

Appendix J. Data and Information Management Plan for the Mojave Desert Network

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Topic

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Acronyms

DMP - Data and Information Management Plan

DEVA - Death Valley National Park

GRBA - Great Basin National Park

I&M - Inventory & Monitoring

JOTR - Joshua Tree National Park

LAME - Lake Mead National Recreation Area

MANZ - Manzanar National Historic Site

MOJA - Mojave National Preserve

MOJN – Mojave Desert Network

PARA – Grand Canyon-Parashant National Monument

Acknowledgments

Many people have contributed to the production of this plan. The overall plan outline and components of all chapters were developed by the Inventory and Monitoring Program Data Management Planning Workgroup. The authors wish to thank all subsequent plan workgroups that contributed their thoughts and materials generously and without concern for credit. The collaboration of network data managers has been a highlight of producing this plan, and sets a precedent for cooperation in the data management tasks we all face in the upcoming years.

The authors thank the national-level Inventory and Monitoring Program data management team, who have provided the vision and created the tools that are essential to our work. In particular, Lisa Nelson, Danelle Malget, Chris Dietrich, Willene Hendon, Joe Gregson, Wendy Schumacher, Mark Wotawa, Simon Kingston, and Alison Loar have all provided outstanding technical support, and have been patient and open-minded in addressing our questions and suggestions.

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This plan would not have been what it is without the combined collaboration and tireless work of the network's data mining team, the Lake Mead NRA GIS staff, and the effort initiated by Craig Palmer (UNLV), the first MOJN Data Manager.

Finally, we want to thank Steve Fancy for his unwavering commitment to data management in the National Park Service.

Executive Summary

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood,
and I— I took the one less travelled
by, And that has made all the
difference –Robert Frost

The road not taken (Frost 1916)



Data management has been adopted traditionally through attrition (Brunt et al. 2002). With the implementation of the Natural Resource Challenge and the subsequent Inventory and Monitoring Program (I&M), the National Park Service (NPS) has instituted a process to mitigate that tradition. A cornerstone of the I&M Program is the strong emphasis placed on data management. All I&M networks, including the Mojave Desert Network (MOJN), expect to invest at least thirty percent of their available resources in data management. The MOJN Data and Information Management Plan (DMP [this document]) is one element in the network’s effort to integrate high-quality data and information management into the I&M program.

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 “knowledge communicated or received concerning a particular fact or circumstance” to “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), which in turn translates into knowledge that we apply to manage the NPS lands that we are entrusted with as stewards. Therefore, it addresses pieces of information, the processing and preservation of those pieces, and the communication of knowledge derived from those pieces (Figure 1).

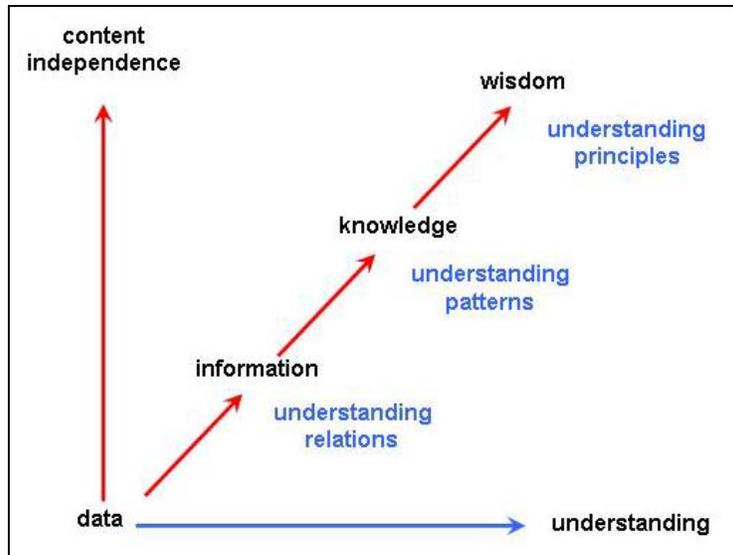


Figure 1. Understanding data (Bellinger 2004)

The central mission of the NPS I&M Program is to provide timely and usable scientific information about the status and trends of park resources to park managers. To meet this challenge, we need a data and information management system that can effectively produce, maintain, and distribute the products (knowledge) of scientific work done in our parks. Information is the common currency among the activities and staff involved in natural resource management in the NPS.

National Park Service Mission

The National Park Service preserves unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education and inspiration of this and future generations...

Good data management is the means by which a thorough understanding of the value of scientific data and information about our natural resources can become a part of our National Park Service heritage. Management of data and information refers to the framework by which data are acquired, maintained, and made available. Data management is not an end unto itself, but instead is the means of maximizing the quality and utility of our natural resource information. A robust system for data management is particularly important for long-term programs where the lifespan of a dataset will span the careers of several scientists. Seen in this way, it becomes obvious that data management is vital to the success of any long-term monitoring initiative.

The overarching goal of MOJN data management systems is to provide timely and usable scientific information about the status and trends of park resources to park managers. The success of our program hinges upon our ability to produce, manage and deliver this information, and the subsequent knowledge derived, to its intended audience. Our strategy for achieving this goal can be summarized as follows: ensure the quality, interpretability, security, longevity, and availability of our natural resource data. In implementing a data and information management system we will strive for the following:

- Confidence in the security and availability of natural resource data and related information
- Easy access to most information, and appropriate safeguards for sensitive information
- Awareness of the intended use and limitations of each dataset
- Infrastructure and documentation that encourages data exploration
- Compatibility of datasets for exploration and analysis at larger scales and across disciplines
- Implementation of standards and procedures that facilitate information management, and that reinforce good habits among staff at all levels of project implementation – project leaders, technicians, and volunteer data collectors
- A proper balance between the standards needed to ensure quality and usability, and the flexibility to meet specific needs and encourage innovation
- A natural resource culture which views data not as a commodity but as the lifeblood of our work

This plan outlines how we intend to implement and maintain a system that will serve the data and information management needs of MOJN. This plan reflects our commitment to establishing and maintaining a robust system for data management to ensure the availability and usability of high-quality natural resource information.

This plan and supporting documentation (Standard Operating Procedures, SOPs) describes how our network will:

- support I&M Program objectives
- acquire and process data
- assure data and information quality
- document, analyze, summarize, and disseminate data and information
- maintain nationally-developed data management systems
- maintain, store, and archive data

The goal of the MOJN's data management program is to maintain, in perpetuity, the ecological data, information, and knowledge that result from the network's resource I&M work. This plan is to describe the resources and processes required to ensure the following standards for data acquired or managed by MOJN:

- *Accuracy*: The quality of the data collected and managed by the I&M Program is paramount. Analyses performed to detect ecological trends or patterns require data with minimal error and bias. Inconsistent or poor-quality data can limit the detectability of subtle changes in ecosystem patterns and processes, lead to incorrect interpretations and conclusions, and could greatly compromise the credibility and success of the I&M Program. To ensure that MOJN produces and maintains data of the highest possible quality, procedures are established to identify and minimize errors at each stage of the data lifecycle.

- *Security*: Digital and hard-copy data must be maintained in environments that protect against loss, either due to electronic failure or to poor storage conditions. MOJN digital data are stored in multiple formats on a secure server, and are part of an integrated backup routine that includes rotation to off-site storage locations. In addition, MOJN is working with NPS museum curators and archivists to ensure that related project materials such as field notes, data forms, specimens, photographs, and reports are properly cataloged, stored, and managed in archival conditions.

- *Longevity*: Countless datasets have become unusable over time either because the format is outdated (e.g., punchcards), or because metadata is insufficient to determine the data's collection methods, scope and intent, quality assurance procedures, or format. While proper storage conditions, backups, and migration of datasets to current platforms and software standards are basic components of data longevity, comprehensive data documentation is equally important. MOJN uses a suite of metadata tools to ensure that datasets are consistently documented, and in formats that conform to current federal standards.

- *Usability*: One of the most important responsibilities of the I&M Program is to ensure that data collected, developed, or assembled by MOJN staff and cooperators are made available for decision-making, research, and education. Providing well-documented data in a timely manner to park managers is especially important to the success of the program. MOJN must ensure that:
 - data can be easily found and obtained
 - data are subjected to full quality control before release
 - data are accompanied by complete metadata
 - sensitive data are identified and protected from unauthorized access and distribution

The MOJN's main mechanism for distribution of the network's I&M data will be the World Wide Web, which will allow data and information to reach a broad community of users. As part of the NPS I&M Program, web-based applications and repositories have been developed to store a variety of park natural resource information (Table 1).

The MOJN's information acquires its real value when it reaches those who can apply it (Figure 1 above). If the web portals listed below (Table 1) do not meet a specific user's requirements, MOJN data management staff will work with users on an individual basis to ensure receipt of the desired information in the requested format.

Table 1. Data that are provided on the MOJN and national I&M websites.

Web Application Name	Data available at site
NPSpecies	Database of plant and animal species known or suspected to occur on NPS park units and as a species keyword search for reference materials (NPSpecies Home Page).
NatureBib	Bibliography of park-related natural resource information (NatureBib Home Page).
NPS IRMA	Portal to a variety of NPS information sources; will include NPSpecies, NatureBib and NPS Data Store links.
NPS Data Store	Park and network -related metadata and selected datasets (spatial and non-spatial) (NPS Data Store Home Page).
NPSstoret	Database for water quality assessment (NPSstoret home page)
MOJN Websites	Through the use of the network's inter- and intra-net web sites and the use of MS SharePoint, reports, summaries, outreach materials, as well as other monitoring data and information for MOJN projects and tools for data; data downloads; database templates will be made available (MOJN Home Page)

Data Management Plan Model

Network data management plans have been written as an iterative process. Each of the networks has been placed into one of four groups, each group submitting their plans in a subsequent year. As each group of network data managers has submitted a draft plan, the groups have worked to identify and synthesize the salient elements of a complete plan. The first group of network data managers worked collaboratively to develop a plan, with 1-2 data managers working on each identified chapter of the plan. The second and third groups of data managers built off the initial work to fill gaps, revise materials, and build a sound set of chapters, ultimately developing a model that is comprehensive. Unfortunately, the resulting network plans are large (therefore discouraging for others to read and implement) and redundant (each network plan discusses the legal mandates, policies, and general data stewardship guidelines).

The last group of data managers have designed and written their plans around a new model for the data management plan. Instead of each network plan containing the same redundant materials (adding to its length) and necessitating that each network update its plan based upon new national guidance and legal mandates, the new model proposed:

- To produce a national-level data management plan guidance document that maintains the overarching documentation (what and why concerning data/information stewardship) and legal mandates relevant to each plan, and can be easily referenced in the development of a network data management plan.
- To produce a new network-level data management plan that is more applicable (how and when concerning data/information stewardship), easily understood, and does not require the lengthy background documentation and legal mandates.

The MOJN plan is written using this new model. For information concerning the national guidance and legal mandates refer to the draft national plan (National Park Service 2008). The network's implementation of that material is contained in this document and the supporting documentation (management sections and SOPs).

This plan is written as both a stand alone document and as a support document for the network's Final Vital Signs Monitoring Plan (Chung-MacCoubrey et al. 2008), for the management of data as well as the subsequently-produced information and knowledge. The plan by itself would be too daunting of a tome to be used or applied (as seen by the plans already developed by the preceding 26 I&M networks) by anyone other than the authors. Hence the plan is only a condensed or abbreviated link between the national data management plan guidance document (NPS 2008) and the more technically oriented and applicable supporting documentation (management sections and SOPs), that are appended to the plan (Figure 2). The supporting documentation are the dynamic guidance that will provide users (park and network staff, cooperators, and others) with the practical know-how to be applied for any particular data and/or information management procedure. The supporting documentation is composed of SOPs that have been arranged into categories of related procedures (i.e. management sections) as illustrated in Figure 2. The national guidance document contains the legal mandates and over-arching justifications, the network plan is the connection between the national guidance and the network level management sections and SOPs.

