National Park Service
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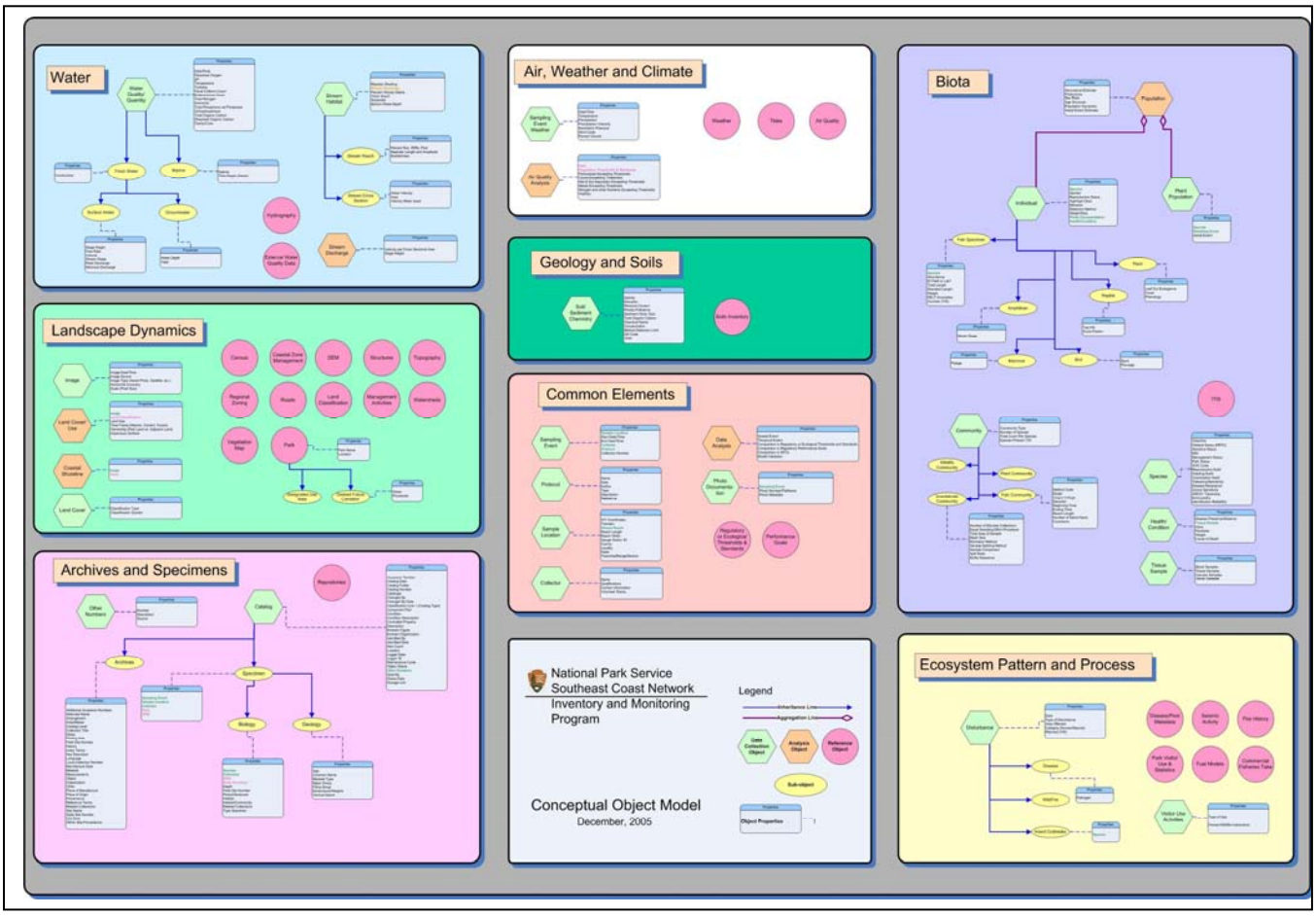
Natural Resource Program Center

Information Management and Archiving Plan
Southeast Coast Inventory and Monitoring Network

Natural Resource Report NPS/SECN/NRR—2008/062



ON THE COVER
Conceptual Data Object Model for the Information System that will support the Southeast Coast Network.
From: DataLOGIC, Inc., 2005

Information Management and Archiving Plan
Southeast Coast Inventory and Monitoring Network

Natural Resource Report NPS/SECN/NRR—2008/062

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Acronyms:

ANCS+	Automated National Catalog System
CSDGM	Content Standard for Digital Geospatial Metadata
DOI	Department of the Interior
FGDC	Federal Geographic Data Committee
FOIA	Freedom of Information Act
GIS	Geographic Information Systems
I&M	Inventory and Monitoring
INA	Information Needs Assessment
IT	Information Technology
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
NPS	National Park Service
OCIO	Office of the Chief Information Officer
QA	Quality Assurance
QC	Quality Control
SECN	Southeast Coast Network
SER	Southeast Region
SERO	Southeast Regional Office
SOP	Standard Operating Procedure
WASO	Washington Support Office
WRD	Water Resources Division

Initial Distribution
SECN Intranet Website http://www1.nrintra.nps.gov/im/units/secn/datamgmt/index.cfm
SECN Internet Website http://science.nature.nps.gov/im/units/SECN/reports.cfm

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Revision Date	Author	Changes Made	Reason for Change	New Version Number
9/12/2008	Christina Wright	Updating content of several chapters before finalizing.	Revisions based on reviewer comments for draft version 1.0.	Version 1.0

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Curatorial Responsibilities Guidance Document
Project Closeout Checklist

The above appendices are available as individual documents at the SECN intranet site by using the links above or http://www1.nrintra.nps.gov/im/units/secn/datamgmt/index.cfm.

The appendices are also available as a compiled document at the SECN internet site http://science.nature.nps.gov/im/units/SECN/reports.cfm.

Acknowledgments

Because network data management plans have been due on an incremental basis depending upon when the network received full funding, those of us in later funded networks have benefited greatly from the work done by those data managers whose plans were due early on in the process. Special thanks needs to go to those people who really helped move things forward by setting the standard for productive collaboration across the NPS data management community and for all of their hard work and ideas: Sara Stevens, Margaret Beer, John Boetsch, Deborah Angell, Dorothy Mortenson, Doug Wilder, Gareth Rowell, Michael Williams, Geoffrey Sanders, Rob Daley, Teresa Leibfreid, Bill Moore, Patrick Flaherty, Fred Dieffenbach, Mark Hart, and Velma Potash. Since this first round of data management plans, data managers across the service have continued to work together through conference calls, emails and the annual data management meeting. Many components of this data management plan were developed over the past several years through collaborative efforts among data managers throughout the I&M Program of the National Park Service and adopted by the SECN as originally presented or with minimal changes. These contributions are noted in the "Credits" section at the end of Plan chapters. An additional thank you is required for the many reviewers of this document; your comments have greatly improved the structure and content of both the plan and plan appendices. Finally, thanks to Joycine Lowe, Sarah Zimny and Sara Pribula in the Southeast Region IT Division who provided information regarding NPS and Southeast Region IT infrastructure, system architecture, security and backups.

Executive Summary

As part of the National Park Service's effort to "improve park management through greater reliance on scientific knowledge," a primary role of the Inventory and Monitoring (I&M) Program is to collect, organize, and make available natural resource data and to contribute to the Service's institutional knowledge by facilitating the transformation of data into information through analysis, synthesis, and modeling (http://science.nature.nps.gov/im/index.cfm). To meet these objectives, each I&M Network needs a decision support system that effectively stores, maintains, analyzes, and distributes the data, information and products of scientific work conducted at each of the network parks. Thus, a foundation of the I&M program is the strong emphasis placed on data and information management for which networks are expected to devote at least 30 percent of available resources.

There are three primary sources of natural resources data of interest to the Southeast Coast Network (SECN) vital signs monitoring program:

- **Vital Signs monitoring data** – Data collected during implementation of the long-term monitoring program following peer-reviewed protocols and standard operating procedures. Data collection is conducted on an ongoing (continuous), cyclic (once every few years), or synoptic (one point in time) schedule.
- **Project data** – Data that are collected following standardized methods during a distinct time period with no expectation of recurrence following those same methods. Examples include baseline inventories, data collected during protocol development, and data collected during research by network, park, or cooperating personnel. Legacy datasets are also considered project data.
- **Incidental Observation Data** – Data collected following no standardized protocol (e.g. opportunistic species observations).

The information management strategy described in this document is focused upon data collected during the implementation of vital signs monitoring protocols although project and incidental observation data are discussed as well. Management of data, specimens, or archives outside of this scope is addressed elsewhere in existing National Park Service (NPS) or Park-specific standard operating procedures (SOPs). Where such SOPs do not exist the Network will develop procedures (or protocols) to appropriately and consistently manage those data. It is the intent of the SECN to develop an information management system that can accommodate vital signs monitoring data, as well as project and incidental observation data.

Chapter 1. Introduction to Information Management

Many organizations suffer from a history of poor data management practices. Studies are funded and data received, only to be lost in an office somewhere and forgotten. Or perhaps data are stored on storage media or saved in software applications that are no longer supported – making that information irretrievable. Another common problem is the existence of data sets that have no metadata (documentation) to explain what data were collected, who collected the data, when and how the data were collected and why. Without proper documentation it is nearly impossible to understand the contents of a data set, the limitations of its use, or to know the quality of the data – thus rendering the data unusable.

The central mission of the NPS Inventory and Monitoring Program is to provide timely, quality and usable scientific information about the condition of park resources to park managers and a wide range of additional end-user groups. To meet this challenge, a decision support system must be developed to effectively store, analyze, maintain, and distribute the data and products of the scientific work being conducted by the program (as well as all relevant legacy data and data from external sources).

Good information management is more than the collection and management of data. Information management is the means by which end-users gain access to and a thorough understanding of the data and information produced as part of the NPS Inventory and Monitoring Program in support of natural resource management over the long-term. To that end, the guidelines and procedures included in this document and its appendices may be applied to any natural resource data or information deemed relevant to the Southeast Coast Network long-term monitoring program – although the focus of this document is vital signs monitoring data.

Southeast Coast Network

The Southeast Coast Network (SECN) contains twenty parks, seventeen of which contain significant and diverse natural resources (Table 1-1 and Figure 1-1). In total, SECN parks encompass more than 184,000 acres of federally- managed land across North Carolina, South Carolina, Georgia, Alabama, and Florida. The parks span a wide diversity of cultural missions also, including four National Seashores, two National Historic Sites, two National Memorials, six National Monuments, two National Battlefields, as well as a National Park, National Recreation Area, National Military Park, and an Ecological and Historic Preserve. The parks range in size from slightly more than 20 to nearly 60,000 acres, and when considered with non-federal lands jointly managed with SECN parks the Network encompasses more than 253,000 acres.

Detailed descriptions of SECN parks and their resources are presented in Chapter 1 (Introduction and Background) of the Southeast Coast Network Vital Signs Monitoring Plan.

Table 1-1. Parks of the Southeast Coast Network with significant Natural Resources [Park codes in italics are administered by the nearest non-italicized entry above].

Park Code	Park	Significant Natural Resources?	Federal Acres	Non-Federal Acres	Total Acres
CANA	Canaveral National Seashore	Yes	57,648	14	57,662
CAHA	Cape Hatteras National Seashore	Yes	34,500	--	34,500
FORA	Fort Raleigh National Historic Site	No	355	--	355
WRBR	Wright Brothers National Memorial	No	421	--	421
CALO	Cape Lookout National Seashore	Yes	25,174	3,070	28,243
CASA	Castillo de San Marcos National Monument	Yes	20	<1	21
FOMA	Fort Matanzas National Monument	Yes	298	--	298
CHAT	Chattahoochee River National Recreation Area	Yes	5,462	5,438	10,900
CONG	Congaree National Park	Yes	21,769	4,663	26,432
CUIS	Cumberland Island National Seashore	Yes	18,849	17,567	36,416
FOFR	Fort Frederica National Monument	Yes	239	2	241
FOPU	Fort Pulaski National Monument	Yes	5,365	258	5,623
FOSU	Fort Sumter National Monument	Yes	194	<1	195
CHPI	Charles Pinckney National Historic Site	No	28	--	28
MOCR	Moores Creek National Battlefield	Yes	88	--	88
HOBE	Horseshoe Bend National Military Park	Yes	2,040	--	2,040
KEMO	Kennesaw Mountain National Battlefield Park	Yes	2,880	5	2,884
OCMU	Ocmulgee National Monument	Yes	702	--	702
TIMU	Timucuan Ecological and Historic Preserve	Yes	8,417	37,583	46,000
FOCA	Fort Caroline National Memorial	Yes	133	5	138
	Total		184,581	68,605	253,187

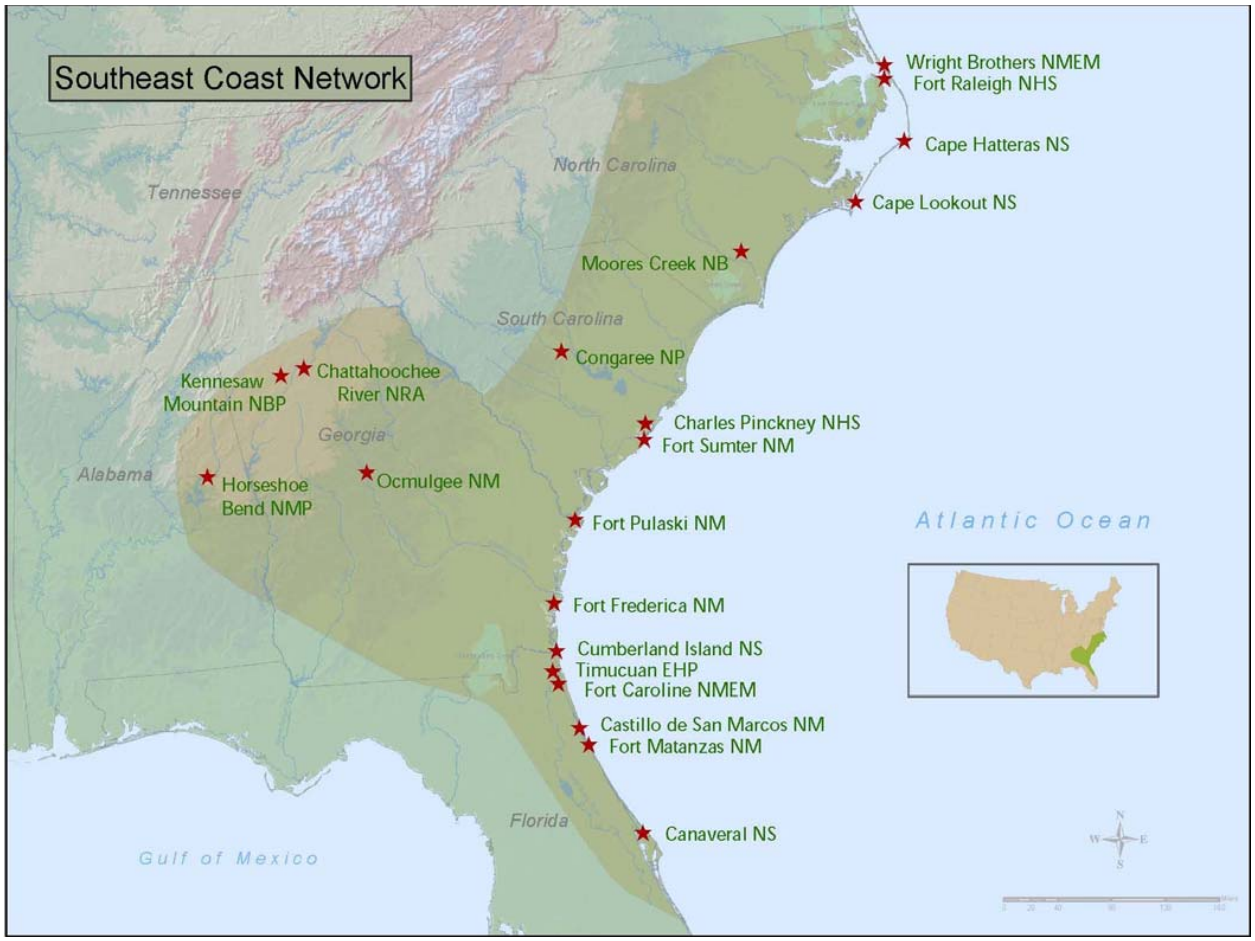


Figure 1-1. Map of Southeast Coast Network Parks

Network Staff

Staffing for the Southeast Coast Network is expected to change as the program moves from a planning to an operational phase. The staffing plan for implementation includes three "tiers" of positions: (a) core professional-level staff with the primary responsibility for stewardship of one or more of the SECN monitoring protocols, (b) support staff, to assist with program administration and field work related to long-term monitoring efforts, and (c) field staff to assist with (or lead) synoptic monitoring projects that augment baseline long-term monitoring efforts.

At full implementation, the network will require twelve full-time staff members and one part-time (shared) administrative support staff member (Figure 1-2). Figure 1-2 shows only core staffing positions. Additional field support staff might be added based on needs identified in annual work plans. The main network office will be located at Cumberland Island National Seashore with a satellite office located at Fort Sumter National Monument. Both office locations were selected to minimize operational costs (rent, travel) while maximizing the Network's ability to partner with other agencies with expertise and interests in monitoring SECN Vital Signs.

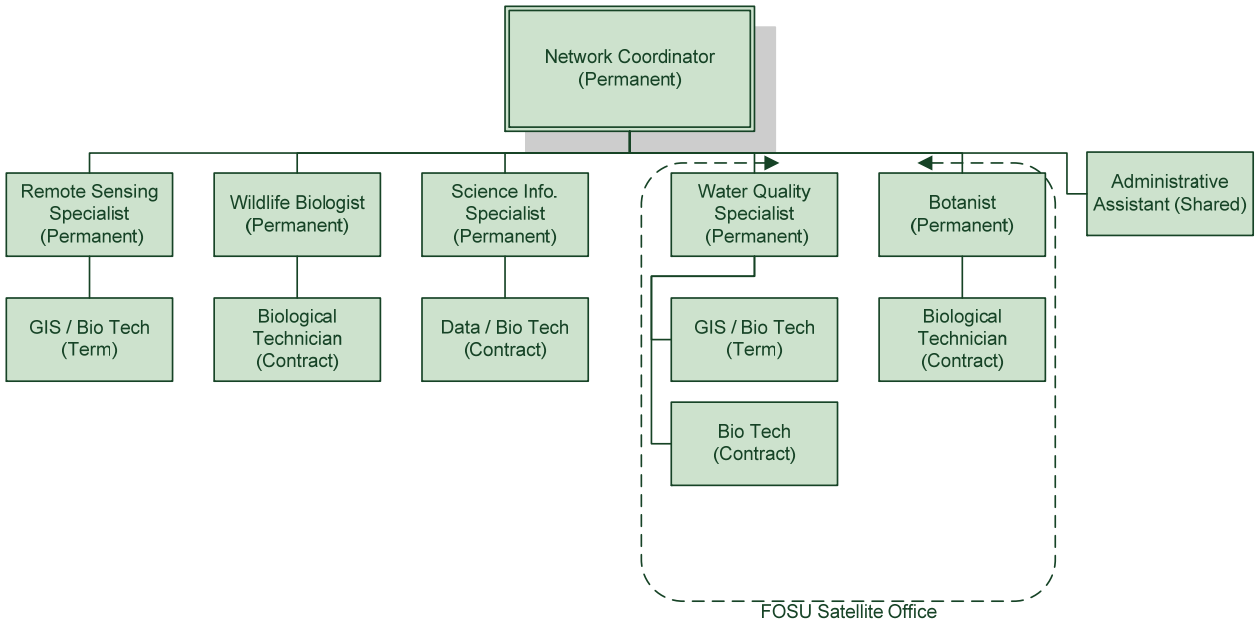


Figure 1-2. Organizational Chart for the Southeast Coast Network.

Board of Directors and Technical Steering Committee

Network member parks are committed to cooperate and foster an atmosphere of fairness, trust, and respect throughout the Network. The parks within the Network are pursuing an inclusive approach in defining Network management issues and resources of concern, and in identifying the best locations to monitor these resources, as well as implementing the I&M program using scientifically credible standards. Operations of the partnership among the SECN parks are governed by the Network Charter, signed by all park Superintendents (Appendix 1 of the Southeast Coast Network Vital Signs Monitoring Plan), which explicitly spells out the roles and membership of three core groups of individuals: the Board of Directors, the Technical Steering Committee, and Network Staff.

The SECN Board of Directors (Board) is comprised of five Network park Superintendents and the Southeast Region I&M Coordinator, with one superintendent elected to serve as the chairperson. The Board promotes accountability and effectiveness by reviewing progress toward goals, quality controls, and Network expenditures. The Board collaborates with the Network Coordinator, Technical Steering Committee, and Network parks' natural resource staffs in the overall design and implementation of vital signs monitoring and in other management activities related to the Natural Resource Challenge.

The Technical Steering Committee is comprised of resource managers (elected by the Network Park Resource representatives with the concurrence of their Park Superintendent), and non-voting, volunteer scientists as needed. In total, the Committee includes the Network Coordinator, Science Information Specialist, CESU coordinator, park natural resource managers, and other scientists with knowledge of sampling procedures, monitoring techniques, and statistical methods that serve as reviewers to evaluate conceptual designs, monitoring strategies, and ecological relevance of monitoring proposals.

