National Park Service – Rocky Mountain Network

Inventory and Monitoring Program

Data and Information Management Plan

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Abstract: This document describes the general framework and policies for managing all data and information within the Rocky Mountain Network I&M program.
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*The current version can be found at: http://www1.nrintra.nps.gov/im/units/romn/ -→ Data Management

Table of Contents

List of Figures

List of Tables

List of Standard Operating Procedures

Operation	Standard Operating Procedure
Data Management	Approving Information for Distribution
	Archive Format Standards
	Data Management Guidelines for Protocol Development
	Developing GPS Basemaps for Use in Garmin Units
	Digitizing Documents
	Directory Structure
	Documentation
	Establishing and Naming Sites and Markers
	Field Season Data Management
	File Naming Conventions
	Guidelines for Using and Updating NPSpecies
	Photograph Management
	Project Deliverables Specifications
	Project Manager Application
	Protecting Sensitive Resources While Conducting Fieldwork
	Quality Assurance and Control
	Requesting Park Research Permits
	Research Permitting and Reporting System Desktop Viewer
	Software Development
	Travel Time Cost Surface Model
	Using GPS-Photo Link to Georeference and Watermark Photographs
	Using the Garmin GPS 76csx
Library	Using Procite to Manage Network References Locally
Infrastructure	Backing Up the Network's Digital Information
	Rocky Mountain Network's Web Page
Administration	Obtaining Project Funding

List of Appendices

Appendix
Directors Order 11B
Directors Order 19B
Directors Order 19
I&M Statement of Purpose (DONPS-75)
FOIA
Executive Order 12906
OMB Circular A110
NPS 1998 Omnibus Act TitleII

Executive Summary

This Plan describes the process for generating, preserving, documenting, and transmitting the context that helps data become information and makes it valuable and interpretable. As such, this plan covers both data and information. This Plan applies to the Rocky Mountain Network (ROMN) which connects six park units: Glacier National Park (GLAC), Grant-Kohrs Ranch National Historic Site (GRKO), and Little Bighorn Battlefield National Monument (LIBI), Montana; and Florissant Fossil Beds National Monument (FLFO), Great Sand Dunes National Park and Preserve (GRSA), and Rocky Mountain National Park (ROMO), Colorado.

This Plan is organized into three levels (Figure ES.1). Level One is this Plan (this document), which contains the information management philosophy, regulations, guidelines, and general data management roles and responsibilities.

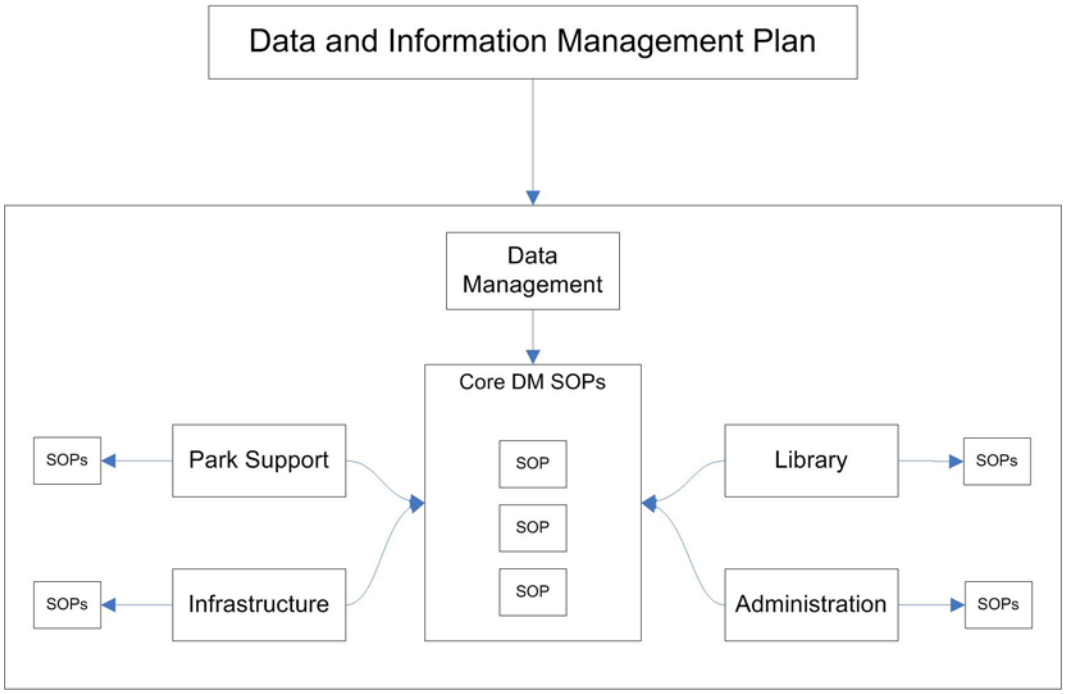

Figure ES.1. Hierarchy of Information Management Plan, Network Operations and Standard Operating Procedures

Level Two consists of the narratives describing the primary data-related operations within the Network:

- Data Management – Manages the Network's official and/or certified datasets and develops and maintains this Information Management Plan and the associated documents and standard operating procedures;

- Library – Oversees the digital and analog collection of documents used and/or generated by the Network;
- Park Support – Organizes the information related to other projects in support of park activities, including the natural resource inventories.
- Infrastructure – Manages the hardware, software, and local area network, and web pages that support the Network's activities including Intranet and Internet functionality; and
- Administration – Organizes the purchasing, travel, personnel management, and funding information.

Level Three is comprised of standard operating procedures (SOPs). They are detailed instructions for consistently accomplishing data- or information-related tasks.

The Plan and its related components are organized hierarchically and available via the Intranet as modules. This organization allows for the easy update of and access to sections, minimizes redundancy of content, avoids conflicting instructions, and accommodates both vision and detail in how information is managed.

The conceptual framework for managing data and information is described using four models. First, the Data Management Conceptual Model describes the seven steps for continually managing information:

- Acquire - Defines the scope of data and information to be acquired, generated and managed.
- Assure and Control for Quality – Develop procedures to prevent and check for errors;
- Document – Provide sufficient information about data (i.e., metadata) to ensure that others will understand how and why the data was created;
- Determine Sensitivity and Ownership/Responsibility – Determine who "owns" the data. That is, who has ultimate responsibility for maintaining and protecting sensitive and non-sensitive information and who is the legitimate source for access to the information;
- Archive – Securely store digital and hardcopy information;
- Catalog – Develop a working inventory of all information so it can be found by others;
- Analyze and Report– Provide the necessary information in the appropriate format to each defined audience.

These steps, which are not always in this exact order, are regularly guided by national and network regulations and policies.

The Project Life-Cycle Conceptual Model describes the general process for managing all projects:

- Initiate - Preliminary decisions regarding project scope and objectives.
- Plan - Details regarding data acquisition, processing, analysis and reporting.
- Execute - Implementation and/or fieldwork.
- Control - Modification of current practices.
- Close - Delivery of final products.

The Operation Life-Cycle model borrows its structure from the data management model and incorporates the project as the data-producing element to describe a system for continually and systematically processing, integrating and managing data. The network recognizes five distinct operations:

- Data Management – Management of network's official data;
- Library – Management of network's official documents;
- Park Support – network support of park activities;
- Infrastructure – Oversight of hardware, software and the local area network;
- Administration – Management of purchasing and payroll information.

Finally, the Enterprise Model of Data Integration describes how the network interfaces with other WASO data systems to serve multiple audiences requiring different format and various levels of synthesis.

This Plan and its related materials are continually changing through a process of analysis, evaluation, and updating to ensure the long-term success of data management within the network and its monitoring efforts for its member parks, the park service, and society as a whole.

1. Introduction

1.1. Purpose

Reliable data and information are essential to managing the national parks, and collecting natural resource information is the first step toward understanding national-park ecosystems. When collected using rigorous methods, maintained through sound management practices, and transmitted to park managers in a useable format, that information can also form the basis for sound management decisions.

Preserving information requires the establishment and maintenance of reliable data and information management practices. Without planning, data are easily corrupted, misplaced, or misunderstood, and information can be quickly lost through staff turnover, lack of effective communication, and changes in hardware, software, and data archive formats. Any good set of facts, whether collected last week or 20 years ago, must also provide enough information about itself to ensure its preservation and meaningful use.

1.2. Scope

This plan is not limited to facts or data contained in the tables, fields, and values that make up a dataset. Its larger purpose is to describe the process for generating, preserving, documenting, and transmitting the context that helps data become information and makes it valuable and interpretable. As such, this plan covers both data—commonly defined as “facts or pieces of information” in scientific or academic literature—and information, defined variously as “1. knowledge communicated or received concerning a particular fact or circumstance” to “7. computer data at any stage of processing, as input, output, storage, or transmission” (Merriam-Webster 2006). In other words, this plan is not just concerned with the management of data and facts; it also intends to ensure that facts become information (e.g., interpretation of the data via analyses and reports). Therefore, it addresses pieces of information, the processing and preservation of those pieces, and the communication of knowledge derived from those pieces.