Data Management Roles and Responsibilities

Data management is collaborative work that involves many persons with a broad range of expertise and abilities. All network staff have a role in data stewardship, and project datasets and products reflect all who have contributed. Table 2 summarizes the roles and responsibilities related to network data management, from field-based data collection, to final distribution and archiving. The fundamental role of the network data manager is to coordinate these tasks.

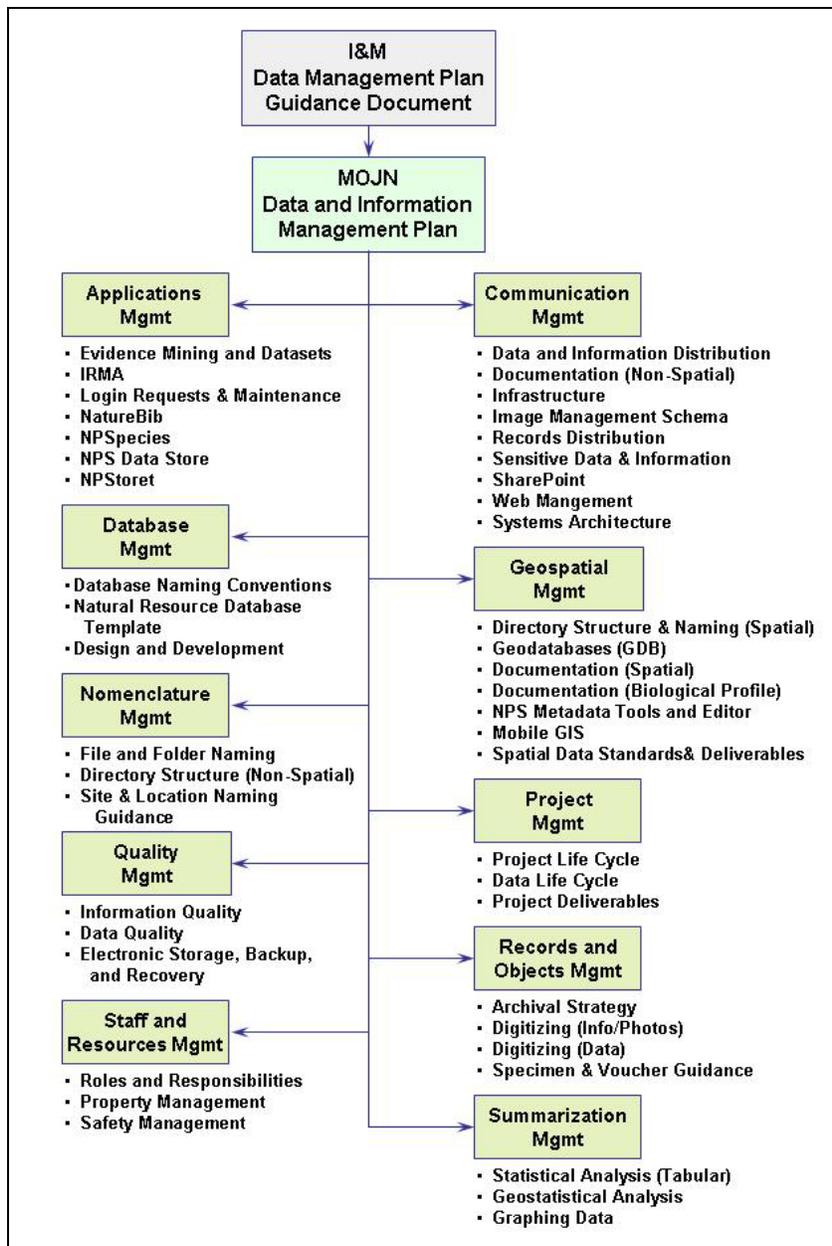


Figure 2. Data and Information Management Plan flowchart

Table 2. Roles and responsibilities related to network data management.

Role	Primary responsibilities related to data management
Project leader	Direct operations, including data management requirements, for network projects
Project crew leader	Supervise crew; communicate regularly with data manager and project leader
Project crew member	Collect, record, perform data entry, verify data; organize field forms, photos, other related materials
Resource specialist	Evaluate validity and utility of project data; document, analyze, publish data and associated information products
GIS specialist	Oversee GPS data collection; manage spatial data; prepare maps; perform spatial analyses
IT specialist	Apply database and programming skills to network projects; maintain information systems to support data management
Quantitative ecologist	Determine project objectives and sample design; perform and document data analysis and synthesis; prepare reports
Network data manager	Ensure program data and information are organized, useful, compliant, safe, and available
Network coordinator	Coordinate and oversee all network activities
Park or regional curator	Ensure project results (documents, specimens, photographs, etc.) are cataloged and accessioned into NPS or other repositories
I&M data manager (national level)	Provide service-wide database support and services; provide data management coordination among networks
End users (managers, scientists, interpreters, public)	Inform and direct the scope of science information needs; interpret information and use to direct or support decisions

Data Sources and Priorities

There are multiple sources of significant data related to natural resources in the MOJN parks. The types of work that may generate these data include:

- inventories
- monitoring
- protocol development pilot studies
- special-focus studies performed by internal staff, contractors, or cooperators
- research projects performed by external scientists
- studies performed by other agencies on park or adjacent lands
- resource impact evaluations related to park planning and compliance
- resource management and restoration work.

Because the I&M Program focuses on natural resource inventories and long-term monitoring, MOJN's first priority is the management of data and information that results from these efforts. However,

Prioritizing data management efforts in a sea of unmanaged data

- Highest priority is to produce and curate high-quality, well-documented data originating with the Inventory and Monitoring Program
- As time and resources permit, assist with data management for current projects, legacy data, and data originating outside the Inventory and Monitoring Program that complement program objectives
- In addition, help ensure good data management practices for park-based natural resource projects that are just beginning to be developed and implemented

the standards, procedures, and approaches to data management developed by MOJN carry over and are being applied to other natural resource data sources.

For example, all natural resource parks need a basic suite of resource inventory data in order to manage their resources and support a successful monitoring program. The national I&M Program has determined that a minimum of 12 inventory datasets, including both biotic and abiotic components, will be acquired by all parks. MOJN is working with individual parks and national NPS programs to acquire and standardize these basic resource datasets, and make them widely available. The datasets are:

- Natural resource bibliography
- Documented species list of vertebrates and vascular plants
- Species distribution and status of vertebrates and vascular plants
- Vegetation map
- Base cartographic data
- Soils map
- Geology map
- Water body location and classification
- Water quality data
- Location of air quality monitoring stations
- Air quality data
- Weather data

A summary of the status of these datasets for network parks is presented in Appendix J (Status of the 12 natural resource inventories, MOJN).

Data Management and the Project Lifecycle

I&M projects are typically divided into five broad stages: initiation, planning, execution, monitoring and control, and closure (Figure 3). During all stages, data management staff collaborate closely with project leaders and participants.

Specific data management procedures corresponding to these five stages are described in the chapters of this plan. Building upon the data management framework presented in Chapters 1 through 5, Chapter 6 is devoted to data acquisition, processing, and reporting, and Chapter 7 provides a framework for verifying and validating data that are collected and entered into databases. Dataset documentation is the subject of Chapter 8, data ownership and sharing is presented in Chapter 9, and data dissemination, including issues such as compliance with the Freedom of Information Act (FOIA), are addressed in Chapter 10. Chapters 11 and 12 provides a framework for the long-term maintenance, storage, and security of MOJN data.

Water Quality Data

The water quality component of the Natural Resource Challenge requires that networks archive all water quality data collected as part of the monitoring program in a STORET (STORAge and RETrieval, EPA 2006) database maintained by the NPS Water Resources Division (WRD, [NPSTORET home page](#)). MOJN will be developing a MS-Access database that consolidates available water quality data collected in and near the 7 MOJN park units. Associated with this

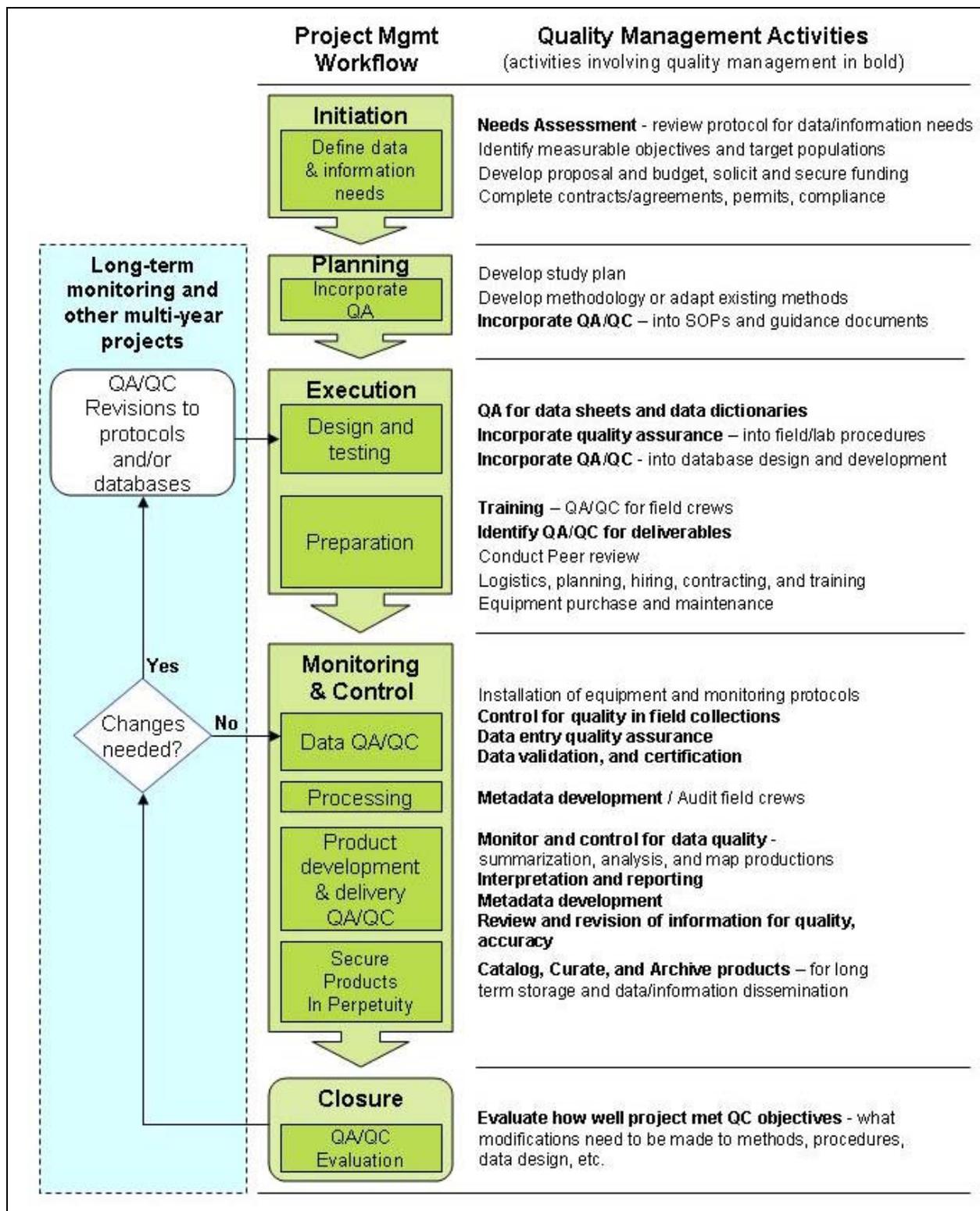


Figure 3. Project workflow and data management activities

database are assessment tools to evaluate water quality that allow comparisons of historical and current data with applicable state standards. MOJN will maintain this database and integrate new data collected so it can serve as an ongoing tool for the network's long-term water quality monitoring and analysis needs.

