or GISD. This provides off-site back-up as well as a mechanism for Region and/or Servicewide access to aggregated sets of data.

Archiving will eventually be done in SDTS (Spatial Data Transfer Standard) format, but until SDTS is fully implemented archives may consist of data formats compatible with the type of GIS software being used at the site, accompanied by metadata files in an interim (preferably dBASE) format describing the archived data. (See *NPS GIS Sourcebook: Data Issues* for additional detail on updates of standard procedures for archiving).

Considerations:

- How will the park process requests for data dissemination?
- What media (e.g., tape, optical) and thus hardware will be used for archiving?
- What are the physical storage requirements?
- What is the strategy to be used for locating archived data at multiple locations and what will be the updating schedule for archived data?

8). Data Preparation

Data Preparation: time and cost involved in resolving ambiguities, minimizing inaccuracies, etc., before converting hard-copy (analog) graphic and non-graphic data or reformatting existing text digital data.

One initial cost for data preparation is stable base maps, which are typically purchased from USGS. Costs (circa 1992) are approximately $30.00 per 7½ sheet. Mylar sheets are overlaid onto the base maps and the data or information is transferred to the mylar sheet for subsequent digitizing. Start-up costs include: map bases, mylar for data transfer, technical pens (LEROY), and associated mapping or drafting accessories. Time to perform these activities varies depending on the accuracy or lack of ambiguities in the original materials, detail contained in the map and related activities. See *NPS GIS Sourcebook: Data Issues* for guidance and technical procedures.

Example:

"Table I identifies the themes, priorities, and status for accomplishing the objectives identified in the plan. Table II is the estimated cost and approximate work years needed to accomplish each objective. Creating baseline data through the vegetation maps and digitizing slope, aspect, and elevation will provide valuable information to partially accomplish many of the objectives. Descriptive information, including park boundaries, land ownership, roads, and trails need to be mapped and digitized as well. Data exists in some format for most of the objectives discussed, but little is presently in a usable format for GIS.

The base maps for portraying the mapped information or the different themes will be the 1:24,000 scale topographic maps. Twenty 1:24,000 scale maps cover the park and important areas around the park. The maps can be purchased in stable base 7-mil., right reading, frosted mylar, from the National Cartographic Information Center" (now the Earth Sciences Information Center (USGS)). " A composite of the following plates could be purchased: lettering, UTM grid, all revisions, hypsography, hydrography, boundaries, transportation routes including roads, trails, and land net. These composites could then be digitized. Having DEM and DLG data digitized for the twenty 1:24,000 quads will be an important early step in developing GIS.

The project boundary for the digitizing work to be done for Rocky Mountain National Park will use the following UTM coordinates. The southwest coordinate will be ....., the northwest coordinate will be....., the southeast coordinate will be....., and the northeast coordinate will be..... The geographic area in between these coordinates will be digitized and all data themes will be developed to cover these coordinates. This is essentially the park boundary plus 2-4 miles outside.

Because of the importance of vegetation and fire in the park, the highest priority in developing GIS is to establish a vegetation cover and habitat map. The park has programmed the spending of $20,000 in FY-88 on developing a vegetation cover map from photo interpretation of aerial photographs taken in 1987. Extensive ground truthing for the vegetation map is expected during the summer months of 1988. The end result will be digitized vegetation cover map and a database file of specific information.... In FY-89 an additional $20,000 is programmed to use satellite imagery to develop a wildlife habitat map. ...In addition, it is expected that USGS Digital Elevation Model tapes including information on slope and aspect, will be purchased and converted into a usable format for the park in FY-89. The park boundary, roads, trails, water courses, and lakes, can be digitized from the park's 1:24,000 scale maps for approximately $5,000"[11], etc.

B. System and Facility Design

Again, the System Design, System Support, and Data Base Design segments of the Park GIS Plan generally develop in parallel. Information on maps, data, and processing requirements have been identified through the planning process and will lend themselves to hardware/software system design. Because several candidate systems typically are available, the specific devices (hardware and software packages) must be determined by evaluating the functional requirements and estimated available resources, including both funding and personnel. The software and hardware configurations will be guided by function, capabilities, and capacities. The system design will take into account specific workstations, plotters, application software requirements, networks, communication requirements, etc.

The Regional GIS Coordinator needs to be consulted when evaluating the relative strengths and weaknesses of available software and hardware systems, in light of the park/Regional requirements. Each park will need to assess and develop its own configuration, based on all of the facts thus far ascertained as well as considerations for System Support. The *NPS GIS Sourcebook: Hardware and Software Issues, Applications,* and *Associated Technologies* might be helpful in planning. Again, due to the rapid pace of change in GIS technology, system design considerations must be discussed with the Regional GIS Coordinator.

1). Software

The park GIS planning process must include an evaluation of software packages, relative to the park's needs. All software packages or combinations of packages have relative strengths and weaknesses, i.e., while CAD can provide detailed drawings and is PC compatible, it cannot perform spatial analysis through multiple themes as a GIS can. A number of proprietary image processing and/or digital cartographic data analysis packages, such as Atlas GIS, ERDAS, and ARC/INFO, are on the market with various capabilities and prices. Parks that are able to achieve management goals with a CAD system do not need to acquire spatial data in GRASS format, but should structure the data topology so that an upgrade to a true GIS is facilitated.

For several years the Division has supported the UNIX-based public-domain software GRASS (Geographic Resources Analysis Support System). GRASS is a powerful raster-based GIS available at no cost to NPS users. There are a number of considerations in deciding what GIS software to use, such as staffing, hardware, costs, and capabilities. GISD performs ongoing evaluations of GIS software and can provide guidance and advice in this area. Consult with your Regional GIS Coordinator, Regional Technical Support Center and/or GISD on this critical issue.