This plan applies to the Rocky Mountain Network (ROMN), one of 32 NPS networks nationwide, which connects six park units: Glacier National Park (GLAC), Grant-Kohrs Ranch National Historic Site (GRKO), and Little Bighorn Battlefield National Monument (LIBI), Montana; and Florissant Fossil Beds National Monument (FLFO), Great Sand Dunes National Park and Preserve (GRSA), and Rocky Mountain National Park (ROMO), Colorado. The core network staff is located in Fort Collins and Estes Park,

Colorado. While the Internet and other modern telecommunication technologies have greatly facilitated contact between the multiple entities of the network, direct personal communication remains critical in establishing common goals, locating and resolving misunderstandings, and setting priorities. Figure 1.1 shows the physical relationship of the network office and the six parks and displays the major airports, roads, and geographic barriers that affect geographic connectivity among the network entities.

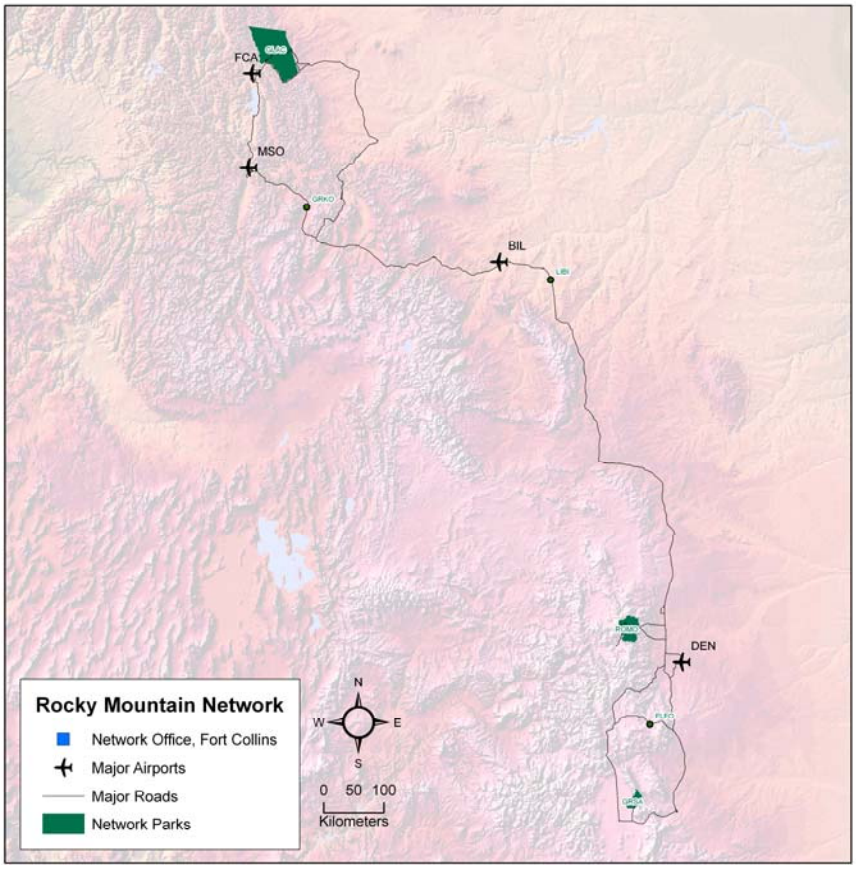

Figure 1.1. Location of Rocky Mountain Network Office Relative to Each of the Network Parks

The primary audience for this plan includes developers and users of network information. Developers include network staff, park professional staff, other NPS staff, and external collaborators. Users include network park managers and staff from all divisions, network staff, Intermountain Region managers and staff, Washington Area Service Office (WASO) managers and staff, and the public.

1.3. Goals and Objectives

The goals of our information management system are to ensure the quality, interpretability, security, longevity, and availability of ecological data and related information resulting from resource inventory and monitoring efforts.

Quality. The ROMN will take measures during all phases (project development, data acquisition, data handling, summary and analysis, reporting, and archiving) to guarantee the quality of the data. These measures will reflect current best practices and meet rigorous scientific standards.

Interpretability. A dataset is only useful if it can be readily understood and appropriately interpreted in the context of its original scope and intent. Data taken out of context can lead to misinterpretation, misunderstanding, and poor management decisions. Similarly, datasets that are obscure, complex, or poorly documented can be easily misused. Sufficient documentation (metadata) will accompany each dataset (and all reports and summaries derived from it) to ensure that users will have an informed appreciation of the dataset's applicability and limitations.

Security. The ROMN will maintain and archive datasets in an environment that provides appropriate levels of access. The network's data-management system will take advantage of existing systems for network security and systems backup, and augment these with specific measures aimed at ensuring the long-term security and integrity of the data.

Longevity. The longevity of a dataset is reliant on thorough documentation (metadata). Longevity is also realized through continued use, which requires that the data be maintained in an accessible and interpretable format.

Availability. Natural resource information can inform decisions only if it is available to managers at the right times and in appropriate forms. The ROMN will ensure that the products of inventory and monitoring efforts are created, documented, and maintained in a manner that is transparent to the potential users of these products.

The objectives that support these goals are as follows:

- To acquire and/or generate the data that the ROMN needs to achieve its goals;
- To compile that data into sets (information) and ensure its accuracy and logical consistency;
- To provide the documentation critical to maintaining the long-term interpretability of the acquired and compiled information;

- To determine the sensitivity level of the information;
- To properly archive the information;
- To properly catalogue the information and report it to the network parks and the public; and
- To provide information to the appropriate audiences in the correct format.

1.4. Organization

This plan and all of its related documents are organized hierarchically into three levels (Figure 1.2). Organizing the plan hierarchically and having it directly accessible to network staff via the web ensures that:

- The entire Data and Information Management Plan is broad in scope yet offers substantial detail to accomplish tasks consistently;
- Staff have direct, immediate access—from the office and on the road—to the documents they require, particularly the Standard Operating Procedures (SOPs);
- The plan, or any one of its components, can be updated as needed (those updates immediately affect the management of all network information);
- Updated schedules are accommodated by this plan, the operation narratives, and SOPs (while SOPs will regularly change, especially due to changes in hardware and software, the general framework for managing data will evolve more slowly); and
- If a printed copy is required, the very latest version is immediately and always available.

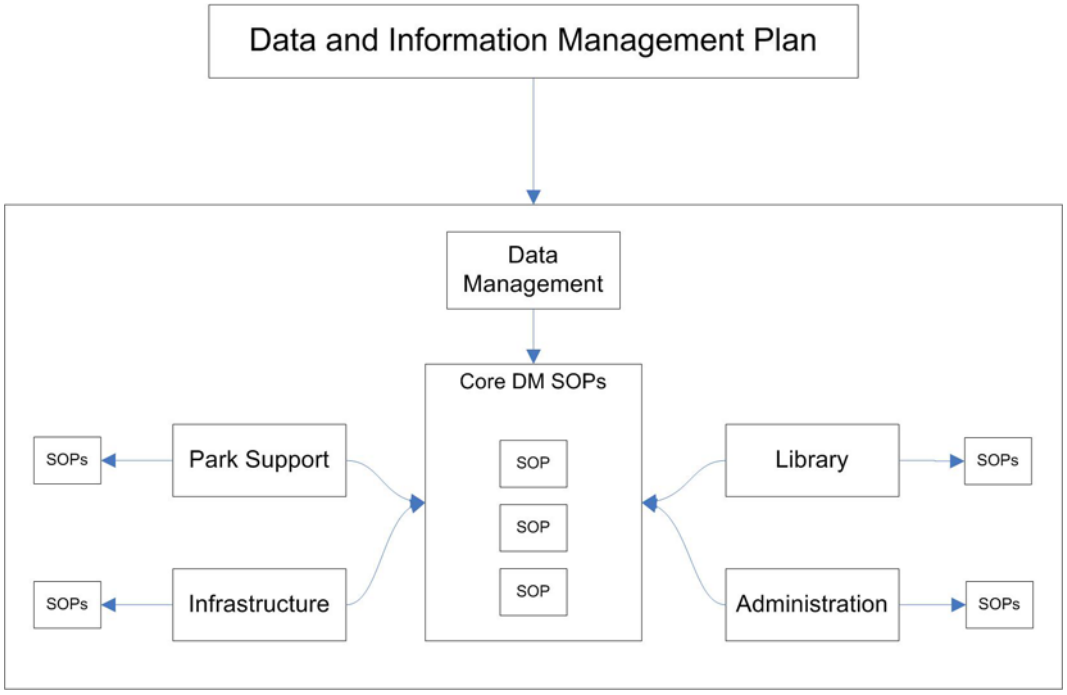

Figure 1.2. Hierarchy of Information Management Plan, Operations and SOPs

1.4.1. Level One

Level One is this plan, which contains the information management philosophy (models), regulations, guidelines, and general data-management roles and

responsibilities employed by the ROMN. This level is the most comprehensive, as it is applicable to all data-related actions within the network, but contains little detail regarding data management.

1.4.2. Level Two

Level Two consists of network operation narratives. Because the types of data and information, and the associated skills and personnel that manage that information, differ within the network, it is useful to divide the network into core operations relative to managing data and information (see Section 3). For instance, the software and skills used to manage payroll and travel information differ significantly from those used to manage grassland protocols and associated data. Each operation narrative describes the more specific and distinct data-related functions (i.e., unique software, hardware and process steps) performed by each operation. (The concept of an operation is further defined in Section 2, and Section 3 provides a brief description of the ROMN operations). The complete operation narratives are available at the network's Intranet site (NPS–ROMN 2007o).

