Request for Proposals and Statement of Work for Padre Island National Seashore –Summary Inventory of Marine and Freshwater Fish (FY 2004)
**Summary**

Padre Island National Seashore’s resource management planning is based upon protection and preservation, as well as public use, of the natural and cultural resources, and is predicated on documented data obtained through appropriate investigation and research. For many natural resources, significant deficiencies exist in the informational baseline, which disallow even cursory assessment of condition. In general, the Seashore’s natural resource inventories do not meet the minimum levels as described in the Standards and Guidelines for Inventory and Monitoring. However, this generalization is primarily a measure of inadequate scope rather than a characterization of quality. Previous fishery studies have been limited to commercially/recreationally important fish, specific habitats, or well-known species. Much fishery work has been conducted by Universities and State agencies throughout and around Padre Island that may serve to fill existing park data gaps. Under this RFP, Padre Island National Seashore (PAIS) is requesting proposals for providing a narrative summarization of reports pertaining to marine and freshwater fisheries specific to fish species, their distribution, and relative abundance of fishes documented throughout the park boundary.

**Background**

Padre Island National Seashore (PAIS) comprises approximately 133,000 acres of undeveloped barrier island habitat. The National Seashore is approximately 70 miles-in-length and ranges from ½ to three miles-in-width. The park is bordered on the west by the hypersaline Laguna Madre and on the east by the Gulf of Mexico (Figure 1). Park habitats generally include grasslands (13,235 acres), emergent wetlands (25,444 acres), wind-tidal flats (27,918 acres), and sparsely vegetated dunes (5,835 acres) (Laine and Ramsey, 1998). The seashore's landscape changes from broad sandy beaches, to ridges of fore-island dunes, then to grassy flats separated by smaller dunes, ephemeral ponds, and wetlands. Back-island dunes and wind tidal flats that merge with the waters of the Laguna Madre define the western portion of the Seashore. Park topography is relatively flat with elevations rarely exceeding 30 feet. Few improved roads exist and accessing the majority of the park requires the use of a four-wheel drive vehicle. Several threats exist within the park and have the potential to affect the park’s natural resources. These threats include 1) oil and gas exploration and production; 2) natural events including hurricanes and sea level rise; and 3) human impacts such as park development and illegal off-road vehicle traffic affect species by eliminating individuals, destroying or modifying of habitat, and altering or eliminating activities such as breeding.

**Inventory Objectives**

- Provide a narrative summarization of reports pertaining to marine and freshwater fisheries specific to fish species, their distribution, and relative abundance of fishes documented throughout the park boundary.

- From past studies done on and adjacent to the park, provide an updated checklist of marine and freshwater fish species for Padre Island National Seashore. This checklist
should identify/describe park habitats, seasonal occurrence, frequency of species occurring within the park, and nativity (native or non-native) to the park.

- List shall also include those species that are federally and state listed as well as those known to be rare, potentially rare or unusual, and/or worthy of special management consideration. Legal status should be included.

- Review previous inventory work and museum collections to determine what fish have been documented and confirmed with voucher specimens. Provide documentation of at least one voucher specimen, and its location, for each species that has been documented present in the park.

- Develop a GIS-compatible electronic files indicating documented GPS locations for each species identified, sampling sites, and the location where and when each voucher specimen was collected. Metadata must be compliant with Federal Geographic Data Committee (FGDC) standards. GIS compatible files will include an MS Excel spreadsheet and an ArcView 3.x format shapefile.

- Update ANCS+, NPSpecies, and NRBib databases by adding all new species data and bibliographic information.

**Basic Inventory Standards**

- **Species inventory must be scientifically valid and defensible.**
- **Existing species lists and collections should be reviewed and verified.**
- Recorded data should include basic habitat information, ecological associations between species and habitat, and frequency of occurrence for each species identified if this information is available.
- Common taxonomic synonyms should be included.
- Data and reports must be provided according to NPS standards for software and product specifications (See attachment A)

**Deliverable Items**

The contractor shall be required to deliver the following items as part of this project:

**QUARTERLY PROGRESS REPORTS**

Three copies shall be submitted by the contractor to the NPS Contracting Officer. These reports shall contain an accurate, up-to-date account of all work during each quarter. Reports must include a detailed description of completed work, indicating the stage of completion of each project deliverable. Reimbursements for expenses will be paid upon acceptance of each quarterly report.
**DRAFT FINAL REPORT**

Six copies of a draft final report containing the information specified below under “Report Format and Contents” shall be submitted by the contractor. Any request for revisions will be forwarded to the contractor within 45 days of receipt of the draft report by the National Park Service. Six copies of the revised draft version shall be submitted within 45 days of receipt of the requested changes. Subsequent to the technical review and recommendations by the Contracting Officer’s Technical Representative, the Contracting Officer reserves the right to require additional changes and submissions of revised drafts until an acceptable report is received. Any subsequent draft submissions shall be prepared and submitted at no additional cost to the government.

**FINAL REPORT**

Thirty copies of the final report shall be submitted following acceptance of the draft report by the Contracting Officer. This report shall contain all the information specified under the Report Format and Contents and incorporate any requested revisions of the draft report.

The draft and final reports shall reflect and report the analysis outlined in the Scope of Work. The report must be typed, single-spaced, on standard size (8.5” x 11”) white paper. All pages must be numbered. Photographs, plans, maps, drawings, photographs, and text must be clean and clear. All reports shall be either spiral or perfect bound.

Additionally, the contractor shall provide one copy of the final report in MS Word format and one copy of the final report in PDF format. These shall be provided on compact disc or zip disc.

The report shall include, but not be limited to, the following items:

1. A cover and title page bearing an appropriate inscription indicating the source of funds to conduct the reported work (NPS Gulf Coast Network Inventory and Monitoring Network) and the contract number.
2. An abstract, suitable for publication in an abstract journal, will consist of a brief, quotable summary useful for informing the technically oriented professional of what the author considers to be the contributions of the investigation to knowledge.
3. A table of contents and list of figures, maps, tables, appendices, etc., where appropriate.
4. An introduction discussing the scope of the investigation.
5. A description of the natural environment of the project area, specifically addressing the variety of habitats from which species were sampled.
6. A discussion of information and data from previous investigations that be-is relevant to the inventory or inventories conducted pursuant to the contract.
7. A brief discussion of the research design of the project.
8. A discussion of the field, laboratory, and statistical methods employed, including any particular difficulties that were encountered.
9. A discussion of the results of the project, including an annotated checklist of all park species encountered with specific mention of all species of management concern. This checklist should include standardized nomenclature and taxonomy for all species, based on the interagency Integrated Taxonomic Information System (ITIS) as well as local synonyms as appropriate. (Refer to [http://www.itis.usda.gov/plantproj/itis/index.html](http://www.itis.usda.gov/plantproj/itis/index.html) for more information on ITIS).
Copies of all MS Excel spreadsheets, databases, and ArcView shapefiles will be provided on a Compact Disk or zip disk. Locations will be supplied in Universal Transverse Mercator (UTM) and North American Datum 1983 (NAD83) format.

In addition, the report must address the data requirements of the National Park Service’s Access database NPSpecies, by covering all information needed to develop a Park-Species Profile that include the categories of Park Status, Abundance, Residency, and Nativity and are defined below:

**Park Status:** Status of each species in each park.

- **Present Species:** occurrence in park is documented and assumed to be extant.
- **Probably Present:** Park is within species' range and contains appropriate habitat. Documented occurrences of the species in the adjoining region of the park give reason to suspect that it probably occurs within the park. The degree of probability may vary within this category, including species that range from common to rare.
- **Historic Species:** historical occurrence in the park is documented, but recent investigations indicate that the species is now probably absent.
- **Unconfirmed:** Included for the park based on weak ("unconfirmed record") or no evidence, giving minimal indication of the species' occurrence in the park.
- **False Report:** Species previously reported to occur within the park, but current evidence indicates that the report was based on a misidentification, a taxonomic concept no longer accepted, or some other similar problem of interpretation.

**Park Status Details:** Additional details for park status; for example if one of the above codes does not offer a complete description or elaboration is desired.

**Abundance:** The current abundance of each species in each park. Park Status as above must be either "Present" or "Probably Present" in order to address the abundance category.

- **Abundant:** Animals: May be seen daily, in suitable habitat and season, and counted in relatively large numbers.
- **Common:** Animals: May be seen daily, in suitable habitat and season, but not in large numbers.
- **Uncommon:** Animals: Likely to be seen monthly in appropriate season/habitat. May be locally common.
- **Rare:** Animals: Present, but usually seen only a few times each year.
- **Occasional:** Occurs in the park at least once every few years, but not necessarily every year.
- **Unknown Abundance:** unknown.
**Abundance Details:** Additional details for abundance; for example if one of the above codes does not offer a complete description or elaboration is desired.

**Residency:** Current residency classification for each animal species in each park. The Park Status, as defined above, must be either "Present" or "Probably Present".

- **Breeder:** Population reproduces in the park.
- **Resident:** A significant population is maintained in the park for more than two months each year, but it is not known to breed there.
- **Migratory:** The species that occurs in park approximately two months or less each year and does not breed there.
- **Vagrant:** Park is outside of the species' usual range.
- **Unknown:** Residency status in park is unknown.