Considerations:

- What GIS software will best serve most of the applications and GIS output required by the park?

- Can the park realistically expect to dedicate a full FTE to the GIS function as is recommended for a UNIX-based system like GRASS?

- What communication software, language compilers, back-up or other special system utilities or support programs are expected to be used with the GIS application software?

- If GRASS is not the park's software choice, where will technical support come from, and what is the cost and accessibility?

- Will networking software be required?

2). Hardware

The Park GIS Plan must state the anticipated hardware configuration. This statement might include the exploration and evaluation of options. Generally, however, hardware should not be purchased until data is almost ready to use, unless one expects to do the bulk of data base development in-house or to use data as it becomes available. Hardware advancement is so rapid that a park could easily waste considerable funding by purchasing hardware that becomes obsolete before it can be used effectively.

GRASS requires a UNIX workstation. Regardless of the type of computer, recommended peripherals include a printer, plotter, digitizing tablet, and various mass storage devices (e.g., optical and magnetic, removable and fixed). Other possible peripherals include a scanner and film recorder. Consult with your Regional GIS Coordinator and RTSC on your hardware needs. See also *Hardware and Software Issues* in the *NPS GIS Sourcebook.*

Considerations:

- What software needs to be supported?

- What hardware acquisition is proposed? What hardware is presently available? What hardware is available through cooperative arrangements?

- What type of output is desired? Needed?

- What data volumes will be handled? What flexibility and security is desired?

- How will the digitizing tablet be used? What size is necessary?

- Would a scanner be useful?

- Will networking hardware be required?

3). Facility Design

Facility alterations, such as rewiring, or security access issues might also need to be considered when determining the optimal physical location for the GIS. See the *NPS GIS Sourcebook: Hardware and Software Issues* for guidance on GIS workspace footprint/design.

Considerations:

- Especially if proposed to go in a park, what are the space, electrical and power conditioning requirements?

- Consider security issues related to access, viruses, and FOIA (Freedom of Information Act).

The following examples are greatly outdated. However, they illustrate a very complete analysis of options at that time. Also, this demonstrates the rapid evolution of GIS technology. For example, current UNIX 32-bit systems have more than ten times the computing power at less than one-tenth the cost.

Example # 1:

"A committee of Everglades research and resources management personnel determined the processing functions required of the GIS. Once these required computing functions were identified, there were two main decisions to be made: what software would perform these functions, and what hardware would run the software. The first step in developing the software/hardware alternatives was to determine the basic range of computational options. In consultation with the GIS Field Unit, three basic options were considered: the use of existing GIS facilities (remote computing), on-site microcomputer based GIS, and on-site super-microcomputer based GIS. These three options are discussed below.

A. Remote Computing

It is possible to tie into an existing computer system through telecommunication. A park can phone into the Prime computer located at the NPS GIS Field Unit in Denver. This option is not considered a viable alternative for Everglades because of the need to perform image processing and analysis with raster data themes. Many of the databases planned for use on the GIS will involve the processing of raw satellite or aircraft imagery data. This will be a continuing need for the park, not a one-time need which could be handled by the GIS field unit. Simply to display a single screen image (1152 x 910 resolution) would take over thirty minutes on a remote terminal. This assumes a data transmission rate of 4800 baud, with no transmission errors. In practice, screen display would take even longer due to transmission errors. This feature is effectively lost if one must wait over 30 minutes for screen display. The GIS Field Unit confirms that it is impractical to perform image processing and raster analysis on the remote terminals due to the large amount of data being handled and the slow communication speeds. In order to perform image processing and raster data analysis, an on-site computer is required.

B. Microcomputer based processing.

Microcomputer versions of many GIS software packages are available. Both SAGIS and ELAS, two Park Service supported packages, are available on IBM AT type computers. Many proprietary GIS software companies also market microcomputer versions. According to the GIS Field Unit, however, microcomputer versions of these packages are only appropriate for parks with fewer than 100,000 acres if parkwide applications are planned. The total area of Everglades (1.4 million acres) makes microcomputers insufficient for GIS processing needs. Both the processing speeds required and the large storage needs make microcomputers inappropriate.

C. 32-bit super-microcomputer.

For the Everglades, the GIS Field Unit has recommended a UNIX based, 32-bit super-microcomputer, such as the one being used at the Field Unit offices in Denver. This type of computer provides the on-site processing power needed for large scale image processing and analysis. Minimum hardware costs for a computer with two graphics display processors, the extra components needed for image processing, digitizer, and graphics printer, is approximately $129,000. This represents a minimum configuration which could be used only for GIS processing.

Given the need for a super-microcomputer based GIS, the software packages available on these systems were investigated. Although the Park Service support and recommends some specific GIS software packages, an evaluation of software options was undertaken to ensure that the full needs of Everglades would be met. A number of state and federal governmental agencies were contacted to see what kind of GIS software was being used, if any. A number of packages were considered, these are summarized below.

NPS supported software

The NPS GIS Field Unit supports a number of public domain (free) software packages for image processing, digital cartography, and geographic data analysis. The Earth Resources Laboratory Application Software (ELAS), and the Geographical Resources Analysis Support System (GRASS) are both used for image processing and analysis. Each of these systems has its own strengths and weaknesses, but together they form a powerful analytical package for raster data. The System Applications Group Information System (SAGIS) is designed for manipulating digital cartographic data. SAGIS is a powerful vector based package. Software exists to transfer data among these three software packages.