1.4.3. Level Three

While operation narratives provide a framework for managing network information, specification of data-management steps is critical to ensuring that all tasks are performed consistently. Thus, the final level of organization is the standard operating procedures (SOPs) (Table 1.1). The SOPs describe the detailed steps necessary to accomplish a data- or information-related task. For example, an SOP may specify exactly how to digitize a document according to network specifications for resolution and color. SOPs can range in their level of detail, but will—when followed—produce consistent results. Finally, SOPs represent the implementation of the policies described in this plan, therefore enforcing these policies through action. All final SOPs are found at the network's Intranet site (NPS–ROMN 2007o).

Operation	Standard Operating Procedure
Data Management	Approving Information for Distribution
	Archive Format Standards
	Data Analysis
	Data Management Guidelines for Protocol Development
	Developing GPS Basemaps for Use in Garmin Units
	Digitizing Documents
	Directory Structure
	Documentation
	Establishing and Naming Sites and Markers
	Field Season Data Management
	File Naming Conventions
	Guidelines for Using and Updating NPSpecies
	Photograph Management
	Project Deliverables Specifications
	Project Manager Application
	Protecting Sensitive Resources While Conducting Fieldwork
	Quality Assurance and Control
	Requesting Park Research Permits
	Research Permitting and Reporting System Desktop Viewer
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	Rocky Mountain Network's Web Page
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Table 1.1. List of Current Operating Procedures Used by the Network

In some cases, SOPs are written for a particular network operation. For instance, an SOP for backing up the network's server is specific to the Infrastructure Operation; no other operations will refer to this SOP. In other cases, SOPs may apply to two or more operations. For instance, the SOP that defines digital file-naming conventions applies to all network operations. SOPs common to multiple operations are known as core SOPs, and are produced by the Data Management Operation (NPS–ROMN 2007e).

2. Conceptual Framework for Managing Data and Information

This chapter describes four models that represent the conceptual framework for managing all network information. The first model, a conceptual model for data management, describes the seven data-stewardship steps (Figure 2.1). Each step is integral to each phase of a project and operation. Beyond the network, Figure 2.1 provides a model for how information is ultimately integrated with other national systems.

2.1. Data Management Conceptual Model

Figure 3 shows a general model for data management. This model is a framework for regularly managing data at any point in time and with any task.

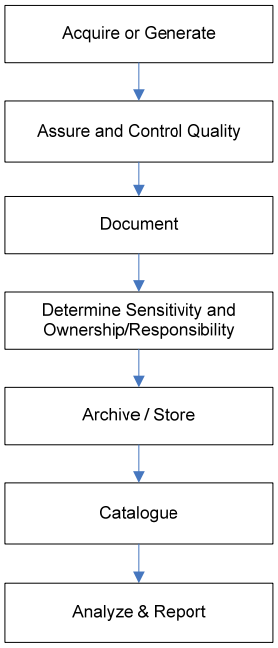

Figure 2.1. Data Life Cycle

These stewardship steps include:

Acquire and/or Generate. The scope of information to be acquired or created and maintained must be defined. Without a clear vision of scope, the network may be overloaded with unnecessary and/or irrelevant information or not collect critical information.

Assure and Control Quality. Quality assurance (QA) involves planning, monitoring, and evaluating the aspects of a project to ensure that standards of accuracy and

consistency are being met. Examples include limiting answers on a form to a pre-defined lookup list or designing field forms that are easy to read and help field crews to identify and record the observations that are needed. Quality control (QC) involves checking the data that has been collected for accuracy and completeness to minimize the risk of producing poor quality data. Examples include verifying that all temperatures were recorded in Celsius, that all field sheets are dated and properly completed, and that information entered into computerized forms matches the original field sheets. Data of inconsistent or poor quality can result in incorrect interpretations and conclusions.

Document. The careful documentation of datasets, the data source(s), and the methodology by which the data were collected or acquired is essential for preserving information over the long-term. Documentation also establishes the basis for the appropriate use of the data in resulting analysis and products. In many cases, documentation refers to metadata, which can be defined as information about the content, quality, condition, and other characteristics of data. However, documentation also applies to other types of information, including reports. For example, some final reports, particularly legacy reports, may have an incomplete title page, making it difficult to discern an author or year of publication. In this case, creation of a more complete title page would suffice for adequate documentation.

Determine Sensitivity and Ownership. While the free flow of information often benefits parks, there are cases in which information can be used to harm their natural resources or, in cases of distributing proprietary materials without permission, hurt the National Park Service. Sensitivity is defined according to whether the use of information by unauthorized individuals will threaten a park's natural and/or cultural resources, or legal obligations. Ownership can take on different meanings, depending on context. In some cases, ownership refers to proprietary or copyrighted information. In other cases, it elucidates whether the network or one of the parks is the ultimate authority over a dataset or information source. This includes not only the distinction between private and public information, but also whether the responsible party is the network, park or another entity.

Archive and Store. Archiving and storage refers to how information is physically organized. Where the information is physically housed depends on a number of factors, including its format, sensitivity, ownership, and content. Integral to properly housing the information are protections from disaster, malice, and degradation. Archiving and storage applies to hardcopy and digital information, drafts, and final versions. It should

be emphasized that archiving, in the context of this plan, is more generalized than the meaning associated with museum collections.

Catalog. Cataloging refers to how information—datasets, reports, maps, projects, ideas—is logically organized. Information may be stored and protected, but in the absence of a logical method for its discovery and retrieval, it may never be used. In some cases, cataloging may be directly connected to the documentation process (e.g., metadata), although cataloging may also be discrete.

Analyze and Report. Analysis involves the examination of information elements and their relations. Reporting involves the export of information, whether it is the analyzed product or original form.

It is important to note that these tasks are neither mandatory nor linear. During any type of data-management task, one or all could apply in any order. Nevertheless, there is a general logic to presenting these tasks in the order shown above.

2.2. Project Life-Cycle Conceptual Model

The data management model assists in building the foundation for a project, which is defined as a temporary endeavor undertaken to create a unique product (PMI 2004). Projects can be divided into five primary stages, each of which is characterized by some or all of the data-management components described above and implemented by staff involved in the project. Figure 2.2 outlines the conceptual model for the project life-cycle.

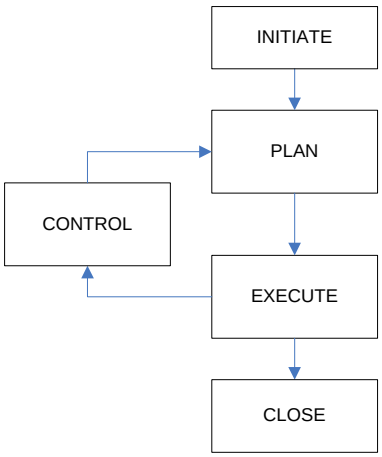

Figure 2.2. General Project Life Cycle

Initiate. This is when many of the preliminary decisions are made regarding project scope and objectives. In addition, funding sources, permits, and compliance are all addressed in this phase. Primary responsibility rests with project leaders and program administrators. Although this phase lacks specific data-management activities, it is important that data managers remain informed of projects at this phase. This is especially true as timelines for deliverables are finalized. All contracts, agreements, and permits should include standard language that describes the formats, specifications, and timelines for project deliverables.

Plan. During this phase, details are worked out regarding how data will be acquired, processed, analyzed, reported, and made available to others. The project leader is responsible for the development and testing of project methodology, or modifying existing methods to meet project objectives. It is critical that the project leader and the data manager work together throughout this phase. This dialogue will help to build and reinforce good data management throughout the project, especially during the crucial stages of data acquisition, processing, and retrieval. By beginning collaborative development as soon after project approval as possible, data integrity and quality can be assured most easily. An important part of this collaboration is the development of the data model (i.e., database structure) and data dictionary, where the specifics of database implementation and the parameters that will be collected are defined in detail. Devoting adequate attention to this aspect of the project is possibly the single most important part of assuring the quality, integrity and usability of the resulting data. Once the project methods, data design, and data dictionary have been developed and documented, a database can be constructed to meet project requirements.

Execute. During the project implementation phase, data are acquired, processed, error-checked and documented. This is also when products such as reports, maps, geospatial themes, and other products are developed and delivered. The project leader oversees all aspects of implementation, from logistics planning to data acquisition, report preparation, and final delivery. Throughout this phase, data-management staff functions primarily as facilitators, providing training and support for database applications, use of GIS and GPS software, and other data processing applications; facilitation of data summarization, validation, and analysis; and assistance with the technical aspects of documentation and product development.

Control. For short-term projects, change control will be built in to the project scope of work and will include SOPs for modifying project objectives, methodology, and products, as well as to document change. For long-term, multi-year projects, annual summary

reports will be produced to summarize results and document the work (including changes).

Close. Upon project closure, records are updated to reflect the status of the project and its associated deliverables in a network project-tracking application. For monitoring protocols, careful documentation of all changes is required. Changes to methods, SOPs, and other procedures are maintained in a tracking table associated with each document. Major revisions may require additional peer review. During this phase, data products, reports, and other deliverables are integrated into national and network databases, metadata records are finalized and posted in clearinghouses, and products are distributed or otherwise made available to their intended audience. Another aspect of integration is merging data from a working database to a master database maintained on the network server (e.g., NPS-ROMN 2007r). This occurs only after the annual working dataset has been certified for quality by the project leader. Certain projects may also have additional integration needs, such as when working jointly with other agencies for a common database.