**Residency Details:** Additional details for residency; for example if one of the above codes does not offer a complete description or elaboration is desired.

**Nativity:** Nativity classification for each species in each park. Park Status as defined above must be either "Present" or "Probably Present".

- **Native:** The native species is native to the park (either endemic or indigenous), or if the Park Status is "Probably Present" as defined above, the species would be native to the park if it were eventually confirmed in the park.
- **Non-Native:** The species is not native to the park (neither endemic nor indigenous), or if the Park Status is "Probably Present" as defined above, the species would not be native to the park if it were eventually confirmed in the park.
- **Unknown:** Nativity classification in park is unknown.

**A series of maps and photographs**, including a map showing the general location of the project and a map showing the locations of any species of management concern andvoucher specimens.

**A bibliography** listing all sources consulted during the inventory and/or referenced in the final report.

**VOUCHER SPECIMENS**

Review previous inventory work and museum collections to determine what fish have been documented and confirmed with voucher specimens. Provide documentation of at least one voucher specimen, and its location, for each species that has been documented present in or immediately adjacent to the park. Ensure that voucher specimens located at University or
museum facilities that were actually collected in the park have been prepared and catalogued using NPS standards and entered into ANCS+ database. In addition, voucher specimens should be entered into the NPSpecies database with all pertinent collection information.

**DATA/INFORMATION REQUIREMENTS**

The NPS has adopted certain word processing, database, and GIS software as the standards to promote compatibility and sharing of data among Parks and promote the development of data management tools to make information more available. Microsoft Word is the standard for word processing and all reports and documents shall be delivered in electronic format in MS Word 97 format unless otherwise specified. MS Access 2002 is the standard for distributed databases, and most Parks throughout the NPS will be using the Natural Resource Database Template. GIS products shall be compatible with the ArcView GIS Theme Manager, have FDGC-compliant metadata, and follow the NPS format for spatial data. Metadata for non-spatial data products (e.g., databases, data files, photographs, field data forms) shall be entered into the Dataset Catalog. Species and voucher information shall be entered into the NPSpecies database, and information for voucher specimens shall also be entered into the ANCS+ application (copy of software will be supplied by the park). Bibliographic citations shall be entered into the NRBib database. These specifications are explained in detail in the NPS document entitled National Park Service Inventory and Monitoring Product Specifications. A copy of this document will be made available to the researchers. Specifications, data dictionaries, technical assistance for each of these databases and applications are available by contacting the network data manager.

An Excel spreadsheet shall be developed containing the GPS location for the following: locations where voucher specimens are permanently housed, where they were collected, locations of sampling sites or collection points, perimeter points (where applicable), locations for species of management concern, and any other sightings (observations) during the inventory that would be of significance to Park management. The cooperator shall provide metadata that is compliant with FGDC requirements at the completion of the project. Metadata guidelines and examples may be obtained from http://www.geology.usgs.gov/tools/metadata. A program extension for ArcView 3.x that allows a user to enter metadata information can be obtained from the Internet at http://arcscripts.esri.com/details.asp?dbid=10413. Access to precise locations of Federally and State listed species, as well as others known to be rare, potentially rare, or unusual and worthy of special consideration shall be restricted to the cooperator and NPS staff.

Contractor shall submit a summary of the project to the NPS Investigators Annual Report Database for each calendar year during which work is conducted. The Investigators Annual Report is submitted online at http://science.nature.nps.gov/research/ac/ResearchIndex.

**DELIVERY SCHEDULE**

For the survey ordered, delivery shall be required by the Government in accordance with:

A copy of the contractor’s safety plan and proof of insurance shall be submitted as soon as possible after award of CA, but must occur prior to initiation of any fieldwork.
Quarterly Progress Reports – By the fifteenth day of each quarter (January 15, April 15, July 15, and October 15).

**Draft Reports:** Within 90 days after completion of the research. The government may require revised draft reports until an acceptable report has been prepared. Any required revisions shall be submitted within 45 days after receipt of the Government’s comments. The Government will have 45 days to review subsequent draft reports.

**Final Reports and Submission of Data:** Within 30 days after receipt of the Government’s comments which indicate that the prior draft version is acceptable.

Various inventories have been completed for the Gulf Coast Network over the past three years, which have yielded a variety of products that failed to meet expectations. A good example of a final report that would be acceptable to the Network can be downloaded from the website: [http://www1.nature.nps.gov/im/units/guln/BaselineInventories.htm](http://www1.nature.nps.gov/im/units/guln/BaselineInventories.htm)
Background

One of the primary goals of the National Park Service Inventory and Monitoring Program is to make existing and new natural resource information more available and useful to park managers, scientists, and educators for planning, management, research and education. The I&M Program is coordinating the development of an integrated set of modern GIS and database tools and an overall framework for organizing, storing, displaying, and analyzing natural resource information. This document presents an overview of these tools and technical specifications for products developed by NPS staff, cooperators and contractors for work funded by the I&M Program. The specifications presented here are a “work in progress”, and the most recent version of this document and updates on the development of the information management tools being developed by the NPS can be found at http://www.nature.nps.gov/im/apps/specs.htm.

The National Park Service has adopted certain word processing, database, and GIS software as the standards to promote compatibility and sharing of data among parks and promote the development of data management tools to make information more available. Microsoft Word is the standard for word processing, and all reports and documents must be delivered in electronic format in MS Word 97 format unless otherwise specified by the park. MS Access is the standard for distributed databases, and most parks throughout the
NPS will be using the Natural Resource Database Template (see below). GIS products must be compatible with the ArcView GIS Theme Manager and have FDGC-compliant metadata. Metadata for non-spatial data products (e.g., databases, data files, photographs, field data forms) should be entered into the Dataset Catalog. Species information should be entered into the NPSpecies database, and information for voucher specimens must be entered into the ANCS+ application (which can then be electronically imported into the Voucher table of NPSpecies). Bibliographic citations are to be entered into the NPBib database. Specifications and data dictionaries for each of these databases and applications are presented below or are available from the Product Specifications website at http://www.nature.nps.gov/im/apps/specs.htm.

Overview of Information Management Tools

The NPS is developing a framework for information management that includes a series of web-based master databases that are linked together, and a set of corresponding distributed databases in MS Access that allow users to download the latest version of data for their park from the master web-based version into MS Access for local use. The applications for which there will be both a master web-based version and a distributed MS Access version available in 2001 include NPSpecies, NPBib, and the Dataset Catalog. The GIS Theme Manager and an initial version of the NR Database Template (a relational MS Access database for storing raw data that can be used in conjunction with the GIS Theme Manager) is available. A brief overview of each of these products and how they can be obtained is as follows:

The GIS Theme Manager is an Arcview extension that can be used as a stand-alone application or in conjunction with the NR Database described below as a means of organizing and displaying integrated natural resource information. The Theme Manager has the full functionality and spatial data analysis capabilities of ArcView for those who routinely use GIS, but can also be used by someone with only a few hours of training to display integrated natural resource information for planning, park operations, and decision-making. GIS products must be compatible with the GIS Theme Manager and have fully FGDC-compliant metadata. Parks are encouraged to compile reports and other data products as Windows help files and link them to GIS themes in the Theme Manager. Details can be found at http://www.nature.nps.gov/im/apps/thmmgr.htm.

The I&M Database Template is a flexible, relational database in MS Access for storing inventory and monitoring data (including raw data collected during field studies). This relational Access database can be used as a standalone database or in conjunction with the GIS Theme Manager to enter, store, retrieve, and otherwise manage natural resource information. The template has a core database structure that can be modified and built upon by different parks and networks depending on the components of their inventory and monitoring program and the specific sampling protocols they use. Modules that will include a written sampling protocol, database table structure, data entry forms and quality checking routines, and queries and reports will be coordinated by the Servicewide I&M Program and made available through a web-based
clearinghouse. Each module will be based on a standard sampling protocol. A description of the template and data dictionary is included as Appendix A. The most recent version and details can be found at http://www.nature.nps.gov/im/apps/template.htm.

The **Dataset Catalog** is a tool for keeping an inventory and providing abbreviated metadata "metadata light" about a variety of natural resource data sets, from physical files and photographs to digital scientific and spatial data. The federal government requires that spatial data have fully FGDC-compliant metadata, but for non-spatial data the Dataset Catalog provides a means for parks to keep an inventory of various data files, notebooks of field data forms, photographs, etc. The one-page input and report forms provide a straightforward way to document all types of resource data that may or may not meet formal metadata standards. As with other NRPC applications, the master version of the Dataset Catalog will be available through a website and will be linked to NPSpecies (the NPS Species database) and NPBib (the bibliographic database). It will also be possible to download a version in MS Access from the website. A printout of a data entry form that lists the information that should be entered into the Dataset Catalog is included in Appendix C. For a copy of the application and details, see http://www.nature.nps.gov/im/apps/datacat.htm.

The purpose of the Dataset Catalog is to provide a single source for information about existing data on parks' natural and cultural resources and to combine the individual databases into a Servicewide catalog of park-based data. The original goal for catalog records consisted of a single page per data set. The current version (v2001.1) of the Dataset Catalog consists of a relational database that can be shared among NPS units and included in the Servicewide system on the Internet. The catalog is not intended to be an exhaustive metadata listing but a basis for implementing comprehensive metadata standards later on. Action is currently underway to integrate the Dataset Catalog with the FGDC metadata standard.