The Technical Steering Committee advises the Board and Network parks on the development and findings of the Network Monitoring Plan by:

- Compiling and summarizing existing information about park resources and the findings and recommendations of scoping workshops
- Assisting in the development of a network monitoring strategy
- Assisting in the selection of Vital Signs
- Evaluating initial sampling designs, methods, and protocols to ensure that they are scientifically credible
- Participating in the development of the Annual Work Plan and Annual Reports
- Reviewing annual data reports, I&M deliverables, and otherwise acting as a peer science review group
- Developing materials for and facilitating the Five Year Program Review

Products and recommendations of the Technical Steering Committee are presented to the Board of Directors for discussion, modification, and approval. When necessary, the Network Coordinator may recommend to the Board of Directors the formation of groups of scientists or specialists from within or outside the Technical Steering Committee to accomplish specific studies/tasks.

Goals and Objectives

The SECN information management plan has been developed to serve as a working reference document to guide users in establishing standardized data management practices and to institute information management as an integral part of vital signs monitoring. This Plan is written as a tactical guidance or reference document that discusses the full array of information management topics – briefly describing a topic, framing any problems or issues associated with that topic and then outlining the strategy for solving the problem from the SECN perspective. All of the details and specific instructions for carrying out these strategies are presented in the Plan appendices with links between the two documents throughout. The appendices provide concise, focused technical guidance for implementing a specific topic area such as photo management, electronic archives and project closeout etc.

The overarching goal of the SECN information management strategy is to ensure the quality, efficiency, interpretability, security, longevity and availability of ecological data and information resulting from previous and ongoing natural resource relevant scientific investigations. These elements are critical to the success of the SECN Vital Signs Monitoring Program and the service-wide I&M program overall. Therefore, all aspects of information management are discussed within this document – ranging from data collection through reporting, to data dissemination and archiving.

- ***Quality:*** Due to the complexity of most ecological studies, the term “quality” affects several different aspects of a project. Within an information management context, our primary objective is to ensure that appropriate quality assurance measures are taken during all phases

of project development, data acquisition, data handling, summary and analysis, reporting and archiving. Avoiding inconsistent or poor-quality data is critical for data analysis and interpretation, as well as the long-term success of the I&M Program. To ensure that the SECN produces and maintains data of the highest possible quality, procedures are established to identify and minimize errors at each stage of the data lifecycle.

- ***Efficiency:*** The concept: "don't collect data if you don't know what you're going to do with it" is essential for maximizing resources (including time, money, and personnel) within a long-term monitoring program. To avoid this pitfall, the SECN held meetings with subject matter experts that combined the planning needs for both information management and long-term monitoring protocol development. By examining protocol needs from data collection through reporting, we sought to ensure that data will be understood and interpreted within the context of their original scope and intent.
- ***Interpretability:*** SECN conducted an information needs assessment focusing on the end-use of data and information originating from the I&M program at the Park, Network and Regional level. Details of this process are presented in Chapter 2. Overall, an important outcome of the information needs assessment was the SECN conceptual object model which is a roadmap for information management system design and development that supports end-user needs and expectations. Combined with rigorous data documentation, all users should have an informed appreciation of the applicability and limitations of all SECN data sets.
- ***Security:*** Digital and hard-copy data must be maintained in environments that protect against loss from a wide variety of factors including: improper storage conditions, hardware failure, software obsolescence, storage media deterioration, and natural disasters (e.g. flooding and hurricanes). Digital data of the SECN 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, SECN and Park curatorial staff (or their designees) are ensuring related project materials such as field notes, data forms, specimens, photographs, and reports are properly cataloged, stored and managed in archival conditions.
- ***Longevity:*** Countless data sets have been lost over time simply because they were not sufficiently documented, organized, and maintained following their creation. Closely tied to security, data longevity can be enhanced through proper documentation (e.g. metadata) and by maintaining the data in currently accessible and interpretable formats. The SECN information management plan addresses proper storage conditions, backups, data migration, and data set documentation requirements to ensure data utility into the future.
- ***Availability:*** One of the most important responsibilities of the I&M Program is to ensure that data collected, developed or assembled by SECN staff or cooperators are made available in a timely manner for decision-making, research, and education for a wide-range of end-users. To support these objectives, the SECN must ensure that: data are easily located and obtained, data have gone through rigorous quality assurance screening prior to release, data are accompanied by complete metadata (documentation) and that sensitive data are identified and protected from unauthorized access or distribution.

To achieve the goals mentioned above, the SECN Information Management Plan has been developed with the following concepts in mind:

- This plan and its appendices are intended to be used by and remain relevant to all users. Thus, input from end-users is important and key to current data management decisions and future revisions to this document.
- The SECN Information Management Plan should remain flexible and evolve over time as end-user needs and technologies change.

Scope, Context and Intended Audience

While this plan is directed towards the immediate needs of the SECN, the principles and guidelines provided can be applied to almost any data gathered by an agency, contractor, or additional sources. We intend for this plan to be informative, useful, accessible, and continue to improve through time. While the SECN Science Information Specialist is the primary author and editor of this document, the involvement of end users in refining and improving these ideas is essential. At a minimum, this document is intended for SECN staff, network park staff and individuals, agencies and cooperators that participate in SECN programs.

This Plan (and appendices) facilitates the practice of sound information management in all new projects while legacy data are brought up to standard and made usable as well. This Plan (and appendices) encompasses all information products generated, as well as primary tabular and spatial data collected as part of the I&M Program. These data fall into five general categories: raw data, derived data, documentation, reports, and administrative records (Table 1-2).

Table 1-2.Categories of data and information products.

Category	Examples
Raw Data	GPS rover files, hard copy field forms and notebooks, electronic data files from data loggers or other digital devices, photographs and sound/video recordings, telemetry or remotely-sensed data files, natural history voucher specimens
Compiled / derived data	Relational databases, tabular data files, GIS layers, maps, species checklists and derived data sets based on the analysis, compilation, or manipulation of other data
Documentation	Data collection protocols, data processing/analysis protocols, record of protocol changes, data dictionary, FGDC/NBII metadata, data design documentation, quality assurance report, catalog of specimens/photographs/GIS layers
Reports	Annual progress report, final report (technical or general audience), periodic trend analysis report, peer reviewed publications
Administrative records	Contracts and agreements, study plans, research permits/applications, other critical administrative correspondence

In order to meet I&M programmatic goals and to ensure the utility of data and information products into the future, it is necessary that all of the above categories are properly documented and managed. Thus the SECN will take a holistic approach to information management, integrating good data management practices from protocol development to data collection, analysis, interpretation, documenting, sharing, and archiving.

Design and Layout

There are four document types being developed as part of this plan:

1. SECN Information Management and Archiving Plan (The SECN strategy for meeting the information management goals and objectives)
2. Conceptual Object Model (A graphical representation of SECN data components and their relationships which serves as the foundation for all decision support system development activities)
3. Protocol-specific Guidance and Standard Operating Procedures (e.g. data analysis and interpretation – included in protocol document or appendices to the protocol)
4. Information Management and Archiving Plan Appendices (Includes subject-specific guidance documents such as GIS specifications, Voucher specifications and User Guides and Cheat Sheets such as GPS Cheat Sheets for Trimble Recon/GeoXH and Pathfinder Office).

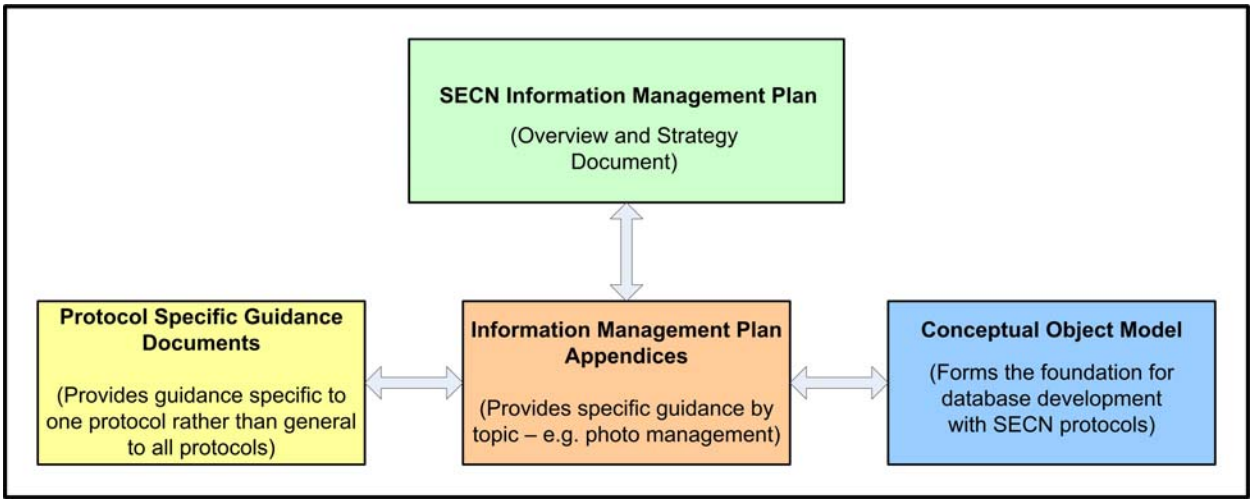


Figure 1-3. Hierarchy of SECN information management documents

The SECN developed this information management plan to provide the SECN strategy for addressing information management topics, from data collection through reporting and archiving. In addition, individual guidance documents, protocols, and standard operating procedures are, in reality, stand-alone documents that may be provided to cooperators as needed and may be more easily reviewed by subject matter experts based upon their area of expertise. However, when considered together, these documents provide the foundation for SECN information management (Figure 1-3) and provide all of the necessary information to relevant personnel to ensure the quality, interpretability, security, longevity and availability of ecological data and information into the future.

Review and Revisions

To ensure that the SECN Information Management Plan will meet overall program needs, the initial version of this document has undergone a prescribed review process that included both an internal network review (i.e., SECN staff), and a service-wide review that involved data

management staff from other networks and the Washington Support Office (WASO) I&M offices. Maintenance of this document will be incremental as changes are needed to reflect best management practices and current information technologies. SECN data management staff will be responsible for this level of ongoing maintenance.

The first few years of the implementation of this Plan will involve learning, testing, and refining. During this period, guidance documents and SOPs will be developed and tested and refined as needed. These procedures will then be applied to other vital sign monitoring protocols. We anticipate that there will be some bottlenecks and their identification and elimination is an important phase in the implementation of this plan. Goals for this period of implementation include:

- All personnel understand the fundamentals of data management, including: file management, documentation, quality assurance and quality control, electronic (digital) storage and archival (non-digital) storage
- Improve data management practices by implementing the conceptual object model for selected vital signs and beginning database development and testing prior to starting data collection
- Develop common SOPs and guidance documents that can be used for multiple protocols
- The first vital signs monitoring protocols will be implemented following the procedures described in this Plan and it's appendices

Recommendations for additions or changes may be forwarded to the SECN Science Information Specialist by any user of SECN inventory and monitoring data – park resource managers, project managers, technicians, superintendents, external users, etc. These recommendations will be discussed by network and park staff as needed to decide what actions to implement. Simple changes may be made immediately in the document, while broader changes will be made during scheduled updates to this plan (minimally every 5 years). Plan updates will be distributed to members of the network Technical Steering Committee prior to implementation and this document will be housed on the SECN website (http://science.nature.nps.gov/im/units/secn/).

Credits

Some materials in this section were taken or adapted from the following data management plans: (Stevens and Entsminger 2004), (Wilder D. (Editor) 2006), (Appalachian Highlands Inventory and Monitoring Network 2004) and (Mohren 2007).

Chapter 2. Information Management Strategy

Collecting natural resource data is the first step towards understanding the ecosystems within national park units. These ecosystems are evolving, as is our knowledge of them and how they function. Raw data are used to analyze, synthesize, and model aspects of ecosystems. In turn we use results and interpretations to make decisions about network park's critical natural resources. Thus, data collected and maintained by the SECN will become information through analysis, synthesis and adaptive modeling.

Because one of the goals of the I&M program is to base management decisions on scientific knowledge in a rapidly changing environment, it is incumbent upon the SECN to develop tools that allow managers to make decisions on the most recent data available from as many relevant sources as possible. It is therefore the interpretation of the Southeast Coast Network that this necessitates the development of a single, integrated decision support system that (a) efficiently and cost-effectively allows for concurrent analysis of data from multiple vital signs and (b) accommodates predictive modeling. This decision support system will also facilitate data integration and data quality locally and will allow the network to institutionalize quality information management practices.

NPS Policies and Information Management

National Park managers are directed by federal law and National Park Service policies and guidance to know the status and trends in the condition of natural resources under their stewardship in order to fulfill the NPS mission of conserving parks unimpaired for the enjoyment of future generations. The mission of the National Park Service as described by the National Park Service Organic Act (National Park Service Organic Act (16 U.S.C. l 2 3, and 4) 1916) is:

> *"...to promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purposes of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations".*

More recently, the National Parks Omnibus Management Act of 1998 established the framework for fully integrating natural resource monitoring and other science activities into the management processes of the National Park System. The Act charges the Secretary of the Interior to "continually improve the ability of the National Park Service to provide state-of-the-art management, protection, and interpretation of and research on the resources of the National Park System", and to "assure the full and proper utilization of the results of scientific studies for park management decisions." Section 5934 of the Act requires the Secretary of the Interior to develop a program of "inventory and monitoring of National Park System resources to establish baseline information and to provide information on the long-term trends in the condition of National Park System resources."

The NPS Management Policies (National Park Service 2006) updated previous policy and specifically directed the Service to inventory and monitor natural systems. Furthermore:

"The Service will:

- *identify, acquire, and interpret needed inventory, monitoring, and research, including applicable traditional knowledge, to obtain information and data that will help park managers accomplish park management objectives provided for in law and planning documents;*
- *define, assemble, and synthesize comprehensive baseline inventory data describing the natural resources under NPS stewardship, and identify the processes that influence those resources;*
- *use qualitative and quantitative techniques to monitor key aspects of resources and processes at regular intervals;*
- *analyze the resulting information to detect or predict changes (including interrelationships with visitor carrying capacities) that may require management intervention and provide reference points for comparison with other environments and time frames; and*
- *Use the resulting information to maintain – and, where necessary, restore-the integrity of natural systems."*

Together, these goals will only be achieved through the development of a modern information management infrastructure (e.g., staffing, hardware, software) and procedures to ensure that relevant natural resource data collected by NPS staff, cooperators, researchers and others are entered, quality-checked, analyzed, reported, archived, documented, cataloged, and made available to others for management decision-making, research, and education.

NPS-75 and Integration

The vital signs prioritization process used by the SECN is described in detail in Appendix 4 of the SECN Vital Signs Monitoring Plan. Vital signs were selected to take maximum advantage of ongoing monitoring efforts being conducted by parks within the network and partnering agencies throughout the region – while meeting high ranking monitoring objectives at all parks. This approach of developing an integrated monitoring program has been stressed in NPS policies (particularly NPS-75) and was identified as a core requirement of the Network's information management strategy based on the SECN information needs assessment (DataLOGIC, Inc. 2005). The SECN has identified four levels of integration through its planning process:

- **Integration among vital signs** – NPS-75 provides examples and suggestions for ways I&M program managers can view data from multiple vital signs to assess, model, predict, or interpret patterns in data across space and time.
- **Integration among parks** – Integration of data from multiple parks into unified data sets allow for Network-wide roll-ups and within network comparisons.
- **Integration with partnering agencies** – NPS-75 encourages integration with other agencies in two manners: through leveraging efforts with other agencies that monitor similar resources and by sharing data in standardized multi-agency formats (e.g. STORET).
- **Programmatic Integration** – Monitoring data can be analyzed and reported in many ways depending on the target audience and intended use of the data. Only by linking findings and

predicted outcomes to prescribed actions can the Network's activities become fully integrated with other aspects of park management (e.g. planning, law enforcement, interpretation, and performance management).

Data integration among key stakeholders (including NPS, universities, state agencies, other federal agencies and non-profits) is and will continue to be critical to the success of the NPS Inventory and Monitoring Program. This chapter of the SECN Information Management and Archiving plan describes the integrated planning approach used by the network in support of vital signs monitoring and information management. Recommendations and implementation strategies for the development of an integrated decision support system are also described.

Information Needs Assessment

The SECN utilized a systems planning approach called an information needs assessment (INA) that was adapted from Roger Tomlinson's "Thinking About GIS: Geographic Information System Planning for Managers" (Tomlinson 2003) and facilitated by DataLOGIC, Inc. through a contract with the SECN. The information needs assessment integrated SECN vital signs monitoring planning with its information management planning efforts. The purpose of the INA was to discuss SECN high-priority monitoring objectives to determine what monitoring data were needed or desired to answer those objectives and how that data would be gathered and analyzed according to the recommendations of subject matter experts assisting with long-term monitoring protocol development. By combining the information management planning and the protocol development process, the INA helped develop the data and information requirements that are essential to support the SECN inventory and monitoring program, missions of network parks, as well as addressing specific end-user requirements pertaining to long-term monitoring.

The SECN INA scoping meetings brought together subject matter experts and NPS end-users to develop 'protocol templates'. These protocol templates define monitoring objectives of interest and make recommendations on data collection needs and techniques, analysis methodology, and reporting requirements by following a structured documentation process. Topics covered for each protocol template include the following components: title, narrative summary, sampling design elements, data / information required, steps required to make the information product, map requirements (spatial data requirements), tabular data requirements, charts/graphs or other visual displays of results, reporting requirements, frequency of creation and use for protocol outputs, relevant legal or policy issues, cost estimates and any additional notes or comments not covered previously. For detailed information about protocol templates or other aspects of the information needs assessment, please refer to the project's final report which is available at http://science.nature.nps.gov/im/units/SECN/docs/SECN_INA-MODEL_FULL_REPORT.pdf.

As a collection, these protocol templates begin to define the data and information requirements of the SECN I&M program – which are synthesized graphically in the SECN conceptual object model. The overall INA process and project outcomes are depicted below (Figure2-1). Application of the results and recommendations from the INA process will be discussed in the remainder of this section.

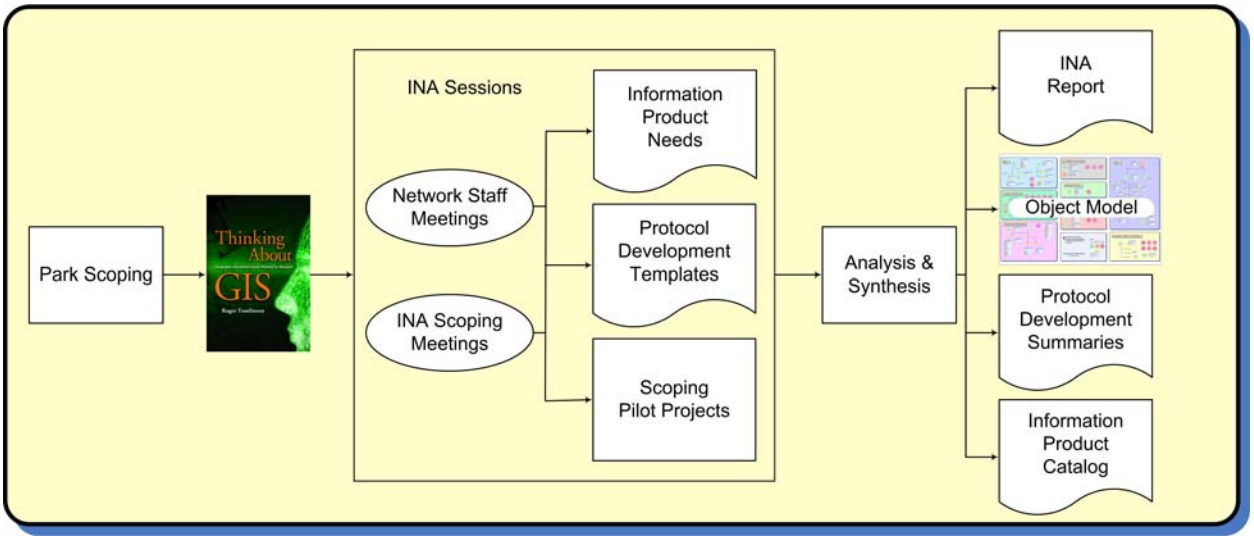


Figure 2-1. Information needs assessment process and project outcomes

Conceptual Object Modeling

In order to build a decision support system that meets SECN information management goals, the first step is to develop a solid understanding of what the SECN vital signs monitoring program entails. Through the INA process described above, SECN staff gained an understanding of the day to day actions that potential decision support system users need to perform and the type of information they need in order to do their jobs. Object-Oriented Data Modeling, or simply Object Modeling, refers to the process of identifying these actions and organizing them into a series of logical components that represent real-world entities that are familiar to users. The result of this process is known as an object model. An object model is software independent, free of database details and focuses on capturing the information needed to accurately express the universe of data objects needed to support a program (in this case the SECN long-term monitoring program).