Projects can vary in their length and complexity, which will affect the effort involved in managing data. Long-term projects will often require a higher level of documentation, peer review, and program support. From a data-management standpoint, a primary difference between short- and long-term projects is an increased need to control for change to ensure internal data compatibility over time.

Projects have particular relevance to the monitoring program because each field season of monitoring can be effectively treated as a project. Using the concepts of project management to coordinate field efforts will provide project managers with the tools and framework to ensure that a season's monitoring activities are well-organized and efficient in the generation of information.

2.3. Operation Life-Cycle

Following project close-out, data are managed under a broader framework: the operation, defined as ongoing and repetitive work with a primary objective of sustaining the business, or in this case, the network (PMI 2004).[†] Both the data management model (Figure 2.1) and project life-cycle model (Figure 2.2) inform how the data-management component of an operation can be conceptualized in the operation life-

[†] We chose to name these ongoing data management activities as "operations" instead of other terms (e.g., protocols, functions, tasks, programs) because the term is common to project management terminology, is not as easily confused with other definitions and uses within the NPS and the I&M program, but is still specific in meaning. Nevertheless, we recognize the limitations of this title.

cycle model (Figure 2.3). This model borrows its structure from the data management model and incorporates the project as the data-producing element. It describes a system for continually and systematically processing, integrating, and managing data during and following project termination. Just like the data life-cycle model, each step is neither mandatory nor linear; however, this model is generally applicable to all data-related operations defined by the network. This model also includes the infrastructure, or the physical medium—local area network, hardware and software—that makes the management of data and information possible.

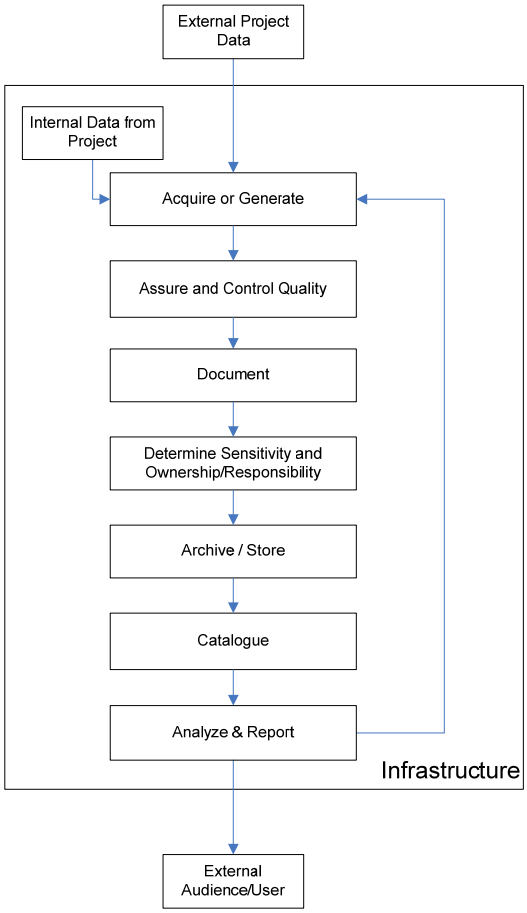

Figure 2.3. Operation Life-Cycle Model

The operation life-cycle model emphasizes a number of other key points beyond the integration of the data and project life-cycles. First, it shows that each operation is a self-contained system with distinct entry and exit points. This ensures that provisional data are not accidentally or inappropriately used by others; data are invisible to external users until they reach a defined process step. Additionally, it shows how reported data and information may feed back into the information system and ultimately require management. For instance, reports regarding the inventory of information are treated as another item to be inventoried. Monitoring reports must also relate back to the original

field information. Finally, the operation life-cycle model shows that information must be continually processed and managed for the network to function properly. Failure to incorporate any one of these steps, either individually or systematically, into an information management system, compromises both data and information over the long-term.

The operation concept has particular relevance to monitoring because each monitoring protocol, once implemented, should ultimately be treated as a unique operation. This model, therefore, provides a common framework for how all network protocols should function.

2.4. Integration of Network, Park and National Systems

Unfortunately, the current configuration of the WASO and regional systems creates some confusion in terms of ownership/responsibility and where official data and reports reside. The ROMN will make every effort to minimize replication of information, make all data available through one interface, and serve multiple audiences who require data in different formats and at various levels of synthesis. Figure 2.4 provides an enterprise-level model of how information generated within the network is ultimately shared with WASO, the parks, and other audiences. Because most of the information generated by the network will be from monitoring (and not other miscellaneous projects), the narrative is specific to monitoring data and information.

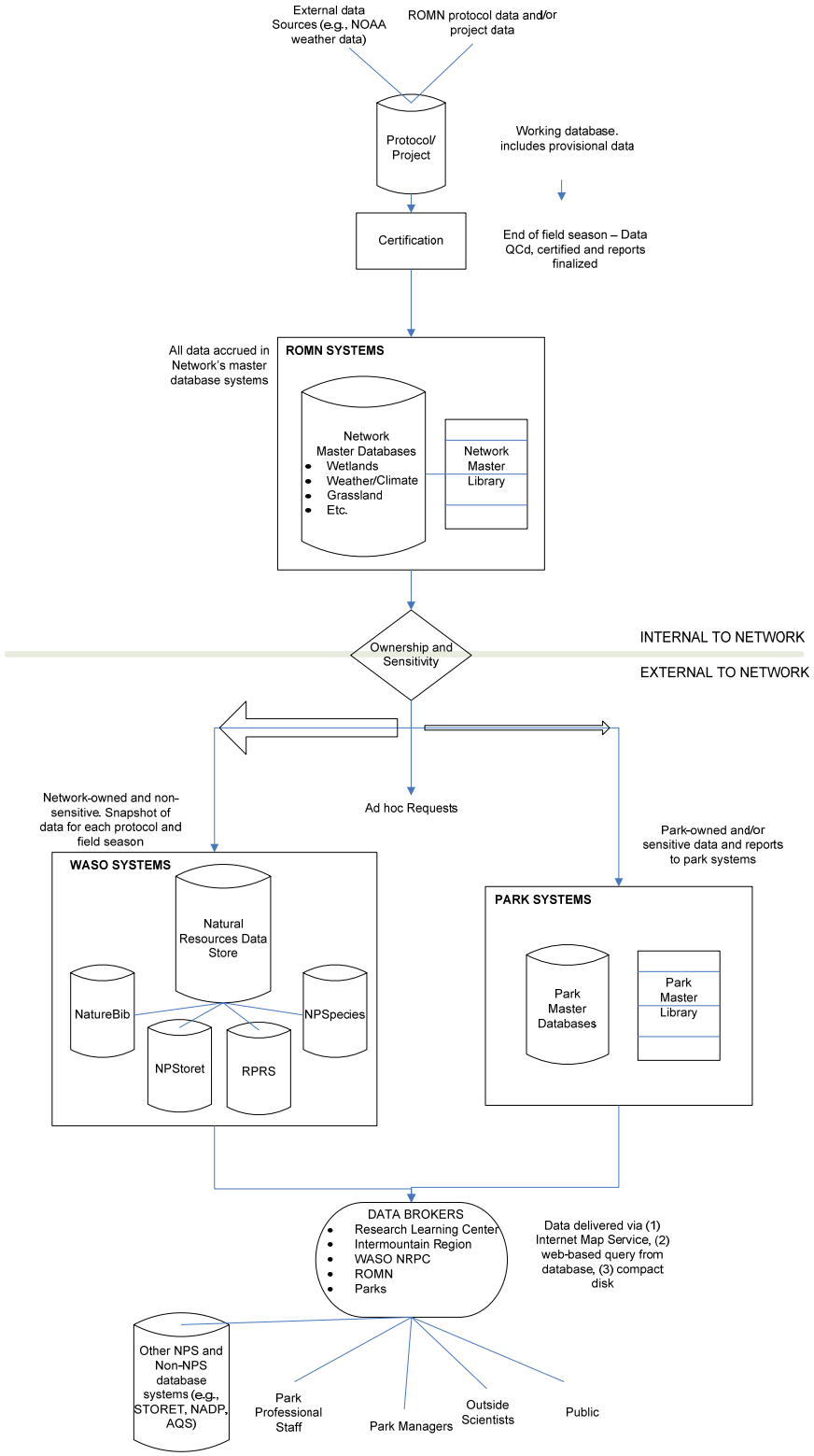

Figure 2.4. Enterprise-Level Integration of Network, Park and National Information Systems

Each field season of a monitoring protocol is treated as a project in which data are collected, managed, and tracked in a working database. During project close-out, or at

the end of the field season, the data are certified, or quality-controlled, and reports are created as a result of data analysis.

Annually, information is integrated into the larger operations. All certified data are integrated and accrued into the network's master vital signs datasets. At this point, the data are made available to the other network operations for integrative analysis.

External sharing of data depends on both ownership/responsibility and sensitivity. Non-sensitive data and reports owned by the network will be provided annually to the NPS national systems as a snapshot; data and the associated analyses will be delivered as a final product for that particular field season. Park-owned and/or sensitive data will be provided to the parks, whose managers have the ultimate responsibility to decide what action they will take regarding its distribution.