**NPSpecies** is the master species database for the NPS. The database lists the species that occur in or near each park, and the physical or written evidence for the occurrence of the species (e.g., vouchers and reports). Taxonomy and nomenclature are based on the ITIS, the interagency Integrated Taxonomic Information System. The master version for each park or network of parks can be downloaded from the master website into the MS Access version of NPSpecies. The web-based version will be the master version and will be in active development over the next several years as the biological inventories proceed. The password-protected version now available on the web contains duplicate records, outdated species names, and various errors, and needs to be further developed and cleaned up before any data will be available to the public. NPSpecies is linked to NPBib for bibliographic references that provide written evidence of a species' occurrence in a park. A data dictionary is included in the appendix. The MS Access application and additional details can be found at http://www.nature.nps.gov/im/apps/npspp.htm.
NPBib is the master web-based database that merges a number of previously separate databases such as NRBib, GeoBib, and others. As with NPSpecies, it will be possible to download data from the master web version into the MS Access version that can be used locally on computers without an internet connection. Details are available at http://www.nature.nps.gov/im/apps/npbib.htm.

ANCS+ is the Automated National Catalog System application distributed by the Museum program of the NPS Cultural Resources. All voucher specimens and cultural objects collected in national parks are required to be entered into ANCS+, regardless of where they are stored. For voucher specimens, ANCS+ requires a lot more information to be entered about the specimen than does the voucher table in NPSpecies, but it is possible to electronically transfer the required fields from ANCS+ to NPSpecies, and parks and their contractors are encouraged to first enter voucher data into ANCS+.

Synthesis is an information management system for efficiently locating, organizing, integrating, and disseminating data and information. Synthesis presents the user with a simple, graphical user interface that functions as a gateway to information that may be stored on local computers, networks, intranets, or the Internet. From this single gateway, a user may view and integrate many types of information including text-based documents, photographic libraries, databases, spreadsheets, presentation graphics, geographic information system (GIS) data, bibliographies, Internet-based information, and decision support systems. All of the databases listed above, including the NPBib, NPSpecies, Dataset Catalog, GIS Theme Manager, and the NR Database Template, will operate as stand-alone applications or can be accessed through Synthesis.

Database Specifications

MS Access is the NPS standard for distributed databases, and raw data should be provided to parks in MS Access. The NR Database Template format is recommended to reduce duplication of effort throughout the NPS and to promote data compatibility and sharing among parks. The Database Template works in conjunction with the GIS Theme Manager. A description of the template and data dictionary is included as Appendix A. The most recent version and details can be found at http://www.nature.nps.gov/im/apps/template.htm.

For web-based databases, Oracle is the NPS standard. A web browser such as Netscape or Internet Explorer is used to view, enter and edit data in the password-protected master databases, and parks and their contractors do not need to use or know anything about Oracle. Parks and their contractors are encouraged to logon to the master web-based databases and enter and edit data directly, but the Servicewide I&M Program has also developed mechanisms to accept data in MS Access and to have someone in Fort Collins, CO upload the data into the master Oracle databases. Details for each database can be found at the webpages listed in the “Overview” section above. See Appendix B for the data dictionary for NPSpecies, and Appendix C for data requirements for the Dataset Catalog.
Spatial Data Specifications

Projection and Coordinate Systems

All digital geospatial should be referenced to two coordinate systems. The first is geographic coordinates (latitude and longitude) represented in decimal degrees; the datum should be the North American Datum of 1983 (NAD83); the ellipsoid should be the Geodetic Reference System 80 (GRS80); the units of measure should be meters. The second coordinate system should correspond to the standard presently in use at the park. The contractor is to contact the park's GIS Coordinator for specific instructions. If a park does not currently have an active GIS program, the data should be referenced to the correct UTM zone in which the park is found; the datum should be NAD83; the ellipsoid should reference GRS80; the units of measure should be meters.

Scale and Spatial Resolution (Vector Data)

New data should not exceed 1:24,000, e.g. 1:50,000. The contractor should contact the park's GIS coordinator for specific scale and spatial resolution requirements based on the scope of the project.

Scale and Spatial Resolution (Image Data-digital or aerial photography)

The contractor should contact the park's GIS coordinator for specific scale and spatial resolution requirements based on the scope of the project. For vegetation classification under the NPS/USGS vegetation classification project (see http://biology.usgs.gov/npsveg/), the current standard is 1:12,000 color infrared aerial photographs with 60% overlap and 30% sidelap.

Horizontal and Vertical Accuracy

All data should meet or exceed National Map Accuracy standards. For maps on publication scales larger than 1:20,000, not more than 10 percent of the points tested shall be in error by more than 1/30 inch, measured on the publication scale; for maps on publication scales of 1:20,000 or smaller, 1/50 inch. These limits of accuracy shall apply to positions of well-defined points only. Well-defined points are those that are easily visible or recoverable on the ground, such as the following: monuments or markers, such as bench marks, property boundary monuments; intersections of roads and railroads; corners of large buildings or structures (or center points of small buildings). In general, what is well-defined will also be determined by what is plottable on the scale of the map within 1/100 inch. Thus, while the intersection of two roads or property lines meeting at right angles would come within a sensible interpretation, identification of the intersection of such lines meeting at an acute angle would not be practicable within 1/100 inch. Similarly, features not identifiable upon the ground within close limits are not to be considered as test points within the limits quoted, even though their positions may be scaled closely upon the map. This class would cover timber lines and soil boundaries. Vertical accuracy, as applied to contour maps on all publication scales, shall be such that not more than 10 percent of the elevations tested shall be in error by more than one-half the contour interval. In checking
elevations taken from the map, the apparent vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal error for a map of that scale. Source: USGS Fact Sheet 078-96, September 1997.

**Attribute Accuracy**
At a minimum, an 80% or greater attribute accuracy at a 90% confidence level is required. The contractor should contact the park’s GIS coordinator for specific attribute accuracy requirements.

**Spatial Data Formats**
At a minimum, all vector data is to be supplied as an Arc/Info coverage and Arc/Info interchange file, e00. All raster data is to be supplied as an Arc/Info GIRD and Arc/Info interchange file. All image data such as aerial photographs are to be supplied as tagged information file format (tiff) files with the proper header file. Data should be delivered on two CD-ROMs.

**Quality Control**
When the contractor has completed 10% of the spatial and attribute data development, the contractor will supply the park and Regional Technical Support Center (RTSC) the data for quality control purposes. The data should be delivered in the format specified in the Spatial Data Formats section. Once the park and RTSC have checked the data and found it acceptable, the contractor may continue data development. Once the contractor has completed the work, the park and RTSC must accept the spatial data, attribute data and FGDC compliant metadata before the job is considered complete.

Tests used to verify all applicable horizontal, vertical and attribute accuracy measurements should be provided to the park’s GIS coordinator and the RTSC whenever data is provided to the park and RTSC.

**Metadata**
All digital geospatial data should have Federal Geographic Data Committee (FGDC) – compliant metadata in digital form developed by the producer. The metadata should be parsed using the metadata parser provided by the FDGC, http://www.fgdc.gov. Metadata should be supplied as ASCII text with a .txt extension, hypertext markup language with an html extension and standard general markup language with an sgml extension. The contractor should contact the park’s GIS coordinator or the RTSC for metadata development instructions. The RTSC contact is Bill Slocumb at North Carolina State University. He can be reached via email at bill_slocumb@ncsu.edu or by phone, 919.515.3432.

**Non-Spatial Data**
The FGDC has developed guidelines for metadata for non-spatial data, but these guidelines are still undergoing review. At a minimum, an abbreviated set of metadata or “metadata light” should be developed by the producer using the Dataset Catalog for all products, such as data files, photographs, etc. See the sections for the Dataset Catalog for more information.
Developing a Database Involving Spatial Coordinates

It is important to develop the database in a manner that accurately represents the data and maintains the integrity of the data. This involves completing and maintaining coordinate data for the following fields in every database that will represent spatial data. (NOTE: Not every database will represent data in both lat/long and UTMs. Actually, those entering data should add and maintain coordinate information in either lat/long OR UTMs, but not both.

**StartUTMX:** Identify the UTMX (easting) coordinate for the center of the plot OR the starting point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto. Double precision to 15 significant digits should be maintained. This is extremely important to maintain millimeter accuracy anywhere on the globe. *Note that in order to preserve the integrity and accuracy of the original data, coordinate information should be entered in either UTMs or latitude/longitude, but not both. The data can later be converted, if required.*

**StartUTMY:** Identify the UTMY (northing) coordinate for the center of the plot OR the starting point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto. Double precision to 15 significant digits should be maintained to allow millimeter accuracy anywhere on the globe. *Note that in order to preserve the integrity and accuracy of the original data, coordinate information should be entered in either UTMs or latitude/longitude, but not both. The data can later be converted, if required.*

**StopUTMX:** Identify the UTMX (easting) coordinate for the ending point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto.

**StopUTMY:** Identify the UTMY (northing) coordinate for the ending point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto.