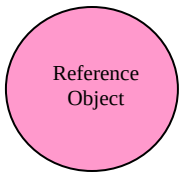
Using an object-oriented approach helps produce a better understanding of SECN programmatic requirements, which results in a more understandable database design and leads to systems that more closely match user's needs and expectations. However, it is important to keep in mind that an object model is not the same thing as a database design. An object model is intended to produce a conceptual representation of the data objects that potential users of the system interact with, whereas a database design is an implementation of the model that provides a means of creating, storing, and working with (reporting on) the objects in the model.

Model Element Definitions

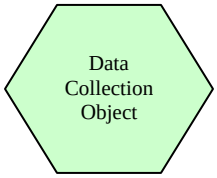
The object model is a logical representation of real-world entities, or data objects. An object is any item that has an identity, structure, or behavior. In a conceptual model, an object can be a tangible, physical "thing" (e.g. fish specimen), an activity such as a sampling event, or even something that is more of a concept (e.g. data analysis).

There are three different types of objects included in the model:

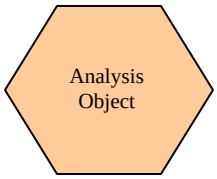
- ***Reference Objects –*** Reference objects are objects that are an integral part of the model but are generally not maintained by the SECN. They may be datasets that are obtained from other outside agencies on an ongoing basis, or they may be maintained by other groups or departments within the NPS. These objects are generally displayed in the model without any associated properties.



- ***Data Collection Objects –*** Data collection objects are objects that are primarily related to actual field data collection activities, or other data gathering operations performed by the SECN in support of the Inventory and Monitoring Program.



- ***Analysis Objects –*** Analysis objects are objects that result from some sort of analysis; most likely an analysis performed using data collection and/or reference objects as inputs. They are similar to data collection objects in that they are generally performed by the SECN as opposed to other outside agencies.



When developing or reviewing an object model, it is important to consider the concept of object inheritance. Inheritance deals with how properties are assigned from one object to the next. Objects of similar types are grouped in the model so that certain objects can be defined as special cases of a more general entity; through this grouping, objects share common properties within the group. Through inheritance, sub-objects (yellow ovals) automatically inherit the properties of their parent object(s) (reference, data collection or analysis objects, described above) in the model hierarchy. Inheritance between objects in the model is indicated by a blue arrow 'inheritance' line. Aggregation is used to represent a compilation of objects, indicating that one object is created through a process of evaluating one or more properties from an aggregate collection of other objects. In the current version of the SECN model, only one object is depicted as having an aggregation relationship with other objects – the Population object, which is created by evaluating aggregate properties of various plant, fish or wildlife individuals. An aggregation relationship between objects is shown in the model using a purple diamond-end arrow 'aggregation' line.

SECN Object Model

The object model presented in this document is not a static model; rather it is subject to growth and change over time as protocols are further developed, new objects are identified and existing objects become more refined. A large format version of the object model is available on the SECN website (http://science.nature.nps.gov/im/units/SECN/docs/NPS_ObjectModel_Final.jpg). A simplified version (the complete model without the properties) is presented here (Figure 2-2) to demonstrate the breadth of material covered in the model. It is important to keep in mind that no attempt has been made to create an exhaustive, all-inclusive list of objects and properties. The objects in the diagrams represent key components that were identified during the INA process to help support the needs of the SECN user group and are intended as a stepping-off point for further future development. In some cases, objects have been identified and added to the model as placeholders, often without properties, to represent examples of the type of objects that may

exist at that level; the model is not meant to imply that the objects shown are the only ones that may exist at any particular level.

Descriptions of each component (e.g. water, landscape dynamics, archives and specimens, etc.) of the SECN conceptual object model are included in the INA project final report (DataLOGIC, Inc. 2005). This report is available on the SECN website (http://science.nature.nps.gov/im/units/SECN/docs/SECN_INA-MODEL_FULL_REPORT.pdf). For the purposes of the SECN information management and archiving plan, it is important to note that the SECN object model is a conceptual representation of the entire spectrum of data required to support the SECN vital signs monitoring program and along with the SECN monitoring protocols, forms the roadmap for the SECN decision support system and application development.

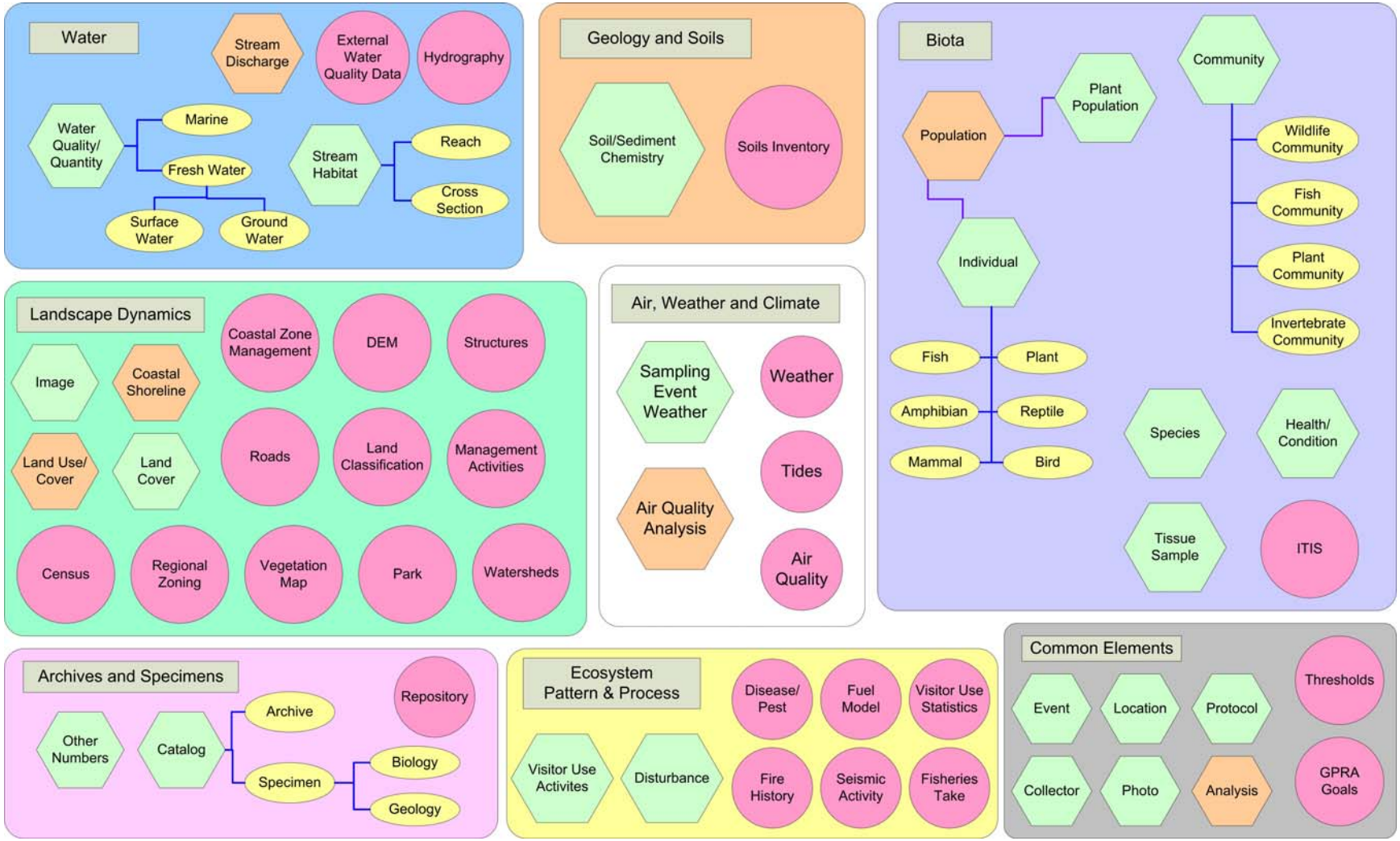


Figure 2-2 SECN simplified conceptual object model

Strategic Application of INA Results

The information gained during the scoping workshops and the conceptual object model will serve as a foundation for future I&M development activities. Figure 2-3 illustrates how the object model can be used to help develop the SECN decision support system and how the protocol development process can be used to enhance detail within the model.

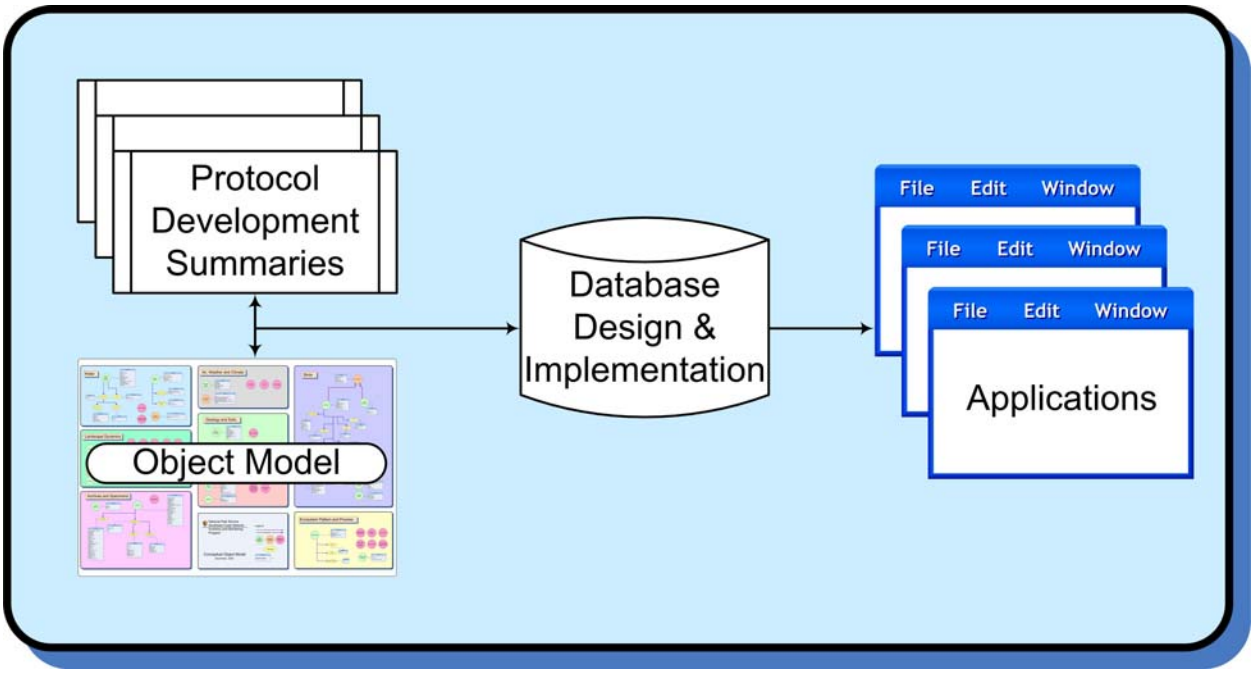


Figure 2-3. Roadmap for SECN database and application development

Following the protocol development process, properties of objects that need to be collected, stored and managed for that protocol, as well as the relationships between these objects, will be determined. Objects may behave differently for different protocols; for example, there may be certain properties of an object that are required for all protocols, while other properties may be required for some protocols but not for others. This information will be directly useful for designing and developing the physical database storage requirements necessary to support the information needs of the various protocols. In addition, the model will be used in conjunction with the protocols and database design to develop future software applications that can be used to retrieve, store and manage data in the database.

Protocol testing and implementation will be ongoing over the next few years. Initial database development work has begun in Microsoft Access, following the general design guidelines developed by the National Park Service Inventory and Monitoring program and working within the Network's conceptual object model framework (described above). Even though the original database development began in MS Access as individual, stand-alone databases, this development process has proceeded within the framework of the network's conceptual object model – making the transition to a long-term, client-server solution much smoother. In other words, this incremental development process will allow databases to be implemented and added to the decision support system over a period of years without encountering many common problems that result from a lack of data management planning (Table 2-1).

Table 2-1. Summary of Lessons Learned from the SECN INA Project

Disadvantages of stand-alone systems:	Advantages of integrated system and lessons learned from INA:
Lack of standard and uniform data collection and recording procedures	Data collection is included in the planning and protocol specification stages. Training for consistent data collection is paramount.
High potential for data quality problems, especially due to data redundancy	The conceptual object model provides a clear map for eliminating data redundancies and an integrated system encourages an implementation requiring singular storage of data. The protocol specifications should include data quality assurance procedures.
Inhospitable for data sharing and accessibility	An integrated system could be made widely accessible online. Partners could provide and access the networked data resource.
Difficult to learn and interpret results from disparate systems	Seldom are single parameters sufficient to conduct data analysis. Many ecological studies require the incorporation of data from multiple fields of study during analysis and interpretation (e.g. water quality data, weather data, and site condition data). In addition, user acceptance is critical for the success of any information system and the conceptual object model provides the logical basis for a system that matches real-world needs. Users can learn a small set of reporting and interpretive techniques on an integrated system that will transfer across multiple monitoring scenarios.
Extra long-term costs associated with all of the above	An integrated system may require a longer planning process but applying a conceptual object model has been proven to improve systems design, accelerate development and lead to smoother deployment of applications in the long run.

Ultimately, a successful inventory and monitoring program is challenged with preserving the data of the past while accommodating the dynamic demands of the present and the future. The INA planning process has resulted in a structured, yet adaptable, conceptual object model that provides a solid foundation for meeting those challenges. The conceptual object model will evolve as it is enhanced through use and application while consistently offering value as a baseline tool. The INA process also provided considerable support for creating an integrated information management system for natural resource monitoring rather than multiple stand-alone databases that each address particular monitoring objectives. This concept is further supported by NPS-75:

> *"Development of an effective data management and Decision Support system is an essential part of the monitoring design process." …. "To facilitate analysis and application of data to management issues, it is important that there be one integrated data management system, rather than separate programs for each component."*

Implementation

The network will be developing or adapting existing protocols for 10 vital signs over the next few years as well as developing 10 set of Standard Operating Procedures (SOP's) to support those vital signs that involve acquiring data from existing sources (e.g. air quality, weather and stream flow data) as presented in Table 2-2. All of these protocols and SOP's must be accommodated by the SECN decision support system. This is particularly important because we

are not only interested in the status and trends of individual vital signs, but we are also interested in being able to put this information into context and say something about the health of the ecosystem as a whole. Thus, over the long term stand-alone MS Access databases would not be robust enough to meet our needs and the network will begin migrating any existing databases and developing new databases to SQL Server as soon as is practical. Finally, reporting and data dissemination are two crucial aspects for the success of the I&M program, which also must be supported by the SECN decision support system.

Table 2-2. Vital Signs to be monitored by the Southeast Coast Inventory & Monitoring Network. [✚ - Vital Signs for which the Network will develop protocols and implement monitoring using funding from the Vital Signs or Water Quality Monitoring programs; ● - Vital signs that are monitored by a network park, another NPS program, or by another federal or state agency using other funding. The network will collaborate with these other monitoring efforts; ◈ - Monitoring deferred]

Ecological Monitoring Framework		Network Vital Signs	KEMO	CHAT	HOBE	OCMU	CONG	MOCR	CAHA	CALO	FOSU	FOPU	FOFR	CUIS	TIMU / FOCA	CASA / FOMA	CANA
Air & Climate	Air Quality	Air Quality	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
		Wet and Dry Deposition	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
		Visibility and Particulate Matter	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
		Air Contaminants	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Weather & Climate	Weather and Climate	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Geology & Soils		Coastal Shoreline Change							✚	✚	✚	✚	✚	✚	✚	✚	✚
	Geomorphology	Salt Marsh Elevation							✚	✚		✚	✚	✚	✚	✚	✚
		Stream/River Channel Characteristics	✚	✚	✚	✚	✚	✚									
Water	Hydrology	Groundwater Dynamics	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
		Surface water Dynamics	●	●	●	●	●	●							●		
	Water Quality	Marine Water Quality							✚	✚	◈	✚	◈	✚	✚	◈	✚
		Riverine Water Quality	✚	✚	✚	✚	✚	✚									
Biological Integrity	Invasive Species	Invasive / Exotic Plants	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚
	Focal Species or Communities	Amphibians	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚
		Breeding Forest Birds	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚
		Plant Communities	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚
Human Use	Consumptive Use	Fisheries Take							●	●	●	●	●	●	●	●	●
	Visitor & Recreation Use	Visitor Usage	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Ecosystem Pattern & Process	Fire & Fuel Dynamics	Fire and Fuel Dynamics	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚
	Landscape Dynamics	Land Cover and Use	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚	✚

Credits

The Southeast Coast Network worked with DataLOGIC Inc. during the Information Needs Assessment process (DataLOGIC, Inc. 2005).

Chapter 3. Data Stewardship Roles and Responsibilities

The collection of natural resource information is often a costly and complex process involving many people. As more people become involved in a project, the likelihood of miscommunication or misunderstanding between project members increases. In addition, as project participant roles become increasingly specialized, the need for well-defined roles and responsibilities becomes crucial to the success of the project and the quality of data and information produced. Thus the concept of data stewardship really encompasses people and organizations in addition to the data, hardware, software, and custom applications that are collected or used within the confines of a particular program. In order to ensure quality data collection and stewardship throughout a long-term monitoring protocol implementation, a collaborative approach among several key groups of people is required.

This chapter discusses comprehensive information management roles and responsibilities that generally apply to all Network activities. It is important to understand that each long-term monitoring protocol contains specific instructions for assignments and tasks that are project specific, but still fall within the overall data stewardship framework. All personnel involved in long-term monitoring programs are responsible for knowing and understanding their individual roles and responsibilities for data stewardship and for knowing how their activities fit into the larger scope of data stewardship. To that end, this section is devoted to defining programmatic roles and responsibilities as they relate to data management and stewardship.

- A Role is a function or position (e.g. Science Information Specialist, Program Ecologist)
- A Responsibility is a duty or obligation (e.g. verify data entry, document database)

Programmatic Roles and Responsibilities

A typical data set within the inventory and monitoring program is collected, handled, viewed, or managed by most or all of the people serving in the roles (jobs) listed in Table 3-1. These roles are divided into park, network, regional and national focal areas to illustrate the integration of SECN data stewardship activities through the wide range of stakeholders as well as the complexity of comprehensive data stewardship in support of long-term programs. The roles and responsibilities listed in Table 3-1 are not all-inclusive and in many cases a single position is expected to perform the duties for multiple roles. Clear instruction (through protocol and SOP development) and communication among involved personnel is critical to the success of long-term monitoring programs. Learning, understanding, and acting on the responsibilities listed for all categories of data stewardship can help prevent the vital aspects of information management from being overlooked or under-funded.

When monitoring protocols are implemented through contract and/or cooperative agreement, the cooperator becomes a key person in the development and documentation of quality data. Only through collaboration with NPS staff, is it possible for cooperators to provide the proper information required by the SECN, in a format that meets the needs of NPS users and documented in a way that ensures the usability of that information in the future. In this case, the cooperator and a NPS staff member(s) work together and assume the roles and responsibilities described in Table 3-1. However, in this situation where the field crew leader and crew are one step removed from core NPS staff, communication becomes even more vital to project success. Meetings between cooperators, NPS program ecologists and the science information specialist

are necessary to ensure that everyone understands all aspects of a protocol, what data are collected and how the data are being recorded and documented. Failure to establish communication among these groups will almost guarantee that programmatic goals are not met and/or that data will not meet program requirements or user needs.

Table 3-1. SECN roles and responsibilities for data stewardship.

Role	Data Stewardship Responsibility
Network Roles	
Field Crew Member	Collect, record, and verify monitoring data
Field Crew Leader	Supervise crew and organize data
GIS Specialist or Data Technician	Acquire data sets from external sources. Process and manage data
Remote Sensing Specialist	Acquire data sets from external sources. Process and manage data.
	Integrate spatial data and develop network sampling framework with program ecologists
Program Ecologists	Oversee and direct data collection operations following standard operating procedures and protocols, including data management.
	Identify, justify and document "outlier" data.
	Apply standard statistical methods to develop sampling designs and analyze data
	Oversee all aspects of specimen acquisition, documentation and preservation.
	Interpret and report findings.
Science Information Specialist (Data Manager)	Ensure inventory and monitoring data are organized, useful, compliant, secure, and available.
	Ensure inventory and monitoring data and information products meet Network, NPS and DOI standards.
	Oversee archival of related field documents and resultant reports as appropriate.
Database Programmer	Develop network databases within the NRDT and SECN conceptual object model framework
	Develop "front-end" applications to facilitate the rapid entry and quality control of monitoring data
	Work with network Ecologists and Science Information Specialist to facilitate data querying and reporting for different end-user groups
Park Roles	
Field Crew Member	Collect, record, and verify monitoring data
Learning Center GIS coordinator	Support park management objectives with GIS needs
End Users (e.g. managers, scientists, interpreters, public)	Interpret information and use Information products to inform management decisions
	Identify new information product needs and inform the scope and direction of science information product development
Park Curator or Museum Specialist	Coordinate curation and archival processes with network Ecologists and Science Information Specialist
	Maintain specimens and archives as appropriate.
Information Technology Specialist	Provide IT support for hardware, software and networking
Regional Office Roles	
Regional GIS Coordinator	Update regional GIS catalog with published SECN data sets
	Provide central repository data for relevant park, regional, and national GIS data sets and accompanying metadata documentation
Information Technology Specialist	Provide IT support for hardware, software and networking
National Roles	
I&M Data Manager (National)	Provide service-wide database availability and support

Program ecologists, the science information specialist, database programmer and GIS specialist comprise the central data management team for vital signs monitoring protocols. Because of the collaborative nature of information management, communication among these positions is essential to meeting program goals. The following section and Figure 3-1 outline the individual and shared responsibilities of each role.