This data will be available to the parks and public through a number of avenues. Non-sensitive reports and datasets for a particular project or field season will be available through the NPS systems. These systems, in certain instances, will link to other federal database systems, including the Environmental Protection Agency's water quality database, STORET (EPA, 2006). Parks also have the option of serving their own data through their own web pages. Access to all of this information will also be facilitated by a number of data brokers, including the Research Learning Centers, which can provide context and meaningful links to the multiple systems which house data. The network will also honor all ad hoc requests for data.

3. Network Data Operations

This section describes the data operations integral to the support of the ROMN. The ROMN recognizes the following operations:

The **Data Management Operation** (NPS–ROMN 2007e) has two primary responsibilities. First, it is charged with the development, implementation, enforcement, and maintenance of this plan and its associated documents and standard operating procedures (see next section). It is also responsible for the management of the network's official and/or certified datasets. Official data includes general geospatial layers such as roads, trails, and park boundaries (which may come from other governmental or non-governmental agencies), as well as information and data derived from the other network operations (e.g., monitoring protocols). By providing an official and definitive data repository, it ensures that there is a single point for data requests and that consistency, quality, and accuracy are maintained among all network activities.

The **Library Operation** (NPS–ROMN 2007j) is responsible for maintaining the digital and analog collection of documents used and/or generated by the network. Documents are in final form and may include administrative records, reports, and scientific manuscripts or papers. This operation is similar to the Data Management Operation, in that it manages the master information for the network. However, because the processes and skills required for managing data and documents presently are so different, the two are split.

The **Park Support Operation** (NPS–ROMN 2007q) includes network support of park activities through the development and oversight of discrete projects. Many of the park-support projects are related to the mining of legacy information, resurrecting and documenting non-functional databases, and supporting the continuing natural resource inventories.

The **Infrastructure Operation** (NPS–ROMN 2007i) oversees the hardware, software, and local area network that support ROMN activities. This operation is also concerned with backing up the digital files found on the network's server. Finally, this operation is charged with the maintenance of the network's Internet and Intranet web pages and oversight of its Sharepoint space (when this becomes available).

The **Administrative Operation** (NPS–ROMN 2007a) includes the management of information related to purchasing, travel, personnel management, and funding sources.

As might be expected, the division among the operations is not entirely discrete. For instance, the Library and Data Management operations both are data and information repositories; the key differences are in how the information in the repository is formatted and used, and in the software catalog used to manage the repository. Nevertheless, classifying the network according to operations has helped to clarify systems for managing data and information that borrow from the data, project, and operation life-cycle models in Section 2. It has also enabled the ROMN to identify clear sets of processes that encapsulate the critical functionalities necessary for success.

The functions of the Library Operation serve to demonstrate how each operation implements the data management model (NPS–ROMN 2007j). Foremost, the library supports one of the fundamental needs of the network: access to final documents related to the network, its parks, or the National Park Service, as well as to natural resource information pertinent the network's vital signs.

In the Library Operation, information, including reports and books, are *acquired* if they fit in to the scope of the collection. The network may receive these reports from outside sources, including researchers, or from internal sources, including project funding by the NPS. Initially, network staff must determine the *quality* of the document and whether it is suitable for the library collection. Quality checking may include following established NPS procedures or just checking to ensure that the document is citable (e.g., author, year, title and publisher) and that none of the pages are missing. In cases where a suitable title page is missing or is vague, it may be necessary to add extra *documentation* to specify the title, author, or publication date. The network must in some way determine *sensitivity and ownership* of the document; this will determine whether the document is free for all to view or is located for privileged access only. Once *archived* either digitally or as a hard copy, the document must be *cataloged*, often through the use of such applications as NatureBib (NPS 2006e). Ultimately, the network will *report* on the collection, by distributing the document online or as a synthesized report such as a collections list. The operation's *infrastructure* is the medium (or context) within which information about the Library Operation flows, and includes the computer, hardware, software, local area network, file cabinets, and shelving.

4. Rocky Mountain Network Data Management Model

This section provides details about how the Rocky Mountain Network will implement the data management conceptual model (see Section 2.1).

4.1. Acquire and/or Generate

The purpose of this section is to define the scope of information the network will acquire and/or create. Both national and network policies affect the scope of collection. National policies are those that apply to all activities within the NPS, and may originate with the agency's director or other entities of the federal government, including Executive Orders. Network policies are those developed internally by the ROMN. A network policy should never conflict with a national policy and should be general enough to apply to all network operations.

4.1.1. National Guidance

National policies establish the scope of collection for all NPS activities, included those related to inventory and monitoring. Director's Order 19 (NPS 2001a) provides general guidance on the management of all NPS records; its Appendix B details what types of records should be maintained and for how long. Because administrative records are included in data and information that must be managed by this plan, the following sections of Appendix B (NPS 2001b), which specify which records are to be collected and managed, are particularly relevant:

- Natural resources records (Section N). Records and reports are considered permanent if they pertain to plant and animal life, the management of natural resources and their areas, research programs and partnerships, geologic features, pollution and environmental quality, weather and climate, pest and weed control, or soil.
- Fiscal records (Section F). Most fiscal records, including budgeting and payroll, are considered temporary and should be purged after three years.
- Personnel records (Section P). Records related to employees, including performance and work schedules are considered temporary and to be purged between two and three years.
- Property (Section S). Property and office supply records are temporary and should generally be removed after three years.

Another key policy is the Inventory & Monitoring Program Statement of Purpose (NPS 2006b). Appendix A of this document specifies the types of park-specific information to be acquired and managed, either directly or indirectly, by the networks:

- Legacy datasets and reports;
- Species information;
- Digital vegetation maps;

- Digital cartographic data;
- Digital soils maps;
- Digital geology maps;
- Water resources inventories;
- Water chemistry and flow information;
- Regional air quality monitoring stations, pollution sources, and data; and
- Precipitation and meteorological data.

4.1.2. Network Guidance

In addition to the national policies, the ROMN has defined its own set of policies applicable to all network operations. The guidelines that apply to information acquired from other sources state that the network will only acquire and manage information that:

- Directly or indirectly supports the defined vital signs and/or facilitates the inventorying of natural resources at or around the network parks;
- Either has basic documentation that identifies the meaning of the information, its source and quality (metadata), or those elements can be documented. The information source can be another document, individual, or agency, as long as it is possible to refer back to this source. Information may be unpublished or incomplete as long as its meaning is defined, its source is identified, and some measure of its quality (its reliability) can be assigned;
- Is one of the following information formats: book, report, gray literature, periodical, journal article, NPS reference material, dataset, or map; and
- Is not a voucher specimen collected at a network park, that is, the network will not house, manage, or curate specimens.

In summary, the network is unable to acquire and manage all types of information. Referring to national and network policies provides guidance as to the types of information, including content and format, on which the network will focus.

4.2. Quality Assurance and Control

Inaccurate, erroneous, or corrupt data or information can be worse than no information at all. Quality Assurance/Quality Control (QA/QC) mechanisms are designed to prevent error, which is the difference between an observed value, the recorded value, and the actual value. Inadequate QA/QC can result in three types of error. One type is commission, caused by data-entry or transcription errors, or malfunctioning equipment. These errors are common, generally identifiable, and can be effectively reduced with appropriate QA mechanisms built into the data-acquisition process, as well as QC procedures applied after the data have been acquired. Another type of error is omission, resulting from missing values or insufficient documentation of legitimate data values, which could affect the interpretation of those values. These errors can be resolved through QA procedures to identify missed values and QC procedures for documenting the steps of a data-collection process. Finally, errors of logical consistency refer to the

inconsistency of relationship among different features. Examples include trees that shrink through time, roads found on lakes, and other illogical measurements. These logical errors may result from inconsistencies in measurement and scale or differing definitions of the variables being measured. They can also be the result of errors of commission. Logical errors are the most difficult to detect because they are often context-sensitive and subtle. For instance, trees can shrink in size following a fire and roads can occasionally be found over lakes as bridges (and under lakes during unusually wet years!). Proper QC procedures will help identify measures that may be logically inconsistent.

4.2.1. National Guidance

National guidance related to information quality is found primarily in NPS Director's Order 11B (NPS 2002). This order specifies that data must be:

- Reliable. Information must be developed from reliable data sources and quality must be ensured at each stage of information development (NPS 2002);
- Accurate and timely. All information will be accurate, timely, and reflect the most current data available. All information sources will be documented (NPS 2002).

4.2.2. Network Guidance

In addition to the national guidance, the ROMN requires that data be:

- Verified to establish the truth, accuracy, or reality of data (e.g., data verification checks for errors of commission). Examples of this include development of database picklists that prevent transcription errors and cross-checking field forms with computer entries.
- Validated to check for errors of logical consistency. Validation is most easily accomplished by working with the protocols and projects to develop queries that test for illogical answers.
- Made decipherable so that it can be fully interpreted without ambiguity. This protects directly against errors of omission. Ensuring that data are easily interpreted and unambiguous is only possible if all supporting information (i.e., methods, codes, and data relationships) are clear and understandable.

Likewise, the network will assure and control quality through the implementation of the following SOPs:

- Standard file-naming conventions (NPS–ROMN 2007h): Provides consistent rules for how to name any digital file, accommodate data versions, and differentiate between draft and final;
- Standard directory structure (NPS–ROMN 2007f): Provides consistent rules for how the structure is to evolve through time;
- QA/QC Procedures (NPS–ROMN 2007k): Provides specific step-by-step guidance on how to effectively QA/QC network information.