**UTMZone:** Identify the UTM zone (zones 1-52). This information is required if coordinates are specified with the UTM grid coordinate system.

**StartLat:** Identify the latitude in decimal degrees of the coordinate for the center of the plot OR the starting point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto. Double precision to 15 significant digits should be maintained. This is extremely important when converting coordinates to UTM to avoid truncation or rounding off of fractional values, and to maintain millimeter accuracy anywhere on the globe. *Note that in order to preserve the integrity*
and accuracy of the original data, coordinate information should be entered in either UTM or a grid system, but not both. The data can later be converted, if required.

**StartLon**: Identify the longitude in decimal degrees of the coordinate for the center of the plot or the starting point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto. Double precision to 15 significant digits should be maintained. This is extremely important when converting coordinates to UTM to avoid truncation or rounding off of fractional values, and to maintain millimeter accuracy anywhere on the globe. *Note that in order to preserve the integrity and accuracy of the original data, coordinate information should be entered in either UTM or a grid system, but not both. The data can later be converted, if required.*

**StopLat**: Identify the latitude in decimal degrees of the coordinate for the ending point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto. Double precision to 15 significant digits should be maintained.

**StopLon**: Identify the longitude in decimal degrees of the coordinate for the ending point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto. Double precision to 15 significant digits should be maintained.

**Datum**: Identify the reference system used for defining the coordinates of points (i.e. North American Datum of 1927 or North American Datum of 1983 (NAD27 or NAD83)).

**EstHError**: (Estimated Horizontal Error) Calculate the “error buffer” associated with the x,y coordinates for the location. This value makes it possible with a GIS to show the uncertainty associated with a location, depending on how the coordinates for that location were obtained. Report error in meters for both UTM and latitude/longitude coordinates. The required Federal reporting standard in the horizontal component is the radius of a circle of uncertainty, such that the true or theoretical location of the point falls within that circle 95% of the time.

**Determining error from maps:**

If using standard mapping sources to determine the spatial coordinates (e.g. USGS 1:24,000 quadrangle topo map), the following are the standard values for errors inherent in the source data, as determined by the National Mapping Accuracy Standards:

- 1:2,500 = 6.94 feet or 2.12 meters
- 1:5,000 = 13.88 feet or 4.23 meters
- 1:12,000 = 33.33 feet or 10.15 meters
1:20,000 = 55.50 feet or 16.91 meters
1:24,000 = 40 feet or 12.19 meters
1:62,500 = 104.17 feet or 31.75 meters
1:100,000 = 166.67 feet or 50.80 meters

Determining error from GPS data:

If using a Global Positioning System (GPS) to determine the spatial coordinates, accuracy varies and is dependent on a number of values (e.g., maximum PDOP and minimum number of satellites). For point data, when you export a file from Pathfinder Office (PFO), point features have an instantaneous attribute value for Vertical Precision, Horizontal Precision and Standard Deviation. Use the Standard Deviation to determine the value of Estimated Horizontal Error. For line and polygon data, accuracy cannot be clearly determined (according to Trimble), and we recommend that you enter the horizontal error for the starting point as an approximation of the positional error associated with the line.

AccNotes: This memo field may be used for any notes related to the positional accuracy of the coordinates. Identify the source data (map, date of map and scale, or GPS unit, or other) used to determine positional coordinates. Another option is to make this a text field with a list of choices of how the coordinates were determined.

References Cited:
Foote, Kenneth E., and D. J. Huebner, The Geographers Craft Project, Department of Geography, University of Texas at Austin. Copyright 1995. Information can be found online at www.colorado.edu/geography/gcraft/notes/notes.html

Report Guidelines

Progress Report Format Guidelines

• As requested, submit progress reports double-sided and single-spaced on 8 1/2” x 11” white bond paper and/or in Word 6.0 (or more recent version) files as an email attachment or on a Windows formatted 3.5” diskette.
• Use Times New Roman 12 pt font.
• Commence pagination on the first page of text as a footer and centered.
• Begin paragraphs left justified without indentation on the first line and separate paragraphs from each other double-spaced.
• Use title case (i.e. first letter of all words capitalized except articles, prepositions, and conjunctions) for all section headings.
• Use the following style for section headings:
Submit the specified number of copies (usually five) to the designated NPS Key Official on or before the date(s) identified in the research permit, contract, or agreement. Depending on the scope of the project, progress reports are usually required quarterly, semiannually, or annually.

Progress Report Content Guidelines

The progress report is a brief, informal, narrative statement of the status of all work accomplished during the period specified, and a summary of work to be performed during the following period. Progress reports should include:

a) a title page containing the following information: the words "Progress Report"; title of project; investigator name(s), affiliation, and address; NPS contract, agreement, or purchase order number; date of submission; and time period covered by report,
b) a quantitative description of overall progress and significant findings to date,
c) an indication of any current problems that may impede performance and proposed corrective actions, and
d) a brief discussion of the work to be performed during the next reporting period.

Draft final and final report format and content guidelines

At the completion of a research study, the investigator must submit a draft final report that documents the study methods, results, and conclusions of the entire project as required by the contract. The specified number of copies (usually five to ten) must be submitted to the designated NPS Key Official on or before the date identified in the contract. The report should be written to an "audience" of park managers who may lack training or exposure to the particular discipline. The report may also be distributed to other government agencies, the scientific community, politicians, reporters, and the public. Keep the main body of the report short and concise. This may be accomplished through the use of appendices for extensive literature reviews, detailed explanations of the research design and methods, supplementary data, information which does not directly address the research objectives specified by park managers, and highly technical material (equations, statistical analyses, and testing). Write in a non-technical jargon-free style, avoiding or clearly explaining any scientific terms or terms unique to a specific discipline. Your goal is to clearly and concisely convey study results and management implications to a nonscientist. It is very important for purposes of proper review that both the draft and final reports adhere to the format and content guidelines presented in this manual.
Upon submission of the draft final report, the designated NPS Key Official will review the manuscript and seek additional management and scientific review comments from appropriate NPS regional and park personnel and peer members of the scientific community to ensure technical quality and accuracy of information. Review comments and recommended changes will then be returned to the author(s) for consideration and preparation of the final report.

All appropriate comments from draft final report reviews should be addressed and incorporated during the preparation of the final report. Before duplication, a copy of the final report must be sent to the designated NPS Key Official for final approval of review modifications and format. Upon approval, a letter quality original, reproducible copy of the final report and the specified number of copies (usually ten to fifteen) must be submitted to the designated NPS Key Official on or before the date identified in the research permit, contract, or agreement. A diskette, containing the report in MS Word 97 must be submitted along with the paper copies.

The final report may be printed and distributed as part of an NPS Technical or Natural Resources Report series. Reports printed in these series are not considered formal publications, and the information may be subsequently submitted by authors to peer reviewed journals. The designated NPS Key Official will notify the author of the decision to print the final report in one of the series and will assign the series name and number to be included on the title page. Preprinted front and back covers will be provided for final duplication and distribution.

Draft Final and Final Report Format Guidelines

• Submit all reports double-sided on 8 1/2" x 11" white bond paper and in Word 6.0 (or more recent version) files on a Windows formatted 3.5” diskette.
• Start all first order sections on a new right hand page.
• Use Times New Roman 12 pt font throughout and avoid bolding text.
• Double-space draft final reports and single-space final reports.
• Allow 1” on all margins.
• Left-justify paragraphs without indentation on the first line and separate paragraphs from each other double-spaced.
• Do not hyphenate whole words at the end of a line, instead use an unjustified right margin.
• Number all pages sequentially at the bottom of the page, centered.
  • The initial sections (Table of Contents, List(s) of Figures, Tables, and/or Appendices, Summary, and Acknowledgments) should be numbered sequentially using lower case Roman numerals (i, ii, iii, ...) with numbering beginning with, but not appearing on, the Title Page.
• The main body of the report (beginning with the Introduction) should be numbered sequentially using Arabic numerals (1, 2, 3,...).
• Blank pages are counted but not numbered.
• Use title case (i.e. first letter of all words capitalized except articles, prepositions and conjunctions) for all section headings.
• Use the following style for section headings:

  First Order Header [center]
  Second Order Header [flush left]
  Third Order Header [flush left, underline]
  Fourth Order Header: [flush left, colon, two spaces, continue with text]
  *Fifth Order Header* [flush left, italicize]

**Table of Contents**

• Include only first and second order section headings in the Table of Contents. Include all first and second order section headings that follow the Table of Contents (i.e. beginning with and including headings for lists of figures, tables, and/or appendices).
• Use title case on all Table of Contents entries.
• Double-space entries.
• Indent second order section headings from first order section headings 7 spaces.
• A space followed by a line of dots followed by a space should proceed from the last word of each entry to a right justified page number.
• Allow page numbers to “stand alone” on the right side of the page by spreading longer entries to additional lines, making sure that each line of the entry is indented to the same starting point as the first word of the entry.
• Repeat the heading (i.e. Table of Contents) followed by “continued” in parentheses at the top and centered for each additional page of the Table of Contents.