Map Overlay and Statistical System (MOSS)

MOSS, a public domain package, is used by a number of federal agencies for GIS work. It is primarily a vector based product which is similar to SAGIS. The U.S. Fish and Wildlife Service is presently using MOSS for its wetlands mapping project. MOSS does not have image processing capability.

ATLAS

ATLAS is a proprietary image processing and analysis package developed by Delta Data Systems. This system combines elements of both raster and vector processing into a single package. This system is being used by the Florida Department of Transportation. The cost of the software is $50,000.

Earth Resources Data Analysis Systems (ERDAS)

ERDAS is a proprietary image processing and analysis package developed by ERDAS, Incorporated. This system is similar to ELAS in terms of processing capabilities. ERDAS is somewhat more user friendly than ELAS, but is not as powerful. ERDAS software is being used by the Florida Department of Natural Resources for image processing and GIS analysis. Prices for the super-microcomputer version of this package start at $50,000 and to $100,000, depending upon what product modules are purchased.

System 600

The System 600 is a proprietary image processing and analysis system developed by International Imaging Systems, Inc. This package is similar to ELAS, and is presently being used at the South Florida Water Management District offices in West Palm Beach. The software for this system costs $52,000.

Arc/Info

Arc/Info is a proprietary digital cartographic data analysis system developed by the Environmental Systems Research Institute. This software does not have image processing capability. Arc/Info is similar to SAGIS in terms of processing functions. The U.S. Geological Survey is planning to use this software, on a nationwide basis, for their digital cartographic work. Metro-Dade County, Florida is also considering Arc/Info for its 911 emergency service. The software starts at $60,000 and goes to $112,000, depending on what software modules are purchased.

The ability to network the GIS hardware with existing microcomputers was an important feature considered. The large capacity disk drives, fast disk access times, and disk buffering techniques used by super-microcomputers make them good file servers for a microcomputer network. The use of the super-microcomputer as a file server, with appropriate networking software, also enables the transparent use of data on either the micro or super-microcomputer. This capability will improve data management, and help ensure data quality, by eliminating the duplication of files which frequently results in differences between supposedly identical files. Using the super-microcomputer as a file server also ensures the frequency and ease of data backup. All important, common interest, databases will be kept on the super-microcomputer and will be backed-up on a regular basis. Networking the microcomputers into the super-microcomputer also gives any computer on the network access to the computing power of the super-microcomputer when the microcomputer is inadequate to process large amounts of data. Networking enables the sharing of expensive peripherals such as plotters, laser printers, and high speed modems. Also, network versions of many software packages are available which reduce the "per-seat" cost of the software, compared to multiple copies of the same software.

Recommended Alternative:

All of the GIS software packages were evaluated by members of the Everglades research and resources management staff. It was concluded that the NPS supported software (ELAS, GRASS, and SAGIS) was the preferred choice. This software provides the best combination of raster and vector processing capabilities, and at the least cost (free). In addition, the continued support of the NPS software by the GIS field unit ensures that it will be refined, improved, and expanded over the course of the coming years.

Therefore, due to the inability to perform all required GIS work either from remote terminals or on standard microcomputers, and considering the long term computer needs of the park, it is recommended that a UNIX based, 32-bit super-microcomputer be acquired for use at Everglades. This computer should include the high resolution, multiple bit-plane graphics displays which are required for image processing. The expected work load within Everglades will require the purchase of two graphics displays. Appropriate hardware and software to enable the creation of a microcomputer network which utilizes the super-microcomputer as a file, peripheral, and computer server is also recommended. This system will give the park the most GIS power, and still allow sufficient flexibility for other computer applications. The total estimated cost for the hardware is $156,900 (Appendix II A). The salient characteristics of this equipment are listed in Appendix II (B)....maintenance contract on the acquired equipment ..." etc. [12]

Example # 2:

"Today, most parks with active GIS databases either have an enhanced AT with an additional Unix processor that effectively transforms an AT into the equivalent of a high performance, high-tech work station or have a high-tech workstation. The advantages of a workstation such as a Sun 386i/250 versus a UNIX-enhanced AT is the workstation is extremely fast in analyzing data, has extremely fast graphics, GRASS (a GIS software package) is faster, resolution is better 1280 x 1024 versus 1024 x 768, and has 8 color bit planes versus 4 color bit planes resulting in twice as many color variations. Differences in cost is that the workstation is approximately $9,000 more than a UNIX-enhanced AT due to the fact that much of the cost is related to the peripherals which are common to both systems.

.... GIS must be accessible to park users, possess a user-friendly query language, connect with color hard copy output devices, and interface with park databases that develop independent of GIS. In addition, GIS operations must perform without lengthy turnaround times. If turnaround time is long, then the GIS cannot be useful in emergency situations, such as forest fires, or search and rescues.

Rocky Mountain National Park (RMNP) proposes to install GIS hardware and software in-house based on recommendations from the National Park Service GIS Division and the Rocky Mountain Region GIS Coordinator. To implement this proposal, it requires that: 10 the system be fully contained within the RMNP versus the equipment, or part of the equipment, being housed at another location; 2) the hardware/software combination support a complete array of GIS functions, including display and hard copy capabilities; 3) data be input and analyzed in raster (remote sensing, digital image) as well as vector formats (digital cartography, point, line, polygon); 4) the software provide multiple user interfaces corresponding to varying levels of user expertise and functional complexity; and 5) the system be of sufficient speed and capacity to handle parkwide applications. Presently the GIS Division and the Rocky Mountain Region is recommending a Sun 386i/250 workstation, or equivalent, to meet these needs (see Appendix One for specifications). These recommendations meet the requirements of the NPS ADP Standards Manual (Chapter 16 and Appendix F, Guidelines for GIS), and the NPS-62 ADP Acquisition Guideline. Total cost for the proposed system is $39,000. Appendix One provides the hardware and cost of the system."[13]

D. System Support

Critical to successful GIS implementation and maintenance planning are system support issues, those being; organizational and physical locations of the GIS, and staff/personnel roles, responsibilities, and training. Considerations for, and examples of, System Support planning are consolidated and located at the end of this section.