Program Ecologist – The program ecologist coordinates the efforts of all involved personnel to ensure that protocols are developed to meet the information needs of the overall I&M program and resource management decision makers. Typically, they are the primary point of contact for information and are responsible for coordination and supervision of all phases of data collection (including training, data entry, and monitoring quality assurance procedures). Their active involvement in information management helps determine the quality and utility of data collected, integration with other protocols implemented by the Network and the overall success of the inventory and monitoring program.

In addition, the program ecologist works closely with the science information specialist to:

- Develop and implement quality assurance and quality control procedures
- Identify training needs for staff related to data handling procedures, quality control measures, and database software use
- Coordinate the design of field data forms and the user interface for the project database
- Develop certified data criteria and certify data. Provide documentation to accompany the dataset for appending the newly certified data into the SECN master database
- Identify sensitive information that requires special consideration prior to distribution
- Provide project documentation, original field data, databases reports and summaries, and other products related to the project to the science information specialist for archiving
- Create data summary procedures to automate transforming data into meaningful information
- Identify and prioritize legacy data for conversion to desired formats
- Increase the accessibility and interpretability of existing natural resources information

Network Science Information Specialist and Database Programmer – The science information specialist plays a vital role as coordinator and facilitator by creating and maintaining data infrastructure and standards, and by communicating the goals of information management to the broader user group. The database programmer develops databases, front end applications and reporting tools to securely house and provide access to SECN data and information resources. The science information specialist and database programmer work closely together to develop and implement information management strategies to facilitate timely access to high quality, documented data and information. They also have close working relationships with cooperators and network staff to develop databases and ensure data are properly recorded and stored – and work with park staff and other information users to make sure that data are made available and usable to all necessary personnel.

In addition, the science information specialist and database programmer will work closely with program ecologists to:

- Define the scope of the protocol data, refine object model to reflect and integrate data objects and properties into the integrated decision support system design
- Become familiar with how data are collected, handled and used
- Develop and implement quality control and quality assurance aspects of protocols
- Identify elements that can be built into the database structure to facilitate quality control, such as required fields, range limits, pick-lists and validation rules
- Create a user interface that streamlines the process of data entry, review, validation, and reporting
- Ensure that protocol documentation is complete, complies with metadata requirements, and enhances the interpretability and longevity of programmatic data
- Ensure proper archiving of materials (e.g. protocols, SOP's, data sheets, data, information products, etc.)
- Reviews data being submitted as master (certified) data prior to appending these data into the SECN master database
- Identify and prioritize legacy data for conversion to desired formats

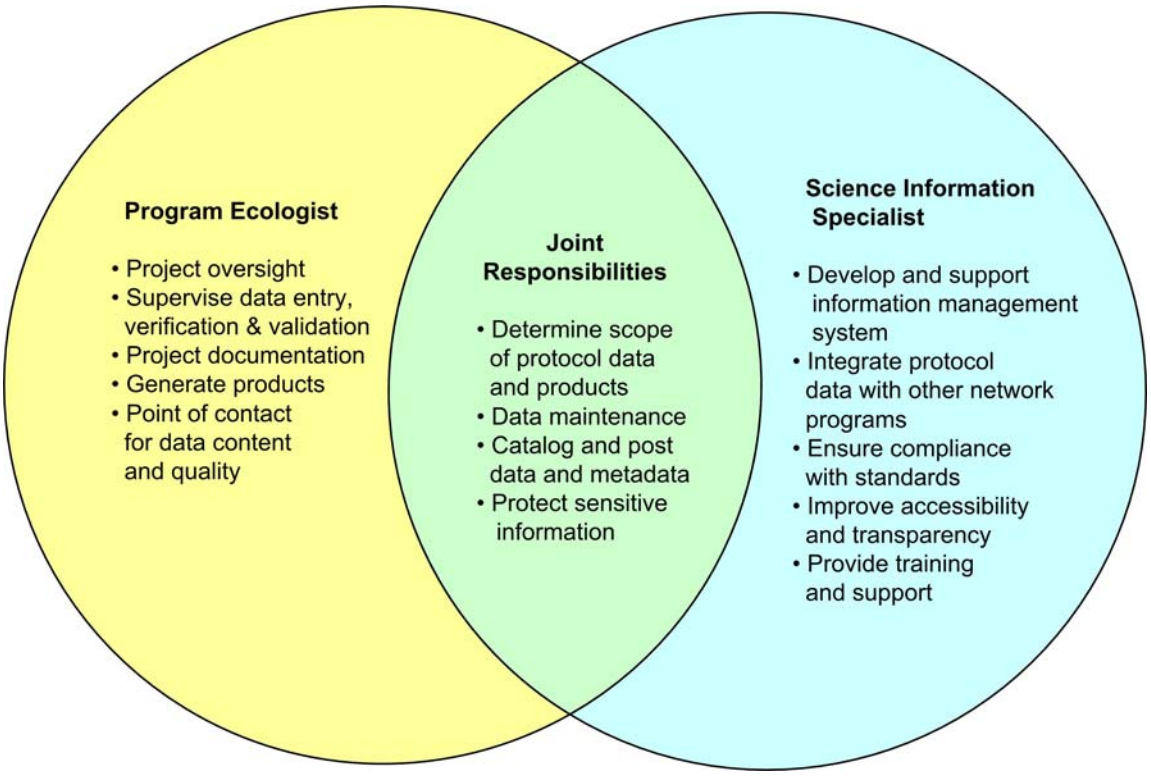


Figure 3-1. Core data stewardship responsibilities of program ecologists and science information specialists

GIS / Remote Sensing Specialist(s) – The GIS and remote sensing specialists manage spatial data themes associated with network inventory and monitoring projects, as well as other spatial data related to the full range of park resources. They incorporate spatial data into the GIS. They also maintain standards for geographic data and are responsible for sharing and disseminating spatial data throughout the network.

The GIS and remote sensing specialists will work in collaboration with program ecologists, science information specialist and database programmer to:
Determine the spatial data and analysis needs for the program and/or individual protocols

- Develop procedures for field collection of spatial data including the use of GPS and other spatial data collection techniques
- Display, analyze, and create maps from spatial data to meet program objectives
- Properly document data in compliance with spatial metadata standards
- Create relationships between spatial and non-spatial data and integrate GIS applications with the network decision support system
- Establish and implement procedures to protect sensitive spatial data according to program needs
- Develop and maintain an infrastructure for metadata creation and maintenance and ensure metadata are created and comply with national and agency standards.

Data Stewardship

The Natural Resource Challenge states that collaboration among the National Park Service, other public agencies, universities, and non-governmental organizations is necessary to effectively acquire, apply, and disseminate the scientific knowledge gained in parks (US Department of the Interior, National Park Service 1999). The Inventory and Monitoring Program encourages coordination among participants at all levels to help ensure that data collected by NPS staff, cooperators, researchers and others are entered, quality-checked, documented, analyzed, reported, archived, cataloged, and made available for management decision-making, research, and education.

Keeping track of data throughout its lifecycle is the shared responsibility of everyone involved in a long-term monitoring program. This, in essence is data stewardship. Data stewardship is a principle of mutual accountability rather than a particular job for one individual. The importance of data stewardship must not be understated – and the degree of success with which it is implemented will have direct bearing on the quality and utility of data and information products developed by the Network.

Successful data stewardship requires that all people involved in Network activities learn and understand the expectations for continuous information management AND be accountable to perform the duties required to meet these expectations. This requirement is equally important for network and park staff, as well as contractors or cooperators. All personnel involved in protocol implementation receive training, briefings, materials and additional regular communication about

data stewardship from supervisors, program ecologists and information management personnel to promote the appropriate level of understanding about how these efforts relate to park and network management objectives, NPS and Department of the Interior policies, and other federal government requirements.

Internal Coordination

The SECN Science Information Specialist works with national Inventory and Monitoring Program data management staff and regional information management personnel to maintain awareness and involvement in service-wide and regional databases, data management policies and guidance and information technology (IT) policies and security issues. The Network science information specialist works locally with Network personnel, park staff, regional and park IT staff to promote and develop workable standards and procedures that result in integration and availability of data sets.

Key contacts for the Network science information specialist include park GIS specialists and resource management staff and the program ecologists for each monitoring protocol. Regular communication among these personnel leads to common understanding and better synchronization of information management activities. Park and Network staff coordinate on resource information management using a variety of methods, including personal visits, phone calls, email, joint meetings and training sessions, as well as the meetings and work of the Network's Technical Steering Committee and Board of Directors. The development of Network planning materials (including this document), inventory study plans, monitoring protocols, guidance documents, standard operating procedures, and user guides/cheat sheets includes involvement and input from park scientists and resource management staff. In addition, data managers throughout the Program regularly coordinate with each other and national program staff via national meetings, conference calls, workgroups, a listserv, web sites, and informal communication. In addition, the SECN decision support system builds upon the considerable resources developed by the service-wide Inventory and Monitoring Program to store and disseminate data to a wide range of user groups (please refer to chapters 4 and 9 of this document and in the appendix: Data Dissemination: Internet and Intranet Resources for additional information). This model of cooperation using available resources and strong communication is effective in the National Park Service and can be productively applied across administrative units of the organization.

External Coordination

Based on lessons learned from other networks and other Agency partners, the SECN information management program focuses on the integration of information management systems both within the Network and between the Network and its partners. In support of this strategy, the SECN conducted a comprehensive information needs assessment which involved key stakeholders within and external to the National Park Service. The outcomes of these scoping meetings are presented in detail in Section 2 and through the INA project final report on the SECN website: http://science.nature.nps.gov/im/units/SECN/docs/SECN_INA-MODEL_FULL_REPORT.pdf.

The needs assessment promoted data integration within and across agencies, jump-started protocol and application development, and fostered long-term partnerships among stakeholders. In addition, data integration among key stakeholders (including NPS, universities, state agencies,

other federal agencies and non-profits) is and will continue to be critical to the success of the NPS Inventory and Monitoring Program. This focus on internal and external data integration within the SECN will continue into the future of the long-term monitoring program. A list of past and current contacts and contributors to long-term monitoring – relevant to SECN parks maintained in Appendix 3 of the SECN Vital Signs Monitoring Plan.

Credits

Some of the materials in this section were taken or adapted from materials developed from the following data management plan: (Daley 2005).

Chapter 4. Information Technology Infrastructure and System Architecture

The ultimate measure of success for the SECN I&M information management program is to supply quality information in a timely manner to a wide-range of stakeholders (e.g. NPS personnel, scientists, and the public) with variable end-uses. The most common method for delivering data and information to stakeholder communities is through data/information clearinghouses. Clearinghouses facilitate one-stop shopping through the internet and provide a mechanism for searching, browsing and downloading or requesting information at the convenience of the user. Typically the data or information products provided directly through clearinghouses are "snapshots" that do not change. These static information products and data sets will be stored in national level systems already developed for such purposes or on the SECN website. Through the use of metadata, these clearinghouses also facilitate data discovery by external users who may then request access to the data from its originator.

This section discusses the components of the information technology infrastructure and system architecture needed to store data and information and also deliver it to SECN stakeholders. The term infrastructure refers to the network of computers and servers that decision support systems are built upon. The term architecture refers to the applications, database system, repositories and other software tools that together make up the SECN information management system.

IT Infrastructure

SECN relies heavily upon national, regional, and park IT personnel and resources to maintain its computer infrastructure. This includes, but is not limited to: computers, servers, other related hardware, software installation and support, email administration, security updates, virus-protection, telecommunications, computer networking, and server backup services. The network staff will incorporate and follow NPS IT policies, standards, procedures and guidelines available from the Office of the Chief Information Officer and/or Regional IT division.

The SECN IT infrastructure needs to support these required functions:

- Provide a central repository for SECN master data sets
- Provide access to SECN master data sets across multiple network and park offices
- Support working data sets for local analysis and other computing needs
- Support data collection efforts and quality assurance (QA) and quality control (QC) procedures
- Provide a means for uploading SECN data to national clearinghouses (e.g. STORET) and for downloading data from national clearinghouses (e.g. National Climatic Data Center)
- Support desktop and intranet applications
- Provide security, stability, and backups

Servers support five primary types of functionality for network information management activities: files, data files, databases, applications, and the internet.

File Servers – File and data file servers work similarly to a personal computer hard drive, but are located on a server to facilitate backup and file sharing and are often referred to as 'network drives'. Users may have their own personal drive space or a set of directories on a shared, network drive. Data file servers are read-only repositories of data files. The files stored here do not change often but are accessed by a wide range of users, thus requiring a centralized storage location. Typical examples of files stored here include: GIS data, imagery, final reports, and other static information products. Write-access to these servers is under strict control. A contact person monitors what is stored in this location and ensures proper archiving and documentation (e.g. Regional GIS Coordinator is the main contact for GIS file server).

Database Servers - Database servers use enterprise (client-server) database software such as SQL Server which provides greater performance and support to a larger group of users than can be provided by stand-alone database platforms such as MS Access. Databases on these servers store and manage the network's core / master data sets. Therefore write-access to database servers is under strict control by the SECN science information specialist and/or regional IT staff. The conceptual object model described in Chapter 2 of this document provides the framework for the SECN decision support system. The SECN master database will be housed on the SECN server in the Southeast Regional Office in Atlanta.

Application Servers – Application servers provide the 'user-interface' or 'front-end' for accessing the network's data and are typically stored on a separate physical server from the database server. Application development provides support for data queries, analysis, and reporting functionality and will continue to grow and develop over time. Application servers may also be internet servers, described below.

Internet Servers – Internet servers provide access to applications and files via the internet, subject to security restrictions. Special software such as ColdFusion and ArcIMS may be used on internet servers for dynamic webpage development and interactive internet mapping respectively.

The infrastructure used by the SECN takes advantage of and builds upon existing infrastructure established at the park, regional, and national level. The infrastructure is maintained by park, regional and national IT specialists, who administer all aspects of system security and backup. Figure 4-1 illustrates the server relationships between the park, regional and national levels (although only parks housing SECN network staff are shown to simplify the diagram).

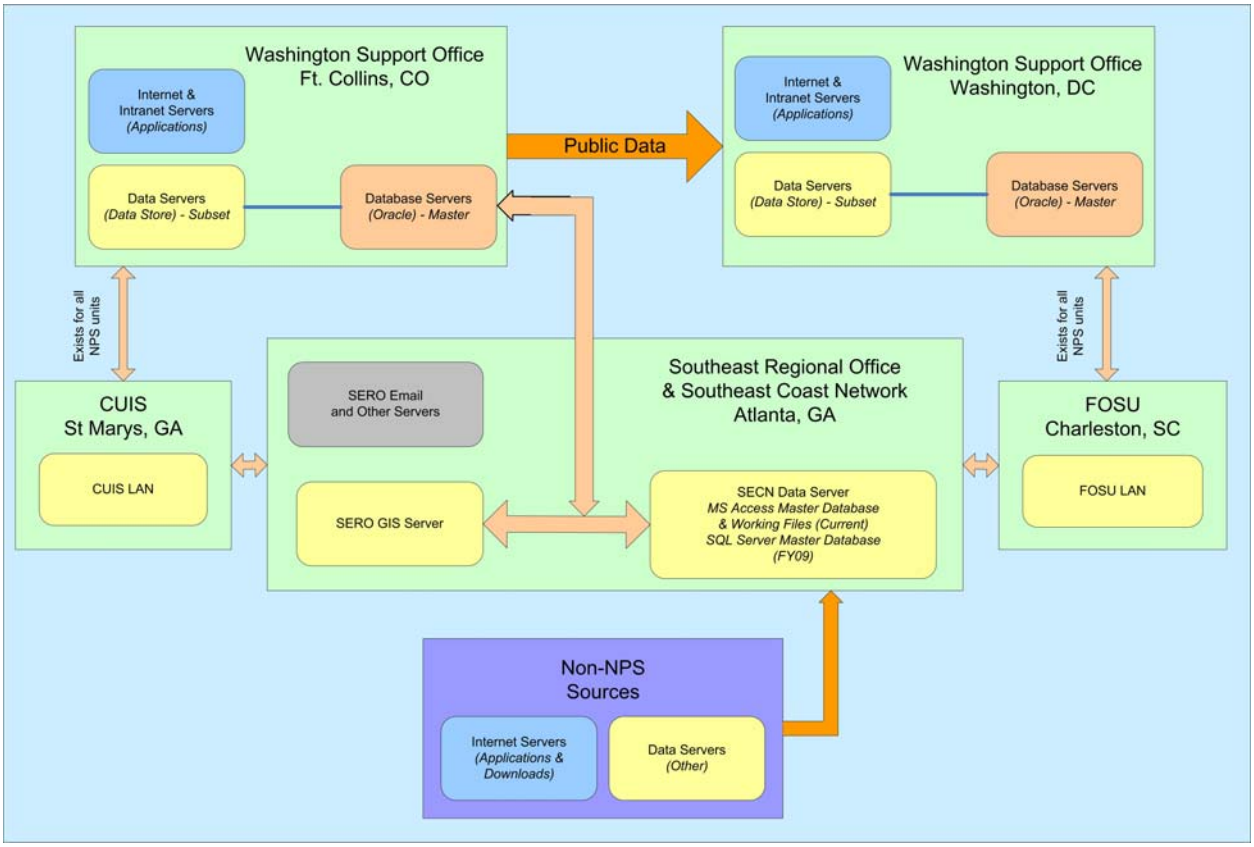


Figure 4-1. SECN & national information management infrastructure

SECN System Architecture

SECN staff offices are currently located at the Southeast Regional Office (Atlanta, GA), Cumberland Island National Seashore (St Marys, GA), and Fort Sumter National Monument (Charleston, SC). The Southeast Regional Office (SERO) location is considered the primary location (from an IT perspective) because it is co-located with regional IT staff. Therefore, the SECN master database will be located and administered out of SERO. Additionally, the placement of the master database server at SERO allows for protection from likely catastrophic events (e.g. hurricanes).

The results of the INA (described in Chapter 2 of this Plan), strongly supported the development of a single, integrated decision support system design – rather than individual, stand-alone databases that address particular monitoring objectives. The conceptual object model (Chapter 2) combined with SECN long-term monitoring protocols and supporting SOP's; serve as the foundation for database and application development that will ultimately form the SECN decision support system. Database development began in MS Access but is currently transitioning to SQL server as long-term monitoring protocols are entering full implementation.

Even though the original database development started with MS Access as individual, stand-alone databases, this development process has proceeded within the framework of the network's conceptual object model – making the transition to a long-term, client-server solution much smoother. In other words, this incremental development process will allow databases to be

implemented and added to the decision support system over a period of years without encountering many common problems that result from a lack of data management planning (Table 2-2). Regardless of platform, the major data management efforts supported by the SECN decision support system include:

- Collect or acquire data (field work, download data, etc.)
- Archive raw data (both digital and physical materials)
- Enter and/or import data
- Verify and validate data
- Produce documentation
- Archive certified data and documentation
- Integrate project data with external (reference) data
- Summarize and analyze data and produce reports
- Archive data and information products
- Catalog data and information products

Details regarding SECN database development planning and implementation are provided in Chapter 12 of this plan.

Network Level Information Management Applications

The Natural Resource Database Template (NRDT) provides the foundation for database development for each Network's long-term monitoring protocols. The NRDT is a flexible, core table structure for relational database development in MS Access (but easily replicated in SQL server) that promotes the standardization of inventory and monitoring data storage service-wide. This relational database can be used as a standalone database or in conjunction with the GIS software (e.g. ArcGIS) to enter, store, retrieve, and otherwise manage natural resource information. The NRDT was developed by the Inventory and Monitoring program and has evolved over time to its current version V3.2. This development process has been led by NRDT users via an active NRDT user board and is supported by staff at the Washington Support Office. The NRDT integrates with other I&M data management tools, including Geographic Information System (GIS) tools and data, the NPS GIS Committee Data Layers Standard and the NPS Metadata Profile. The current policy is that inventory and monitoring-related databases designed by I&M networks after January, 2006, should follow these minimum conventions whenever possible.

A database complies with NRDT standards if the core mandatory tables, fields, relations, and naming conventions are used. These core tables are: tbl_Locations, tbl_Events, and tbl_DB_Meta and tbl_DB_Revisions. Detailed documentation on the development strategy behind the NRDT is available online at http://science.nature.nps.gov/im/apps/template/index.cfm and will not be discussed in detail here. In general, however, the basic, recommended tenants of the tbl_Locations and tbl_Events were followed as described in the NRDT Version 3.2

Documentation. For example, all fixed locations are stored in one table (tbl_Locations), all data locations are stored in a second/equivalent table (tbl_Data_Locations), and events are defined as a place visited for sampling and are linked to a single record in tbl_Locations (e.g. sampling point, gauging station, permanent/fixed station, etc.). These concepts are reflected in the SECN Conceptual Object Model, Common Elements component which define concepts that are standard to most or all long-term monitoring protocols. The Common Elements component is included below in Figure 4-2.