**List of Figures, List of Tables, and List of Appendices**

• Each of these lists must begin on a new right hand page.
• Double-space entries.
• Begin entries with a capitalized label followed by a space then a number (for figures and tables) or capitalized letter (for appendices) then a period then a double space then a title (e.g. “Figure 1. Map of survey area”, “Table 21. Estimated larvae in survey area”, or “Appendix G. Checklist of butterfly species”).
• If there is only one appendix, do not include a List of Appendices page; list it as the last entry in the Table of Contents as “Appendix” with no letter afterward.
• A space followed by a line of dots followed by a space should proceed from the last word of each entry to a right justified page number.
Citing Literature

• Follow the author and year system for citing literature references in the text. If you wish to mention the author in your discussion say, for example, "Wakeley (1954) reported that...". Otherwise, place the author and year within or at the end of your statement, (Wakeley 1954).

• Semicolons separate citations of works by different authors in one set of parentheses (Wakeley 1954; McManus 1957).

• Commas separate several cited works by the same author (Hackett 1970, 1972a, 1972b).

• List all references in the “Literature Cited” section of the report using the Council of Biology Editors (CBE) bibliographic style as outlined in Table 4.

Table 1. Example list of figures

List of Figures

Figure 1. Map of Shenandoah National Park indicating study area ........................................ 3

Figure 2. Location and size of survey plots established to survey and monitor Lepidoptera species in the study area ................................................................. 15

Figure 3. Estimated number of Lepidoptera species per plots surveyed, January 1998 to December 1999 ................................................................. 21

Figure 4. Species distribution of Lepidoptera surveyed in study area, January 1998 to December 1999 ................................................................. 38
Figure 5. Wing venation of selected Lepidoptera species captured in study area, January 1998 to December 1999

.......................................................... 45

Figure 6. Illustration of Itylos psin captured April 23, 1998 in Limberlost study area, Shenandoah National Park

.......................................................... 57
Table 2. Example list of tables

List of Tables

Table 1. Study sites, habitat types and number of sampling points for surveying Lepidoptera species at Shenandoah National Park
......................................................................................... 4

Table 2. Number of Lepidoptera species predicted and previously documented in survey areas at Shenandoah National Park
........................................................................................................ 12

Table 3. Estimated Lepidoptera species richness for areas surveyed at Shenandoah National Park, January 1998 to December 1999
................................................................................................. 31

Table 4. Identification, number and location of United States threatened and endangered Lepidoptera species encountered in survey areas at Shenandoah National Park, January 1998 to December 1999
........................................................................................................ 47

Table 5. Identification, number and location of Virginia threatened and endangered Lepidoptera species encountered in survey areas at Shenandoah National Park, January 1998 to December 1999 ........................................................................ 55

Table 6. Estimated range of select Lepidoptera species encountered in survey areas at Shenandoah National Park, January 1998 to December 1999
......................................................................................... 67
Table 3. Example list of appendices

List of Appendices

Appendix A. Checklist of common and scientific names of Lepidoptera species observed or collected in survey areas at Shenandoah National Park, January 1998 to December 1999 ................................................................. 92

Appendix B. Vegetation maps of Lepidoptera survey areas at Shenandoah National Park .................................................................................................................................................. 98

Appendix C. Checklist of common and scientific names of flora species observed in surveys areas at Shenandoah National Park, January 1998 to December 1999 ...................................................... 101

Appendix D. Records of Lepidoptera species collected and cataloged in surveys areas at Shenandoah National Park, January 1998 to December 1999 .............................................................. 104


Appendix F. Annotated bibliography of Lepidoptera research conducted in Shenandoah National Park, 1930-1990 .................................................................................................................. 134
Table 4. Literature cited section format

Journal Article

**Format**

First author Surname, Forename initial Middle initial(s)., and Second author Forename initial Middle initial(s). Surname. Publication date. Article title. Journal title. Volume number(Issue number):page number-page number.

**Example**


Book

**Format**

First author/editor Surname, Forename initial Middle initial(s)., and Second author/editor Forename initial Middle initial(s). Surname, editors [if applicable]. Publication date. Title of book. Edition number. Publisher, City of Publication, State/Country of Publication. number of pages pp.

**Example**


Report

**Format**

First author Surname, Forename initial Middle initial(s). and Second author Forename initial Middle initial(s). Surname. Publication date. Title of report. Report Identification Number. City of Publication, State/Country of Publication. number of pages pp.

**Example**

Table 4. Literature cited section format (continued)

Chapter in Book or Paper in Conference Proceedings

**Format**

First author Surname, Forename initial Middle initial(s)., and Second author Forename initial Middle initial(s). Surname. Publication date. Title of chapter or paper. Pages page number-page number in First editor Forename initial Middle initial(s). Surname and Second editor Forename initial Middle initial(s). Surname, editors. Title of book or conference proceedings. Publisher, City of Publication, State/Country of Publication.

**Examples**

**Chapter in Book:**


**Paper in Conference Proceedings:**


**Thesis**

**Format**

Author Surname, Forename initial Middle initial(s). Date of thesis. Title of thesis. Type of thesis. University. number of pages pp.

**Example**

Figures and Tables

- Figures and tables should have brief descriptive titles.
- Numbers and titles for figures should be below the figure and left justified.
- Numbers and titles for tables should be above the table and left justified.
- Explanatory information and keys to symbols should be placed in the legend to the figure or as a footnote at the bottom of the table.
- The title, heading, legend, and footnotes must contain all the information the reader needs to understand a table or figure without referring to the text.
- All figures (including maps and photographs) and tables should be in digital format as part of the final document. If line drawings and artwork are necessary, they must be in high-contrast black and white and of a professional reproducible quality.
- Figures and tables should not be placed on a page with text but should be on their own numbered page immediately following the page (double-sided) in which they are referenced.
- Use sentence case for all figure and table titles.
- Figures and tables, respectively, are numbered sequentially with Arabic numerals in the order of their presentation in the text.
- Every table and figure must be cited in the text (e.g. “(Table 1)” or “…in Figs. 2 and 3”).
- For figures and tables which are more than one page, repeat the figure or table number and title followed by “continued” in parentheses, for each additional page.

Appendices

- Each appendix must begin on a new right hand page.
- Appendices are labeled sequentially with capitalized letters (e.g. “Appendix A”, “Appendix B”, etc.) followed by a brief concise title in sentence case at the top of the page and centered.
- A single appendix is labeled “Appendix.”
- If possible, the title should appear on the same page with the appendix material; if not, the title can be placed centered on the top of the preceding right hand page.
- For appendices that are more than one page, repeat the title at the top and centered, followed by “continued” in parentheses, for each additional page.

Measurement Units

- All measurement units must be metric.
- Include U.S. equivalent measurements parenthetically.
Use abbreviated standard units of measure when with a numeral, whereas, units of measure are to be spelled out if no quantity is given (e.g. “10 m” or “…meters”).

Retain only the final unit of measure in a series (e.g. 10 to 15 kg).

Use a “/” for ratios with numbers (e.g. 10 deer/ha) but use “per” for ratios without numbers (e.g. deer per hectare).

Numbers

Numbers from one through nine are written out; numbers above nine are expressed as numerals except when first word of sentence. Ordinal numbers (e.g. second, 23rd) are treated the same.

Physical measurements (length, width, distance, area, volume, decimals, percentages, degrees, symbols, latitude/longitude, fractions over one) and time (days, years) are always expressed as numerals.

Taxon Names

The NPS has adopted ITIS (Integrated Taxonomic Information System) as its standard for taxonomy and nomenclature, and all scientific names should follow that standard. See http://www.itis.usda.gov/plantproj/itis/index.html

Use common species names of plants and animals initially followed with scientific names parenthetically; thereafter, only the common name is necessary.

If a large number of species are referred to in the text, a reference list of common and scientific names must be included as an appendix.

Copyrighting

Authors are responsible for obtaining written permission for use of any copyrighted figures, tables, graphs, and information.

Errors

Authors are responsible for conducting an editorial review of the draft report to ensure: clarity; proper grammar, spelling, and punctuation; accuracy and completeness of all numbers, tables, figures, and references; and adherence to these format and content guidelines.

Draft Final and Final Report Content Guidelines
The following list provides a general outline of first order headings for all draft and final reports. Each first order heading must begin on a new right hand page. These headings may vary or others may be added, but their order should approximate the following:

- Title Page  [see Table 5 for example]
- Table of Contents
- List of Figures  [if applicable; see Table 1 for example list]
- List of Tables  [if applicable; see Table 2 for example list]
- List of Appendices  [if applicable; see Table 3 for example list]
- Summary
- Acknowledgments  [optional]
- Introduction
- Study Area
- Methods
- Results
- Discussion
- Conclusions
- Literature Cited  [see Table 4 for example formats]
- Appendices [if applicable]

Title Page

The following information, duplicating as close as possible the title page format shown in Figure 5, must appear on the title page.

- Title  [use title case and bold]
- Author(s)  [first name, middle initial(s), surname; no professional titles or academic degrees; avoid the use of “by”]
- NPS Report Identification Code and Number [if assigned by designated NPS Key Official]
- Author’s Organization Mailing Address
- Month/Year
- Month/Year of Update(s)  [if applicable]
- Contract or Agreement Number [include Supplemental Agreement Number, if applicable]
- Appropriate Regional or Support Office Mailing Address

Table of Contents

Include a table of contents listing lists of figures, tables and /or appendices, and all first and second order section headings.