On an annual basis MOJN will compile and format new water quality data from the MOJN H₂O MS-Access database into an electronic data deliverable (EDD) that is compatible with WRD-STORET. WRD will ensure that content is transferred to the Environmental Protection Agency's STORET database (Figure 4).

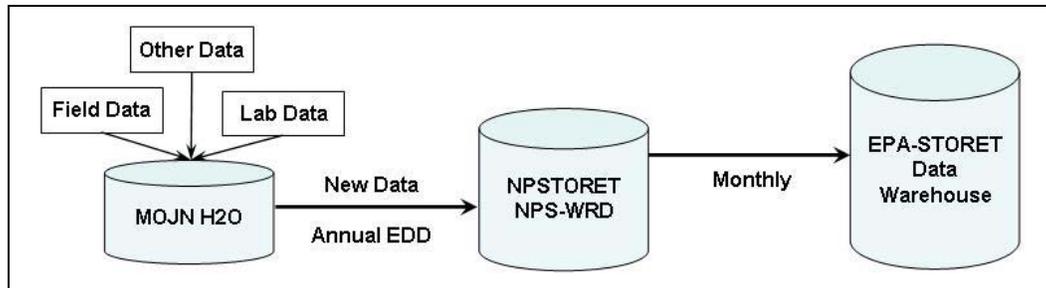


Figure 4. Simplified data flow diagram for water quality data

Data Management Plan Maintenance

The MOJN approach is to maintain a DMP that is useful to a broad audience, and that can provide guidance on data management practices at a number of different levels. MOJN will keep the plan simple, flexible, and evolving, and include data users in the decision-making process whenever possible.

The document has undergone an initial prescribed review process that included both an internal network review (i.e., by members of the technical committee and network staff), and a service-wide review that involved the regional data/GIS coordinator, data management staff from the WASO I&M Program, and other network data managers.

MOJN will update the plan to ensure that it reflects accurately the network's current standards and practices. Recommendations for changes can be forwarded to the network data manager by any interested party or user of network I&M data (e.g., park resource managers, project leaders, technicians, superintendents, external users). These recommendations will be discussed by data management and network staff and actions decided upon. Simple changes can be made immediately in the document, while substantive changes will be made during version updates.

The most current version of the plan is available on the MOJN website (<http://science.nature.nps.gov/im/units/mojn/index.cfm>).

1.0 Introduction

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 data management practices, and transmitted to park managers in a useable format, that information can also form the basis for sound resource 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.

The knowledge to make science-based resource management decisions is sometimes misunderstood from the perspective of knowledge management, what does it involve? The American Productivity and Quality Center (O'Dell et al. 1998) provides that:

"Knowledge Management is a conscious strategy of getting the right knowledge to the right people at the right time and helping people share and put information into action in ways that will improve organizational performance."

The Gartner Group (Bair 1998) articulates a more detailed concept of knowledge management as: "*...a discipline that promotes an integrated and collaborative approach to the process of information asset creation, capture, organization, access and use. Information assets include databases, documents, and most importantly, the uncaptured, tacit expertise and experience resident in individual workers.*"

1.1 Objectives

The goals of our data and 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 MOJN 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 MOJN 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 MOJN 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 MOJN 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 level of sensitivity 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.

1.2 Scope

This plan applies to the MOJN (Figure 5), one of 32 NPS networks nationwide, which encompasses seven park units: Death Valley National Park (DEVA), Joshua Tree National Park (JOTR), Great Basin National Park (GRBA), Lake Mead National Recreation Area (LAME), Manzanar National Historic Site (MANZ), Mojave National Preserve (MOJA), and Grand Canyon-Parashant National Monument (PARA). The core network staff is located in Boulder City, Nevada (LAME), and other network staff are duty-stationed at other parks in the network (Table 3). 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.

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, Region managers and staff, Washington Support Office (WASO) managers and staff, and the public.

Table 3. MOJN Staff and duty station

Network Staff	Number of Staff	Duty Station
Network Coordinator	1	LAME
Network Data Manager	1	LAME
Ecologist	1	LAME
Data Mining Team	1	DEVA
Data Mining Team	1	MOJA
Data Mining Team	2	JOTR
Administrative Assistant	1	PWR CESU (Seattle)

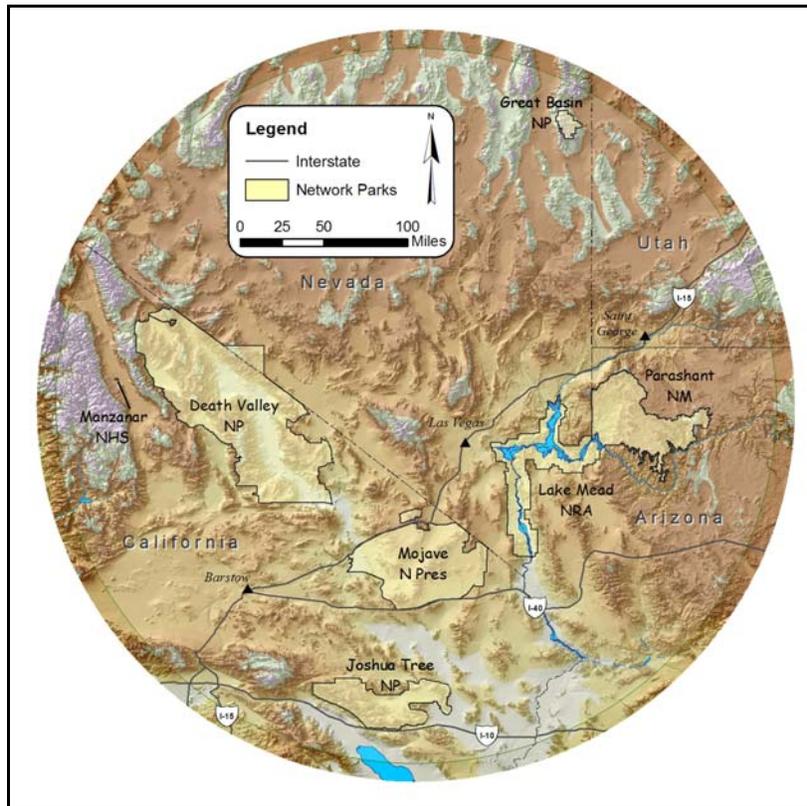


Figure 5. Parks of the Mojave Desert Network.

While this document is about data and information management, it is intended to address all data and the derived information from that data either directly collected by or funded by the MOJN. Hence this plan incorporates both tabular and spatial datasets and their associated informational derivatives. This plan therefore combines the network’s data and geographical information system (GIS) management plans into one seamless overarching document.

1.3 Purpose

Preserving knowledge 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 (Figure 6). Any good set of facts, whether collected last week or 20 years ago, must also provide enough information about the facts themselves to ensure their preservation and meaningful use (Figure 7).

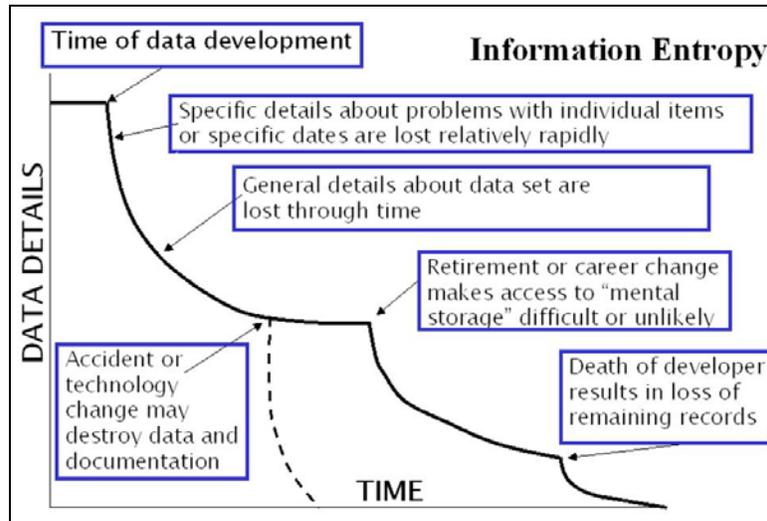


Figure 6. Information entropy - without sound management practices (Michener 2000)

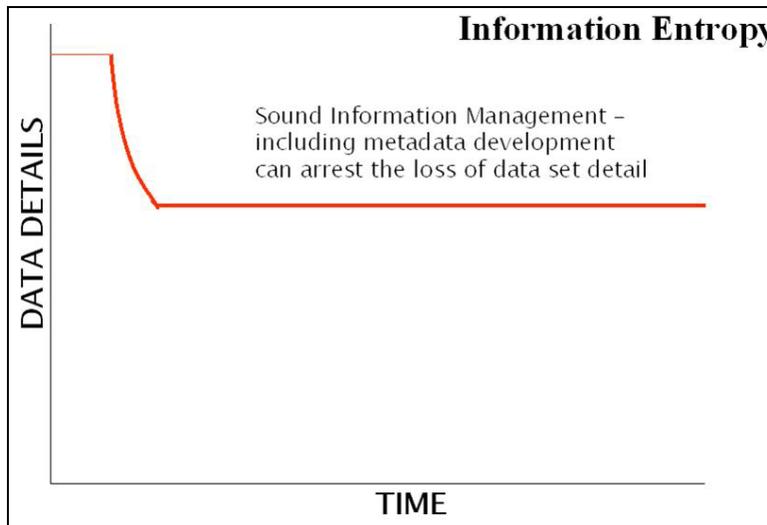


Figure 7. Information entropy - with sound management practices

1.4 Supporting Documentation

This document, the MOJN Data and Information Management Plan (DMP), is written as both a stand alone document and as a support document for the network’s Vital Signs Monitoring Plan (Chapter 6 in Chung-MacCoubrey et al. 2008), to guide the management of data, the information derived, and the knowledge gained. This document, by itself, would be too daunting of a tome to

be used or applied (as witnessed by the plans already developed by the preceding 26 I&M networks) by anyone other than the authors. Hence, this plan is only a condensed or abbreviated link between the national data management plan guidance document (NPS 2008) and the more technically oriented and applicable supporting documentation (i.e. management sections and SOPs), that are appended to this plan (Figure 8). Within the supporting documentation are the dynamic guidance and specifications that will provide users (e.g. park and network staff, cooperators, and others) with the practical know-how to be applied for any particular data and/or information management procedure.

There are three components that together contribute to a comprehensive data management plan for the MOJN: 1) a national-level data management plan that provides guidance, policy references, and the bases for good data management practices; 2) the technical documentation on how the network will apply any particular data management activity or task (i.e., the SOPs); and 3) a stand-alone network data and information management plan that connects the first two components. Figure 8 depicts the relationship of the two higher-level documents and their primary subject matter.