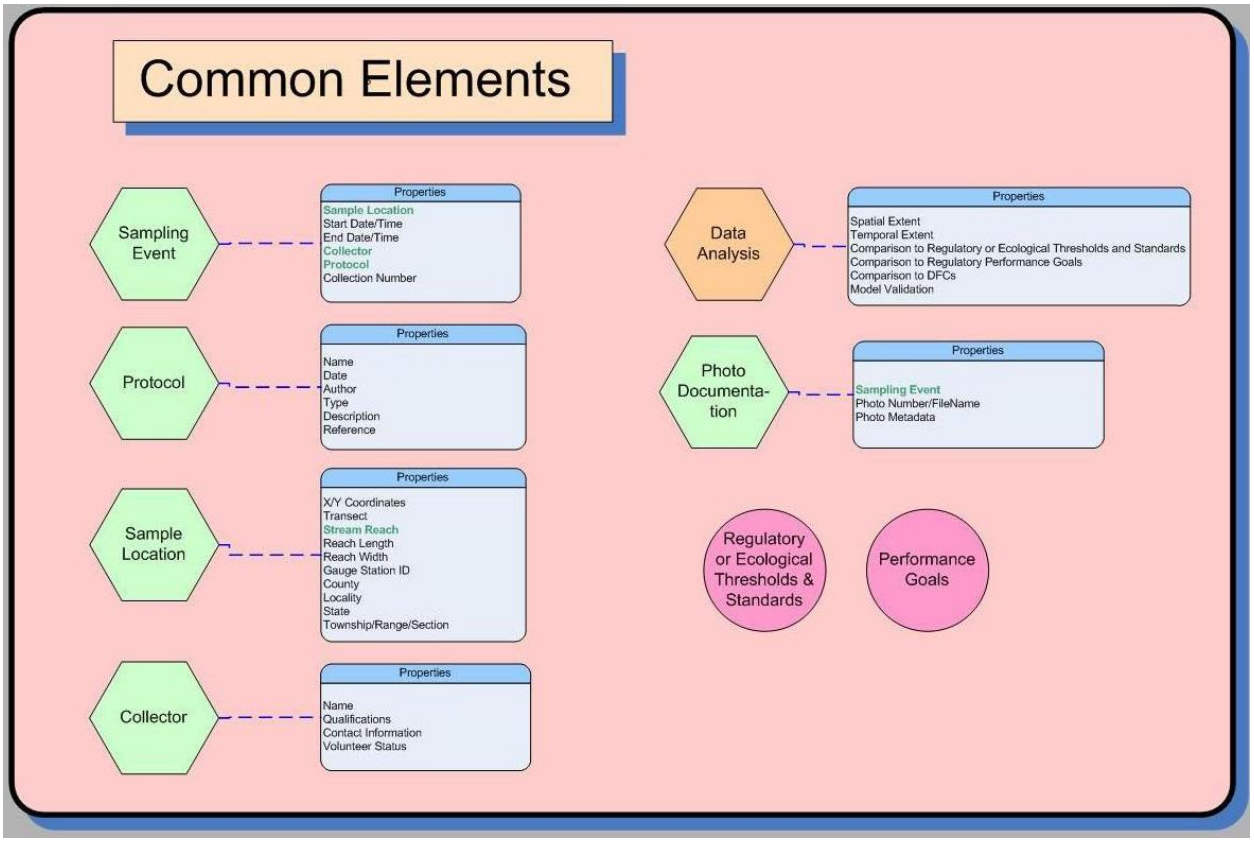


Figure 4-2. Common Elements component of the SECN Conceptual Object Model.

In the conceptual object model, the green hexagons are data collection objects – reflecting data that are collected by SECN (or cooperators) in support of long term monitoring protocol. The objects depicted in the Common Elements component mirror the standard core tables described in the NRDT documentation – although details may be slightly different given that the object model was last updated prior to the development of the latest NRDT documentation. As the object model is updated over the next few years, the common elements component should reflect the standard, core tables of the NRDT along with some additional standard lookup tables and analysis techniques used by the SECN. For example, the following mappings will be rectified and (perhaps) expanded upon: Sampling Event (tbl_Event), Sample Location (tbl_Location and tbl_Data_Location), Collector (tlu_Contacts), and so forth. The field data (or protocol specific data) will be captured in the remaining components of the SECN conceptual object model: Air, Weather and Climate; Archives and Specimens; Biota; Ecosystem Patterns and Process; Geology and Soils; Landscape Dynamics; and Water. The next major revision to the object model is

expected to occur in Fall/Winter of FY09 as the content of current databases are updated within the model and work planning for ongoing database development needs occurs.

National-level Application Architecture

One of the primary goals of the NPS I&M Program is to make existing and new natural resource information more available and useful to a wide variety of potential end-user groups in order to facilitate natural resource management, research and education. To that end, the NPS Natural Resource Program Center (NRPC) and the I&M Program are continually developing and implementing a national-level, programmatic information management framework. NRPC and I&M staff are in the process of integrating current applications into one standardized web portal. Thus, the current natural resource data management framework is in transition, but will be accessed following the general procedures depicted in Figure 4-3, below. Descriptions of the individual information management systems (below) will be updated as this transition to a single data portal is put into practice – but currently reflect the existing status of these applications, not the anticipated outcome of this transition process.

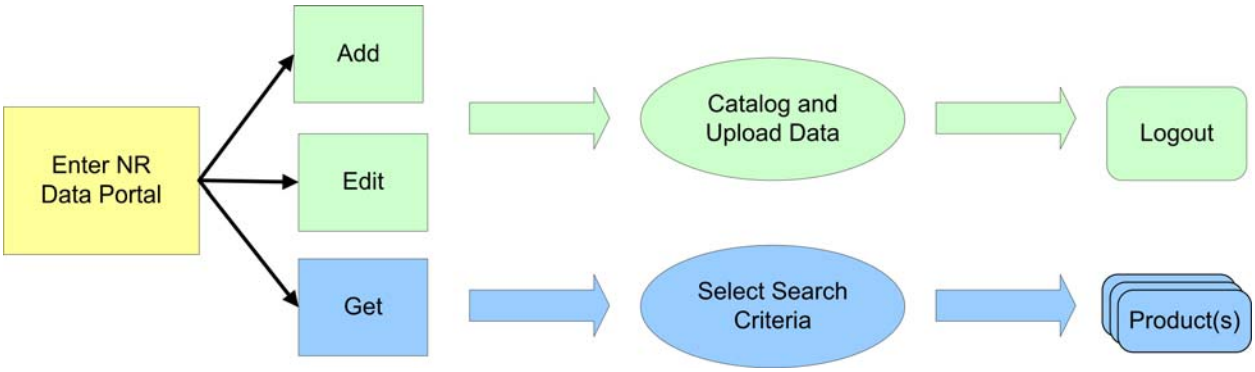


Figure 4-3. Model of the national level application architecture

National Level Information Management Applications

The Integration of Resource Management Applications (IRMA), described above, refers to a formal process approved by NPS and the Department of the Interior, not an application. However, the IRMA process will facilitate the development of an application that will: eliminate redundancy of selected natural resource data and information systems; provide a single sign-on to access multiple data systems for adding, editing and retrieving records; and provide a common interface (e.g. data portal) based upon an extensive user needs assessment that promotes collaboration between users and developers. NPSpecies, NatureBib and the Data Store are the first three applications being migrated into this integrated system.

NPSpecies

NPSpecies is the National Park Service database to store, manage and disseminate scientific information on the biodiversity of organisms in National Park Service units throughout the United States and its territories. The database lists the species that occur within each park along with the accompanying physical or written evidence documenting the occurrence of the species (e.g., references and vouchers). Additional details regarding NPSpecies can be found at: http://science.nature.nps.gov/im/apps/npspp/DesktopApp.htm.

NatureBib
NatureBib is the master web-based database for scientific citations presented as bibliographic references. NatureBib merges a number of previously separate NPS databases dealing with natural resource related topics like air, deer, geology and paleontology. Additional details regarding NatureBib may be found at: http://www.nature.nps.gov/nrbib.

NPS Data Store
The NPS Data Store application manages and shares natural resource and GIS metadata and data generated by the Natural Resource and Servicewide GIS Programs of the National Park Service. To facilitate data dissemination to the public and throughout the National Park Service, the NPS Data Store application posts information to the NPS GIS Clearinghouse. Additional details regarding the NPS Data Store can be found at: http://science.nature.nps.gov/nrdata.

This integration process will greatly streamline standard functions across these service-wide applications, with additional data systems being integrated over time. There are additional, national level information management applications commonly used by the networks in the I&M program and they are described more comprehensively in the Data Dissemination: Internet and Intranet Resources appendix.

IT Security
Information technology security is managed by the Southeast Regional IT staff under the guidance of the NPS Office of the Chief Information Officer (OCIO). SECN staff will comply with all required security training and procedures advised by SERO IT staff.

Security concerns have continued to grow over the past several years. The NPS has been implementing enhanced security procedures at the service-wide level, as well as under the guidance of the US Department of the Interior. National IT security solutions are currently under development and will be applied and enforced by regional IT staff. These procedures will affect local control to access servers and their respective information. As these procedures become finalized, additional information regarding IT security will be presented here.

Credits
Some of the materials in this section were taken or adapted from materials developed from the following data management plans: (Southwest Alaska Network 2005), (Boetsch et al. 2005), and (Hart and Gafvert 2005).

Chapter 5. Data Acquisition and Priorities

Numerous individuals and organizations are actively collecting natural resource data, either within the park boundary or on adjacent lands. In addition, similar data collection efforts have occurred throughout the past. Typical data sets or studies of interest to the I&M Program include: inventories, monitoring, pilot studies related to protocol development, targeted and general research studies, environmental assessments, resource evaluations related to park planning and compliance, restoration work, resource management activities, and so forth. Together, these studies contribute to the body of knowledge or baseline of information that the I&M Program utilizes to build its long-term monitoring program.

Due to the many potential sources of relevant natural resource data and information, it is important to prioritize data management efforts to receive the greatest benefit from effort expended. Of highest priority is to produce and curate high-quality, well-documented data originating from within the I&M program. As time and resources permit, SECN data management staff will assist with data management for current projects, legacy data and data originating outside the I&M program. Finally, SECN data management staff will help ensure good data management practices for park-based natural resource projects that are being developed and implemented. By providing guidance and facilitating good data management practices at all levels, SECN information management goals will be met in a more efficient and timely manner.

Acquisition of Programmatic Data

Three primary sources of programmatic natural resources data are of interest to the SECN vital signs monitoring program:

- **Vital Signs Monitoring data** – Data collected during implementation of the long-term monitoring program following peer-reviewed protocols and standard operating procedures. Data collection is conducted on either an ongoing (continuous), cyclic (once every few years), or synoptic (one point in time) schedule.
- **Project data** – Data that are collected following standardized methods during a distinct time period with no expectation of recurrence following those same methods. Examples include baseline inventories, data collected during protocol development, and data collected during research by network, park, or cooperator personnel. Legacy datasets are also considered project data.
- **Incidental Observation Data** – Data collected following no standardized protocol (e.g. opportunistic species observations).

The information management strategy described in this document is focused upon the data collected during the implementation of vital signs monitoring protocols. However, some discussion of project and incidental observation data is included here and in appendices to this document, as noted below.

Vital Signs Monitoring Data

The SECN will be developing or adapting existing protocols for 10 vital signs to be implemented over the next few years (please refer to Appendix 13 of the SECN Vital Signs Monitoring Plan for protocol development summary information). Additionally, 10 sets of standard operating procedures (SOP's) will be developed to support the acquisition and analysis of data for 10 additional vital signs which involve using data collected by other sources (e.g. existing state and federal monitoring programs). Park vital signs monitoring is designed to inform managers of the condition of air, water, geologic resources, plants and animals – as well as the various ecological, biological and physical processes that act on those resources. Thus, all of these protocols and SOP's must be accommodated by the SECN decision support system in order to assess the status and trends of individual vital signs and also to put this information into context and say something about the health of the ecosystem as a whole.

Vital signs monitoring protocols commonly involve field studies conducted by the I&M Program, while others, such as air quality monitoring, rely on identifying, acquiring and analyzing data already being collected by other NPS divisions and/or outside agencies. Regardless, each monitoring protocol will include protocol-specific standard operating procedures (SOPs) which provide guidelines, standards and methodologies related to information management, including: data collection, processing, analysis, reporting, storage, and maintenance. This may range from detailing the proper use of data entry forms or databases to outlining calibration procedures for automated data loggers. Please refer to the individual protocols for information regarding protocol-specific SOPs.

The science information specialist and program ecologists are responsible for ensuring that all SOPs are followed. There are numerous methods for collecting data in the field ranging from paper field forms to automated computers and sensors that collect information independent of user input. Depending upon the protocol in question, different methods of data collection are appropriate and even recommended. To the greatest extent possible, the SECN will utilize data collection methods that reduce the chance for human error – the most common cause of data quality problems. Data collection methodology will be described in detail as a part of each long-term monitoring protocol. The appendix QA/QC and Field Data Collection Standards provides an overview of different data collection methods as well as describing data entry, verification and validation methods used by the SECN to meet its data quality objectives – as mandated by the National Park Service Director's Order 11B Ensuring Quality of Information Disseminated by the NPS.

The SECN has also developed an appendix containing a set of cheat sheets for the proper use of GPS tools when collecting field data (GPS Cheat Sheets for Trimble Recon/GeoXH and Pathfinder Office). This document describes the methods to be used when collecting GPS data utilizing the Trimble Recon and GeoXH GPS units and Pathfinder Office software provided by the Southeast Coast Network. It is the responsibility of the Program Ecologist or GIS Specialist to train the field crews on the correct methods to employ when collecting GPS data.

Project and Incidental Observation Data

Project data that are collected following standardized methods include such data sets as baseline inventories, data collected during protocol development, and data collected during research by

network, park, or cooperator personnel. Each of these examples of project data contributes to the baseline of information that exists for each network park. Therefore, to remain useful over the long-term, these data sets have been and will be subject to the same data processing and lifecycle steps described below for long-term monitoring data. The main divergence from long-term monitoring data procedures is the initial use of MS Excel to house these data sets, rather than a relational database in MS Access. The use of spreadsheets over relational databases was mainly due to the reluctance of personnel (typically non-NPS cooperators) to use MS Access, even when provided with a fully functional database at the beginning of a project. Therefore, only a small portion of the SECN inventory data is currently housed in MS Access – though these data sets may be converted to MS Access as time and resources permit. *Note: legacy data are also considered project data and are described below in the section on data mining and in detail in the appendix:* SECN Data Mining Strategy.

Incidental observation data has a long history within the National Park Service. In most parks, incidental observation data were collected on observation cards from the public or NPS staff, while in other parks observation data were stored in a spreadsheet. As part of the park data mining process (described below) these observation records have been reviewed by Park and Network staff and if deemed valid (and adequately documented with observer, date and location), have been incorporated into NPSpecies and MS Excel for long-term storage. The SECN is planning to develop a Species Observation database in the near future for use at Network parks and/or to house incidental observation data received from network parks.

Acquisition of Non-programmatic Data

The SECN is only one of many organizations conducting long-term ecological monitoring in the southeastern United States. The Network vital signs scoping and prioritization process took ongoing monitoring efforts in the vicinity of network parks into account when selecting the final list of network vital signs. By developing partnerships and leveraging existing monitoring programs in the region, the SECN was able to maximize the number of vital signs for implementation – without collecting redundant data. Vital signs related to air and water resource monitoring are prime candidates for harvesting data from external organizations (or non-I&M NPS programs such as the air resources division, fire program or exotic plant management teams). Because non-programmatic data are collected, maintained and distributed outside of the control of SECN, there are many things to consider when utilizing these data sets:

- How will non-programmatic data be accessed? Is there a cost involved?
- Once downloaded or otherwise harvested how will the data be stored and integrated with other SECN data sets?
- Are the data properly documented (i.e. accompanying metadata documents QA/QC procedures, errors/missing data/outlier data, methodology and proper use, etc.)?
- What is the contingency should this data source disappear? Is there a need for cost-sharing or some type of Memorandum of Understanding?

Program ecologists are encouraged to work with external agencies, as necessary, to facilitate partnerships and data sharing to the greatest degree possible – for the mutual benefit of both groups (please refer to Chapter 8 of the SECN Vital Signs Monitoring Plan for additional

information on SECN partnerships). Data sets of unknown quality or incomplete documentation are not acceptable for use by the SECN monitoring program. Therefore, protocols involving non-programmatic data will provide comparable guidance and SOPs on the proper harvesting, integrating, use and reporting of these data sets as those developed for SECN data collection efforts.

Data Mining

A fundamental step in developing and maintaining the information base for SECN is locating, evaluating, and documenting park-related natural resource information (and relevant local/regional natural resource information). The term "data mining" refers to this process, which requires regular visits to network parks and establishing data mining procedures specific to each park. The range of materials that require documenting is broad, ranging from historical inventories, ongoing monitoring projects, to GIS and remote-sensing data. Data mining efforts in the SECN are ongoing and will continue over the next few years until the current backlog of information has been processed. Please refer to the SECN Data Mining Strategy appendix for a detailed description of SECN data mining efforts and standard procedures.

Acquisition of New Spatial Data

Spatial data acquired by the network either directly or through contractors must meet established standards and product specifications. GIS data standards established by NPS are presented available online at http://science.nature.nps.gov/nrgis/standards.aspx. Additional standards or requirements may be identified on a project-by-project basis. Spatial data gathered using global positioning system (GPS) units must also meet established standards. SECN specifications for GPS and GIS data are available in the following appendices to this plan: SECN Geospatial Data Specifications and Strategy, GPS Cheat Sheets for Trimble Recon or GeoXH and Pathfinder Office and SECN Metadata Guidance Document.

Data Processing and Lifecycle

Data may take different forms and be maintained in different places as they are acquired, processed and documented prior to being added to the SECN master database. All data used and maintained by the SECN, regardless of source or origin, must meet certain standards. To meet these standards, all data and data products are subjected to certain processing steps, including data quality assurance and control, data documentation, and data integration into National information management systems and into the SECN master database once certified. Specific details of each protocol's data lifecycle may vary depending on protocol implementation and project personnel. However, several standard practices will be implemented for all SECN protocols:

- Data are classified in one of three categories – Raw, Provisional, and Certified. All data migrate from Raw to Certified data following procedures set forth in network SOPs and protocols. Raw, provisional and certified data tables exist within SECN long-term monitoring databases, to support this migration and QA/QC review of all SECN data. Category descriptions are as follows:
    - **Raw** – Data that have not been subjected to either quality control or documentation procedures

    - **Provisional** – Data that have been initially screened for quality to meet minimum standards for generation of provisional information products.
    - **Certified** – Data that have undergone thorough quality assurance and screening as well as complete documentation.

- All raw data are archived, intact in their original format.
- Working database tables are the focal point for all modification, processing, quality assurance screening and documentation of data.
- Upon data certification all data will be locked from editing and necessary changes made only by the SECN Science Information Specialist. In addition, certified data will be archived and posted (as appropriate) or otherwise integrated with national information management applications.
- End-users will be able to access (read-only) SECN certified data and download data sets of interest, depending on user security access restrictions.
- As a general rule, information products (e.g. maps, charts, graphs, etc.) developed by the SECN will be based only on certified data. These products are also archived and made available to users through appropriate data servers or national repositories.
- Provisional information products may be developed using uncertified data in special cases, but will not be released to the public through national systems until such time as they have been certified. The QA/ QC status of all data sets and information products will be specified in the documentation that accompanies all network data or products that are made available to end-users.
- Any subsequent changes to certified data sets must be documented in an edit log which is distributed along with the data.

A general schematic for the migration of all SECN data throughout the data lifecycle is depicted below in Figure 5-1. The migration of raw data to certified data is shown, along with corresponding data dissemination strategies to both the SECN master database as well as national information management systems.

The typical steps involved in data processing and lifecycle are as follows:

1. **Acquire data** – For data recorded by hand in the field, data forms should be reviewed regularly (at least daily) for completeness and validity in order to capture errors as close to their origin as possible.
2. **Data entry / import** – Analog data are entered manually and digital data files are uploaded to the working database.
3. **Archive raw data** – Copies of all raw data files are archived intact. Digital files are copied to the project archive directory. Hard copy forms are either scanned and placed in project archive directory, or copied and placed in the archives.
4. **Verification, processing and validation** – The accuracy of raw data transcription is verified; data is processed to remove missing values and other data flaws; and data is validated using

database queries to capture missing data, out-of-range values, and logical errors. At this point, data sets may be considered 'Provisional'. In certain, limited situations (and for limited distribution) it may be necessary to produce products based on provisional data.