List(s) of Figures, Tables, and/or Appendices
Include a separate list for each set of figures, tables, and/or appendices that are included in the report.

Summary

This “stand alone” section should summarize the prominent facts discussed in the report and the conclusions reached in relation to research objectives. It should be as brief as possible, yet cover the subject in a clearly written, non-technical style so that, on its own, this section tells the reader what the project was about and what conclusions were made. This section is often removed from the report and used by the park Superintendent to inform legislators, public individuals and organizations, and NPS park, regional, and Washington Office staff of the completion and results of the study.

Acknowledgments (optional)

Briefly acknowledge those who directly helped with research or writing. Acknowledgments of typists, illustrators, editors, and referees may be included, but generally are discouraged. Use only forename initials with surname(s) and do not include professional titles or academic degrees.

Introduction

The introduction should include the hypotheses and purpose of the investigation, research objectives, conditions under which the study was conducted, the general plan of treatment of the subject, and summary of previous work accomplished (literature review) that relates to the project.

Study Area

Provide a concise narrative description and justification of the study area(s) for the research. Include a detailed map of the study area(s) for further clarity.

Methods

Present a detailed explanation of the methods, materials, and analytical techniques that were used in the field, laboratory, and office during the study. Describe how, when, where, and by whom the data were acquired for the investigation. The methods should be documented so that the investigation could be exactly repeated, if necessary. Be sure to include how data were analyzed and what statistical tests were employed. Describe the process used for determining whether the data met the data quality objectives and, if not, what corrective actions were taken. Detailed information about QA/QC procedures for data collection, verification, and validation should be placed in an appendix if it is too lengthy and detracts from the main body of the text.

Results
In a logical sequence, present, in detail, the findings of the study that either support or provide evidence against the hypotheses or that answer the question(s) presented in the “Introduction”. Basic descriptive statistics (sample size, percentages, mean, median, maximum, and minimum) are appropriate when clearly presented. Avoid technical discussions of complex statistical testing; instead refer readers who may be interested in this type of information to an appendix.

Discussion

This section and the “Conclusions” section are the most important parts of the report. Present a clear interpretation of the data that addresses the hypotheses, objectives, or purpose for which the study was conducted. Be sure to include how this research is applicable to the park where it took place, and to other studies that have been conducted in that area of research. Other findings may be reported that would be of general interest to the scientific community.

Conclusions

Provide a specific and detailed summation of the conclusions of the research. In some instances, this is one of the few parts of the report that park managers will read. If the research was initiated due to specific park management needs, management implications should be emphasized and thoroughly discussed.

Recommendations regarding policy positions of the agency should not be included. If desired, recommendations of this nature should be covered in a special supplementary report separate from the scientific report.

Literature Cited

List all references cited in the report.

Appendices

Include supplementary materials (e.g. QA/QC procedures) that support the main body of the report.
Table 5. Title page format

FLORA OF PETERSBURG NATIONAL BATTLEFIELD

Michael S. Rosenweig
and
Duncan M. Porter

Technical Report NPS/PHSO/NRTR-98/075

Department of Biology
Virginia Polytechnic Institute
and State University
Blacksburg, VA 24061-0324

January 1991
Revised September 1993

Cooperative Agreement
4000-9-8014
Supplemental Agreement 4

National Park Service
Northeast Region, Philadelphia Support Office
Stewardship and Partnerships
U.S. Custom House
200 Chestnut Street
Philadelphia, PA 19106
INTRODUCTION

The National Park Service (NPS) Service-wide Inventory and Monitoring Program is funding the development of a species database to document the occurrence of vertebrates and vascular plants in national park units with significant natural resources. The Service-wide program has begun to compile existing verifiable information from national databases and institutions, such as museums and herbariums. Funding will be provided to parks to supplement this initial draft compilation of existing information with local records and voucher specimens, and additional funding will be provided for targeted field investigations to begin after data gaps and priorities have been identified by each park.

The initial development of the Species Database was based on the recommendations of the September 1993 Biological Inventory Database Development Workshop held in Chapel Hill, North Carolina. Subsequent advances in database development and internet technology have been incorporated into the currently proposed database structure. Key features of the Species Database will be as follows:

- The goal of high quality, legally and biologically defensible data will be pursued.
- All records will show the source and quality of information.
- Standardized nomenclature and taxonomy will be used based on the interagency Integrated Taxonomic Information System (ITIS) to allow consistency and compatibility of data nationwide and to allow for future changes in taxonomy (see http://www.itis.usda.gov/plantproj/itis/index.html for more information on ITIS).
- The database will be easily accessed and used, but will incorporate various levels of security to prevent the release of species’ locations that would endanger exploited species.

The master copy of the NPSpecies database will be a web-based Oracle database with different levels of access for different individuals. This database will eventually be linked to the Natural Resource Bibliography. NPSpecies will be a synonomized checklist of vertebrates and vascular plants in each park, with certain categorical information such as federal and state legal status, TNC Global Rank, documentation source, abundance, and whether the species is native, invasive or cultivated (see detailed description of database fieldnames below). The database has tables to contain more detailed information on voucher specimens or documented observations of species such as when and where they were collected, where voucher specimens are stored, etc. The database will allow export of locations and other information from voucher specimens and observations to Arcview GIS. The Service-wide I&M Program will fund the development of the synonomized checklist and initial population of records in the Vouchers and Observations tables that document the occurrence of species in parks. However, inclusion of additional data from wildlife observation cards, research studies, and other sources is optional and each park will be responsible for populating the database with that type of information.

A Microsoft Access version of NPSpecies is being developed by the Service-wide I&M Program to be distributed to each park. Parks will be able to modify the structure of the database and make various enhancements to suit their specific needs, as long as certain core information can be provided annually to the Service-wide program to update the master, web-based version of the database. Thus,
each park has the option of using either the web-based version or the park-distributed version of the database.

The following are several examples of how park managers, interpreters, scientists, and the public may use the database:

- Park managers can get an up-to-date, documented listing of all vertebrates and vascular plants in their park, including information on legal status, whether they are native or exotic, abundance, and other basic information.
- Park interpreters can use the list to update species checklists for the park.
- By clicking on a species name, the database will show which other parks the species occurs in so that distributions of species can be determined. For example, which parks have a particular invasive species?
- The link to the Natural Resource Bibliography will allow parks to take advantage of studies and reports done by other parks on a particular species. This is expected to be a particularly useful and cost-effective feature.
- The link to the Specimen/Observation database will allow parks to identify where voucher specimens are stored, and the coordinates where the specimens were collected.
- Locations of animals and plants in the Specimen/Observation database can be exported to Arcview GIS to produce distribution maps.
- The Specimen/Observation database will contain important historical records for species no longer found in a park.
- The database will allow parks and outside scientists to do analyses of various biodiversity and exotic species issues.
- The database would be an important source of information for a future "State of the Parks" report, and would allow the NPS to report to Congress and the public on the status of species occurring in national parks.
DEFINITIONS OF FIELDS AND VALUES

PARK-SPECIES FORM (for data entry)

Park Code  4-character park code.

Park Administrative Unit  This is an optional entry that will allow parks to identify whether a species occurs in different units of the park, such as on different islands or in different park units for park complexes.

TSN  Taxonomic Serial Number. All taxonomic information and synonyms will be tied to the Integrated Taxonomic Information System (ITIS) through the TSN. Full taxonomic information, such as Scientific name, Common Name, Genus, Family, Order, Class, etc. as well as the taxonomic authority and all common name and scientific name synonyms will be provided with the same database structure used by ITIS.

ITIS Recognized Names  The scientific and common (or vernacular) name(s) recognized by ITIS.

Preferred Local Name(s)  The database allows parks to enter a preferred alternate scientific name or common name of a species in addition to the accepted ITIS name. When reports are generated (e.g., list of exotic species in the park), the database will first check to see if there is a preferred local name to include in the report, and otherwise will use the accepted ITIS name.

Park Status  Status of each species in each park.

Present  Species' occurrence in park is documented and assumed to be extant.

Historic  Species' historical occurrence in the park is documented, but recent investigations indicate that the species is now probably absent.

Probably Present  Park is within species' range and contains appropriate habitat. Documented occurrences of the species in the adjoining region of the park give reason to suspect that it probably occurs within the park. The degree of probability may vary within this category, including species that range from common to rare.

Unconfirmed  Included for the park based on weak ("unconfirmed record") or no evidence, giving minimal indication of the species' occurrence in the park.

False Report  Species previously reported to occur within the park, but current evidence indicates that the report was based on a misidentification, a taxonomic concept no longer accepted, or some other similar problem of interpretation.

Park Status Details  Additional details for park status; for example if one of the above codes does not offer a complete description or elaboration is desired.

Abundance  The current abundance of each species in each park. Park Status as above must be either "Present" or "Probably Present".

Abundant  Animals: May be seen daily, in suitable habitat and season, and counted in relatively large numbers. Plants: Large number of individuals; wide ecological amplitude or occurring in habitats covering a large portion of the park.