The supporting documentation is composed of standard operating procedures (SOPs) that have been arranged into categories of related procedures (i.e. management sections). :

- *Applications Management*: consolidates all of the SOPs that address any national-level applications, tools, or on-line logins required during routine network activities related to data management.
- *Communications Management*: unites all of the SOPs that are centered on the communication of data and information including web development and maintenance, sensitive data, image management, distribution specifications, etc. All hardware and software involved in communicating data and information to the appropriate NPS staff and cooperators are also included in this management section.
- *Database Management*: brings together all SOPs associated with tabular database design, development, and deployment, as well as standardized database naming conventions employed by the network. There is some limited overlap with particular summarization SOPs (see below) where general summaries and basic statistics are automated into a database; these are addressed on a case-by-case basis.
- *Geospatial Data (?)Management*: combines those SOPs that are uniquely relevant to spatial datasets and information. There exists some blending of SOPs with other management sections, such as embedding an MS-Access database into a Geodatabase for greater functionality. Any spatial analysis or modeling has been merged with tabular data summary processes and activities into its own summarization management section (see below).
- *Nomenclature Management*: ties together those SOPs related to the naming of files and folders, how they are arranged (i.e. directory structures), and access privileges. Since

spatial data are uniquely organized, nomenclature related to spatial data is included in the geospatial management section.

- *Project Management*: since each vital sign monitoring protocol is unique and typically involves different staff and resources, each is considered its own unique project, separate from the network's I&M program, which provides oversight for all associated projects. Therefore a set of SOPs have been developed to address project and data management as they relate to the activities involved, the role of staff, and scheduling and tracking a project and associated deliverables.
- *Quality Management*: quality assurance and control are important at all levels of data and information management. Included with data and information quality is the capacity to maintain and protect the quality of files and folders over time, hence the network SOP storage, backup, and recovery is also included in this management section. Quality management is also integrated into all SOPs to the degree necessary to identify specific QA/QC requirements for that SOP.
- *Records and Objects Management*: consolidates all of the SOPs related to records (e.g. documents, field data sheets) and object. Objects are all voucher specimens and associated records that are under the purview of the network. Archiving of documents and curation of specimens are addressed under this management section.
- *Staff and Resources Management*: addresses staff, time, funding, and equipment necessary to implement protocols. These SOPs address how tasks are accomplished safely, how equipment will be maintained, and which parties are responsible. Staff and resources management is also integrated into all SOPs to the degree necessary to identify the staff and resource needs required to perform each SOP.
- *Summarization Management*: addresses the summarization or the manipulation of data to extract salient information and trends. One example of these SOPs includes statistical analyses that are not automated into a database but where data are extracted and used in a separate, specifically-designed application for advanced data analysis, modeling, and graphing techniques.

A number of the SOPs and/or management sections will be applicable to more than one chapter of this plan. Therefore each chapter has a final sub-section on supporting documentation, which lists all applicable management sections and SOPs relevant to the subject matter. A complete list of SOPs is presented in Table 4. All SOPs, including their development status and timetable for completion, of the draft documents are available in Table 8 (page 31).

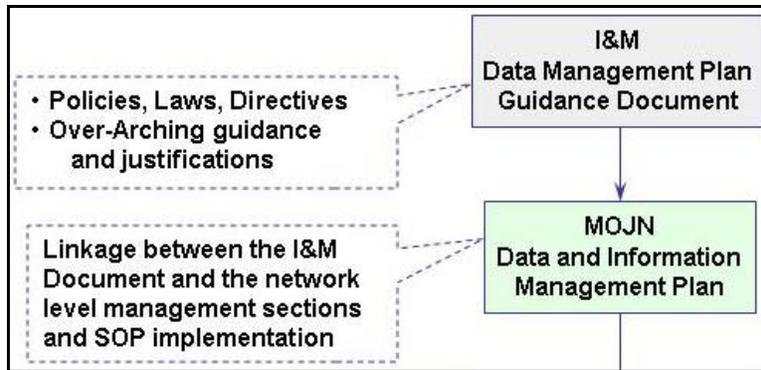


Figure 8. Higher-level management plan content

Table 4. MOJN management sections and associated SOPs.

Applications Management	Nomenclature Management
Login Requests and Maintenance	File and Folder Naming Conventions
Evidence Mining and Datasets	Directory Structure (Non-Spatial)
IRMA	Site and Location Naming Guidance
NatureBib	Project Management
NPS Data Store	Project Life Cycle and Workflow
NPSpecies	Data Life Cycle and Workflow
NPSoret	Project Deliverables
Communications Management	Project Scheduling and Tracking
Data and Information Distribution	Quality Management
Records Distribution	Data Quality
Documentation (Non-Spatial)	Information Quality
Image Management Schema	Electronic Storage, Backup, and Recovery
Sensitive Data and Information	Records and Objects Management
MOJN Infrastructure	Archival Strategy
MOJN Systems Architecture	Digitizing (Information and Photos)
Network SharePoint	Digitizing (Data)
Web Management	Specimen and Voucher Guidance
Database Management	Staff and Resources Management
Database Naming Conventions	Roles and Responsibilities
Natural Resources Database Template	Property Guidance
Database Design and Development	Safety Guidance
Geospatial Management	Summarization Management
Spatial Data Standards and Deliverables	Graphing Data
Directory Structure and Naming (Spatial)	Statistical Analysis (Tabular)
Geodatabases (GDB)	Geospatial Statistics
Documentation (Spatial)	
Documentation (Biological Profile)	
NPS Metadata Tools and Editor	
Mobile GIS	
Digitizing (Maps)	

2.0 Infrastructure and System Architecture

Modern information management infrastructure and system architecture represent the foundation of network data and information management systems. *Infrastructure* refers to the system of computers, servers, I/O devices, and global positioning system devices that are functionally or directly linked through computer networking services (in lay terms “the hardware”). *System architecture* refers to the applications, database systems, repositories, and software tools that make up the framework of our data and information management enterprise (in lay terms “the software”).

2.1 Objectives

- Ensure staff has appropriate access to electronic files that are secure and protected from accidental and malicious loss.
- Simplify GIS software installation and management, and expedite access and retrieval of GIS data using automation tools.
- Identify and implement appropriate collaborative technologies and tools that enhance networking and communications at both an intra- and inter-agency level.
- Develop a collective long-term strategy towards identifying and developing a content management system and intranet portal for storing, managing, searching, and disseminating electronic files.

2.2 Scope

The staff of the MOJN is located across the network parks and region as shown in Table 4. This creates a logistically challenging environment within which to develop and maintain comprehensive and united network infrastructure and systems architecture. The network relies upon the M&M IT Network (the combined MOJN and Mediterranean Networks’ park IT staff) and the individual parks and regional IT support where staff is located to provide computer IT needs. Network staff is required to comply with all federal, department, and agency IT requirements as outlined in the national Data Management Plan guidance document (NPS 2008). A comprehensive explanation and presentation of the MOJN’s infrastructure and system architecture is in the network supporting documentation (see section 2.3).

Table 5. MOJN staff duty Stations

Number of Staff	Duty Station
3	LAME
1	DEVA
1	MOJA
2	JOTR
1	PWR CESU (Seattle)

Data and information management is an important component of the I&M Program. The national Data Management Plan guidance document (NPS 2008) outlines the policies and standards by which national-level applications and tools (e.g. NPSpecies, NatureBib, NPS Data Store, NPStoret) need to be implemented and why. Chapter 2 provides information on the systems architecture and the use of the I&M tools and applications as repositories for data and information. Chapter 9 addresses ownership of sensitive data and information, and Chapter 10 discusses the use of the I&M tools and applications for their dissemination. To achieve an integrated data and information management system, three of the national-level data management applications (NatureBib, NPSpecies, and NPS Data Store) use distributed application architecture with both desktop- and internet-accessible (master) components.

Figure 9 provides a visual representation of the MOJN services, in an operational and functional context. The network’s operational requirements are inextricably linked to our infrastructure; without reliance upon the technological hardware, we would have to resort to paper, file cabinets, and typewriters to implement a monitoring program. There exists a strong link however between our software requirements and their requirement for an infrastructure to be functional. The system architecture provides the interface with, and graphic interpretation of, the data in its numerous iterations that are stored within the hardware (i.e. infrastructure). Embedded within the operational requirements is the capability to store, backup, and recover electronic data and information that is functionally deployed through applications (i.e. software). The network is then linked through a series of local area networks (LAN), or network of devices. The ultimate desire is deployment through enterprise architecture accessible by all stakeholders with the appropriate levels of privileges and securities.

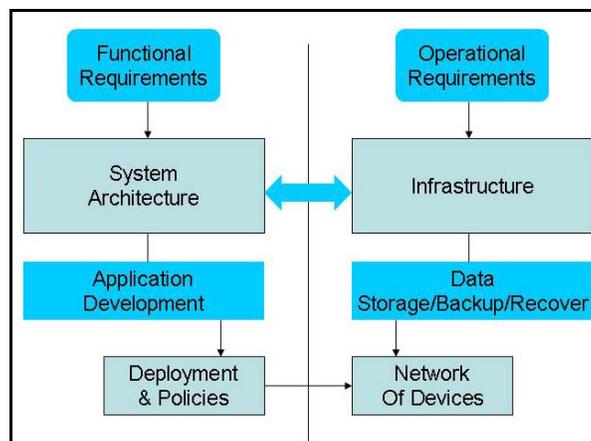


Figure 9. Functional and operational requirements (modified from Maarten and Burner 2002).

2.3 Supporting Documentation

Application and communication management are the primary sections with SOPs relevant to the network infrastructure and system architecture. How park and network staff will apply and utilize the I&M tools and applications. How the network develops and maintains its infrastructure and systems architecture. How the network will maintain its web sites and dissemination of data and information products. What the roles are of network staff and their responsibilities, relative the oversight of network property.

2.3.1 Management Sections and Recommended SOPs

- A. Applications Management
 - a. Login Requests and Maintenance SOP
 - b. NatureBib SOP
 - c. NPSpecies SOP
 - d. NPS Data Store SOP
- B. Communications Management
 - a. MOJN Infrastructure SOP
 - b. MOJN Systems Architecture SOP
 - c. Network SharePoint SOP
 - d. Web Management SOP
 - e. Sensitive Data and Information SOP
 - f. Image Management Schema SOP
- C. Staff and Resources Management
 - a. Roles and Responsibilities SOP
 - b. Property Guidance SOP

3.0 Project Development and Data Management Workflow

The objective of this chapter is to illustrate the data and information management tasks that are associated with each stage of a project. By describing the progressive stages of a project and the life cycle of the associated data, we can clearly define the overall objectives and specific steps of the data management process. Addressing the data and information management needs throughout the project lifecycle will allow network staff to effectively manage the staffing resources needed to produce, maintain, and deliver high-quality data and information.

The MOJN conceptual model of project management is illustrated in Figure 10. The Natural Resource Challenge (NRC) and the subsequent I&M Program are the initiator/sponsor of the network model for inventory and monitoring. The MOJN has developed the DMP based upon the guidance from the I&M Program (NPS-75), the overarching national data management plan guidance document (NPS 2008), the network's stakeholders (i.e. Technical Committee, Board of Directors), the vital signs scoping workshops, and identified network oversight groups (e.g. Data/GIS work group, Water Resources work group). This guides the identification of protocols and SOPs to be designed, developed, and implemented (executed for field and laboratory data collection), as well as the operational requirements necessary. An annual project is brought to a close with the synthesis and reporting on data acquisition and processing, and as project deliverables are completed, integrated, and archived into the preceding years.