5. **Documentation and certification** - Project metadata is developed or updated, and the data set is certified. Both data and metadata are checked to assure they meet proper standards and are ready to be posted and delivered.
6. **Archive versioned data set** – Copies of the certified data and metadata are placed in the digital library. This can be accomplished by storing a compressed copy of the working database, or by exporting data to a more software-independent format (e.g., ASCII text; see Chapters 6 and 10).
7. **Upload data** – Certified data are uploaded from the working database to the master project database.
8. **Reporting and analysis** – Certified data are used to generate data products, analysis, and reports, including automated summary reports for monitoring projects.
9. **Store products** – Reports and other static information products may (depending on their complexity in generation) be stored according to format and likely demand – either in the digital library or document archives.
10. **Post products and data to national databases** – To make data available to others, reports and other products are posted to national repositories such as NPS Data Store and national databases such as NPSpecies and NPSTORET. In addition, products are catalogued in NatureBib and posted to the Data Store. Data products may not be posted if they contain protected information about the nature or location of rare, threatened or endangered species, or other natural resources of management concern (see Chapter 9 of this Plan for additional details).
11. **Track changes** – All subsequent changes to certified data are documented in an edit log, which accompanies project data and metadata upon distribution. Significant edits will trigger reposting of the data and products to national databases and repositories.

This sequence of events occurs in an iterative fashion for long-term monitoring projects or once, for short-term projects that do not recur. As long-term monitoring projects reach reporting milestones; products are finalized by the program ecologist and products are sent to the science information specialist who will review the product for conformance with format standards and then integrate and store the product on the network data server. After storing the products, they are indexed via the metadata records that are uploaded to the NPS Data Store (as appropriate). The metadata records provide pointers to data and data products. Distribution then follows as data discovery allows potential users to find and either request or download the data sets from the appropriate repositories. In addition to storing and distributing data products, product integration also involves updates to national databases such as NPSpecies and NPSTORET (described above in Chapter 4).

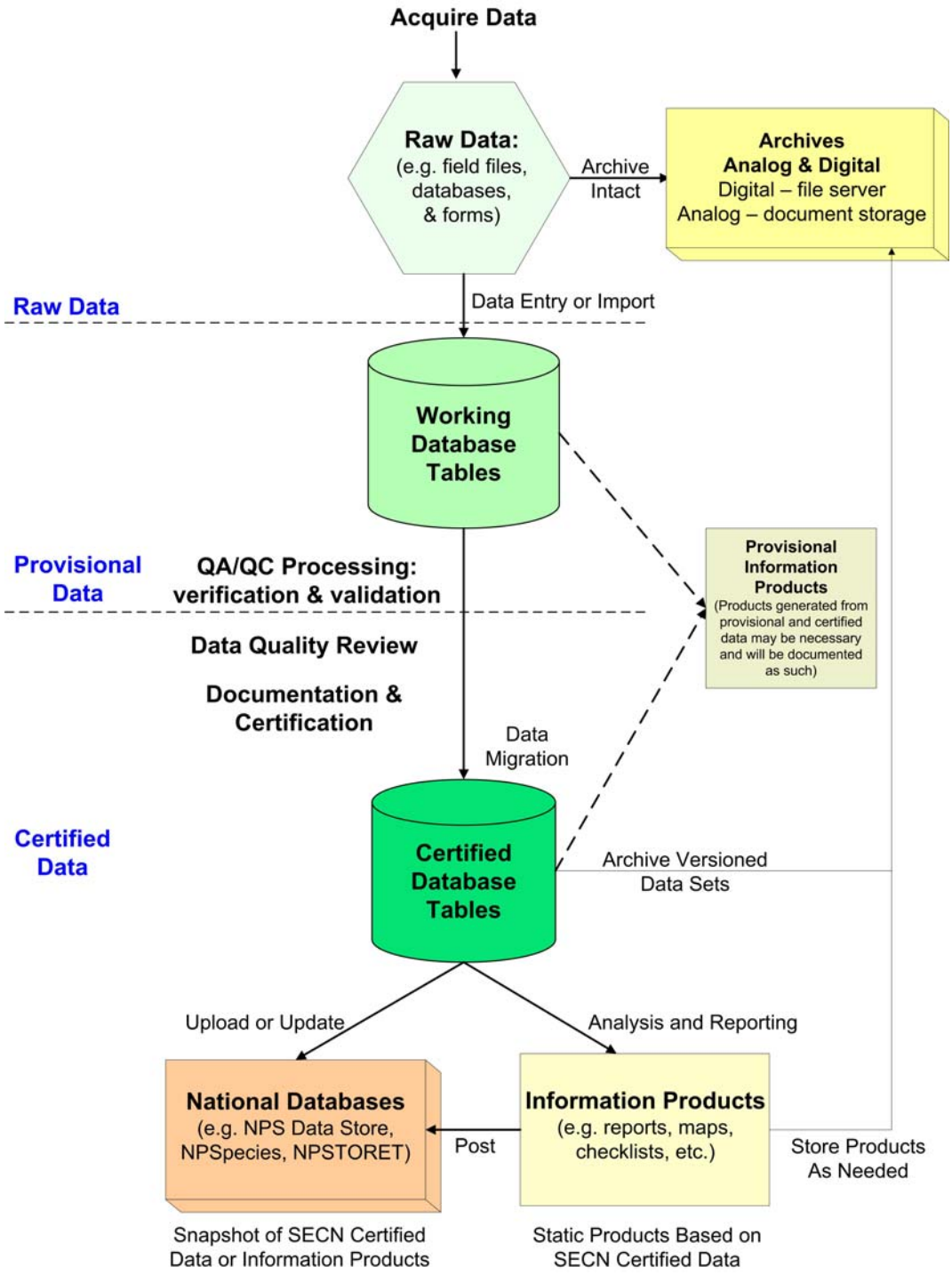


Figure 5-1. Schematic of the migration of data through the typical data lifecycle

Credits

Some of the materials in this section were taken or adapted from materials developed from the following data management plans: (Southwest Alaska Network 2005), (National Park Service 2005).

Chapter 6. Quality Assurance and Quality Control

The use of quality assurance and quality control practices from data collection through reporting and the dissemination of information products is essential to the reliability and defensibility of materials generated by the SECN long-term monitoring program. These terms are defined here as presented in (Palmer 2003):

- **Quality Assurance (QA)** – "An integrated system of management activities involving planning, 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 customer."
- **Quality Control (QC)** – "The overall system of technical activities that measures the attributes and performance of a process, item or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill the requirements of quality."

Protocol-specific data quality procedures are included in long-term monitoring protocols or SOP's for each vital sign. However, some general concepts apply to all work being conducted by the network. Quality assurance and quality control methods will be established and in place at the inception of any protocol and continue through all implementation stages until the final archiving of data has occurred. It is critical that each member of the monitoring team work to ensure data quality. Finally, all SECN data will be accompanied by documentation and/or metadata as appropriate upon distribution. This chapter describes the general quality assurance and quality control procedures that will be applied to all SECN data collection and/or harvesting procedures, as applicable.

NPS Mandates for Data and Information Quality

Director's Order 11b (National Park Service 2002) "Ensuring Quality of Information Disseminated by the National Park Service" states that "all information disseminated by the NPS must comply with basic standards of quality to ensure and maximize the objectivity, utility, and integrity of information disseminated to the public". In complying with Director's Order 11b, the following definitions apply:

> *"**Utility** – refers to the usefulness of the information to its intended users, including the public. In assessing the usefulness of the information that the NPS disseminates to the public, the office needs to consider the uses of the information not only from the perspective of the office, but also from the perspective of the public. As a result, when transparency of information is relevant for assessing the information's usefulness from the public's perspective, the office must take care to ensure that transparency has been addressed in its review of the information.*
>
> ***Objectivity** – involves two distinct elements, presentation and substance. "Objectivity" includes whether disseminated information is being presented in an accurate, clear, complete, and unbiased manner. This involves whether the information is presented within the proper context. In addition, "objectivity" involves a focus on ensuring accurate, reliable and unbiased information. In a*

scientific, financial, or statistical context, the original and supporting data shall be generated, and the analytic results shall be developed, using sound statistical and research methods.

***Integrity** – refers to the security of information – protection of the information from unauthorized access or revision, to ensure that the information is not compromised through corruption or falsification."*

While not every data element collected will ultimately be made public, this policy establishes the standard for quality data that are reliable, accurate, timely, and compliant with existing laws or policies. In addition, these standards apply not only to National Park Service generated information but also to information provided to NPS by other parties, if the NPS disseminates or relies upon this information. In order to achieve these objectives, the SECN has incorporated quality assurance and quality control procedures into all applicable phases of protocol implementation including (but not limited to): data acquisition, data handling, summary and analysis, reporting and archiving.

Quality Assurance and Quality Control Mechanisms

QA/QC mechanisms are designed to prevent data contamination, which occurs when a process or event other than the one of interest affects the value of a variable and introduces two fundamental types of errors into a data set:

- Errors of commission include those caused by data entry and transcription errors or malfunctioning equipment. They are common, fairly easy to identify, and can be effectively reduced upfront with appropriate QA mechanisms built into the data acquisition process, as well as QC procedures applied after the data have been acquired.
- Errors of omission often include insufficient documentation of legitimate data values, which could affect the interpretation of those values. These errors may be harder to detect and correct, but many of these errors should be revealed by rigorous QC procedures.

QA/QC procedures applied to ecological data include four procedural areas (or activities), ranging from simple to sophisticated, inexpensive to costly:

- Defining and enforcing standards for electronic formats, locally defined codes, measurement units, and metadata
- Checking for unusual or unreasonable patterns in data
- Checking for comparability of values between data sets
- Assessing overall data quality

Much QA/QC work involves the first activity (defining and enforcing…), which begins with data design and continues through acquisition, entry, metadata development, and archiving. The progression from raw data to provisional data to certified data implies increasing confidence in the quality of the data through time (Figure 6-1).

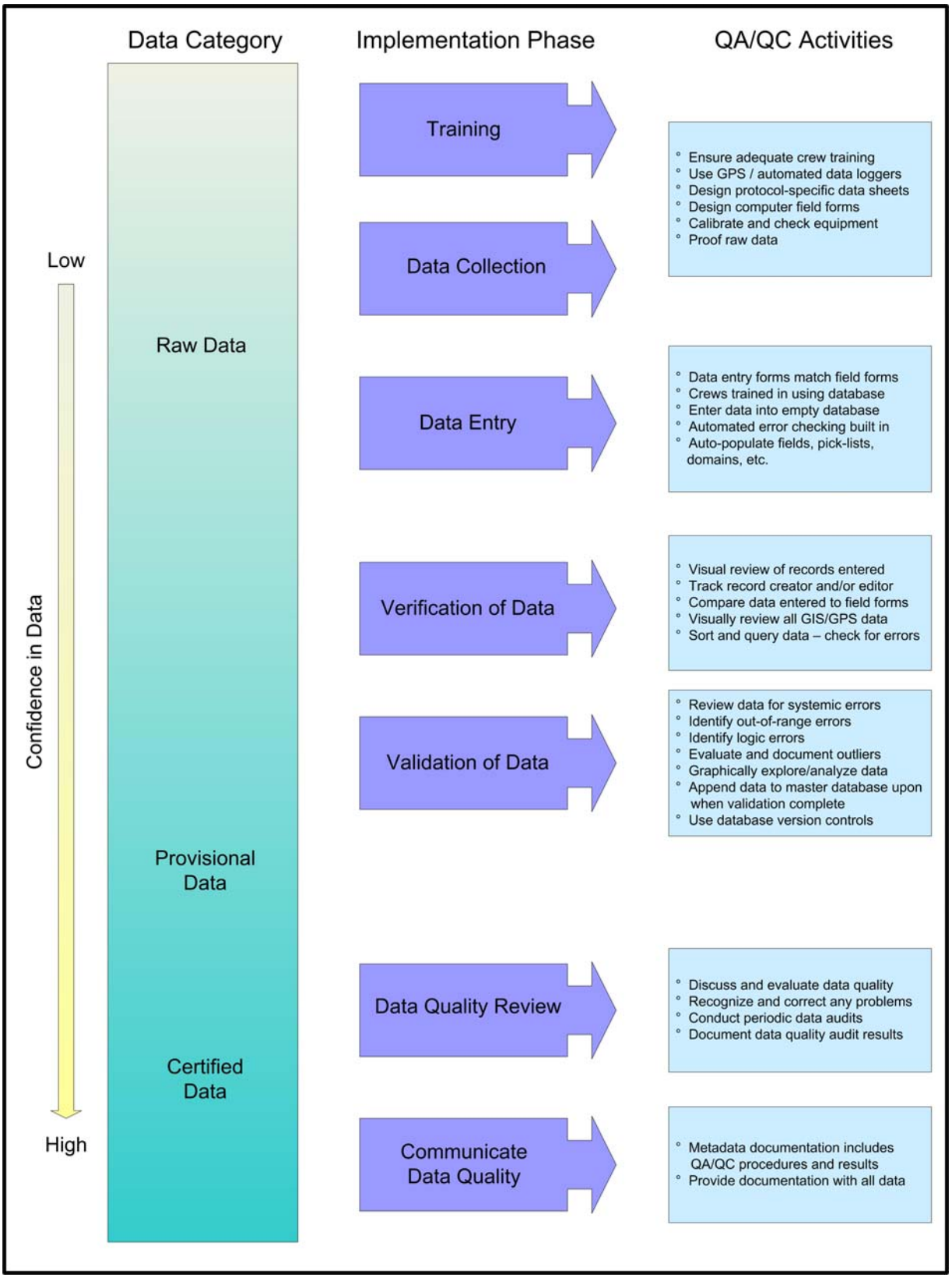


Figure 6-1. QA/QC controls from raw data through certified data

QA/QC Roles and Responsibilities

Quality assurance and quality control methods should be developed and in place at the implementation of any protocol and continue through all stages to final archiving of the data set or at appropriate project milestones (likely annually). It is critical that each person involved with the data works to ensure data quality. Everyone involved in an implemented protocol plays a part in producing and maintaining high-quality data, and everyone assigned to a specific activity or task is responsible for the quality of the results generated from his or her task (see Chapter 3 for more detailed information on role-related responsibilities).

To briefly review information presented in Chapter 3 related to quality assurance and quality control – the program ecologist and network science information specialist have joint responsibility for developing, implementing, and evaluating the QA/QC mechanisms used for each vital signs monitoring protocol. The science information specialist and database programmer have joint responsibility for facilitating QA / QC mechanisms in the database and streamlining the data entry, review, validation and reporting processes. Technicians and other personnel must follow established protocols for data collection, data entry, and verification established in the project protocol SOPs.

Data Quality Objectives

Another positive outcome of the SECN information needs assessment (please refer to Chapter 2 and the INA project final report at http://science.nature.nps.gov/im/units/secn/reports.htm for more detailed information) was the early involvement of end-users and subject matter experts in determining the data and information products required to meet or answer SECN long-term monitoring objectives. Through pilot project work and protocol development these requirements will be further refined to ensure that each monitoring protocol produces data of the right type, quality, and quantity to meet project objectives and user needs. This pre-implementation planning work is critical to the success of the SECN long-term monitoring program since five years into implementation is too late to determine that certain critical data parameters were never collected or were collected at an inappropriate spatial or temporal scale or level of accuracy.

Data quality criteria should be set at a level proportionate to project-specific objectives. The Environmental Protection Agency (US Environmental Protection Agency 2003) defines data quality objectives as qualitative and quantitative statements that:

- clarify the intended use of the data
- define the type of data needed to support management decisions
- identify the conditions under which the data are to be collected
- specify tolerable limits on the probability of making a decision error due to uncertainty in the data

The most effective mechanism for ensuring that a monitoring protocol produces data of the right type, quality, and quantity is to provide procedures and guidelines to assist the researcher in accurate data collection, entry, and validation. The SECN will initiate a comprehensive set of SOPs and data-collecting protocols for quality control, field methodologies, field forms, and data entry applications with some built-in validation mechanisms. As previously mentioned, although

specific QA/QC procedures will depend upon the individual vital signs being monitored and must be specified in the protocols and SOPs, some general concepts apply to all network projects. These general concepts are described in the following guidance documents: QA/QC and Field Data Collection, SECN Digital Photo Management Strategy, SECN Directory Structure and File Naming Conventions, SECN Guidance for NPSpecies Certification, GPS Cheat Sheets for Trimble Recon or GeoXH and Pathfinder Office, SECN Metadata Guidance Document, and SECN Geospatial Data Specifications and Strategy.

Data Quality Review

As described above, the National Park Service requires QA/QC review prior to communicating and/or disseminating data and information. Only data and information that adhere to NPS quality standards can be released. Therefore, the SECN must evaluate and identify the types of data and information it will disseminate and the appropriate review and documentation guidelines that will be provided along with all data and information products disseminated by the Network.

Brunt (2000) identifies a series of checks that should be performed during the QA/QC process and associates each with four distinct project segments: design; acquisition; metadata; and, archive (Brunt 2000). The Southeast Coast Network has adopted the checklist presented by Brunt (Table 6-1) and has integrated it into the data certification process, generating a record of the QA/QC checks that have been performed, who performed the checks, the date the check was performed, and any comments that were recorded for each check. QA/QC reports will be permanently archived with other project information. Data documentation and metadata will be used to notify end users, project managers, and network management of data quality. A descriptive document for each data set/database will provide information on the specific QA/QC procedures applied and the results of the review. Descriptive documents or formal FGDC-compliant metadata will document quality for spatial and non-spatial data files posted on the Internet.

Feedback

Quality assurance procedures may require revision if random checks and data audits reveal an unacceptable level of data quality. However, quality checks should not be performed with the sole objective of eliminating errors, as the results may also prove useful in improving the overall process. For example, if the month and day are repeatedly reversed in a date field, the data entry technicians may require retraining about the month/day entry order. If retraining is unsuccessful in reducing the error's occurrence, the computer program may need to be rewritten so that month and day are entered separately, field length limits are enforced, or a pick list is created. In this manner, the validation process will serve as a means of improving quality as well as controlling the lack of quality.

Edwards (2000) suggests the initiation of quality circles, regular meetings of program ecologists, the science information specialist and other data management personnel for discussing data quality problems and issues (Edwards 2000). These meetings promote teamwork attitudes while focusing brainpower on data quality issues. Participants become more aware of quality issues and learn to anticipate problems. Moreover, all participants develop a greater appreciation of the importance of their role in data quality and the entire monitoring effort.

The Network intends to evaluate each project by conducting post-project reviews with cooperators, project leaders, Network staff, and others familiar with the project to identify notable project successes as well as elements that could be improved. For projects that are anticipated to continue for long-periods, similar assessments will be performed early on with cooperators, Network staff, and others familiar with the project to identify notable successes as well as elements that warrant a mid-project correction.

Table 6-1. Quality assurance and quality control procedures that are associated with data design, data acquisition, metadata development and data archival phases in a comprehensive data management system (From Brunt, 2000).

Quality Assurance / Quality Control (QA/QC)	Design	Acquisition	Metadata	Archive
Check that data sheets represent experimental design	X			
Check that measurement units are defined on the data sheet	X			
Check that attribute names meet protocol standards	X			
Check that date, site and coded values meet standards	X			
Check that attribute names and descriptions are provided	X			
Check that data are complete		X		
Check that data entry procedures were followed		X		
Check that data include time, location and collector(s)		X	X	X
Check that measurement data are within the specified range		X		
Check that data values or codes are represented correctly		X		
Check that data are formatted correctly for further use		X	X	X
Check that data table attribute names are reasonable		X	X	X
Check that the data table design reflects experimental design		X	X	X
Check that values for each attribute are represented one way		X	X	X
Check that errors and corrections are recorded		X	X	X
Check that metadata are present			X	X
Check the metadata content for accuracy and completeness			X	X
Check that the data dictionary is present and accurate			X	X
Check that measurement units are consistent		X	X	X
Check that data and metadata are complete				X

Monitoring Conformance to QA/QC Plans and Standards

Data managers can use periodic data audits and quality control inspections to maintain and improve their data quality procedures. Data audits should verify that staff is operating in conformance with the data quality procedures specified in this plan and the protocol-specific data management SOPs. In addition, audits should track and facilitate the correction of any deficiencies. These quality checks promote a cyclic process of continuous feedback and improvement of both the data and the quality planning process. Therefore, it is important to conduct the first data audit very early in the field season and shortly after just a few days worth of data have been entered, verified and validated. Waiting until the end of the field season to conduct the first audit can result in missed opportunities at improving data quality (at best) and un-recoverable data collection and/or entry errors (at worst). Periodic checks by the science information specialist to see if network personnel are adhering to the data quality procedures established in this plan and protocol SOPs may include verification of the following:

- Data collection and reporting requirements are being met
- Data collection and reporting procedures are being followed
- Verification and validation procedures are being followed

- Data file structures and maintenance are clear, accurate, and according to plan
- Revision control of program documents and field sheets are adequate
- Calibration and maintenance procedures are being followed
- Seasonal and temporary staff are trained in data management practices
- Metadata collection and creation for the program are proceeding in a timely manner
- Data are being archived and cataloged appropriately for long-term storage
- The results of quality assessments should be documented and reported to the research staff and the network coordinator. The program ecologists and network coordinator are responsible for ensuring that nonconformities in data management practices are corrected.
- Communicating Data Quality

The Network will use data documentation and metadata to notify end-users, program ecologists and other network staff about the QA/QC procedures used in the management of data quality as well as the data quality goals and objectives (see Chapter 7 for additional information regarding data documentation). A descriptive document for each data set/database will provide a 'quality report' (i.e., information on the specific QA/QC procedures applied and the results of the review) along with other data documentation such as a data dictionary, methodology, etc. Descriptive documents and/or formal FGDC-compliant metadata will document quality for spatial and non-spatial data files posted on the Internet. For specific details on metadata and database documentation, please refer to the following appendices: SECN Metadata Guidance Document and Database Documentation and Data Dictionary Guidance Document.