4.3. Document

The careful documentation of datasets, the data source(s), and the methodology by which the data were collected or acquired is essential for preserving information over the long-term. Documentation also establishes the basis for the appropriate use of the data in resulting analysis and products.

4.3.1. National Guidance

Executive Order 12906 (EO 12906) mandates all federal agencies to:

- Fully document all new geospatial data collected or produced, either directly or indirectly, using Federal Geographic Data Committee standards (FGDC 2006);
- Document, to the best practical extent, all geospatial data previously collected. This policy applies to all legacy geospatial data.

The Federal Geographic Data Committee (FGDC 2006) provides guidance on a number of standards, including those specific to the information generated by the network:

- Content Standard for Digital Geospatial Metadata (CSDGM): The objectives of the standard are to provide a common set of terminology and definitions for the documentation of digital geospatial data. The standard establishes the names of data elements and compound elements (groups of data elements) to be used for these purposes, the definitions of these compound elements and data elements, and information about the values that are to be provided for the data elements.
- Federal Geographic Data Committee (FGDC) Biological Data Profile: The objective of the profile is to provide a common set of terminology and definitions for the documentation of biological data through the creation of extended elements and a profile of the FGDC Content Standard for Digital Geospatial Metadata.

A final requirement, from the NPS GIS Committee (NPS 2006d), requires that all GIS data layers be described using FGDC standards (FGDC 2006) and the NPS Metadata Profile (NPS 2006c).

4.3.2. Network Guidance

In addition to the national policies, the network will:

- Ensure that all documents, including reports, news articles, and letters, in final form (i.e., not draft) will have a cover page that clearly indicates the author(s), year of publication, title, and publisher;
- Document all tabular datasets, regardless of whether they meet the FGDC standards (FGDC 2006) for geospatial datasets;
- When possible, bundle all datasets, reports, protocols, metadata, and any other supporting documents as one archive;
- Use XML as the common documentation format; and
- Build documentation into all stages of a project life-cycle model.

These national and network policies are implemented through the following SOPs:

- Documentation (NPS–ROMN 2007g): Specifies how to document datasets, documents, and photographs, and how to bundle them together to preserve context and the supporting documentation necessary for the interpretation of the datasets.
- Project Manager (NPS–ROMN 2007m): Provides the means to keep notes of a project. Theses notes may contribute to the documentation of a dataset.
- Archive Format Standards (NPS–ROMN 2007c): Provides basic guidance for creating archives intended for long-term storage and distribution of network data.

4.4. Determine Sensitivity and Ownership

Network staff will need to regularly evaluate information for conflicts related to sensitivity and ownership.

4.4.1. National Guidance

At the national level the following rules and regulations apply to, and must be included in, all agreements with outside parties for research, monitoring, or protocol development. In short, these guidelines ensure that all data acquired via public funding belongs to the people of the United States. U.S. Office of Management and Budget (OMB 1999) guidance, particularly sections 36 “Intangible Property” and 48 “Contract Provisions”, mandates that the NPS:

- Reserve a royalty-free, nonexclusive and irrevocable right to reproduce, publish, or otherwise use the work for Federal purposes, and to authorize others to do so (Section 36);
- Has the right to obtain, reproduce, publish or otherwise use the data first produced under an award; and authorize others to receive, reproduce, publish, or otherwise use such data for Federal purposes (Section 36);
- Shall request, and the recipient shall provide, within a reasonable time, the research data (Section 36); and
- Shall include contract provisions or conditions that allow for administrative, contractual, or legal remedies in instances in which a contractor violates or breaches the contract terms in relation to data ownership (Section 48).

The Freedom of Information Act (FOIA; US-DOI 2006) restricts general public accessibility to:

- Geological and geophysical information and data concerning wells;
- The nature and specific location of (a) endangered, threatened, rare, or commercially valuable species, (b) minerals or paleontological objects, or (c) objects of cultural patrimony;
- The nature and location of any archaeological resource for which the excavation or removal requires a permit or other permission; and
- The specific location of any significant caves.

FOIA also specifies that all non-sensitive information be fully accessible to the public.

4.4.2. Network Guidance

At the network level, there is an additional level of policy with regard to the ownership and sensitivity of data. Determining whether data falls under the purview (ownership) of the network or of one of the member parks is essential because it determines which organization has the responsibility to make this information available to the public and who will respond to questions concerning its source, meaning, accuracy, and implications. To preserve ownership, the network will ensure that:

- Copyrighted documents (e.g., publications resulting from research in parks) will not be posted or distributed unless written permission is provided by the copyright holder;
- Data generated in a park, by park staff, or via park-funded research projects remains the property of the park. Use of the information will be granted to the network in cases where it supports resource inventory and monitoring; however, public release of the information will be reserved to the park;
- Data acquired or generated by the network outside of the member parks is the property of the network. These data will be available to park staffs via internet, intranet, and/or other means;
- Information developed from analysis and summarization by network staff or cooperators is the property of the network;
- The network will not distribute anything it does not own unless its dissemination has been previously approved by its constituent parks, and any other information owner or copyright holder;
- All cooperative or interagency work will be conducted as part of a signed collaborative agreement. Every cooperative or interagency agreement or contract involving the network will cite OMB Circular A-110 (OMB 1999) under the Reports and Deliverables Section of all agreements and contracts; and
- Cooperative or interagency agreements or contracts must include a clearly defined list of deliverables and products. Details on formatting and media types that will be required for final submission must be included. Typical products include, but are not limited to, field notebooks, photographs (hardcopy and digital), specimens, raw data, and reports. All reports and deliverables will follow the current version, at the time of the agreement, of the network specifications for project deliverables (NPS–ROMN 2007n).

The issue of sensitivity will be interpreted according to which organization will be most damaged by the accidental dissemination of sensitive information. To maintain sensitive information, the network will ensure that:

- Decisions involving the sensitivity of data (i.e., threatened, endangered, rare, or commercially valuable park resources) remain the responsibility of the relevant park;
- Reports, maps, analytical documents, or datasets will not be released by the network to the general public without approval by the relevant park's assigned agent; and
- Information to be used in pending litigation will be treated as sensitive.

Sensitivity and ownership policies are implemented through the Approving Information for Distribution (NPS–ROMN 2007b) standard operating procedure, which provides

decision points for whether data are sensitive and/or copyrighted and whether it is suitable for public distribution or available to select individuals only.

4.5. Archive and Store

The network will develop a storage system to accommodate a large volume of information. In most cases, the information will be in digital format, but analog copies—especially of historic documents—are sometimes the primary source of information. Where information is secured also depends on whether it relates to sensitive species and/or locations.

4.5.1. National Guidance

The NPS differentiates between records and mission-critical records. Records are all documentary materials, including books, electronic data, maps, moving images, papers, photographs, and sound recordings, made or received by the National Park Service during the transaction of public business (NPS 2001a).

- Mission-critical records are those records that are most necessary for fulfillment of the NPS mission (NPS 2001a). Mission-critical records are permanent records that will eventually become archival records. They should receive the highest priority in records-management activities, and resources and should receive archival care as soon as is practical in the life of the record. Mission critical records include:
- All records of natural and cultural resources and their management that contain information that affects the future management of the resource,
- General management plans and other major planning documents that record basic management philosophies and policies, or that direct park management and activities for long periods of time,
- All land records regarding legal title, rights, and usage of NPS lands; and
- Any records that directly support the specific legislated mission of a park unit in addition to, or distinct from, the overall NPS mission.

In addition, national guidance directs the NPS to:

- Follow the Records Retention Schedule. All NPS records must be retained for the amount of time specified by the NPS Records Retention Schedule. The schedule for all types of documents is covered in Director's Order 19-B (NPS 2001b);
- Store all records in areas that have the lowest possible risk of damage (NPS 2001a); and
- Permanently maintain original copies of natural resources information, including records related to animal and plant life. Document copies are to be held for 30 years and then transferred to the National Archives (NPS 2001b Section N).

4.5.2. Network Guidance

Network data maintenance, storage, and archiving procedures aim to ensure that data and related documents and materials (digital and analog) are protected against loss,

environmental hazards, catastrophe, and human malice; and archived in a manner that expedites recovery. Implementation instructions for the archiving policies are found in the following SOPs:

- Directory Structure (NPS–ROMN 2007f): Ensures that files are consistently, logically organized and easily accessible by all network staff.
- Network Backup (NPS–ROMN 2007d): Outlines steps to ensure that all digital information found on the network server is protected from accidental and deliberate loss.
- Photo Management (NPS–ROMN 2007l): Details how photographs are to be managed.
- Archive Format Standards (NPS–ROMN 2007c): Describes the steps for bundling data, photographs, and documents together into one zipped archive.

4.6. Catalog

Although there is not a single master cataloging system for data discovery, the network will use such systems when appropriate, with the goal of simplifying the search process.