1). Organizational Location

The organizational, or administrative, location of the park's GIS needs to be defined. The GIS organizational structure defines the authority, responsibility, chain of command, staffing level, and other management characteristics. The structure may be centralized, with one park providing GIS services to a cluster of other smaller parks, as in a node/cluster situation, or it may be similarly be organized within a park where one division provides all GIS services to all other park users. The structure may be distributed, with each division operating independently of, but coordinating with, the others. If the participants share data or resources, standards for a compatible definition and structure of the data base and compatibility among the hardware devices and software components of the system must be established by the GIS organization. Defining the organizational location will, further, assure adequate sustained support and access.

2). Technical/Staffing Support

a.) Roles and Responsibilities

At this juncture in planning for the park's GIS, it is critical to define the roles and responsibilities of the GIS operators and users, i.e., who will authorize and prioritize GIS work and coordinate funding for the data? Integral to this portion of the plan are GIS security issues such as, responsibility for Freedom of Information Act processing, system and data "virus" checks, etc.

The anticipated frequency and intensity of GIS use; types of hardware and software, and complexity of analysis will dictate the staffing requirements in the long run. The *NPS GIS Sourcebook: Institutional Issues* section addresses staffing needs/recommendations for DOS and UNIX systems.

Park GIS Plans must identify collateral or dedicated positions that will manage their GIS program. Model position descriptions for GIS Specialists are available from Regional GIS Coordinators or GISD. Currently, GISD is working with NPS Personnel to "benchmark" grades for GIS positions. Furthermore, GISD maintains a data base of candidates interested in NPS GIS positions (*NPS GIS Sourcebook: Institutional Issues*).

b.) Training and Staff Orientation

A GIS will not succeed without knowledgeable, committed people to plan, implement and maintain the system. Proper training is critical and might best be considered an investment, since over time, staffing costs are usually one of the most expensive components of a GIS. GPS training should also be anticipated for park staff involved with field data collection.The GIS Division and the Regional GIS Coordinator can assist in defining suitable training prescriptions for park-based GIS staff.

3). Physical Location

State where the GIS components and staff will reside to best meet all users' needs. Alternatives might include: an in-park system, CPSU, a Regional system, contract GIS, off-site cooperator, or any cost-effective and use efficient combination.

Considerations for System Support Planning:

- Who will need access, at what frequency and intensity of use?
- Will the proposed physical location of the GIS components allow ease of access for timely analysis?
- Additional applications will be developed as the staff becomes more proficient with using GIS, expectations become routine, and analysis will become more sophisticated.
- Where will the system administratively reside?
- Who will operate and maintain the GIS data bases, hardware, and software?
- Who will use the GIS on a regular basis?
- How much will alternative arrangements cost?
- How will the roles and responsibilities of GIS support staff necessitate proximity to the GIS?
- What training will be made available to managers, operators, etc.
- What are the anticipated resources for staffing? Can these resources be sustained?
- How will other organizations contribute to the development and implementation of the GIS?

Example # 1:

"Anticipated use of the GIS will be administered and coordinated by two positions in the beginning. Administration's Programmer/Analyst will assist with technical aspects of the hardware, software, communications, and tabular database integration with GIS to or from the park computer systems. The Resource Management Division will be responsible for technical aspects of maintaining the software, hardware, and GIS database development, as will as assisting primarily research personnel with applications. The NPS GISD estimates about 50% of a full-time employee's time could be devoted to an active GIS program. That individual, besides maintaining and operating the software and hardware, would also have to coordinate data collection and verification of data during database construction."[14]

Example # 2:

A node/cluster GIS organization might assign responsibilities and resources in the following way. "Staffing will be the most critical element in the success of the NCR GIS Program. Knowledgeable staff must be involved in the planning and implementation of the program at the park and regional level. The need for additional staff has been identified..... The GIS-NCR has been established as a GIS facility available for parks to use. It has been equipped with hardware which may be too costly for individual parks to acquire....GIS-NCR identified the need to establish a minimum of 3 full-time FTEs to manage the GIS program and facility. Under the direction of the Regional Planning Coordinator, a full time GIS coordinator would provide oversight and manage the GIS program, while providing consistency for GIS acquisitions, assistance to the parks for the planning and implementation process, coordination with GISD and funding requests. A systems administrator is needed to manage the computer system, assist parks with installing software and provide technical support and a GIS specialist would assist parks with use of software, application design, implementation, analysis and interpretation of data. Two additional FTEs were requested by the GIS-NCR to establish field units and begin the planning process at the park level. The facility will continue to be available to parks under the proposed program and would operate as a technical support facility and one of the field unit base locations identified below. ...As the data base is created, both an increasing dedication of time and need for technical knowledge by the coordinator will be required. To this end, we recommend that parks which are physically close to one another share the cost of a dedicated GIS coordinator. The following list is a general proposal of possible clustered park units which could share personnel and systems in the first five year implementation period."[15]

D. Implementation Schedule

1). Feasibility Evaluation

Management's evaluation of a draft plan and commitment of initial and sustained resources is essential to the final phase of planning, the GIS implementation schedule.