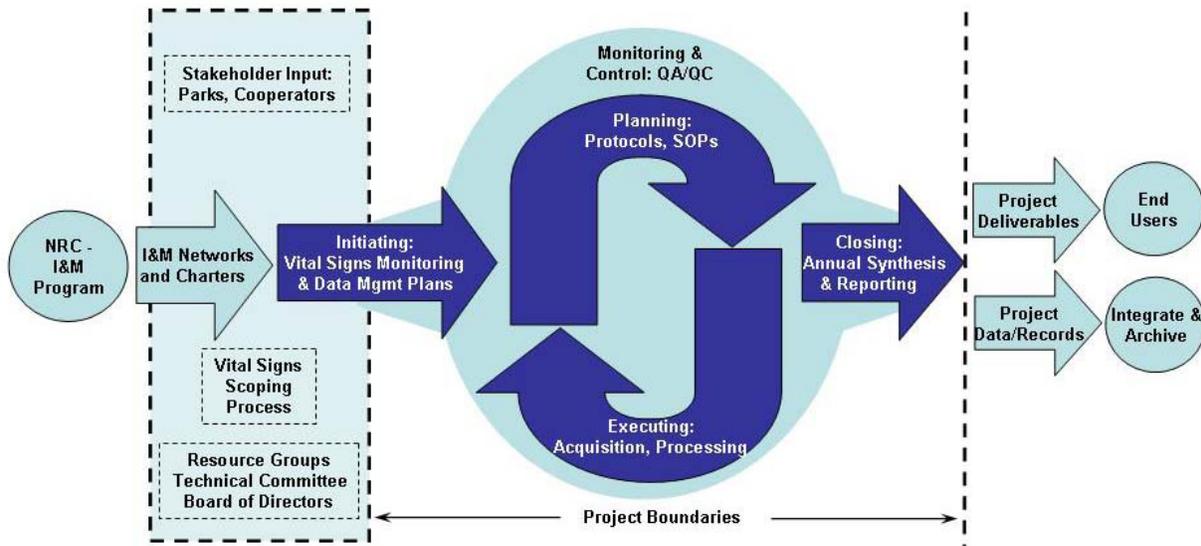


Figure 10. Conceptual Model of MOJN project management

3.1 Objectives

- Illustrate the project management workflow and its relevant data management activities
- Describe the progressive stages of a project and the resulting data life cycle
- Define the specific steps of the data management process
- Effectively manage the staffing resources needed to produce, maintain, and deliver high quality data and information

3.2 Scope

Figure 3 in the executive summary displays the project life cycle and workflow as related to the MOJN and associated data management activities. This project life cycle deviates slightly from the one in Chapter 3 of the I&M data management guidance document (National Park Service 2008) and needs to be referred to for all MOJN projects. A Project is divided into five knowledge groups recognized by the Project Management Institute (PMI, www.pmi.org): initiation, planning, execution, monitoring and control, and closing. Each knowledge area has a series of nine process areas associated with it (incorporated into the network's SOP template structure); the MOJN has adopted this project management structure and strives to incorporate our data and information management activities into it.

To maintain our network's data and information management in a PMI context that a "project is unique and temporary", we chose to identify each year or season of data and information derived from the vital signs monitoring protocols as a project, and each annual project is then one component of the network's overall vital signs monitoring program. All other data and information not protocol-related will be differentiated between short- (<3 years) and long-term (>3 years, however with a finite scheduled completion date). Long-term projects have an

increased need to adhere to and maintain standards for an extended period of time. Maintaining standardization from year-to-year will be necessary when comparing data over an extended period of time (decades for long-term monitoring). To ensure the development of high quality scientific information, data management must be an integral component in all aspects of project development. The following is a short description of the five knowledge areas:

Initiate. This is when many of the preliminary decisions are made regarding project definition, scope, and authorization. In addition, the proposal has been accepted, funding secured, so that the permits, and compliance, are addressed in this phase. Primary responsibility rests with project leaders and program administrators. Specific data management activities can include mining for existing datasets and data relevant to the project (both NPS and non-NPS). Final authorization is then received to proceed with the project.

Plan. During this phase, details are worked out regarding how data will be acquired, processed, analyzed, reported, and made available to others (development or modification of existing SOPs). The project leader is responsible for the development and testing of the 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 authorization as possible, data integrity and quality can be assured most easily. This is especially true as timelines for deliverables are finalized (in the execution area below). It is recommended that all contracts, agreements, and permits include standard language that describes the formats, specifications, and timelines for project deliverables (this can be accomplished by referencing the appropriate SOPs). Another 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, protocols and SOPs have been developed, documented, and approved, a project can move into the execution phase.

Execute. During the project execution phase, data containers are developed, a complete list of deliverables identified, field crews hired, training accomplished, and logistics finalized. Data sheets, data dictionaries, databases, and/or geodatabases are designed, developed, tested, and modified for use. The necessary equipment for the protocol is obtained, tested and integrated as needed. The project deliverables have their formats and destinations established. Field staff are trained in the use and operation of mobile GIS, data loggers, and other technologies/software used for field data collection.

Monitoring and Control. This phase is where the 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 hardware/software, and other data processing applications. Data management staff also facilitate data summarization, validation, and analysis, and assist with the technical aspects of documentation (i.e. metadata) and product development.

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. 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.

3.3 Supporting Documentation

The Project Management section is the primary source of network technical guidance and implementation regarding this chapter, however other management section SOPs apply on a case-by-case bases. See subsection 3.3.1 for further information.

3.3.1 Management Sections and Recommended SOPs

- A. Project Management
 - a. Project Life Cycle and Workflow SOP
 - b. Data Life Cycle and Workflow SOP
 - c. Project Deliverables SOP
 - d. Project Scheduling and Tracking SOP
- B. Geospatial Management
 - a. Spatial Data Standards and Deliverables SOP
 - b. Documentation (Spatial) SOP
- C. Nomenclature Management
 - a. File and Folder Naming Conventions SOP
 - b. Directory Structure (Non-Spatial) SOP
- D. Quality Management
 - a. Data Quality SOP
 - b. Information Quality SOP
- E. Communication Management
 - a. Documentation (Non-Spatial) SOP
- F. Staff and Resources Management
 - a. Roles and Responsibilities SOP

4.0 Data Management Roles and Responsibilities

Data management is about people and organizations as much as it is about information technology, database theory, and applications. Data stewardship is the assignment and acceptance of responsibility for overseeing management aspects of information. For park and network resource programs to work effectively, everyone within the program, and all those in collaboration with it, must take responsibility for the production, analysis, management, and/or end use of the data collected and information produced by the program. In order to meet the data management goals and standards developed by the I&M program (National Park Service 2008) and its constituents, program staff must understand what their roles and responsibilities are in this process.

4.1 Objectives

- Clearly define roles associated with data management functions
- Establish data ownership throughout all phases of a project
- Instill data accountability
- Ensure that adequate, agreed-upon data quality and metadata metrics are maintained on a continuous basis

4.2 Scope

This chapter is relevant to all staff within the MOJN I&M Program, and all those in collaboration with it, that have data stewardship responsibilities for the production, analysis, management, and/or end use of data and information produced by the program. Most of the guidance for roles and responsibilities is well documented in the national data management plan guidance document (NPS 2008); however the MOJN does have an SOP related to the roles and responsibilities of data stewardship (see the next section). Figure 11 displays the network staff and their inter-relationships. There are a number of staff scheduled to be hired, or potentially hired, in the future (Figure 11).

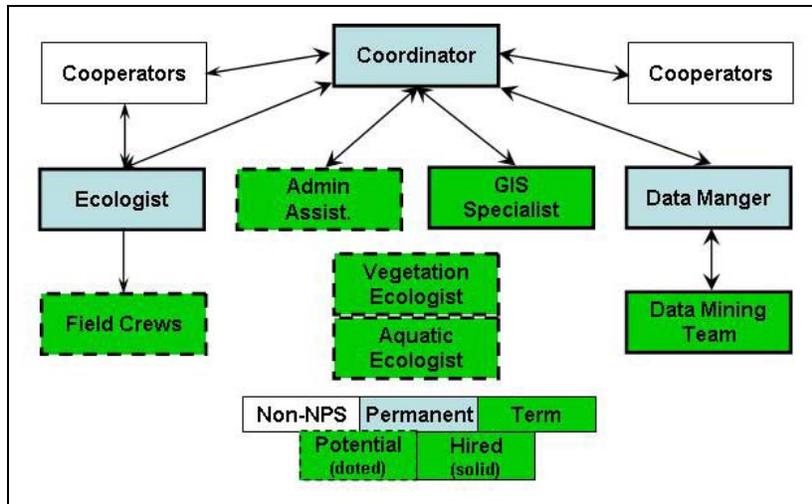


Figure 11. MOJN staffing chart, showing existing staff (solid lines) and potential staff (dotted lines).

4.3 Supporting Documentation

The Staff and Resource Management section is the primary source of network information regarding this chapter; however, other management section SOPs apply (see subsection 4.3.1 for further information). Staff roles and responsibilities are also incorporated into individual SOPs.

4.3.1 Management Sections and Recommended SOPs

- A. Staff and Resources
 - a. Roles and Responsibilities SOP
- B. Project Management
 - a. Project Life Cycle and Workflow SOP
- C. Communications
 - a. Data and Information Distribution SOP

5.0 Databases

The adoption of sound database design principles that will help facilitate interpretation, ensure integrity, and promote compatibility of natural resources data collected in the parks is a primary goal of the MOJN DMP. Deming's third point, in his 14 tenets on management (Deming 1986), states that quality should be built in and not inspected for afterwards. Following this philosophy, the network will integrate quality assurances into database design and development to the maximum extent possible.

5.1 Objectives

- To clearly articulate sound database design and development practices for the MOJN
- To develop all MOJN databases compliant with the Natural Resources Database Template (NRDT)

5.2 Scope

The national data management plan guidance document (NPS 2008) provides overarching information on the guidance and policies for database use by the network. For all network staff and cooperators that have responsibility for the design, development, modification, and/or maintenance of network databases that are associated with the MOJN I&M vital signs monitoring protocols, data collection will follow the guidance and other supporting documentation listed below. The MOJN has integrated fully with the Natural Resources Database Template (NRDT) for the implementation of all network level database design and development, and will attempt to integrate its use in legacy datasets where possible. The next section identifies the supporting documentation concerning the execution of database implementation in the MOJN Vital Signs Monitoring.

5.3 Supporting Documentation

The database management section is the primary section with SOPs important to database design, development, and implementation (see the subsection 5.3.1 for further information); however, other management section SOPs apply as they have components relevant to the design, development, and maintenance of databases.

5.3.1 Management Sections and Recommended SOPs

- A. Database Management
 - a. Database Design and Development SOP
 - b. Database Naming Conventions SOP
 - c. Natural Resources Database Template SOP
- B. Applications Management
 - a. NatureBib SOP
 - b. NPSpecies SOP
 - c. NPS Data Store SOP
 - d. Evidence Mining and Datasets SOP
- C. Staff and Resource Management
 - a. Roles and Responsibilities SOP
- D. Project Management
 - a. Project Deliverables SOP
- E. Communications Management
 - a. Documentation (Non-Spatial) SOP
- F. Quality Management
 - a. Data Quality SOP

- G. Records and Objects Management
 - a. Digitizing (Data) SOP

6.0 Acquisition, Processing, and Reporting

Large, multi-scale natural resources programs increasingly rely on data and information gathered from multiple sources. This chapter describes the general steps involved with acquiring, processing, and reporting of data to meet standards established by the I&M program, although these standards could apply broadly to any of the programs covered by this plan. Guidelines for the acquisition and processing of physical objects (photographs, voucher specimens) which are often collected as part of resource management, inventory and monitoring, and other research projects are covered in Chapter 11 of this plan. Instructions specific to particular projects must be developed and included with the protocols for those projects.

6.1 Objectives

- Acquire, through a variety of sources, data and information needed by MOJN Park managers to properly manage and maintain the natural resources of their parks.
- Acquire data and information needed to understand broad-scale changes in the environment that impact ecosystems on a regional or national level in cooperation with NPS and related monitoring efforts.

6.2 Scope

This chapter is relevant to all staff within the MOJN I&M Program, and all those in collaboration with it, that have responsibility for the acquisition, processing, and/or end use of programmatic and non-programmatic data and information, as judged applicable to the program.