4.6.1. National Guidance

National guidance directs the NPS to:

- File in a manner that is coherent, organized, and not random, haphazard, or handled solely by individual employees (NPS 2001b);
- Use NatureBib (NPS 2006e) to track natural resource bibliographic citations;
- Use NPSpecies (NPS-2006g) to track the scientific information on the biodiversity of all organisms in all national park units;
- Use the NPS Data Store (NPS-2006f) to catalog metadata and associated geospatial data; and
- Use ANCS+ (NPS-2006a) to catalog museum collections

4.6.2. Network Guidance

The network will:

- Keep up-to-date records such that the data can be easily accessed and their heritage and quality easily learned;
- Use Project Manager (NPS–ROMN 2007m) to track all network projects and their related files; and
- Use the FGDC-compliant metadata in xml format to track all datasets.

Further implementation of the network's cataloging policies are found in the following SOPs:

- Standard file-naming conventions (NPS–ROMN 2007h): Provides consistent rules for how to name any digital file, accommodate data versions, and differentiate between draft and final; and

- Standard directory structure (NPS–ROMN 2007f): Provides consistent rules for how the structure is to evolve through time.

4.7. Analyze and Report

Some common purposes of ROMN analysis include:

- Determining patterns/trends in status and trend;
- Discovering explanatory mechanisms, characteristics and correlations among information;
- Providing context or scale for a particular pattern or trend;
- Recommending changes to information management; and
- Presenting information in a manner that is readily communicated.

4.7.1. National Guidance

National guidance directs the NPS to:

- Report all non-sensitive geospatial metadata to the National Geospatial Data Clearinghouse (US-Gov 1994);
- Report all water quality data collected to NPSTORET (NPS 2006h), the NPS equivalent to EPA's STORET, according to the guidelines from the NPS Water Resources Division.

4.7.2. Network Guidance

The Network will:

- Use sound scientific analyses that are defensible in peer review and court. These must be definitive and defensible to shortstop public misperceptions and prevent or curtail costly interruptions to the Agency's management investments;
- Use the internet and intranet as the main mechanisms for distributing information;
- Promptly provide all reports to park natural resource managers, the Network's Technical Committee (TC), and Board of Directors;
- Prepare reports that are understandable and useful to its primary audience: park resource managers, administrators, facilities management, and interpreters and public affairs officers;
- Use graphical methods when possible that promote the understanding and interpretation of the information;
- Only release datasets and reports that have been subjected to full QA/QC;
- Distribute information with appropriate documentation that accurately and clearly defines the information and establishes the data as a product of the NPS I&M program.
- As much as possible, use presentations, posters, brochures, and for communication.

These guidelines are implemented through:

- Archive Format Standards (NPS-ROMN 2007c) – Specifies how information is to be bundled for distribution
- Quality Assurance and Control (NPS-ROMN 2007k)– Ensures that all information is checked for quality and accuracy

- Documentation (NPS-ROMN 2007g) – Details how to adequately document datasets, photographs and documents that are intended for distribution.

5. Rocky Mountain Network Project Life-Cycle Model

This section details the network's vision for project management, given a lack of national standards and policies (see Section 2.2). This section is written for all projects, recognizing that they can range in level of complexity, network input, and time. When possible and practical, it follows the Project Management Institute standards and terminology for project management, as articulated in the Project Management Body of Knowledge, PMBOK (PMI 2004). The steps and critical elements will aid in creating projects that successfully accomplish their goals, are realistically scheduled and budgeted, and are relatively easy to manage. These steps and elements will always be considered, and should be adopted at every possible opportunity.

5.1. Initiate

Projects exist to fulfill a need, for example: to create a database to contain the data collected during grassland monitoring, to plan for a season's field operations, to make more efficient use of office space, or to develop general and specific safety protocols for field crews. These needs can be developed from several sources—internally (vital signs monitoring), requested via the park support operation, or from other sources (WASO). In all cases, it is important to clearly identify the primary beneficiaries from the proposed project.

A network lead will be assigned to work with the beneficiaries in developing the background for the project and a general scope of work and objectives. The network lead will serve as the ROMN's primary representative and point of contact. In most cases, this person will also serve as the project manager. The general scope of work constitutes a statement of what is intended to be accomplished, a general budget for the project, and a simple description of what deliverables it will have. This will result in a descriptive document, or "charter," accepted by the parties involved.

The final phase of the initiation step involves competing for funding. The details of the various funding sources are included in respective SOPs for Administrative Operation. However, in a broader sense, every allocation of network resources, including personnel time and travel, will be included in the calculation. The competition for resources and funding will involve establishing priorities and taking the resulting list of projects in order.

5.2. Plan

The network differentiates between minor and major projects. Projects that involve significant allocation of either staff time or money will be considered major projects. If a major project is funded, a team will be created involving park contacts (if the project involves the parks) and third-party contacts (if they are involved either as working crew or beneficiaries). This team is responsible for producing a detailed scope of work and objectives, including a clear, concise statement of what is to be accomplished, detailed budgets, and a complete list of deliverables. In addition, any contracts, agreements, research permits, or permissions required by the project should be completed and signed.

Many kinds of projects may reach this stage. Those that are repetitive will be covered in individual SOPs, such as the Software Development SOP (NPS–ROMN 2007p) or annual field work for each protocol (Field Season Data Handling; NPS–ROMN 2007r). However, most projects, major or minor, require documents and resources developed in the planning process to be available during the implementation phase. If other, minor projects (such as database development) are created that must be completed before implementation of a major project, sufficient time must be allocated.

In every case, a schedule for the project will be created. Minor projects will only require a simple timeline. Major projects will benefit from a work breakdown structure (WBS), PERT (Program Evaluation and Review Technique) charts or Critical Path Method (CPM) plotting. These control techniques greatly aid in keeping projects on time and on target. Useful examples of these tools are found in the PMBOK (PMI 2004).

5.3. Implement

Project execution and control make up the implementation step. Execution consists of carrying out the tasks defined in the planning phase. Control consists of feedback to the schedule to account for variances from expected accomplishment goals as well as errors and omissions in the planning phase (e.g., the field team needs three tapes instead of one or there is no place to record water temperature in the field form). It will be necessary for the project manager to assess the feedback from the execution phase and make any necessary modifications to ensure project completion. In cases where significant variances exist and modifications are required, it will be necessary to document these changes.

5.4. Close

The following items, when available, are required at project close:

- Final reports
- Datasets and metadata
- Other defined project deliverables

5.5. Organization

To accommodate the project life-cycle model and clearly distinguish finalized information from planning and field work, all information for a particular project will be organized in a manner that clearly represents the various project phases, thereby preserving the temporal element to the creation of information and preventing planning/preliminary information from being confused with the final version.

6. Roles and Responsibilities

Data management is a process characterized as much by attitudes and habits as by infrastructure, standards, and procedures. Although primary responsibility resides with the data managers, good data stewardship cannot be accomplished by data managers alone; it is truly a collaborative endeavor that involves many people with a broad range of tasks and responsibilities. As such, a valid data-management system must be developed and continually modified to meet the needs of everyone with a role in coordinating, generating, maintaining, and using natural resource information in its many forms. This is a diverse group made up of network and park staff and other cooperators (Table 6.1). A successful data-management system is maintained by reinforcing communication, awareness, and acceptance among everyone with responsibilities related to the origin, quality, disposition, and use of the data.

Organization	*Position*	*Data Stewardship Responsibilities*
ROMN	Data Manager	Ensure inventory and monitoring data are organized, useful, compliant, safe, and available; development data management policies and procedures
ROMN	Ecologist	Oversee and direct certain protocols, analyze data, report results
ROMN	Program Manager	Coordinate and oversee all network activities, ensure adequate data management resources are available for network activities, enforce data management policies, report monitoring results,
ROMN cooperator or temp. staff	Field Crew Member	Collect, record, and verify data
ROMN cooperator or temp. staff	Ecologist/Crew Leader	Train and supervise crews in field data collection, organize and QA/QC field data, prepare summary statistics and reports for each field season
ROMN cooperator or temp. staff	Geospatial Analyst	Process and manage data
ROMN cooperator or temp. staff or ecologist	Protocol or Project Leader	Oversees and directs project, including data management
ROMN or ROMN cooperator	Database Application Developer	Know and use database software and database applications
Park	Natural Resource Managers and Specialists/Ecologists/Biologists/Hydrologists	Inform the scope and direction of science information needs and activities. Validate and make decisions about data. Integrate science in park and network activities.
Park	GIS Coordinator (or is this the geospatial analyst?)	Support park management objectives with GIS and resource information management
Park	Curator	Oversee all aspects of specimen acquisition, documentation, and preservation, and manage the park collections

Park	Park Research Coordinator	Facilitate data acquisition by external researchers. Communicate NPS requirements to permit holders.
Park	End Users (Superintendents, Resource Managers, Interpreters, Rangers, Facility Managers, etc.)	Inform the scope and direction of science information needs and activities. Interpret information and apply to decisions.
WASO	I&M Data Manager (National level)	Provide Service-wide database availability and support
WASO cooperator	NRPC Information Technology Specialist	Provide IT support for hardware, software, networking
Other agencies and academia	Scientists	Inform the scope and direction of science information needs and activities. Interpret results.
ROMN Tech. Comm.	Natural Resource Managers and Research Coordinators	Inform the scope and direction of science information needs and activities. Interpret results.
ROMN Board of Directors	Park Superintendents and Managers	Inform the scope and direction of science information needs and activities.
ROMN Science Panel	Scientists	Inform the scope and direction of science information needs and activities (during VS planning) in the context of current scientific research and knowledge of park ecosystems.

Table 6.1. Common Data Management Responsibilities by Position.