A review or evaluation of the feasibility of implementing a GIS before making a major investment involves identifying the extent to which the GIS is practical and estimating its costs and benefits. This evaluation/study should be based on a requirements analysis, which includes, applications, needs, and available alternative GIS configurations. Depending on the complexity of requirements and availability of support, the scope of the evaluation may be extensive or may require only several hours and management's acknowledgment of GIS's value and sustained commitment to its implementation and maintenance. Presuming commitment to acquire and implement a GIS, the planning moves to its final stage, an implementation schedule.

2). Schedule

An important note on scheduling and operational aspects: the system can be used for various applications as data, software, hardware, etc., are procured. If well planned, early applications can be accomplished before even the nominal data base is developed. Hardware, however, should not be purchased until data is ready, or almost ready to use, unless one expects to do the bulk of data base development in-house. See the Example Appendix V, GIS Implementation Schedule at the end of this document for further guidance.

The schedule may cover a range of up to five years and should:

- Identify individual tasks (i.e., acquisition of data, hardware, training, and FTEs),

- Assign responsibilities to accomplish identified tasks (vendor, park GIS Specialist, or Superintendent),

- Indicate estimated resources to be committed per fiscal year, and identify anticipated source of funding,

- List products and milestones (i.e., when individual tasks are expected to be completed).

Considerations:

The size of the park, scales of mapping, amount of existing data, complexity of the resources, amount of digitizing and availability of digital data from other agencies need to be taken into account when creating the schedule for data base development.

The previous sections of the Park GIS Plan should have established precedence of actions by order of urgency or importance.

Other considerations for scheduling GIS implementation might include:

- What is the amount and the timing of projected funding?

- Is the tentative GIS implementation schedule consistent with the Regional Management Plan (GIS Project Statements)? Is it consistent with the General Management Plan schedule?

- What data, technical support, and training can be purchased, or will be available, and in what order?

- What can/will be digitized, in what order, and by whom?
- What is the schedule for other hardware acquisition such as GPS equipment and associated costs?

References

1. *Rocky Mountain National Park GIS Plan*, R. Schiller and J. Thompson, 1988.

2. *Organ Pipe Cactus Monument GIS Plan*, G. Dupuy, 1991.

3. *Apostle Islands National Lakeshore GIS Plan*, A. Banta, 1992.

4. *Rocky Mountain National Park GIS Plan*, R. Schiller and J. Thompson, 1988.

5. *Equipment Acquisition for Everglades National Park GIS*, M. Finley, 1987.

6. *Apostle Islands National Lakeshore GIS Plan*, A. Banta, 1992.

7. *Pictured Rocks GIS Plan*, G. Petersen and B. Kenner, 1992.

8. *Santa Monica Mountain National Recreation Area GIS Plan*, C. Jenkins, 1992.

9. *Saint Croix and Lower Saint Croix National Scenic Riverways GIS Plan*, H. Hughlett and A. Andersen, 1992.

10. *Southeast Utah Group Draft GIS Plan*, H. Wickware, 1990.

11. *Rocky Mountain National Park GIS Plan*, R. Schiller and J. Thompson, 1988.

12. *ADP Equipment Acquisition for the Everglades National Park GIS*, M. Finley, 1987.

13. *Rocky Mountain National Park GIS Plan*, R. Schiller and J. Thompson, 1988.

14. *Rocky Mountain National Park GIS Plan*, R. Schiller and J. Thompson, 1988.

15. *National Capital Region's Regional GIS Plan*, J. Hall and P. Gregerson, 1990.

GIS PARK PLAN GUIDELINES

Example Appendices I through IV

Example APPENDIX I

GIS USERS REQUIREMENTS

Applications	Themes	Required Text Data	Frequency of Use	Relation to Other Management Activities
Natural Resources: Impacts on threatened & endangered or other sensitive animals	Park Boundaries & Environs, Vegetation, Topography, specific Habitats, and Watersheds	census & habitat condition	constant use	Interrelated with Multi-agency research & monitoring efforts; intra-related with park's maintenance, ranger activities, etc.
Cultural Resources: Protection/Loss of Cultural Landscapes	Boundaries & Environs, Historical Maps, Right of Ways, Trail Access	metadata on archeological sites, classified structures, human burial sites, & visitor use	used often by Park & State agencies	Park ranger and nat. resources activities & State Depts. of Transportation and Tourism
Regional: Model & characterize watershed system dynamics; nutrient & sediment transport & flow regimes	Topography, Slope, Aspect, Soils, Vegetation, Precipitation and Geohydrology	water monitoring site data and test results; rainfall data	on-going monitoring at/by various users	Park ranger, cult. resources, & maintenance: use to determine & plan for archeol. sites threatened by erosion. Inter-agency (AZ State & Air Resour. Lab, NOAA): transport & wet deposition monitoring studies from Navajo Power Plant
Interpretation: visitor reference materials & site bulletins	Topography-Elevation, Boundaries, Trails, Vegetation, LANDSAT Image		constant	Ranger, education, R/O public affairs
Maintenance: design & analyses of developments as they relate to visitor perceptions	Boundaries, Mow Areas, Transmission Lines, Roads (primary, secondary, 4-wheel), Trails (walking & biking), Snow mobile routes	schedules for maintenance	occasional	Park Interpretation, Concessionares, DSC & Park planners, adjacent landholders (county)