Administrative records derived from the MOJN I&M Program must follow the Director's Order 19 (NPS 2001a) that provides general guidance, and in particular, Appendix B (NPS 2001b), which details the types of records required to be maintained and for how long.

- 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 are to 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 are removed after three years.

Appendix A of the I&M Guidelines document (Natural Resources Inventory and Monitoring, NPS-75, [NPS 1992]) specifies the types of park-specific information to be acquired and managed, either directly or indirectly, by the network:

- 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.

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.

6.3 Supporting Documentation

A number of management sections and their associated SOPs apply to acquisition, processing and reporting. Spatial and tabular data collection, analysis and synthesis of data to information (e.g. posters, newsletters, presentations, graphs) and the subsequent reporting on the status and trends of park ecosystem health are included.

6.3.1 Management Sections and Recommended SOPs

- A. Geospatial Management
 - a. Documentation (Spatial) SOP
 - b. Documentation (Biological Profile) SOP
 - c. Mobile GIS SOP
- B. Protocol Specific SOPs
 - a. Climate Data Acquisition
- C. Communications Management
 - a. Documentation (Non-Spatial) SOP

- b. Data and Information Distribution SOP
- c. Records Distribution SOP
- d. Image Management Schema SOP
- e. Sensitive Data and Information SOP
- D. Quality Management
 - a. Data Quality SOP
 - b. Information Quality SOP
- E. Summarization Management (in development)
 - a. Statistical Analysis (Tabular) SOP
 - b. Geostatistical Analysis SOP
 - c. Graphing Data SOP

7.0 Quality Assurance and Quality Control

Quality assurance (QA) can be defined as an integrated system of management activities involving initiation, planning, execution, monitoring & control, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the consumer. Quality control (QC) is a system of technical activities that measure the attributes and performance of a process, item, or service relative to defined standards (Palmer and Landis 2002). While QA procedures maintain quality throughout all stages of data development, QC procedures monitor or evaluate the resulting data and derived information products. Quality must be built in at every opportunity, integrated instead of inspected for at the end of a project (Deming 1986).

7.1 Objectives

- Ensure natural resources projects produce high quality and credible data that can be confidently used by managers, researchers and the public
- Implement standard quality assurance and quality control procedures to meet the first objective

7.2 Scope

Quality management or the QA/QC of data and information is an element of every individual and activity that we perform either in a program or an operational perspective. The Bureau of Land Management (BLM) data life cycle (Figure 11) incorporates QA/QC into each process involved with the management of data (BLM 2006).

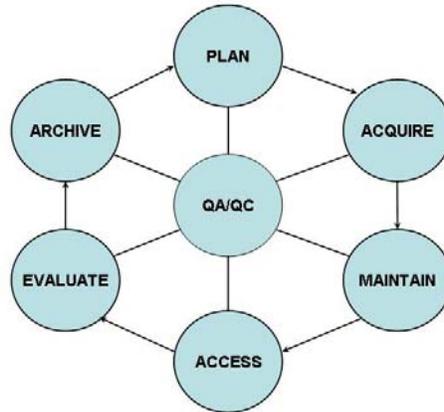


Figure 12. Data life cycle from a BLM perspective

The I&M draft data management plan guidance document (NPS 2008) provides the network with the guidelines, standards, and policies with respect to quality management (e.g. errors of commission and omission, verification/validation, instrument error, errors of logical consistency) from an NPS and DOI perspective. Figure 12 illustrates the common QA/QC activities involved with the network's monitoring.

Applying quality control to informational (e.g. written) materials is more difficult than to data. The network has instituted a set of procedures requiring all written material have two internal network reviews prior to external distribution or dissemination to parks or other stakeholders. The first is a technical review to insure that the material is both technically sound, correctly formatted, and spelling and grammar reviewed. The second internal review is performed by either the network coordinator or their identified agent to insure consistency with the network's vision and determine whether it is ready for external distribution.

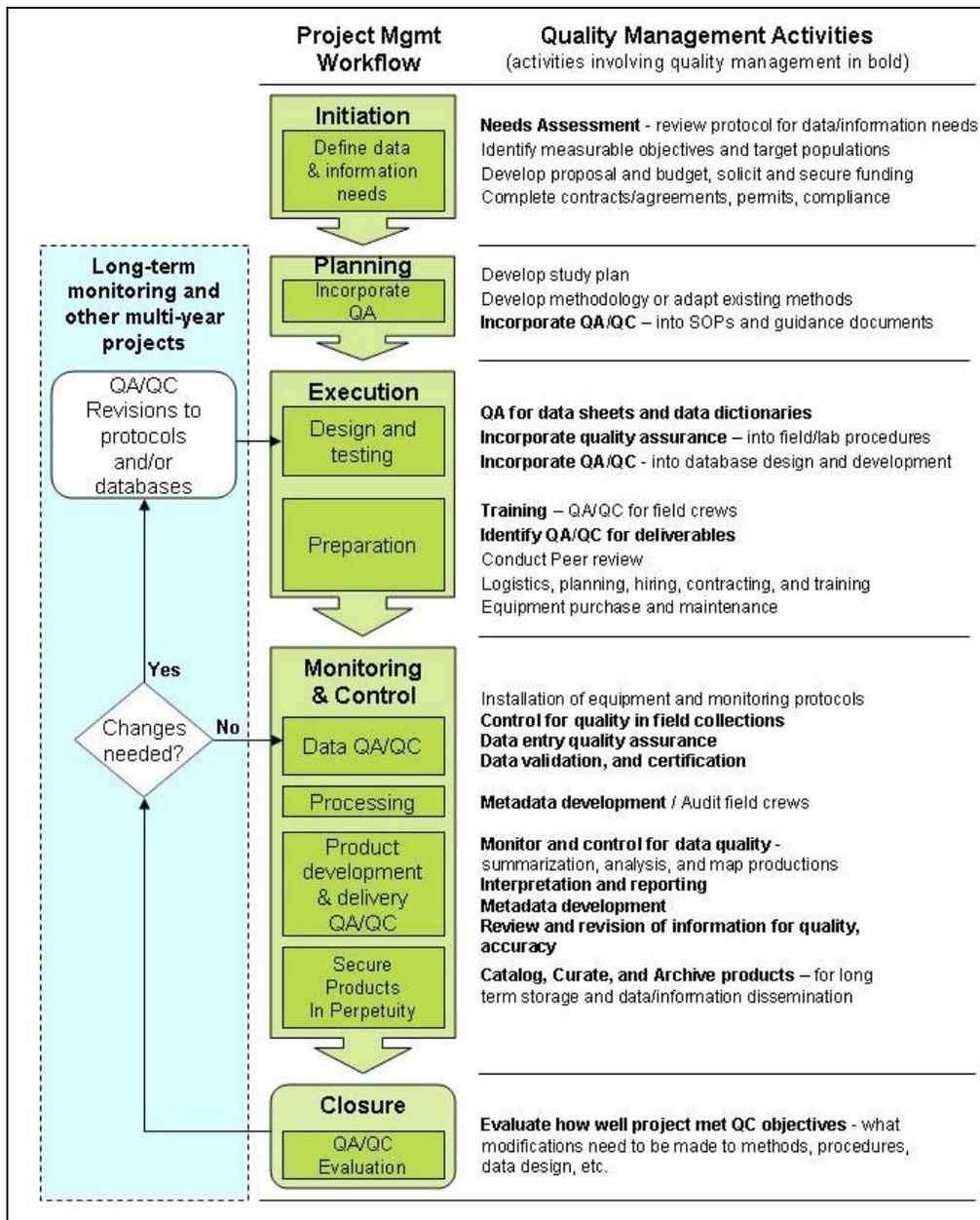


Figure 13. Project workflow and quality management activities

7.3 Supporting Documentation

Quality management is integral to all steps in managing data and information (Figures 11) and in a project (Figure 12). Thus, it is challenging to provide one set of procedures that fulfill all needs. Therefore the guidance on quality management for data and information has been divided into different SOPs; one on Data Quality and another on Information Quality. The Quality Management section applies as well as parts of other management sections (see the subsection 7.3.1 for further information). Each of the network’s SOPs describe how MOJN will implement quality management into each stage of a project (Figure 13).



Figure 14. Quality is important in all aspects

7.3.1 Management Sections and Recommended SOPs

- A. Quality Management
 - a. Data Quality SOP
 - b. Information Quality SOP
 - c. Electronic Storage, Backup, and Recovery SOP
- B. Project Management
 - a. Project Deliverables SOP
- C. Communications Management
 - a. Documentation (Non-Spatial) SOP
- D. Records and Objects Management
 - a. Digitizing (Data) SOP
 - b. Digitizing (Information and Photos) SOP
- E. Geospatial Management
 - a. Spatial Data Standards and Deliverables SOP
 - b. Directory Structure and Naming (Spatial) SOP
 - c. Documentation (Spatial) SOP

8.0 Dataset Documentation

Data developers often perceive data documentation or metadata creation as a tedious process whose benefits are realized only by those that later utilize or inherit their data. However complete, robust metadata is increasingly used to manage in-house data resources, assess the utility of available data resources, instill data accountability, establish data liability, evaluate return on data investments, and provide a common language for both data contributors and consumers. Metadata help insure an organization's investment in data. As personnel change or time passes, information about data will be lost and the data may lose their value. Subsequent staff may have little understanding of the content and uses for a dataset and determine that they can't trust the data. Complete metadata descriptions of the content and accuracy of a dataset will encourage appropriate use of the data. Such descriptions also may provide some protection for the producing organization, if conflicts arise over the misuse of data.

8.1 Objectives

- Document all significant geographic and tabular datasets to MOJN standards described in this chapter.
- Maintain and leverage the investment made by NPS staff and cooperators in producing quality data.
- Aid the discovery of relevant data by NPS staff, collaborators, and the public.
- Preserve integrity and longevity of data and its documentation

8.2 Scope

The MOJN will adhere to all of the guidance, policies and standards that are enumerated within the I&M data management plan guidance document (NPS 2008). From project development through final delivery of information products, the Network data manager and project leaders will place a high priority on documenting the purpose, quality, and meaning of data and information, and allow for the time these tasks will take.

To the fullest extent possible, the MOJN will implement and use the NPS Metadata Tools and Editor (MTE) for the creation and revision of dataset related metadata. The MOJN will place all created metadata records on the NPS Data Store for long-term storage, dissemination, and discovery, the datasets themselves will only be stored locally for the near future.

8.3 Supporting Documentation

Documentation or “metadata” must be incorporated into all deliverables. Programmatic deliverables (i.e. products of vital signs monitoring) will have documentation incorporated into the development process to the extent applicable (see documentation SOPs for both spatial and non-spatial). Non-programmatic data must be reviewed and determined adequate and then checked for associated documentation (to be revised or added) prior to being incorporated into the program. The management section below and associated SOPs appropriate to the documentation of data and information are identified, as well as other pertinent SOPs.

8.3.1 Management Sections and Recommended SOPs

- A. Applications Management
 - a. Evidence Mining and Datasets SOP
 - b. NatureBib SOP
- B. Communications Management
 - a. Documentation (Non-Spatial) SOP
- C. Geospatial Management
 - a. Documentation (Spatial) SOP
 - b. Documentation (Biological Profile) SOP
 - c. NPS Metadata Tools and Editor SOP
 - d. Spatial Data Standards and Deliverables SOP
- D. Project Management

- a. Project Deliverables SOP

9.0 Data Ownership and Sharing

Ownership and sensitivity are the two major factors in the determination in the sharing of data and/or information. This chapter outlines the approval for data and information distribution (sharing) to the National Park Service, cooperators, and the public. This applies to all datasets, models, analysis, graphs, presentations, and their release in any format (via the web based internet or intranet, e-mailing electronic copies, providing printed materials, optical media, verbal descriptions, or any other form).