Common  Animals: May be seen daily, in suitable habitat and season, but not in large numbers. Plants: Large numbers of individuals predictably occurring in commonly encountered habitats but not those covering a large portion of the park.
<table>
<thead>
<tr>
<th>Abundance</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncommon</td>
<td>Animals: Likely to be seen monthly in appropriate season/habitat. May be locally common. Plants: Few to moderate numbers of individuals; occurring either sporadically in commonly encountered habitats or in uncommon habitats.</td>
</tr>
<tr>
<td>Rare</td>
<td>Animals: Present, but usually seen only a few times each year. Plants: Few individuals, usually restricted to small areas of rare habitat.</td>
</tr>
<tr>
<td>Occasional</td>
<td>Occurs in the park at least once every few years, but not necessarily every year. Applicable to animals only.</td>
</tr>
<tr>
<td>Unknown</td>
<td>Abundance unknown.</td>
</tr>
</tbody>
</table>

**Abundance Details**
- Additional details for abundance; for example if one of the above codes does not offer a complete description or elaboration is desired.

**Residency**
- Current residency classification for each animal species in each park. Park Status as above must be either "Present" or "Probably Present".

<table>
<thead>
<tr>
<th>Residency</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeder</td>
<td>Population reproduces in the park.</td>
</tr>
<tr>
<td>Resident</td>
<td>A significant population is maintained in the park for more than two months each year, but it is not known to breed there.</td>
</tr>
<tr>
<td>Migratory</td>
<td>Migratory species that occurs in park approximately two months or less each year and does not breed there.</td>
</tr>
<tr>
<td>Vagrant</td>
<td>Park is outside of the species' usual range.</td>
</tr>
<tr>
<td>Unknown</td>
<td>Residency status in park is unknown.</td>
</tr>
</tbody>
</table>

**Residency Details**
- Additional details for residency; for example if one of the above codes does not offer a complete description or elaboration is desired.

**Nativity**
- Nativity classification for each species in each park. Park Status as defined above must be either "Present" or "Probably Present".

<table>
<thead>
<tr>
<th>Nativity</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native</td>
<td>The species is native to the park (either endemic or indigenous), or if the Park Status is &quot;Probably Present&quot; as defined above, the species would be native to the park if it were eventually confirmed in the park.</td>
</tr>
<tr>
<td>Non-Native</td>
<td>The species is not native to the park (neither endemic nor indigenous), or if the Park Status is &quot;Probably Present&quot; as defined above, the species would not be native to the park if it were eventually confirmed in the park. Persistent plant populations (as defined below) that reproduce are also considered non-native.</td>
</tr>
<tr>
<td>Unknown</td>
<td>Nativity classification in park is unknown.</td>
</tr>
</tbody>
</table>

**Cultivation**
- Cultivation classification (if applicable) for each non-native plant species in each park.

<table>
<thead>
<tr>
<th>Cultivation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated</td>
<td>A non-native species that is currently cultivated in the park.</td>
</tr>
<tr>
<td>Persistent</td>
<td>A non-native species that persists in the park (either reproducing or non-reproducing) from a previous cultivation.</td>
</tr>
</tbody>
</table>

**Weedy**
- Yes/No field for plant species only. Plant species are considered "weedy" or "invasive" if they (a) occur almost exclusively in disturbed habitats, (b) relatively recently occupied natural habitats in competition with native species, or (c) occur across a broad range of ecological conditions.

**Nativity Details**
- Additional details for origin, for example if one of the above codes does not offer a complete description.
Data Source  The source of the status, abundance, residency, nativity, cultivation, and/or weedy data. For data initially entered by the NPSpecies development/data team, the value will identify the data object (reference, digital file, etc.) submitted by the Park to the I&M office. Parks may update this field as individual records are updated or verified.

Comments  General comments regarding this species in this park.

Entered By  Name of last person to enter or update the park-species record.

Entered Date  Date when park-species record was most recently updated.

Graphic Links  Link to digital photograph or drawing of the species for informational purposes.

Changes Log  Explanation of what was changed and why to log the history of changes to the database. This feature will be activated after the initial database has been developed and distributed to each park.

VOUCHERS AND OBSERVATIONS FORM (for data entry)

Park Code  4-character Park Code

Park Administrative Unit  Park Administrative Unit (optional - see PARK-SPECIES FORM).

TSN  Taxonomic Serial Number linked to ITIS (see PARK-SPECIES FORM).

Sensitivity  Security level based on the sensitivity of this particular voucher or observation record.

- Public  No access restrictions
- NPS Only  Restricted to National Park Service Employees
- Sensitive  Restricted to specified individuals

Documented Name  Latin or common name that was used when the species was collected or observed (the name on the original record).

Date  Date of observation or collection.

Time  Time of observation or collection (24-hour clock).

Observer  Name of observer or collector.

Observer Number  Collection number provided by collector, if available. This is a standard datum cited in botanical studies.

Habitat  Description of habitat where observation or collection was made.

Elevation  Elevation where observation or collection was made.

Elevation Units  Units for elevation (feet or meters)

Specimen ID  Vouchers only. Identification number of voucher specimen (ID number provided by the repository, as contrasted with the collection number provided by the collector).
<table>
<thead>
<tr>
<th><strong>Specimen Location</strong></th>
<th>Vouchers only. Acronym, name and address of herbarium, museum, collection or other location where voucher specimen is stored.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location Description</strong></td>
<td>Concise description of collection site within the park, or location given on specimen label for historical specimens.</td>
</tr>
<tr>
<td><strong>Local Location Code</strong></td>
<td>An optional code identifying a permanent locally recognized location. Can be used in lieu of coordinates when numerous records need to be added.</td>
</tr>
<tr>
<td><strong>Latitude</strong></td>
<td>Latitude in decimal degrees.</td>
</tr>
<tr>
<td><strong>Longitude</strong></td>
<td>Longitude in decimal degrees.</td>
</tr>
<tr>
<td><strong>UTM X</strong></td>
<td>UTM X coordinate (easting).</td>
</tr>
<tr>
<td><strong>UTM Y</strong></td>
<td>UTM Y coordinate (northing).</td>
</tr>
<tr>
<td><strong>UTM Zone</strong></td>
<td>UTM Zone of X and Y coordinates for the observation.</td>
</tr>
<tr>
<td><strong>UTM Datum</strong></td>
<td>Datum for UTM coordinates (i.e. NAD27 or NAD83).</td>
</tr>
<tr>
<td><strong>Coordinate Error (meters)</strong></td>
<td>Estimated accuracy of the location coordinates in meters.</td>
</tr>
<tr>
<td><strong>Comments</strong></td>
<td>General comments for this record.</td>
</tr>
<tr>
<td><strong>Data Source</strong></td>
<td>The source of the voucher or observation data. For data initially entered by the NPSpecies development/data team, the value will identify the data object (reference, digital file, etc.) submitted by the Park to the I&amp;M office. Parks may update this field as individual records are updated or verified.</td>
</tr>
<tr>
<td><strong>Entered By</strong></td>
<td>Name of last person to enter or update the species record.</td>
</tr>
<tr>
<td><strong>Entered Date</strong></td>
<td>Date when species record was most recently updated.</td>
</tr>
<tr>
<td><strong>Graphic Links</strong></td>
<td>Link to digital photographs for this voucher or observation record.</td>
</tr>
<tr>
<td><strong>Changes Log</strong></td>
<td>Explanation of what was changed and why to log the history of changes to the database. This will be implemented after the initial database has been developed and distributed.</td>
</tr>
</tbody>
</table>

**REFERENCES FORM (for data entry)**

<table>
<thead>
<tr>
<th><strong>NRBib ID</strong></th>
<th>Reference code that links (or will link) this record to the NPS NRBib database.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Citation</strong></td>
<td>Citation or description that will facilitate eventual linking to the NPS NRBib database.</td>
</tr>
<tr>
<td><strong>Access Level</strong></td>
<td>Security level based on the sensitivity of this particular specimen or observation record.</td>
</tr>
<tr>
<td><strong>Public</strong></td>
<td>No access restrictions</td>
</tr>
<tr>
<td><strong>NPS Only</strong></td>
<td>Restricted to National Park Service Employees</td>
</tr>
<tr>
<td><strong>Sensitive</strong></td>
<td>Restricted to specified individuals</td>
</tr>
<tr>
<td><strong>Park Code</strong></td>
<td>4-character Park Code</td>
</tr>
<tr>
<td>----------------</td>
<td>----------------------</td>
</tr>
<tr>
<td><strong>Park Administrative Unit</strong></td>
<td>Park Administrative Unit (optional - see PARK-SPECIES FORM).</td>
</tr>
<tr>
<td><strong>TSN</strong></td>
<td>Taxonomic Serial Number linked to ITIS (see PARK-SPECIES FORM).</td>
</tr>
<tr>
<td><strong>Changes Log</strong></td>
<td>Explanation of what was changed and why to log the history of changes to the database. This will be implemented after the initial database has been developed and distributed.</td>
</tr>
</tbody>
</table>
Relationships among end-user data entry tables and related look-up tables.
Relationships among parks master data tables.
Relationships among ITIS master data tables.
Relationships among threatened and endangered species (T&E) master data tables.
Template for an Integrated Natural Resource Database  
Version 1.1

A major emphasis of the integrated inventory and monitoring effort is to make information more readily available to decision makers and the public and to integrate natural resource information with other park operations such as interpretation and maintenance. Tools such as Synthesis, the GIS Theme Manager, and Servicewide databases such as NPSpecies, the Dataset Catalog and the NPBiQ bibliography will make information more readily available and useful to park managers, resource professionals, and others in the field. During preparations for both inventory and monitoring, the large body of existing data will be cataloged and evaluated, and the more useful datasets will be converted to modern databases and GIS products.