Example APPENDIX II

DATA INVENTORY

Existing Digital Data

Theme	Original Source of Data	Date of Source Material	Scale	Positional Accuracy	Resolution	Data Type (Point, Raster, Vector, and/or Text)	Data Format or Software Data Resides In	Extent of Data Coverage	Is Data Georeferenced?	Coordinate System (UTM, Lat-Long, State Plane, etc.)	Datum (If Known)	Method of Capture	Attributes or Categories Description
Elevation (1:24000 scale DEM-2)	USGS	1989	1:24000	Not Applicable	30 x 30 meter	Raster	ASCII DEM on 9-track tape	Park & Buffer Zone	Yes	UTM	NAD27	Not Applicable	1 meter elevations (plus or minus 15 meters)
Elevation (1:250000 scale DEM)	USGS	1988	1:250000	Not Applicable	90 x 90 meter	Raster	GRASS Raster	Park & Buffer Zone (Plus more)	Yes	UTM	WGS72	Not Applicable	1 meter elevations (plus or minus ? meters)
Elk Habitat	Colorado Div. of Wildlife - Field Survey	1954	1:24000	Unknown	15 acres	Vector	AutoCAD	Elk Run Watershed	Yes	Lat-Long	NAD27 probably	Scanned	4 Categories of Habitat
List of Classified Structures	NPS - Field Survey	6/89 - 7/91	1:24000	$\pm$ 40 feet	Not Applicable	Text & Points	dBASE & Atlas GIS	Park	Yes	UTM	NAD27	Manual Digitizing	Building name and ID number
Vegetation	TM	Images: 11/89 & 7/90 Mapped: 6/92	Not Applicable	$\pm$ 30 meters	30 x 30 meter	Raster	GRASS	Northern 1/2 of Park & Environs	Yes	UTM	NAD27	Not Applicable	21 Vegetation Association Types
Historical Sites	Field Survey with GPS	3/92 through 5/92	Not Applicable	$\pm$ 2 meters	Not Applicable	Points & Text	GRASS sites files & dBASE	Within 5 miles of Park Headquarters	Yes	UTM and Lat-Long	NAD27 and WGS72	Not Applicable	Site name, ID number, Type of site, etc.

Example APPENDIX II Existing Digital Data Definitions

Scale:

Scale is a representative fraction defining the relationship of measurements on the map to measurements on the ground (e.g. 7 1/2 minute USGS Quadrangle maps are at a scale of 1:24000 which means that 1 unit of measurement on the map equals 24000 units of measurement on the ground).

Positional Accuracy:

Positional accuracy is a measure of how accurate the geographic coordinates are, as compared to the actual location on the ground.

Resolution:

For raster data, the dimensions of a data cell (e.g., 30m, 10m), and for vector data, the minimum mapping unit, (i.e., the smallest classified area delineated on a map).

Data Format:

Digital data formats include but are not limited to: DLG-3 optional, ASCII DEM, ARC/info, Atlas/GIS, GRASS raster, GRASS vector, and GRASS sites.

Is Data Georeferenced?:

If so, data is linked to location via geographic coordinates (e.g. Lat-Long, UTM, or State Plane).

Coordinate System:

If the data is georeferenced, what is the reference system used for geographic locations?

Datum:

Generally referring to horizontal control, however if vertical control is known, it can be noted. Historically most maps have used the national horizontal control network based on the North American datum of 1927 (NAD27) which covers the conterminous U.S. and Alaska. However some new data is based on the North American datum of 1983 (NAD83). A USGS topographic map will indicate the datum in the lower left corner of the map.

Attribute:

alphanumeric, non-graphic data that describes the entities represented spatially in a GIS.

Catagory:

a class of data in a particular theme (e.g., spruce-fir forest in a vegetation map theme).

Example APPENDIX II (Continued)

DATA INVENTORY

Existing Analog Data

Theme	Type of Data	Data Format	Date of Source Material	Scale of Map or Image	Resolution	Condition	Extent of Theme Coverage	Is Data Geo-referenced?	Coordinate System(s) (UTM, Lat-Long, State Plane, etc.)	Datum (If Known)	Projection	Attributes or Categories Description	Number of Maps or Images
Vegetation Plot 27-A	Text & Map	Statistical Park Report & Paper Map	1978	1:2400	Unknown	Original paper map in poor condition (creased)	1 hectare surrounding site	Yes	Lat-Long	NAD27	Transverse Mercator	Written description & statistical report	1
Surficial Geology	Map	Mylars from Report Publication	6/86	1:50000	Probably about 60 acres	Original in good condition	Park & Environs	Yes	Lat-Long & UTM	WGS72	Transverse Mercator	Between 100 & 150 unique categories	12
Fire Fuels	Map	Paper	unknown	1:100000	Unknown	Copy in good condition	Park & Environs	Yes	Lat-Long	Unknown	Unknown	6 fire fuel models	1
Description of Cecil Soil Characteristics	Text	Text & Number	6/91 thru 7/92	Not Applicable	Not Applicable	Field Notes (hand written)	Smith 7 1/2' Quad	No	Not Applicable	Not Applicable	Not Applicable	27 distinct soil type descriptions	Not Appli-cable
Therialt Springs	Aerial Photos	B & W Paper Prints, 9" x 9"	5/21/88	About 1:6000	Not Applicable	Original prints; good condition; $\leq$ 5% cloud cover	Immediate vicinity of Springs	No	Not Applicable	Not Applicable	Not Applicable	Not Applicable	5
USGS Quads	Maps	Paper (Mylar Available)	1964 - 1971	1:24000	Not Applicable	Good condition; Mylar copies available from USGS if/when desired	Park and Buffer Zone	Yes	Lat-Long, UTM & State Plane	NAD27	Transverse Mercator	Not Applicable	22
USGS Quad	Map	Paper (Mylar Available)	1956	1:250000	Not Applicable	Good condition; Mylar copy available from USGS if desired	Park & Environs	Yes	Lat- Long, UTM & State Plane	NAD27	Transverse Mercator	Not Applicable	1
Existing Land Classification Map	Map	Mylar & Paper	Compiled 1969 from 1:24000 scale maps dated 1964 thru 1967	1:62500	Unknown	Paper & mylar copies in good condition	Park and Immediate Vicinity	Yes	Lat-Long	1927 North American datum	Polyconic projection	7 categories with several "special use zones" described	3

Example APPENDIX II Existing Analog Data Definitions

Type of Data:
This would include: maps, text, photography, etc.