For the purposes of releasing data, the term *sharing* means releasing to an individual or entity upon request or as part of an agreement to do work that benefits the parks. The term *dissemination* (as well as *distribution*) includes releases to the public via publications or other standard routes of delivery such as the NPS Data Store. Chapter 10 provides detailed standards and guidelines for data dissemination. Guidelines for data sharing, including sensitive data procedures, are described in this chapter.

9.1 Objectives

- Establish clear guidelines for the ownership and sharing of natural resources data and information.
- Protect sensitive data from unauthorized access and inappropriate use.

9.2 Scope

The network staff and cooperators will follow all applicable Freedom of Information Act (FOIA), Indian Sacred Sites (Executive Order No. 13007), National Parks Omnibus Management Act, National Historic Preservation Act, Federal Cave Resources Protection Act, Archaeological Resources Protection Act and all other pertinent guidance and polices (NPS 2008). Data and Information that is protected includes but is not limited 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.

Each cooperative or interagency agreement or contract will include a list of deliverables and products clearly defined within each agreement or contract (or have the appropriate network SOPs as attachments). This will include the details on formatting and media types that are required for final submission. Agreements and contracts will list all products expected to result

from the project. These include, but are not limited to, field notebooks, photographs (hardcopy and digital), specimens, raw data, databases, and reports.

Data and information will be shared internally through Network channels, externally through online databases and repositories, and by special request as appropriate, and only after quality control procedures have been fully implemented.

9.3 Supporting Documentation

The communications management section has three particular SOPs that are primarily applicable to data sharing (data and information, and records distribution) and ownership (sensitive data and information). A number of other SOPs relative to data ownership and sharing apply, as listed below. Data in this instance also applies to all photographs and digital images.

9.3.1 Management Sections and Recommended SOPs

- A. Communication Management
 - a. Data and Information Distribution SOP
 - b. Records Distribution SOP
 - c. Documentation (Non-Spatial) SOP
 - d. Sensitive Data and Information SOP
 - e. Web Management SOP
 - f. Image Management Schema SOP
- B. Applications Management
 - a. NatureBib SOP
 - b. NPSpecies SOP
 - c. NPS Data Store SOP
- C. Geospatial Management
 - a. Documentation (Spatial) SOP
- D. Staff and Resources Management
 - a. Roles and Responsibilities SOP
- E. Quality Management
 - a. Electronic Storage, Backup, and Recovery SOP

10.0 Data Dissemination

Under the terms of Freedom of Information Act (5 U.S.C. § 552), public agencies must make non-protected data and information (described in Chapter 9) available for inspection and copying in public reading rooms, the Internet, or via requests through a specified process. Providing well-documented data in a timely manner is one of the most important goals of the I&M program, and is critical to the success of the program. This chapter describes the methods by which quality natural resource data and information collected by the Network are made available to park managers, researchers, educators, and the general public.

10.1 Objectives

- Ensure non-sensitive data are easily discoverable and obtainable.
- Ensure data that have not yet been subjected to full quality control are not released to the public, unless necessary in response to a Freedom of Information Act request.
- Distribute data with complete and accurate metadata that clearly identify who collected the data, what data were collected, and where, when and how the data were collected.
- Identify and protect sensitive data from unauthorized access.

10.2 Scope

This chapter applies to all internally-collected data or MOJN I&M funded data collection and provides for the distribution of the data and any subsequent information materials. Internally-collected data refers to all data collected by MOJN I&M staff (permanent, term, temporary, interns, and/or volunteers), or park staff collecting data directly for a MOJN vital signs monitoring protocol or inventory. MOJN funded data collection refers to data collection by non-NPS personnel who are funded with MOJN I&M funds for a MOJN vital signs monitoring protocol or inventory.

Chapter 8 states that the project staff will, when appropriate, upload datasets to the NPS Data Store. Chapter 11 states that project staff will collaborate with curation staff with regards to all voucher specimens collected in conjunction with the network protocols. Informational products will be documented by the authors into the appropriate applications (e.g. NatureBib) and images or photographs will be submitted to the network's image management schema for integration with the appropriate metadata.

The network is developing an Image Management Schema (IMS) to address documentation, storage and retrieval, and the dissemination of digital images created as a result of protocol implementation. This will be provided in an IMS SOP when completed. In conjunction with the network's IMS, the network is collaborating with the service-wide redesign of NPS Focus, which ..., and will integrate the new procedures as they become available.

All reports, articles, and subsequent written materials developed from the network's vital signs monitoring will be recorded in NatureBib according to the appropriate SOP. All written materials will also be made available through the appropriate web site based upon their ownership and sensitivity.

10.3 Supporting Documentation

There are a number of SOPs and management sections that contain guidance and specifications on how the MOJN will implement the dissemination/distribution of vital signs monitoring products (e.g. data, information, and reports). The communications management section contains

a number of applicable SOPs (see subsection 10.3.1), however several other management sections contain SOPs that also apply.

10.3.1 Management Sections and Recommended SOPs

- A. Communication Management
 - a. Data and Information Distribution SOP
 - b. Records Distribution SOP
 - c. Sensitive Data and Information SOP
 - d. Documentation (Non-Spatial) SOP
 - e. Web Management SOP
 - f. Image Management Schema SOP
- B. Applications Management
 - a. NPS Data Store SOP
 - b. NatureBib SOP
 - c. NPSpecies SOP
- C. Staff and Resources Management
 - a. Roles and Responsibilities SOP
- D. Geospatial Management
 - a. Documentation (Spatial) SOP
- E. Quality Management
 - a. Electronic Storage, Backup, and Recovery SOP

11.0 Records Management and Object Curation

Documenting park resources and their management is an essential part of National Park Service administration. The potential for loss of data, documents, or objects can come from a variety of sources, including catastrophic events (e.g., fire, flood, and earthquake), user error, hardware failure, software failure or data corruption, theft, and intentional acts of vandalism.

This chapter also provides guidelines and standards for the curation of natural history specimens and other non-record objects. Such collections, and their associated records, are by definition museum objects, but have much in common with resource management records.

11.1 Objectives

- Adopt and implement robust standard file directory structure specifications.
- Where practical, maintain *mission critical* and *permanent* paper records in both hardcopy and electronic file format, and protect and preserve them indefinitely.
- Maintain datasets no more than two versions behind current software versions, or store in American Standard Code for Information Interchange (ASCII) format, complete with data and file documentation.
- Ensure information can be easily obtained, shared, and properly interpreted by a broad range of users.
- Ensure backup, storage, and recovery practices for electronic files equal or exceed the minimum standards established by the NPS Office of Chief Information Officer.
- Store all electronic files on servers in a networked environment using approved file-naming standards and file directory structures.
- Maintain all data, programmatic, and administrative electronic files indefinitely.
- Ensure all short- and long-term projects are well-documented, organized, and protected according to local and national standards and guidelines.
- Ensure all collected natural history specimens and objects are well-documented and preserved in perpetuity.

11.2 Scope

The responsibility for the preservation of park records begins with each employee and thorough implementation of effective best practices is crucial to ensuring long-term preservation and accessibility of park records. Network data management staff will collaborate with the park curation and archive staff to integrate our procedures with theirs. The network has a stand alone version of the new ANCS+ rediscovery software that submits voucher records to the appropriate park curation staff for review and integration, as they deem appropriate.

11.3 Supporting Documentation

Records and Objects Management is the primary section that applies; however, SOPs related to other management sections also have limited applicability (e.g. image management; see the next subsection 11.3.1 for further information).

11.3.1 Management Sections and Recommended SOPs

- A. Records and Object Management
 - a. Archival Strategy SOP
 - b. Digitizing (Information and Photos) SOP
 - c. Digitizing (Data) SOP
 - d. Specimen and Voucher Guidance SOP
- B. Applications Management

- a. Evidence Mining and Datasets SOP
- b. NatureBib SOP
- C. Communications Management
 - a. Documentation (Non-Spatial) SOP
 - b. Image Management Schema SOP
 - c. Web Management SOP
- D. Quality Management
 - a. Electronic Storage, Backup, and Recovery SOP
- E. Project Management
 - a. Project Deliverables SOP
- F. Geospatial Management
 - a. Spatial Data Standards and Deliverables SOP
 - b. Mobile GIS SOP

12.0 Project Tracking and Documentation

Develop and implement a comprehensive and cohesive procedure for tracking I&M projects*, including project status, data, and the products of analysis to support program coordination and annual reporting, and to improve accountability for network natural resource inventory and monitoring efforts and products.

* so as to maintain our network’s data and information management program in a Project Management Institute context that a “project is unique and temporary”, we chose to identify each year or season of data and information as a project, and each annual project is then one component of the overall network’s monitoring program.

12.1 Objectives

- Adopt and implement well organized standard project directory structure specifications
- Develop and implement a mechanism for tracking projects
- Establish clear guidelines for project narratives and documentation

12.2 Scope

All project electronic files must be well organized; the MOJN digital directory structure is organized at the project level, such that most or all digital files associated with a project are filed under a common root directory. Project file names will adhere to the naming conventions established for the network (see subsection 12.3.2). Physical objects acquired as part of a project will be stored according to specification in Chapter 11 and its appendices.

Project-specific protocol narratives and SOPs are the principal means by which I&M projects will be documented. Standards for these documents have been developed by the national I&M Program (NPS 2008) and are discussed for the MOJN in Chung-MacCoubrey et al. (2008). These documents must always accompany the distribution of monitoring data.

Project tracking has not yet been discussed by network staff who must come to a consensus on the tracking software or database that will be implemented. As the network progresses towards full implementation of the protocols, these and other relevant subjects will be discussed and modes of execution identified. Two potential possibilities for project tracking are MS Project or ThinkingRock. It will be necessary to address a number of considerations in the final selection of a specific software. These include: how and what mechanisms to use for deployment, levels of access and privileges, and ability and frequency to update.

12.3 Supporting Documentation

The project management section and its related SOPs provide guidance and specifications for how the MOJN will implement project tracking and documentation. There are SOPs in other management sections that are also applicable (see the next subsection 12.3.1 for further information).

12.3.1 Management Sections and Recommended SOPs

- A. Project Management
 - a. Project Scheduling and Tracking SOP
 - b. Project Life Cycle and Workflow SOP
 - c. Data Life Cycle SOP
 - d. Project Deliverables SOP
- B. Nomenclature Management
 - a. File and Folder Naming Conventions SOP
 - b. Directory Structure (Non-Spatial) SOP
- C. Geospatial Management
 - a. Directory Structure (Spatial) SOP

13.0 Implementation

The data management plans for each of the 32 I&M Networks are the first comprehensive documents of their kind in the NPS and contain practices that may be new to staff and cooperators. However, almost every requirement stems from federal law, Executive Orders, Director's Orders, or national I&M Program guidance. The DMP helps put these requirements into context, and provides operational guidance for achieving them.

13.1 Objectives

- Acceptance and understanding by all staff of targeted programs and their cooperators of the fundamentals of data and information management
- Improvement of data management practices by implementing standards, integration into field studies, and improved quality control practices
- Inclusion of data and information management consistent with the data management plan in all protocols developed
- Development of procedures and outlets for communication, education, and training for data management practices

13.2 Scope

Full implementation of this plan by the MOJN I&M Program is expected to be achieved by 2010-2011. Implementation at the broader park level is expected to be an ongoing process and will most likely occur in stages. Realistically, it will not be possible for all programs to fully adopt the practices and procedures recommended without an increase in current levels of funding and staff support. Currently, none of the network park resource divisions have a data manager on staff, although a number of parks within the network have identified GIS staff that are recognized as the park-level data management experts. Programs wishing to participate need to identify those areas that can be implemented given existing resources. For example, it is relatively easy for programs to begin implementing standards and guidelines for organizing and managing electronic files, including digital photos. Pragmatism should dictate prioritization and implementation. Critically important to successful implementation at the broader park level will be the active support of park resource management teams.