Credits

Some of the materials in this section were taken or adapted from materials developed from the following data management plans: (Angell 2004) and (Dieffenbach 2006).

Chapter 7. Data Documentation

The definition of metadata is data documentation or data about data – making it a key aspect of information management. Metadata documents the: who, what, why, where, when, and how of a project and when linked to data (and information products) – enables users to properly evaluate and utilize data sets throughout the lifecycle of the data. In other words, the creation of metadata serves to facilitate data longevity, helps publicize data and facilitates access to and the use of data by others into the future. In general, data longevity is roughly proportional to the comprehensiveness of their documentation (Michener 2000).

National Park Service Standards

Guidance for documentation at the national and NPS level are as follows:

- Executive Order 12906, mandates federal agencies to "...document all new geospatial data it collects or produces, either directly or indirectly..." using the Federal Geographic Data Committee Content Standard for Digital Geospatial Metadata.
- The Federal Geographic Data Committee (FGDC) Content Standard for Digital Geospatial Metadata (CSDGM) extensions, such as the Biological Data Profile, Remote Sensing Extension, and Shoreline Data Profile are not required, but recommended where appropriate.
- NPS Geographic Information System (GIS) Committee requires all GIS data layers be documented with FGDC standard metadata and the NPS Metadata Profile (described below).

Southeast Coast Network Standards – Spatial Data

Spatial data documentation will be completed using the full standards set by the FGDC Content Standard for Digital Geospatial Metadata (CSDGM). Metadata records created by the networks are integrated into the National Park Service, NPS Metadata profile and the metadata and associated datasets will be stored in the NPS Data Store. The locations of the associated datasets are directly linked in the metadata record. Metadata records will be coordinated through the Southeast Regional Office, GIS coordinator to ensure quality and consistency. The primary tools for spatial metadata generation in the SECN will be ArcCatalog and the NPS Metadata Tools and Editor.

For more information about NPS geospatial metadata requirements, see:

- NPS Metadata Profile
- NPS Metadata Profile Document Type Descriptor
- NPS GIS Metadata Information and Tools

Metadata Development

Metadata creation should begin during the planning phase of a project and can be easily initiated using 'metadata questionnaires,' (please refer to the SECN Metadata Guidance Document appendix for additional information) which should be completed by the project lead (typically a Network Ecologist). A formal metadata record will then be created with the assistance of the GIS Specialist or Science Information Specialist. The metadata record should continue to be updated during the data acquisition and data delivery phases of a project. When the project is complete,

the metadata record should be finalized by reviewing for quality, parsing for errors, checking FGDC- and NPS-compliance, and screening for sensitivity. If appropriate, the resolution of sensitive data may be degraded to allow release to the public and the accompanying metadata revised accordingly. Non-sensitive data will then be uploaded to the NPS Data Store by the Science Information Specialist or GIS Specialist.

The tools most commonly used for metadata generation are described below:

- **ArcCatalog** – ArcCatalog is a management tool for GIS files contained within the ArcGIS Desktop suite of applications. With ArcCatalog, users can browse, manage, create, and organize tabular and GIS data. In addition, ArcCatalog comes with support for several popular metadata standards that allow one to create, edit, and view information about the data. There are editors to enter metadata, a storage schema, and property sheets to view the data. With ArcCatalog, users can view GIS data holdings, preview geographic information, view and edit metadata, work with tables, and define the schema structure for GIS data layers. Metadata within ArcCatalog is stored exclusively as Extensible Markup Language (XML) files. The NPS Integrated Metadata System Plan recommends ArcCatalog for gathering GIS-integrated geospatial metadata. An optional but highly recommended extension for ArcCatalog is the NPS Metadata ArcCatalog Extension developed by NPS Midwest Region GIS Technical Support Center.
- **NPS Metadata Tools and Editor** – NPS Metadata Tools and Editor is a metadata management and editing application that implements two separate interfaces: either 1) as an extension within ArcCatalog (v9.0 and greater), or 2) as a standalone desktop interface. The application is intended to be the primary editor for metadata that will be uploaded to the NPS Data Store. The NPS Metadata Tools and Editor application integrates with the NPS Data Store information system by producing XML metadata based on the NPS Metadata Profile. This XML metadata file can then be uploaded to the NPS Data Store application.

The goal of the SECN metadata workflow is to create formal, comprehensive metadata documentation that meets both federal (FGDC) and NPS standards. The following section describes how datasets from varying sources are treated with regard to metadata creation. A detailed outline of the steps involved in the creation of compliant dataset and product documentation can be found in the SECN Metadata Guidance Document appendix of this Plan. However, in general dataset documentation is to be completed annually – at the end of each field season when the final data set and/or information product is certified by the program ecologist. Currently, XML is the current standard for NPS metadata. Accordingly, all spatial and non-spatial data files will be accompanied by an XML metadata file.

Metadata Publication – NPS Metadata Profile

The NPS Metadata Profile was developed in 2004 to support the NPS-wide interoperability of GIS metadata with natural resource and other data management systems using Extensible Markup Language (XML). The NPS Metadata Profile Document Type Definition combines the FGDC CSDGM, the FGDC Biological Data Profile, the ESRI Profile of the CSDGM, the NPS Inventory and Monitoring Program's Dataset Catalog, GIS data layer standards tracking, and

other NPS-specific metadata system requirements. The NPS Metadata Profile is utilized in the NPS Data Store for managing GIS and other data for both internal use and publication to the NPS Data Clearinghouse and NPS Focus Digital Library and Research Station.

The NPS Integrated Metadata System Plan for spatial and natural resource data sets incorporates the generation of metadata by Network and Park users (through desktop applications), metadata posting to and retrieval from the NPS Data Store and dissemination of non-sensitive records to the public through the Geospatial One-Stop clearinghouse available at: http://gos2.geodata.gov/wps/portal/gos (Figure 7-1).

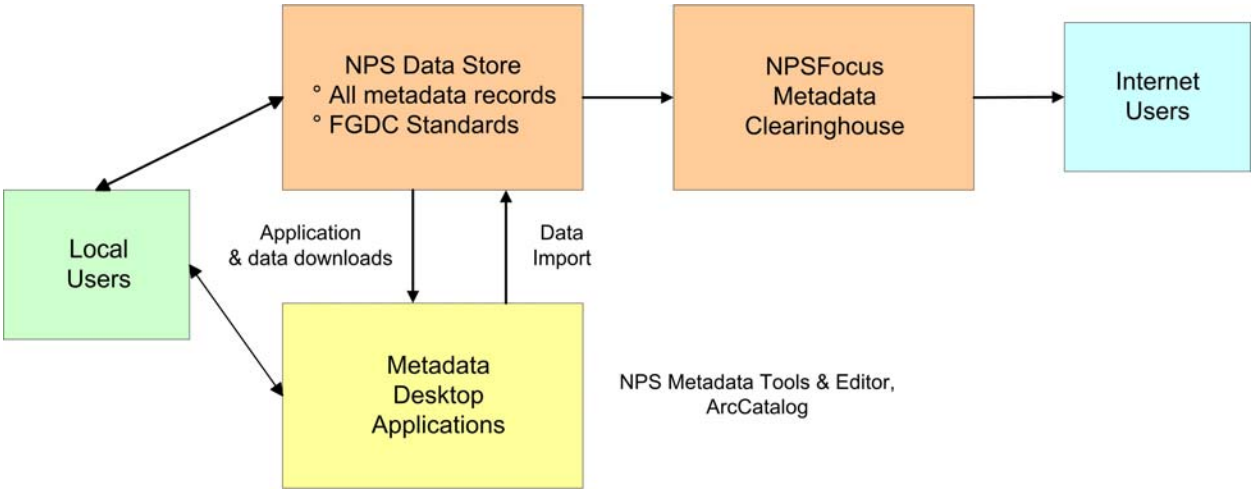


Figure 7-1 NPS integrated metadata system

Metadata Publication – NPS Data Store

The National Park Service Data Store application (NPS Data Store) manages and shares National Park Service metadata and data generated by the Natural Resource and Servicewide GIS Programs of the National Park Service. To facilitate data dissemination to the public and throughout the National Park Service, the NPS Data Store application posts information to the federal Geospatial One-Stop. The NPS Data Store application provides data producers and users with standardized, integrated metadata and data management and dissemination capabilities. The NPS Data Store is a web-based system designed to integrate data dissemination and metadata maintenance for Natural Resource, GIS, and other program data sets, digital documents, and appropriate digital photos.

The NPS Data Store application is accessible at http://science.nature.nps.gov/nrdata/index.cfm and includes the following components:

- An integrated metadata database (NPS Metadata Database) based on the NPS Metadata Profile
- A web-based data server (NPS Data Server) with hierarchical folder structure for storing and organizing data sets
- Remote, secure file and folder management capability for data stewards

- Search interfaces for data and metadata discovery
- Automated posting of appropriate records to NPS Focus and the National Spatial Data Infrastructure (NSDI) Clearinghouse (e.g., non-sensitive metadata records; links to non-sensitive digital documents and digital images)

Tabular Data Documentation

Tabular database documentation will be completed using the minimum standards set by the FGDC Content Standard for Digital Geospatial Metadata. This allows for data discovery through the use of FGDC clearinghouses and the NPS Data Store. Since it is difficult to document a relational database in adequate detail using the FGDC standard alone, all SECN databases / data sets will be documented following the SECN Database Documentation Guidance Document appendix of this Plan) and should include the following information:

- Descriptions of revisions to the database
- Overview of the use and purpose of the data
- Illustration of the entity relationship diagrams (ERDs)
- Data dictionary of tables, attributes, and relationships
- Explanation of queries, forms and reports

Vital Signs Monitoring Protocol Documentation

Vital signs protocol documentation will be completed following the standards in "Guidelines for long-term monitoring protocols" (Oakley et al. 2003). Vital signs protocols (including the protocol narrative and accompanying SOPs) constitute essential documentation that must accompany the distribution of monitoring data. Over time there will be instances when the protocol narrative and SOPs will need to be updated. Narrative and SOP updates may occur independently – in other words, a change in one SOP will not necessarily invoke changes in other SOPs and a narrative update may not require SOP modifications. Changes to protocol narratives and SOPs will be tracked and documented in a Master Version Table (MVT) shown in Table 7-1. The MVT contains a version key number that designates the narrative and SOP versions that are in use at a specific time. Every protocol document contains a MVT and is required to be updated when any protocol revisions are made. The protocol narrative, SOPs, and data will not be distributed independently of the MVT.

Table 7-1. Example of the master version table to track changes to vital signs monitoring protocols and SOPs

Version Key #	Version Key Date	Protocol Narrative	SOP #1	SOP #2	SOP #3	SOP #4	SOP #5	SOP #6	SOP #7
VK1	9/15/2005	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
VK2	1/31/2006	1.00	1.01	1.00	1.00	1.00	1.00	1.01	1.01
VK3	3/10/2006	1.00	1.01	1.00	1.01	1.00	1.00	1.01	1.01

Credits

Some of the materials in this section were taken or adapted from materials developed from the following data management plans: (Southwest Alaska Network 2005) and (Beer et al. 2005).

Chapter 8. Data Management Support for Data Summary and Analysis

Providing meaningful results from data summary and analysis is a cornerstone of the I&M program and characterizes the Network's information management mission to provide useful information for managers, scientists and other end-users in a timely manner. Each monitoring protocol establishes requirements for on-demand and scheduled data analyses, report and product generation. Based on these requirements, the associated information management system will include functions to summarize and report directly from the data as well as output formats for import into other statistical analysis software programs. In addition to tabular and charted summaries, the SECN decision support system provides maps of natural resource data and GIS analysis products to communicate spatial locations, relationships and geospatial modeling results.

Timeline for Analysis and Reporting

Each project will have a schedule for data analysis and reporting requirements specified in the monitoring protocol, study plan, cooperative agreement, or contract. However, in general, the SECN will complete data analysis and reporting within one year of seasonal data collection or the end of the project. Each project leader will maintain his or her working data set throughout the duration of the project. At a minimum of once per year (or within a year of project completion), the project leader is responsible for reviewing and certifying the data set, producing appropriate data summaries/analyses, writing a report, and submitting the data set to the science information specialist, who will place it in the appropriate repository and/or integrate it into the master database, where it will be available for other syntheses or analyses. Specific timelines for data processing will be established for each vital signs monitoring protocol. Chapter 7 of the Southeast Coast Network Vital Signs Monitoring Plan describes the reports that the Network will produce.

Internal coordination for Analysis and Reporting

Close coordination between the program ecologists, science information specialist and database programmer are important when defining the process of transforming raw data into meaningful information. These personnel work together to identify opportunities and methods to streamline data extraction and exports from databases and to automate data summaries, analyses and reports. Where possible, the network will use built-in functions or custom programming within the database to facilitate the production of data summaries and reports.

Extracting the data needed for analysis or summary requires an understanding of the database design, including the relationships, table fields and table structures. In many cases, the pieces of information necessary for data analysis or summary come from more than one table. The program ecologists, science information specialist and database programmer will work together to create and test the necessary queries and evaluate the reported results to ensure that they meet the programmatic needs.

Basic statistics such as mean, standard deviation, max/min, etc. may be calculated within a database. However, in most cases, data from databases will be exported to other formats for further analysis in more robust statistical programs. Third-party applications, such as SAS

(commercial) or R (Freeware) will be used for procedures such as frequency distributions; tests for normality; single, multivariate and repeated measures analysis of variance; and regression analyses.

SECN Reporting Schedule

Disseminating results in a useable format for managers and a wide range of additional end-users is central to the success of the SECN monitoring program. Detailed descriptions of standard SECN reports are provided in Chapter 7 of the SECN Vital Signs Monitoring Plan. Examples of these reports include:

Table 8-1. Typical reports generated by the SECN Vital Signs Monitoring Program

Report Title	Purpose
Annual Administrative Report and Workplan	Addresses all aspects of program implementation, required to satisfy national requirements (Annual).
Protocol Development Reports	Serves as a record of decision for protocol design, based on the findings of pilot-testing work.
Protocol Review Report	Review of a protocol's implementation, effectiveness and data management activities
Program Review Report	Documents program operations and effectiveness (e.g. adherence to monitoring schedule and budgetary allocations and meeting reporting requirements).
Annual Protocol Reports	Provides a general accounting of yearly monitoring activities, issues and problems. Provides a status summary of measured indicators.
Comprehensive Analysis and Synthesis Reports	Provides park- and network-level assessments of network vital signs, interactions among drivers/stressors and responses measured at similar scales and across multiple scales.
Resource Briefs	Will summarize information provided through the comprehensive analysis and synthesis reports to highlight key findings and communicate results to a wider audience.
State of the Parks Reports	An initiative of the National I&M Program and monitoring data from SECN will contribute to this effort.

Credits

Some of the materials in this section were taken or adapted from materials developed from the following data management plan: (Angell 2004).

Chapter 9. Data Dissemination

The SECN data dissemination strategy aims to ensure that:

- Data are easily discoverable and obtainable.
- Only certified data (data subject to complete quality assurance procedures) are released unless necessary to respond to limited/specific data requests (e.g. within network requests and FOIA).
- Distributed data are accompanied by appropriate documentation.
- Sensitive data are identified and protected from unauthorized access and inappropriate use.

The Network's website and server (through SharePoint Services and direct access) and national NPS information / data repositories serve most of the Network's data and information distribution requirements. The network also serves data requests using file transfer protocol (FTP), attaching reports and other products with small file sizes to email and shipping digital media such as DVD, CD-ROM, diskette and magnetic tape cartridge.

In general, all data are available to network staff and network parks; most data are available service-wide and non-protected data are available to all external users.

Mechanisms for Distribution

Access to SECN data products will be facilitated via a variety of means that allow users to browse, search and acquire Network data and supporting documents. SECN data and information products (final deliverables or periodic milestones) will be 'packaged', where possible, and made available for distribution as a complete set. This 'package' will contain (as applicable) a snapshot of data, related protocols, data quality assurance reports, metadata and/or documentation and reports or synthesis documents.

In general, information will be made available to two primary audiences: public and NPS employees, as determined by data sensitivity and development status. Only fully documented, certified, non-sensitive data and data products may be uploaded to public distribution repositories or otherwise released to the public. For guidance on materials available only through data request or FOIA request, please refer to the appendix SECN Policies for Fulfilling Data Requests.

For more detailed information on SECN data distribution methods via the internet and intranet, please refer to the appendix SECN Data Dissemination: Internet and Intranet Resources.

Ownership, FOIA and Sensitive Data

SECN data and information products are considered property of the National Park Service (OMB, Circular A-110 Section 36). The Freedom of Information Act, 5 U.S.C. § 552, referred to as FOIA, stipulates that the United States Government, including the National Park Service, must provide access to data and information of interest to the public, regardless of whether or not the federal government created the records. FOIA is intended to establish a right for any person to access federal agency records that are not protected from disclosure by exemption or by special

law enforcement record exclusions. Under the terms of FOIA, agencies must make non-protected records available for inspection and copying in public reading rooms and/or the Internet. The NPS is directed to protect information about the nature and location of sensitive park resources under one Executive Order and four resource confidentiality laws:

- Executive Order No. 13007: Indian Sacred Sites
- National Parks Omnibus Management Act (NPOMA; 16 U.S.C. 5937)
- National Historic Preservation Act (16 U.S.C. 470w-3)
- Federal Cave Resources Protection Act (16 U.S.C. 4304)
- Archaeological Resources Protection Act (16 U.S.C. 470hh)

When any of these regulations are applicable, public access to data can be restricted. If disclosure could result in harm to natural resources, the records may be classified as 'protected' or 'sensitive' and information withheld regarding the following resources recognized as sensitive by the NPS:

- Endangered, threatened, rare, or commercially valuable National Park System resources
- Mineral or paleontological sites
- Objects of cultural patrimony
- Significant caves

The Network will comply with all FOIA restrictions regarding the release of data and information, as instructed in NPS Director's Order #66 and accompanying Reference Manuals 66A and 66B (currently in development). Classification of sensitive data will be the responsibility of network staff, park staff, and any cooperating (non-NPS) staff. Network staff will classify sensitive data on a case-by-case, project-by-project basis, working closely with park resource management staff to ensure that potentially sensitive park resources are identified, that information about these resources is tracked throughout the data / product lifecycle, and that potentially sensitive information is removed from documents and products that will be released outside the Network. Specific procedures related to managing sensitive data and information are available in the SECN Policies for Fulfilling Data Requests appendix to this plan.

Access Restrictions and Sensitive Data

Network staff is responsible for managing access to sensitive data handled by the Program. All potentially sensitive park resources will be identified and investigators working on network protocols will be informed that:

- All data and associated information must be made available for review by network staff prior to release in any format
- Any information classified as protected should not be released in any format except as approved in advance by the National Park Service

Sensitive park resources will be identified through a cooperative effort. The network and park staff should identify all potentially sensitive park resources to the program ecologist for each protocol. Reciprocally, the program ecologist must identify any known references to potentially sensitive park resources. When preparing information for any repository, SECN staff ensures that all protected information is properly identified and marked so that access is granted only to users with the proper security credentials. For public forums, all references to protected information must be removed or obscured in any reports, publications, maps, or other document types.

Data Sharing with Federal Agencies and Sensitive Data

In general, any federal agency that holds information about the nature and specific location of park resources that qualifies as protected information under the provisions of National Parks Omnibus Management Act must withhold that information from the public unless the Director of the National Park Service determines that its release: 1) would further the purposes of the unit of the national park system in which the resource is located; 2) would not create an unreasonable risk of harm, theft, or destruction of the resource; and 3) would be consistent with other applicable laws protecting the resource.

NPS often enters into information-sharing agreements with other federal agencies in order to facilitate scientific study. NPS should notify these federal agencies that protected information must be withheld under resource confidentiality laws and the Executive Order applicable to park resources. NPS should also notify the other federal agency that it needs to consult the service regarding any request from an outside party for the information before releasing it, whether pursuant to FOIA request or any other oral or written request. Protected information must be withheld unless the NPS Director, after applying the criteria of the resource confidentiality laws and the Executive Order, determines that it can be released. The specific details of FOIA and sensitive data should be addressed at the beginning of any partnership through the use of data confidentiality agreements between the two (or more) agencies. Additional details are provided in Director's Order #66b – Protected Information about Park Resources (still in development).

Data Sharing with State Agencies and Sensitive Data

When sharing information with state employees, whether from state agencies or state funded universities, NPS must be aware that those state employees may be governed by state freedom of information or sunshine laws that may require them to release information in their possession to any party requesting it. Some state freedom of information laws may contain exemptions that allow state employees to withhold certain types of information. In those states, it is possible that state employees would have authority to enter into contractual agreements with NPS. In states where state employees are authorized to withhold certain types of information, NPS may share protected information with state employees when NPS and the state have entered into an appropriate contractual agreement that ensures confidentiality of shared information. Other state freedom of information laws may require all information to be released from state records upon request. NPS must not share protected information with state employees in those states. Additional details are provided in Director's Order #66b – Protected Information about Park Resources (still in development).