Data Format:
This would include: paper & mylar maps, text, numbers, graphic, photo prints and/or film positives.

Scale:
(see Existing Digital Data Definitions)

Resolution:
(see Existing Digital Data Definitions)

Condition:
Notes on any qualities of the data format which might affect the digitizing process.

Extent of Theme Coverage:
What area is covered by the theme? This might be indicated by quad names, number of quads, data base boundary, a watershed, etc.

Is Data Georeferenced?:
Are there geographic coordinates on map/image which can be used to link the map to a geographic location?

Coordinate System:
If the data is georeferenced, what system(s) is(are) used (e.g. Lat-Long, UTM, State Plane, etc.)?

Datum:
(see Existing Digital Data Definitions)

Projection:
The representation of the earth's surface on a flat map. Some common projections include: Mercator, Lambert Conformal Conic, Albers Conical Equal-Area, Transverse Mercator, and Polyconic. The projection used for the map may affect the digitizing process.

Example APPENDIX III

DATA COLLECTION

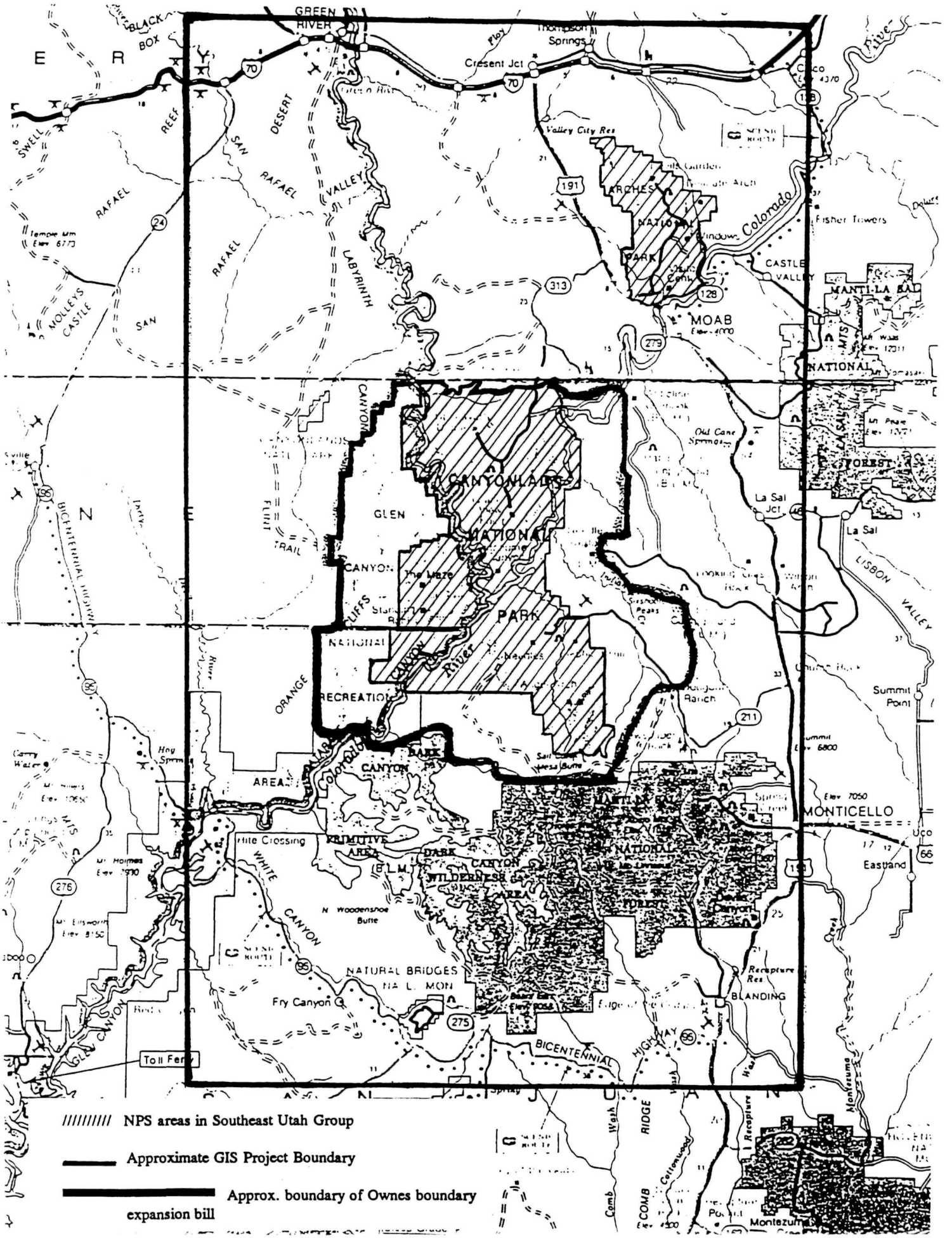
Theme	Collection or Derivation Method	Urgency of Need (ASAP, before GMP, etc.)	Data Type (Point Raster Vector and/or Text)	Base Map Scale	Accuracy of Measurements	Resolution	Data Format or Software to Reside In	Extent of Data Coverage	Attribute or Category Description	Cost Estimate of Collection
Spotted Owl Nesting Sites	Field Survey with GPS	ASAP	Text and point	Not Applicable	Within 10 meters	Not Applicable	GRASS sites file and dBASE	Park & Buffer Zone	To be defined	Staffing costs, arrange use of USFS GPS base station
Aspect	Derived from existing digital elevation data (DEM)	By March 1993	Raster	1:24000	Not Applicable	30 x 30 meter raster	GRASS raster file	Park and Buffer Zone	16 points of compass and flat	Minimal staff time (~ 1 day)
Soil Types	Photo Interpretation and Field Survey	By Sept 1994	Vector & Raster	1:24000	± 40 feet	15 acres	GRASS raster file	15 7.5 minute quads in the center of the park	Soil descriptions used in adjoining soil surveys	Unknown
Burned Areas From Recent Fires	Satellite Image Analysis	ASAP	Raster	Not Applicable	± 30 meters	30 x 30 meter raster	GRASS	Park and Buffer Zone	Burned vs Unburned	Unknown
Elevation	Contract Survey	By Oct 1993	Vector	1:2400 (1"=200')	± 10 cm	Not Applicable	GRASS & ARC INFO	Smith Watershed below 20,000 feet & within park boundary	2 foot contours	Approx. $10,000
Elevation, Slope & Aspect	Derived from contract survey data (above)	By Dec. 1993	Raster	1:2400 (1"=200')	Not Applicable	2 X 2 meter raster size	GRASS	(Same as above)	1 foot contours; 0-90 degrees; 16 points of compass & flat	3 weeks of GIS specialist's time