Although numerous positions share responsibility for data management, the chief personnel involved with data management include the network coordinator, project manager, and data manager. The network coordinator interacts with project leaders to ensure that timelines for data entry, validation, verification, summarization/analysis, and reporting are met. The project manager is responsible for the complete oversight of his/her respective project, including being involved in each step of the project and communicating with the data manager regarding network standards. The data manager is responsible for the development, maintenance, and enforcement of all data-management policies and procedures within the network, which requires being up-to-date with national policies and also understanding what is reasonable for network staff to follow. The data manager is also responsible for assisting and guiding the project manager during all stages of a project, from planning and database design to organizing and managing the project information, to reporting. Finally, the data manager is responsible for working with the network coordinator to ensure that adequate resources are made available for the management of all project- and network-level data.

7. Conclusion

The purpose of the ROMN Data and Information Management Plan is threefold. First, it provides a general framework and vision, articulated by the models described in Section 2. The plan further describes each of the data management model steps and any associated national and/or network policies. Finally, the plan provides a hierarchical structure that accommodates both vision and detail. The plan is general, theoretical and visionary, while each operation and its respective SOPs are practical and detailed.

7.1. Implementation

Because this plan reflects and formalizes the information management processes that have evolved in the network since its inception, implementation will be immediate. However, it will occur as an ongoing evolution as a product of learning, testing, refining, and technology changes. This plan is seen as a living, changing, tool to aid in preserving and protecting the information required for successful long-term monitoring of the network's constituent parks. Therefore, more SOPs, representing specific, data-related tasks, will be developed, tested, and adopted to reflect this evolution. We anticipate that there will be bottlenecks, the identification and elimination of which is an important element in the implementation of this plan.

Short-term (years 1–3) goals for implementation include:

- Ensuring that all network staff understand the core plan and operations,
- Empowering network staff to provide feedback, and
- Developing working SOPs that reflect the policies established in this plan.

Long-term (years 3+) goals for implementation include:

- Streamlining and standardizing the plan and SOPs within the network,
- Sharing SOPs and concepts among other networks, and
- Adapting the plan and SOPs to changing technologies and accepted practices.

7.2. Review and Revision

To determine whether these procedures are followed through time, the plan, operations, and SOPs have a periodic evaluation cycle. This plan, which describes the conceptual models, operations, and policies, will be slowest to change and, therefore, will require the least-frequent review. In contrast, SOPs, which are detailed and written to specific hardware, software, and data formats, will require frequent review and revision. How often the documents describing the network operations are modified falls somewhere in between.

During these evaluations, staff will review the documents for two qualities: adherence to the procedures and overall success of managing the information. Figure 7.1 provides a continuum of possible scenarios and actions following the review, in which the X-axis reflects how closely staff followed the policies and procedures and the Y-axis indicates the ultimate success of managing the information.

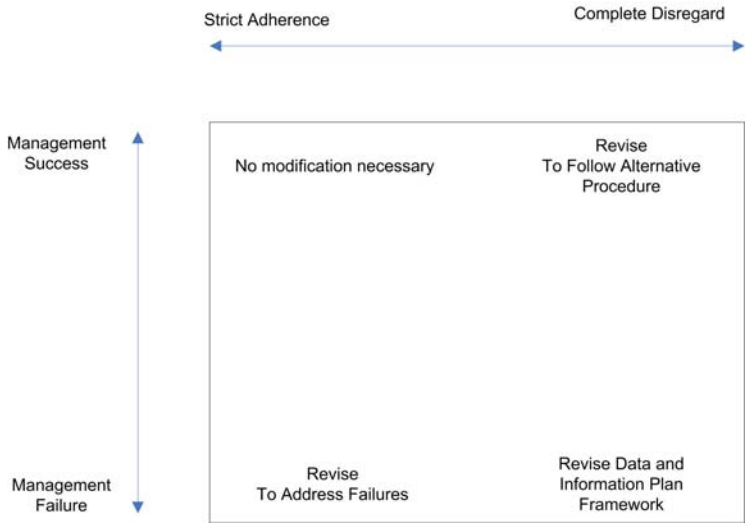

Figure 7.1. Continuum of Possible Outcomes to the Implementation of the Data and Information Management Plan, Operations, and SOPs

Because all of the network documents will be regularly updated, it will be essential to account for changes via versioning. Every document will contain a version number. Version numbers will be incremented by one (e.g., Version 1.3 to Version 2.0) each time there is a significant change in process and/or changes affect the interpretation of the data. Version numbers will be incremented after the decimal (e.g., Version 1.6 to Version 1.7) when there are changes to grammar, spelling, or formatting, or minor changes in process that do not affect the interpretation of the data. In addition, each document will contain a modification date and "change log" table which tracks the following:

- Original Version Number: Indicates which version was modified;
- Date of Revision: The date the new revision is approved by network staff;
- Revised By: Primary author/contact;
- Changes: Description of changes, including how it will affect the interpretation of data;
- Justification: Why the change was necessary; and
- New Version #: Indicates the new version number (this ensures that there are not any gaps in notation between versions).

The change log for this document is found in Section 10.

7.3. Relationship with the Monitoring Plan

On a final note, this plan is intended to be a stand-alone document in support of the network, the monitoring plan, and each monitoring protocol the network produces. Chapter 6 of the network monitoring plan is a brief synopsis of data and information management. Each monitoring protocol will also include a data-management section detailing how to protect and preserve the pieces of information that are collected. As much as possible, these sections will reference the core data-management SOPs.

8. Definitions

- **Books** – Any bound publication with a designated library of congress number;
- **Data** –The original information collected from the field. When used with a plural verb indicates individual facts, statistics, or items of information. If used with a singular verb it means a collection of facts or particulars, information. Usage:

  > "Data are a plural of datum, originally a Latin noun meaning 'a thing given'. Today, Data are used in English both as a plural noun meaning 'facts or pieces of information' (*These data are described on page 8.*) and as a singular noun meaning 'information'." "It is almost always treated as a plural in scientific or academic writing, as a singular or plural elsewhere depending on the context." (Random House Webster's College Dictionary, 2nd Edition, 1997)

- **Decipher** - to make out the meaning of despite indistinctness or obscurity **b :** to interpret the meaning of
- **Error** - the difference between an observed or calculated value and a true value; specifically : variation in measurements, calculations, or observations of a quantity due to mistakes or to uncontrollable factors b : the amount of deviation from a standard or specification (Merriam Webster, 2006)
- **GIS Data** – Spatial and tabular information that is of a format that can be read and projected directly onto a digital map. Formats include, but are not necessarily limited to shapefiles, coverages, relational database tables, geodatabase feature classes and tables, tab-delimited text files, grids, geo-tifs, MrSid, and Imagine images.
- **Information** –

  > "1. knowledge communicated or received concerning a particular fact or circumstance." "7. computer data at any stage of processing, as input, output, storage, or transmission." (Random House Webster's College Dictionary, 2nd Edition, 1997)

- **Information Technology** – the infrastructure needed to move large quantities of digitized information in an efficient and secure manner from one place or person to another
- **Operation** – A system of related procedures that function to support the fundamental needs of the Network. An operation is implemented through a protocol or other document giving a general description of its elements and functions, linked to standard operating procedures (SOPs).
- **Protocol** –

  > "6. a plan for carrying out a scientific study or patient's treatment." "7. a set of rules governing the format of messages that are exchanged between computers." (Random House Webster's College Dictionary, 2nd Edition, 1997)

- **Quality** - degree of excellence; superiority in kind (Merriam Webster, 2006)
- **Quality Assurance** - a program for the systematic monitoring and evaluation of the various aspects of a project, service, or facility to ensure that standards of quality are being met (Merriam-Webster, 2006), generally used to refer to methods of ensuring quality during data generation and acquisition.
- **Quality Control** - an aggregate of activities (as design analysis and inspection for defects) designed to ensure adequate quality especially in manufactured products (Merriam-Webster, 2006), generally used to refer to checking acquired data for accuracy and completeness.
- **Reliable** - giving the same result on successive trials

- **Standard Operating Procedure (SOP)** – Detailed step-by-step methodology to accomplish a specific data management task.
- **Reports & Gray Literature** – Documents that summarize research or are completed to fulfill legal or procedural requirements (e.g., NEPA or planning documents);
- **Periodicals** – Published with a fixed interval between the issues that frequently have an editor and a series of reports/articles from separate authors. Falling under this category are NPS bulletins;
- **Journal Articles** – Peer-reviewed articles that are distributed through periodicals;
- **NPS Reference Materials** – Publications created by the NPS for general reference
- **Validate** - to support or corroborate on a sound or authoritative basis
- **Verify** - to establish the truth, accuracy, or reality of (Merriam Webster, 2006)

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10. Change History

Table 10.1 provides the ability to document change to the Plan. All documents, including those related to operations and specific SOPs, will contain this table.

Original Version #	Date of Revision	Revised By	Changes	Justification	New Version #
1.0					

Table 10.1. Change History for the Network Information Management Plan

Version numbers will be incremented by one (e.g., Version 1.3 to Version 2.0) each time there is a significant change in the process and/or changes are made that affect the interpretation of the data. Version numbers will be incremented after the decimal (e.g., Version 1.6 to Version 1.7…1.10….1.21) when there are changes to grammar, spelling, or formatting, or minor modifications in the process that do not affect the interpretation of the data.