Feedback Mechanisms

Overall comments and questions concerning SECN I&M Program are welcome at any time and may be submitted via e-mail or telephone to the Network Coordinator. The SECN website will provide an opportunity for NPS staff, cooperators and the public to provide feedback on data and information gathered as part of the Network's I&M Program. The metadata attached to each dataset available to the public will include information on where to send comments or questions regarding the specific data.

Credits

Some of the materials in this section were taken or adapted from materials developed from the following data management plan (Stevens and Entsminger 2004).

Chapter 10. Data Maintenance, Storage and Archiving

This chapter provides an overview of the long-term management and maintenance of digital files and data that result from SECN long-term monitoring protocols. The overall goals for data maintenance, storage and archiving include:

- To ensure that network information can be easily obtained, shared, and properly interpreted by a broad range of users.
- To ensure that data are kept up to date with regards to content and format such that data are easily accessed and their lineage and quality easily learned.
- To ensure that data are physically secure against environmental hazards, catastrophe and security threats.

Effective long-term data maintenance is inseparable from proper data documentation, thus making accompanying explanatory materials an essential component of the digital archive (Olson and McCord 2000). Data documentation is more fully explained in Chapter 8 and the following appendices of this Plan: SECN Metadata Guidance Document and Database Documentation and Data Dictionary Guidance Document.

NPS and SECN Standards for Electronic Archives

- The SECN will keep current with all Department of Interior software platform migrations. Currently the standard office software platform is Microsoft products (Microsoft Office) for all Department of Interior (DOI) agencies (DOI, Assistant Secretary for Policy, Management, and Budget, Findings and Determination, September 13, 2002).
- SECN will update and maintain datasets to no more than two versions behind current version of software, or store the dataset in American Standard Code for Information Interchange (ASCII) format, complete with data and file documentation.

Electronic Archiving and Storage

Inventory or Synoptic (short-term) Studies – Electronic versions of deliverables, as listed in the cooperative agreements, permits, study plans protocols or other administrative records will be electronically archived by three archiving methods:

- *Online Archive* – The online archive packages all records as stand alone units, encompassing databases, reports, information products, metadata and other documentation. This information will be write-protected so users may access and copy records but cannot make inadvertent changes.
- *Offline Archive* – The offline archive includes the same information described above – just stored on CD or DVD. Currently, gold – archival quality CD-R's and high quality DVD-R's are the preferred long-term storage media.
- *Product Library* – Certain static products are stored in product libraries. This may include final reports and other documents stored in the SECN bibliographic database, Reference

Manager or photographs stored in the SECN Image Management Database – Portfolio Extensis.

Monitoring (long-term) Protocols – Static, milestone products should be electronically archived similarly to the finite (short-term) deliverables described above. Static products may include items such as annual reports and annual status and trends data analyses. On-going datasets will go through the protocol-specific QA/QC procedures and then be migrated into the SECN master database – including the standard archiving and back-up procedures of the SECN data server. The SECN master database is write-protected so that users may access and copy records but cannot make inadvertent changes. Raw data will be archived in its native format. Please refer to the SECN Data Processing and Lifecycle Workflow and the SECN Digital Archiving Guidance Document appendices for the detailed procedures required for managing and maintaining electronic archives.

Guidance for records management, collections management and natural history archives are presented in the next chapter and in the following appendices: SECN Records Management Standard Operating Procedure, Summary of Laws and Regulations for the Management of NPS Natural History Collections and SECN Curatorial Responsibilities Guidance Document.

Credits

Some of the materials in this section were taken or adapted from materials developed from the following data management plan: (Southwest Alaska Network 2005).

Chapter 11. Natural History Archives, Storage and Records Management

This chapter applies to documents such as final reports prepared by staff or contractors, program administrative documents, contracts and cooperative agreements, memoranda of agreement or understanding, and other documents related to SECN administration, activities, and programs. This chapter also applies to physical items such as natural history specimens, photographs, and audio tapes. In most instances these documents and objects are essential companions to the digital data described in the previous chapter.

This chapter is intended to alert users to NPS standards for records management and natural history archives. This chapter is not intended to provide a full description of archiving or curatorial procedures. Detailed information regarding archiving and curatorial procedures is covered in NPS museum manuals, NPS regulations, and to a limited extent – in the following appendices to this plan: SECN Curatorial Responsibilities Guidance Document and Summary of Laws and Regulations for the Management of NPS Natural History Collections.

National Park Service Standards

> *"As an agency of the federal government, the National Park Service (NPS) is responsible for managing its records responsibly and according to law and regulation. Records are all documentary materials, including books, electronic data, maps, moving images, papers, photographs and sound recordings, made or received by the National Park Service during the transaction of public business."* NPS Director's Order 19 (National Park Service 2001)

NPS Director's Order 19: Records Management and its appendix, NPS Records Disposition Schedule: NPS-19 Appendix B, revised 5-2003 describe NPS activities and standards in maintaining and providing access to records at all levels of the Service. NPS-19 states that all records of natural and cultural resources and their management are considered mission-critical records, that is, necessary for fulfillment of the NPS mission. NPS-19 further states:

> *"Mission critical records are permanent records that will eventually become archival records. They should receive the highest priority in records management activities and resources and should receive archival care as soon as practical in the life of the record."*

Section N of NPS-19 Appendix B, which provides guidelines on natural resource-related records including the results of Inventory and Monitoring Programs, indicates that all natural resource records are considered "permanent" and need to be retained either in an appropriate park museum facility or at the National Archives. Section N of NPS 19 also indicates that non-archival copies of natural resource-related materials are "...potentially important for the ongoing management of NPS resources" and should not, in any instance, be destroyed.

The NPS Museum Handbook provides the overarching guidance for archival procedures. In particular, Part II, Appendix A: Mandates and Standards for NPS Museum Collections list the cultural and natural history laws, regulations and conventions for NPS museum collections and should be reviewed prior to object collections. The following is a synopsis of current regulations,

policies and guidelines for the accountability and preservation of natural history collections in the national park system.

- NPS Management Policies (2006)
- Code of Federal Regulations, Title 36--Parks, Forests, and Public Property
- NPS-77: Natural Resources Management Reference Manual
- Museum Handbook, Part I: Museum Collections
- Museum Handbook, Part II: Museum Records
- Director's Order #19: Records Management
- NPS Records Disposition Schedule: NPS-19 Appendix B, revised 5-2003
- Director's Order 24, NPS Museum Collections Management
- Director's Order 74, Studies and Collecting (still in development)

Descriptions of these regulations and policies are contained in the Summary of Natural History Collections Laws and Regulations appendix to this Plan. In addition, SECN Curatorial Responsibilities Guidance Document provides guidance for SECN parks in the NPS permitting and collections process.

Park Unit Standards

Direction for managing materials for each park unit is described in each park unit's "Scope of Collection Statement". In general, only materials directly "... related to one or more of the park's themes or site-related materials that the NPS is legally mandated to preserve" will be accepted. All of these materials are required to be cataloged in the NPS cataloging system (ANCS+) (36 CFR, Section 2.5)

All specimens collected as part of SECN programs are property of the respective park. The collection of specimens, whether or not they will be consumptively used or saved and if saved, why they will be saved and where they will be preserved/stored are all documented during the development of a collection permit on a park by park basis.

SECN Standards

SECN programs will adhere to the NPS standards described above – including any special stipulations provided by individual network parks. In addition, given the limited number of park curatorial staff in the network, the SECN will provide guidance and/or assistance with cataloging and archiving materials generated as a result of SECN activities. SECN will also assist in identifying final specimen repositories for network programs likely to generate specimens.

Credits

Some of the materials in this section were taken or adapted from materials developed from the following data management plan: (Southwest Alaska Network 2005).

Chapter 12. Implementation

The central goal of vital signs monitoring is to understand the long-term patterns and processes of park ecosystems at multiple spatial scales. Good data management practices are essential to achieving this goal. Data cost less to save than to collect again, and ecological data often cannot be collected again at any cost. The SECN Information Management Plan contains practices that may be new to staff and principal investigators. With a few exceptions, however, the Plan does not include any requirements that are new. Almost every requirement comes from law, Director's Orders, or the I&M Program. The Plan helps to put these requirements into context and in sequence, and provides operational guidance for achieving these requirements. The plans for each of the 32 I&M Networks are the first comprehensive documents of their kind and will establish a gateway at each network for managers, educators, and the greater scientific community to reach data and information about the park resources. Good data management practices will take time. Some vital sign collection procedures and data management practices are already in use and may require minimal revisions. Others may involve several iterations of procedures and databases before reaching their acceptable and functional data reporting formats.

SECN Decision Support System Development Plan

As described previously, the results of the INA (Chapter 2) strongly supported the development of a single, integrated decision support system design rather than individual, stand-alone databases that address particular monitoring objectives. The conceptual object model combined with SECN long-term monitoring protocols and supporting SOP's serve as the foundation for database and application development that will ultimately form the SECN decision support system. Although database development began in MS Access, concerns related to database size, reporting capabilities, backup and access across multiple offices has encouraged a rapid transition to a client-server approach utilizing SQL server. The decision support system developed to support SECN long-term monitoring will meet the following requirements:

- Database and application development will be compatible with NPS standards/requirements, and build upon the SECN conceptual object model.
- Database and applications will support both spatial (e.g. vector and raster GIS data) and non-spatial (tabular) data.
- SQL server will serve as the primary database repository
- The current SECN production environment includes the following:
    i. Windows Server 2003
    ii. SQL Server 2005, enterprise version (potentially migrating to SQL Server 2008 – enterprise version upon release)
    iii. SQL Server Reporting Services
    iv. Microsoft Office SharePoint Server (MOSS) 2007 – enterprise version
    v. Internet Information Services (IIS) 6.0
    vi. .NET framework 2.0 and 3.0
    vii. Dundas Data Visualization for Reporting Services
- The current SECN development tools are Microsoft Office InfoPath 2007, Microsoft Visual Studio 2005, and Microsoft SQL Server 2005.

The following databases are currently in MS access and will be transitioned to SQL server in the near future:

- Coastal Fixed-station Water Quality Monitoring
- Probabilistic Water Quality Monitoring
- Migratory and Wintering Shorebird Monitoring

In addition to the protocols listed above, the following additional protocols will be next on the schedule for development during FY09:

- Amphibians – Vocal Anurans and Visual Encounter Surveys
- Breeding Forest Birds
- Migratory, Wintering and Beached Shorebird Monitoring
- Volunteer Wildlife and Bird Monitoring

Due to the cooperation required among SECN staff (ecologists, database programmer and science information specialist) to successfully develop and deploy a database that meets all network needs, ongoing communication between network staff is essential.

Table 12-1. Database development schedule for all field protocols and data acquisition SOPs to be implemented by the SECN. Development schedule and status of each SOP that outlines for the acquisition, management and interpretation of data for these Vital Signs are provided in Appendix 13 of the SECN Vital Signs Monitoring Plan.

	Vital Sign(s)	MS Access Database	SQL Server Database	Automated Reporting
Field Protocols	Coastal Shoreline Change	Not Planned	FY09	FY10
	Stream Habitat Assessment	Not Planned	FY10	FY11
	Salt Marsh Elevation	Not Planned	FY09	FY10
	Marine Water Quality	Completed	FY08	FY09
	Fixed-Station Water Quality	Completed	FY08	FY09
	Amphibians	Not Planned	FY09	FY09
	Breeding Forest Birds	Not Planned	FY09	FY09
	Plant Communities	Not Planned	FY10	FY11
	Wintering & Migratory Shorebirds	Completed	FY08	FY09
	Landscape Change Detection	Not Planned	FY10	FY11
Data Acquisition & Analysis SOPs	Ozone	Not Planned	FY10	FY10
	Wet and Dry Deposition Air Contaminants	Not Planned	FY10	FY10
	Visibility and Particulate Matter	Not Planned	FY10	FY10
	Weather & Climate	Not Planned	FY09	FY10
	Groundwater Dynamics	Not Planned	FY09	FY09
	Stream Flow Discharge	Not Planned	FY10	FY10
	Stream Water Quality	Not Planned	FY10	FY11
	Fisheries Take	Not Planned	FY11	FY12
	Visitor Use	Not Planned	FY11	FY12
	Land Management & Disturbance	Not Planned	FY11	FY11

Information Management Plan Implementation – Years One to Five

The first few years of the implementation of this Plan will involve learning, testing, and refining. Data management fundamentals training will be provided to network and park staff. The Plan will be implemented for the first few vital sign monitoring protocols. During this period, templates and SOPs will be developed and tested and refined as needed. These procedures will then be applied to the other vital sign monitoring protocols. We anticipate that there will be some bottlenecks and their identification and elimination is an important phase in the implementation of this plan. Goals for this period of implementation include:

- All Network personnel understand the fundamentals of data management, which include:
    - File management
    - Documentation
    - Quality assurance and quality control
    - Electronic (digital) storage
    - Archival (non-digital) storage
- Improve data management practices by implementing:
    - The conceptual object model for all vital signs monitoring protocols as they are implemented
    - Database development and testing prior to starting data collection
    - Develop common SOPs and guidance documents that can be used for multiple protocols
    - The first vital signs monitoring protocols will be implemented following the procedures described in this Plan and it's appendices

Implementation – Years Five and Beyond

In five years, the Plan will be revised. This next revision may become more streamlined and direct. With the experience gained and practices commonplace, generalizations may be eliminated. The goals for this period of implementation include:

- The Plan will be revised and streamlined for vital signs monitoring.
- All vitals signs monitoring protocols will be implemented following the Plan
- Remaining database and application development will begin with the long-term monitoring protocol and refinement of the SECN conceptual object model – integrating into the SECN decision support system
- The framework and gateway for integration of data with other agencies or networks will be established.

Credits

Some of the materials in this section were taken or adapted from materials developed from the following data management plans: (Southwest Alaska Network 2005) and (Dicus 2005).

Literature Cited

36 CFR 2.5: Research Specimens (Code of Federal Regulations). 2001. Accessed on 9/15/2008 at http://ecfr.gpoaccess.gov/cgi/t/text/textidx?c=ecfr&tpl=/ecfrbrowse/Title36/36cfr2_main_02.tpl

Angell D. 2004. Sonoran desert network data management plan. National Park Service, Inventory and Monitoring Program. Tucson, AZ.

Appalachian Highlands Inventory and Monitoring Network. 2004. Draft data management plan. National Park Service. Asheville, NC.

Beer M., Nance E., Wight A., Powell M. & DenBleyker R. 2005. Northern Colorado Plateau Network, data management plan. National Park Service, Inventory and Monitoring Program, Northern Colorado Plateau Network. Moab, UT.

Boetsch J., Christoe B. & Holmes R. 2005. Data management plan for the North Coast and Cascades network inventory and monitoring program. USDI National Park Service. Port Angeles, WA.

Brunt, J. W. 2000. Data Management Principles, Implementation and Administration. Pages 25-47 *in* W. K. Michener, and J. W. Brunt editors. Ecological Data: Design, Management and Processing. Blackwell Science, Malden, MA.

Daley R. 2005. Data and information management plan: Greater Yellowstone inventory and monitoring network. National Park Service, Greater Yellowstone Network. Bozeman, MT.

DataLOGIC, Inc. 2005. Information needs assessments for the definition of inventory and monitoring data products and conceptual object model. DataLOGIC, Inc. Avondale Estates, GA. Available online at http://science.nature.nps.gov/im/units/SECN/docs/SECN_INA-MODEL_FULL_REPORT.pdf

Dicus, G. 2005. Appendix N: Data Management Plan. *in* L. HaySmith, F. Klasner, S. H. Stephens, and G. H. Dicus editors. Pacific Island Network Vital Signs Monitoring Plan: Phase III (draft) report. National Park Service, Pacific Island Network, Hawaii National Park, HI.

Dieffenbach F. 2006. Data Management Plan, Northeast Temperate Network. National Park Service. Woodstock, VT.

Edwards, D. 2000. Data Quality Assurance. *in* W. K. Michener, and J. W. Brunt editors. Ecological data: design, management, and processing. Blackwell Science, Malden, MA.

Executive Order 12906. 1993. Coordinating geographic data acquisition and access: the National Spatial Data Infrastructure. Accessed on 9/15/2008 at http://www.archives.gov/federal-register/executive-orders/pdf/12906.pdf

Hart M. & Gafvert U. 2005. Data management plan Great Lakes inventory & monitoring network. GLKN/2005/20. National Park Service Great Lakes Inventory and Monitoring Network Report.

Michener, W. 2000. Metadata. Pages 92-116 *in* W. K. Michener, and J. W. Brunt editors. Ecological data: design, management, and processing. Blackwell Science, Malden, MA.

Mohren S.R. 2007. Data management plan, Klamath Inventory and Monitoring Network. NPS/KLMN/NRR--2007/012. National Park Service. Fort Collins, CO.

National Park Service. 2002. Director's Order 11B: Ensuring Quality of Information Disseminated by the National Park Service. National Park Service. Accessed on 9/15/2008 at http://www.nps.gov/policy/DOrders/11B-final.htm

National Park Service. 2001. Director's Order 19: Records Management. National Park Service. Accessed on 9/15/2008 at http://www.nps.gov/policy/DOrders/DOrder19.html

National Park Service. 2004a. Draft Director's Order 66: Freedom of Information Act and the Protection of Exempted Information. Accessed on 9/15/2008 at http://www1.nrintra.nps.gov/do66/DO_66_Final_Draft.doc (NPS-only)

National Park Service. 2004b Draft Reference Manual RM-66A: Freedom of Information Act and the Protection of Exempted Information. Accessed on 9/15/2008 at http://www1.nrintra.nps.gov/do66/RM-66A-Draft.doc (NPS only)

National Park Service. 2004c Draft Reference Manual RM-66B: Handling Protected Information. Accessed on 9/15/2008 at http://www1.nrintra.nps.gov/do66/RM-66B-Draft.doc (NPS only)

National Park Service. 2006. National Park Service Management Policies. National Park Service. Accessed on 9/15/2008 at http://www.nps.gov/policy/MP2006.pdf

National Park Service. 1998. National Parks Omnibus Management Act of 1998. Public Law 105-391. Accessed on 9/15/2008 at http://www.nps.gov/legal/laws/105laws.htm

National Park Service. 1999. Natural Resource Challenge: the National Park Service's Action Plan for Preserving Natural Resources. National Park Service. Accessed on 9/15/2008 at http://www.nature.nps.gov/challenge/challengedoc/NatRes2.pdf

National Park Service. 1992. Natural Resources Inventory and Monitoring (NPS-75). National Park Service. Accessed on 9/15/2008 at http://www.nature.nps.gov/nps75/nps75.pdf

National Park Service. 2005. Data management plan for natural resources in the national capital region network: Inventory and monitoring program. Center for Urban Ecology. Washington DC.

National Parks Omnibus Management Act 16 U.S.C. 5937. Accessed on 9/15/2008 at http://www4.law.cornell.edu/uscode/html/uscode16/usc_sup_01_16_10_79.html

Oakley, K., L. Thomas, and S. Fancy. 2003. Guidelines for long-term monitoring protocols. Wildlife Society Bulletin **31**:1000-1003. Accessed on 9/15/2008 at http://science.nature.nps.gov/im/monitor/protocols/ProtocolGuidelines.pdf

Office of Management and the Budget. 1999. Circular A-110. Accessed on 9/15/2008 at http://www.whitehouse.gov/omb/circulars/a110/a110.html#1

Olson, R., and R. McCord. 2000. Data Archival. Pages 117-141 *in* W. K. Michener, and J. W. Brunt editors. Ecological data: design, management, and processing. Blackwell Science, Malden, MA.

Palmer, C. 2003. Approaches to Quality Assurance and Information Management for Regional Ecological Monitoring Programs. Pages 211-225 *in* D. E. Busch, and J. C. Trexler editors. Monitoring Ecosystems: Interdisciplinary Approaches for Evaluating Ecoregional Initiatives. Island Press, Washington, D.C.

Southwest Alaska Network. 2005. Data management plan for the inventory and monitoring program, Southwest Alaska Network. National Park Service. Anchorage, AK.

Stevens S. & Entsminger G. 2004. Information management plan, northeast coastal and barrier network, inventory and monitoring program. National Park Service.

The Freedom of Information Act 5 U.S.C. § 552, As Amended by Public Law No. 104-231, 110 Stat. 3048. Accessed on 9/15/2008 at http://www4.law.cornell.edu/uscode/5/552.html

The National Park Service Organic Act 16 U.S.C. 1, 2, 3 and 4, 39 Stat. 535. Accessed on 9/15/2008 at http://www.nps.gov/legacy/organic-act.htm

Tomlinson R. 2003. Thinking About GIS: Geographic Information System Planning for Managers. ESRI Press, Redlands, CA.

US Environmental Protection Agency. 2003. Guidance for geospatial data quality assurance project plans (EPA QA/G-5G). EPA/240/R-03/003, pp. i-98. Washington, DC, US Environmental Protection Agency. Accessed on 9/15/2008 at http://www.epa.gov/quality/qs-docs/g5g-final.pdf

Wilder D. (Editor). 2006. Data management plan, Central Alaska Network, National Park Service. Fairbanks, AK, Inventory and Monitoring Program, National Park Service.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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