Example APPENDIX IV DATA ACQUISITION AND CONVERSION

Theme	Urgency of Need	Data Source	Source Data Type	Source Data Format	GIS Data Type	Scale	Resolution	Area Covered	Is Source Data Georeferenced same as GIS?	Acquisition &/or Conversion Costs
Elevation	10/93	USGS DEM	Raster	ASCII DEM	Raster	1:24000	30m X 30m	Park & Environs	UTM - yes	20 quads @ $230.00 total
Fire History	12/93	NPS Park	3 maps	paper	Vector	1:24000	≥15 acres minimum	park only	UTM - yes	staff time to digitize
Soils	2/95	State	1 map	available in paper or mylar	Raster & Vector	1:62500	90 acre	Park & Environs	State Plane - no	$1,500.00

Example APPENDIX V

DATA BASE BOUNDARIES



////////// NPS areas in Southeast Utah Group

Approximate GIS Project Boundary

Approx. boundary of Ownes boundary expansion bill

Example APPENDIX VI

IMPLEMENTATION SCHEDULE

Task	Responsibility	Estimated Cost and Funding Source	FY Funding Avail./Obligated	FY Completed	Comments
"GIS for Managers" Training - Superintendent	Supt. & GISD	$1,000/park base	Start Year	Start Year	
assign temporary .5 FTE ("GIS Tech.")	Supt. & Resource Mgmt. Spec.; Personnel Off.	-0-	Start Year	Start Year	write PD; classify, advertise & hire
prep. for digitizing (13 priority themes) from existing park maps	GIS Tech.	$2,000/park base	Start Year	Out Year 1	GISD to process USGS DEMs & DLGs; & provide direction
digitize above ref'd/prep'd maps	contract; coordinated by GIS Tech.	$10K/park base	Start Year	Out Year 1	Contract
acquire thematic data from external sources (6)	GIS Tech. & RO Procurement	$15K/GISD Proj.	Start Year	Start Year	From USGS, SCS, and County
hire GIS Specialist	Supt., Resource Mgmt. Spec., and Personnel		Start Year	Out Year 1	write PD; classify, advertise & hire
UNIX SPARC workstation & peripherals	GIS Tech. & RO Procurement	$25K/Nat & Cult Resources	Start Year	Out Year 1	
software acquisition (GRASS 4.1)	GIS Tech.; RTSC or GISD	$ -0-	Out Year 1	Out Year 1	
GRASS training for GIS Specialist & Res. Man. Staff	University/GISD	$5K	Out Year 1	Out Year 1	
UNIX training for GIS Specialist	University	included in above	Out Year 1	Out Year 1	
continue database development (digitizing in-house) & begin doing applications	GIS Specialist	-0-	Out Year 1	Out Year 2	Ongoing process (new & updated); 1st phase DBMS done end of Year 2
Advanced GRASS training for GIS Specialist	University	$1K	Out Year 2	Out Year 2	
acquire GPS Rover Unit	GIS Tech.	$7K	Out Year 2	Out Year 2	use USFS base station data
GPS training - GIS Specialist	GIS Specialist	$1K	Out Year 2	Out Year 2	
GRASS training for Maintenance & Rangers	University	$3K	Out Year 3	Out Year 3	

Task:
Hardware, Data, or Software Acquisitions; Data Capture, Personnel Staffing, Training, etc.

Responsibility:
Vendor, NPS personnel office, GIS Coordinator, etc.

Estimated Cost and Funding Source:
Estimated cost of task and who is funding the task (e.g., Park, Region, GISD, Other Agency, CPSU, no cost involved, etc.)

FY Funding Available/Obligated:
Anticipated Fiscal Year funding will become available and obligated to support the task

Date of Completion:
Anticipated completion of task