The network data manager will, on a case-by-case basis as requested by parks, provide assistance, guidance, and recommendations for the implementation of data and information. Otherwise various trainings and other educational opportunities will be provided to network and park staff on documentation, metadata, databases, applications (I&M tools), and other areas as requested.

13.3 Supporting Documentation

All of the management sections and their associated SOPS are written as guidance and specifications documents on how the MOJN will implement its DMP. However it would be to no benefit to simply list them all, but instead to list only those that are clearly applicable to the implementation of data and information management (see subsection 13.3.1).

13.3.1 Management Sections and Recommended SOPs

- A. Applications Management
 - a. IRMA SOP
 - b. NatureBib SOP
 - c. NPSpecies SOP
 - d. Natural Resources Database Template SOP
 - e. Evidence Mining and Datasets SOP
- B. Communications Management
 - a. Documentation (Non-Spatial) SOP
 - b. Image Management Schema SOP
- C. Geospatial Management
 - a. NPS Metadata Tools and Editor SOP
 - b. Documentation (Spatial) SOP
 - c. Documentation (Biological Profile) SOP

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15.0 Change History

Table 6. Change history table for the MOJN DMP.

Previous Version	Revision Date	Revised By	Change Description	Justification	New Version Number
1.0	yyyymmdd	Truitt, R. E.	Original Draft		

Table 4 reflects changes to this document. 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.

16.0 Supporting Documentation

There are a number of SOPs involved with data and information management for the MOJN. As stated in the introduction to this plan, the network plan is the link between the national guidance document and the SOPs or implementation steps to network data and information management (Figure 8, page 4). The network's SOPs have been grouped into management sections (Figure 2, page xi), each management section containing SOPs of related subject mater. Table 6 (below) provides a catalog of the management sections and their associated SOPs.

SOPs can be categorized into two general areas: specifications and guidance. Specifications are those which have to be followed for minimum data management, and guidance are those that should be followed for a high-quality level of data management. Refer to table 6 to find what management section or associated SOPs apply.

The MOJN has numerous individual SOPs on guidance, standards, and specifications related to the various tasks and activities associated with data and information management. To assist in the process of determining which SOP(s) are relevant. Figure 14 below provides a general overview of tasks and activities divided into three categories: organizational, data, and spatial.

Table 7. MOJN Management Sections and associated SOPs.

Applications Management	Nomenclature Management
Login Requests and Maintenance	File and Folder Naming Conventions
Evidence Mining and Datasets	Directory Structure (Non-Spatial)
IRMA	Site and Location Naming Guidance
NatureBib	Project Management
NPS Data Store	Project Life Cycle and Workflow
NPSpecies	Data Life Cycle and Workflow
NPSStoret	Project Deliverables
Communications Management	Project Scheduling and Tracking
Data and Information Distribution	Quality Management
Records Distribution	Data Quality
Documentation (Non-Spatial)	Information Quality
Image Management Schema	Electronic Storage, Backup, and Recovery
Sensitive Data and Information	Records and Objects Management
MOJN Infrastructure	Archival Strategy
MOJN Systems Architecture	Digitizing (Information and Photos)
Network SharePoint	Digitizing (Data)
Web Management	Specimen and Voucher Guidance
Database Management	Staff and Resources Management
Database Naming Conventions	Roles and Responsibilities
Natural Resources Database Template	Property Guidance
Database Design and Development	Safety Guidance
Geospatial Management	Summarization Management
Spatial Data Standards and Deliverables	Graphing Data
Directory Structure and Naming (Spatial)	Statistical Analysis (Tabular)
Geodatabases (GDB)	Geospatial Statistics
Documentation (Spatial)	
Documentation (Biological Profile)	Protocol Specific SOPs
NPS Metadata Tools and Editor	Climate Data Acquisition
Mobile GIS	
Digitizing (Maps)	

Organizational tasks and activities generally fall into those general or “house-keeping” operational needs such as file and folder naming conventions, directory structures, computer hardware, property management, storage, backup, and archiving of data/records/information, etc... The data category concerns all aspects related to data, and in particular tabular data, such as field/laboratory collection, database design and development, quality control and assurance, statistical and graphic information for data. The spatial category is much the same as the data category except it is specific to GIS types of data and other related activities. Each of these categories is further arranged into associated SOPs in Figures 15-17.

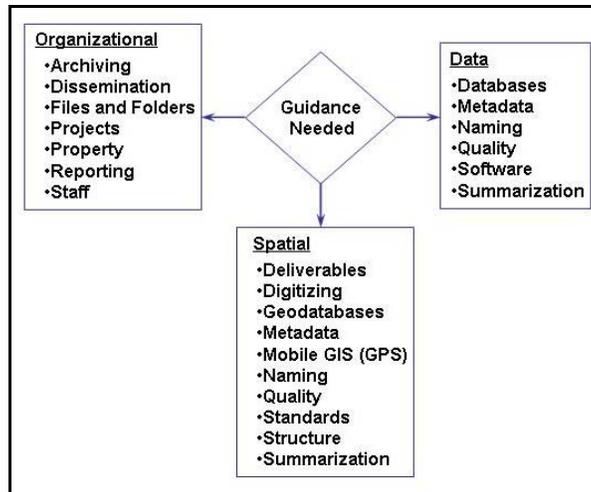


Figure 15. Guidance assistance decision tree

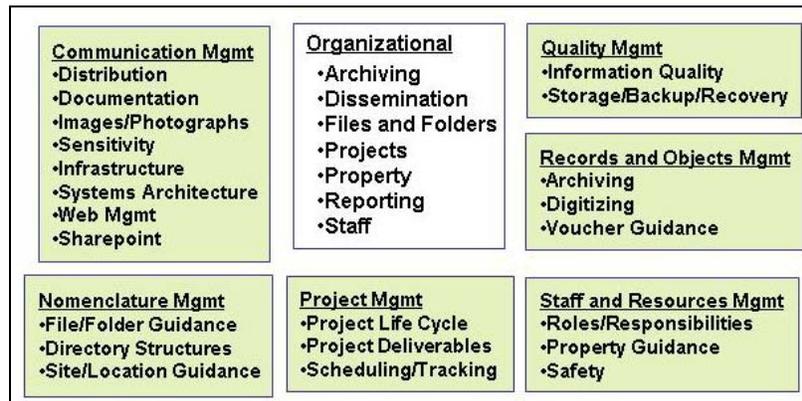


Figure 16. SOPs relevant to organizational tasks and activities

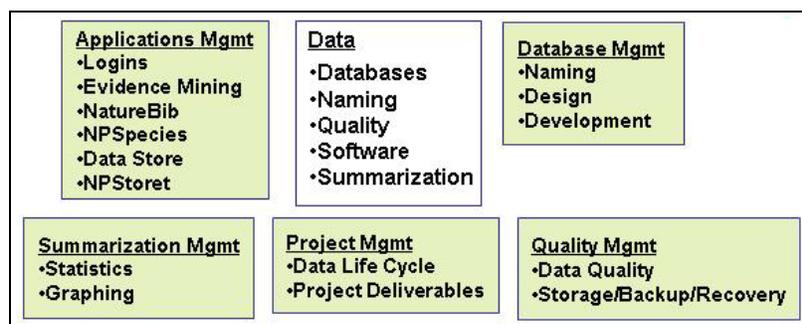


Figure 17. SOPs relevant to tabular data

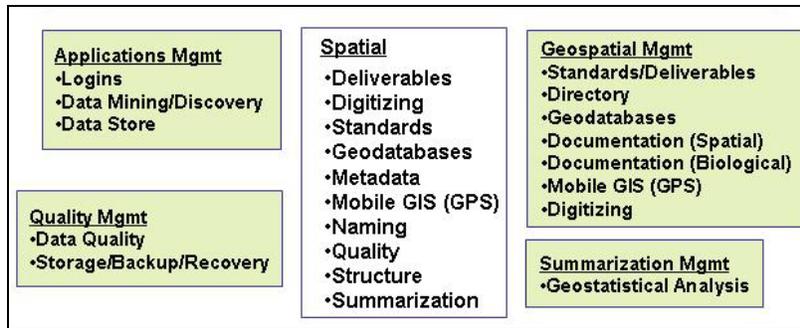


Figure 18. SOPs relevant to spatial data.

Table 8. Table of MOJN SOPs and their development status.

Completed = ready for technical review

In Progress = draft document in progress

Planned = planned for but need to progress on other aspects first (i.e. protocol development)

Mgmt Section/SOPs	Development Status	Timeline
Applications Management		
Login Requests and Maintenance	In Progress	Winter 2009
Evidence Mining and Datasets	In Progress	Winter 2009
IRMA	Planned	Unknown
NatureBib	In Progress	Fall 2008
NPS Data Store	In Progress	Fall 2009
NPSpecies	In Progress	Fall 2008
NPStoret	Planned	Unknown
Communications Management		
Data and Information Distribution	In Progress	Fall 2009
Records Distribution	In Progress	Winter 2010
Documentation (Non-Spatial)	In Progress	Spring 2009
Image Management Schema	Planned	Unknown
Sensitive Data and Information	Planned	Unknown
MOJN Infrastructure	In Progress	Spring 2009
MOJN Systems Architecture	In Progress	Winter 2009
Network SharePoint	Planned	Unknown
Web Management	In Progress	Fall 2008
Database Management		
Database Naming Conventions	In Progress	Fall 2008
Natural Resources Database Template	Planned	Unknown
Database Design and Development	Planned	Unknown
Geospatial Management		
Spatial Data Standards and Deliverables	Planned	Unknown
Directory Structure and Naming (Spatial)	In Progress	Winter 2009
Geodatabases (GDB)	Planned	Unknown
Documentation (Spatial)	In Progress	Spring 2009
Documentation (Biological Profile)	In Progress	Spring 2009
NPS Metadata Tools and Editor	In Progress	Spring 2009
Mobile GIS	Planned	Unknown
Digitizing (Maps)		Winter 2009
Nomenclature Management		

Mgmt Section/SOPs	Development Status	Timeline
File and Folder Naming Conventions	In Progress	Fall 2008
Directory Structure (Non-Spatial)	In Progress	Spring 2009?
Site and Location Naming Guidance	Planned	Unknown
Project Management		
Project Life Cycle and Workflow	In Progress	Winter 2009?
Data Life Cycle and Workflow	In Progress	Winter 2009?
Project Deliverables	Planned	Unknown
Project Scheduling and Tracking	Planned	Unknown
Quality Management		
Data Quality	Planned	Unknown
Information Quality	Planned	Unknown
Electronic Storage, Backup, and Recovery	In Progress	Spring 2009
Records and Objects Management		
Archival Strategy	Planned	Unknown
Digitizing (Information and Photos)	In Progress	Fall 2008
Digitizing (Data)	In Progress	Fall 2008
Specimen and Voucher Guidance	Planned	Unknown
Staff and Resources Management		
Roles and Responsibilities	Planned	Unknown
Property Guidance	In Progress	Fall 2008
Safety Guidance	In Progress	Fall 2008
Summarization Management		
Graphing Data	Planned	Unknown
Statistical Analysis (Tabular)	Planned	Unknown
Geospatial Statistics	Planned	Unknown
Protocol Specific SOPs		
Climate Data Acquisition	Planned	Unknown