Microsoft Access is the NPS standard for distributed databases, and several parks have developed relational databases in MS Access to enter, store, display, summarize, and produce reports for natural resource data. To assist other parks and networks in developing an integrated database, the Natural Resource Program Center (NRPC) is developing a “Natural Resource Database Template” in MS Access with associated documentation and technical support that presents a recommended database structure that can be built upon by parks and networks. This Natural Resource Database can be used as a standalone application in MS Access to enter, edit, display, summarize, and generate reports for inventory or monitoring datasets, or it can be used in conjunction with the GIS Theme Manager to zoom in on an area of the park, identify where sampling has occurred, and view the actual data for those sampling locations that are stored in Access tables. The recommended database structure was developed after studying relational databases developed at Channel Island NP, Organ Pipe Cactus NM, and the Prairie Cluster prototype monitoring program and taking into account the latest implementation strategies for inventory and monitoring in individual parks and the 32 park networks.

The Natural Resource Database Template will be developed through a modular approach, whereby modules consisting of a sampling protocol in MS Word and associated database components in MS Access (tables, forms, queries, reports, etc.) will be available for download from a web-based clearinghouse. Certain fields in the Locations and Events tables are required for the Natural Resource Database to work with the GIS Theme Manager, but the various modules (e.g., weather data, vegetation plots, water quality, bird point counts) are optional and each park or network of parks can include only those modules of interest to their program.

We plan to develop three versions of this Natural Resource Database Template, and develop a web-based clearinghouse where users can download modules:

1. Version 1 will include the core database structure or “skeleton” needed for the Access database to be compatible with the GIS Theme Manager, and will include a few records in each table to demonstrate the recommended relational database structure. The core structure is very flexible and can be built upon by any park or network depending on the components (e.g., weather, water quality
monitoring, vegetation plots, bird monitoring) included in their inventory and monitoring program.

2. Version 2 will include the same core structure as Version 1, but will add examples of lookup tables, data entry forms, simple queries for selecting and displaying data, and examples of simple reports.

3. Version 3 will be a fully-developed Natural Resource database that will include a user interface or “switchboard”; examples of forms for entering and displaying information, including examples of “range checking” to reduce data entry errors; various types of queries for selecting, displaying, and doing simple analyses of data; examples of automated reports that can be generated by the database to simplify reporting requirements; and examples of how data can be summarized and graphed using MS Access query and report functions.

For each version, documentation will be developed to help the user understand how the database was developed, and technical support will be provided by the staff in Fort Collins to assist parks or networks with developing their own relational database in MS Access.

Simple data summaries and graphing can be done in MS Access using queries and reports. For more complicated statistical analysis and graphing of data, it is recommended that data be exported to SYSTAT statistical software. The web-based clearinghouse will include a library of modules to help park staff conduct certain routine data analysis and graphing tasks. These modules will show examples of SYSTAT command language and the type of graph or output produced.

**Note on Database Design:** It is possible to design a much simpler database structure using autonumbers such that tables are joined by a single key field. However, the recommended structure shown here (using Park, Program, LocationID and Event ID as a compound key) allows various parks and principal investigators to collect and enter their data independently of others, and to then later merge the various data sets together into a single database. Experience from the prototype monitoring programs and elsewhere has shown that the ability of principal investigators in different parks and programs to work independently of each other is critical for the program to be successful. Also, field names are limited to 10 characters (dBase format) to allow variables and data to be passed between the GIS Theme Manager (Arcview) and MS Access.

**Version 1: Basic Database Structure**

Each “component” of a park’s inventory and monitoring program will require one or more tables to store data. Examples of the types of data collected for different components might be **weather data** downloaded from a weather station’s datalogger; **water quality data** from samples taken at different stream reaches; the species, sex, age, and measurements of **small mammals** captured in traps; measurements of plant density or percent cover in **vegetation plots**; or distances between the observer and
individual **birds** recording during variable circular plot counts. A “component” is defined by the sampling protocol being followed: different tables are required for different protocols, because the protocol specifies what information is to be collected. For example, two different tables may be needed to store weather data for a park (e.g., minimum and maximum daily temperature, precipitation) if one set of data was downloaded from dataloggers at automated weather stations, whereas the other data set was recorded by rangers each day using a different sampling protocol. For bird sampling, a park may need separate tables for storing data for land birds, marsh birds, shorebirds, and raptors, because different sampling protocols are used for each of these and the types of information recorded and thus the “field names” in the database will differ. Thus, the number and structure of tables in the database are determined by the sampling protocols used in the field.

In the Natural Resource Database Template, there are two tables that are shared by all components, and then a variable number of component tables. The two shared tables are **Locations** and **Events**. Each record in the **Locations** table corresponds to a physical location on the ground where the data was collected. This location might be the center of a vegetation plot, the start of a transect, the center of a grid of pitfall traps or small mammal traps, a cave, a stream segment, or a glacier. The other field names in the **Locations** table record information for that location that does not change from one sampling event to the next, such as the x,y coordinates, how accurately the x,y coordinates were determined, and the elevation, slope and aspect of the location. It may be possible for the same Location to be shared by different components, such as if a vegetation plot and small mammal sampling plot are co-located. However, in order to allow different Project Leaders to keep track of their data separately without always having to coordinate with other Project Leaders, the database allows each Program (such as vegetation and small mammals) to have their own location data in the **Locations** table even though it may be the same physical location.

The other shared table is the **Events** table, which contains certain information that does not change during the sampling event, such as who collected the data (observer initials), the starting date and time, and perhaps weather conditions when the data were collected. The duration of a sampling event may range from minutes to days, depending on the sampling protocol. For example, for water quality sampling, an observer may travel to a stream reach, and then spend several hours taking a number of measurements at that stream reach. In this case, the sampling event is several hours long. Another example would be the case where a person monitoring land bird abundance walks along a transect and stops at sampling stations every 200 m to record birds heard and seen during a 5-minute sampling period. In this case, each sampling station along the transect has one record in the **Locations** table because the x,y coordinates, elevation, slope etc. associated with it differ, and each 5-minute sampling period is a sampling event because the start time, weather conditions, background noise level, and other information associated with the sampling event differ among 5-minute sampling periods.
An example for a component table is the (optional) **VCPCounts** table, which stores information collected during variable circular plot counts of land birds. This type of distance sampling involves an observer who stands at a “sampling station” for a fixed number of minutes (e.g., 5 or 8 minutes) and records the estimated horizontal distance from the observer to any birds detected by sight or sound. In the example data set, an observer on Transect 200, Station 3 records birds detected during a 5-minute count in Rocky Mountain NP and records two Cassin’s Finches and two Swainson’s Thrushes. For this 5-minute count, there is one record in the **Locations** table, one record in the **Events** table, and four records in the **VCPCounts** table (one for each detection).

In the **VegPlots** example of a component table, a vegetation plot in Rocky Mountain NP near the bird sampling transect is sampled once each year in August of 1994, 1995, and 1996. There is only one record in the **Locations** table for this plot, but there are three records in the **Events** table, one for each time the plot was sampled. If the plot contained a number of subplots, the **VegPlots** table might include one record for each subplot. In the example shown, the observer takes several photographs of the vegetation plot and records the film roll number and starting and ending frames for the roll, and also records a few percent cover measurements.

The Primary Key fields for the **Locations** table are ParkCode, Program, and LocationID. The combination of these three fields defines a unique record in the **Locations** table. These three fields, along with EventID, must appear as Foreign Key fields in each of the component tables. For some component tables it may be possible to uniquely identify each record by a combination of ParkCode, Program, LocationID and EventID, and these four fields could serve as the Primary Key for the component table, but there are some cases (such as the VCPCounts example) where these four fields would not uniquely identify each record and some sort of autonumber or other identification code is needed as the Primary Key. In the example, both of the component tables use RecordID (type=autonumber) as a Primary Key, although the **VegPlots** table could use ParkCode+Program+LocationID+EventID as a composite primary key.

Version 2 of this Natural Resource Database Template will show examples of lookup tables and “pick lists” that would also be shared among component programs. For example, for Observer, there would be a table and a form for entering details about each observer, such as their full name, address, phone number, etc. For Program, there would be a lookup table and a form for entering or editing Program codes as the overall I&M program changes. For categorical variables such as aspect, there would be a lookup table or “field list” that lists the choices that can be entered into the particular field.

Version 1 of the template has only one query, named qryFlatFile. This example demonstrates how the query combines each record in the **VCPCounts** table with data from the **Locations** and **Events** tables to create a flat table structure that could be exported to some external statistical package or other software. A demonstration is currently being developed in conjunction with the GIS Theme Manager to show how a
query can be run in Access to select a subset of records stored in the relational database structure to produce a flat file structure, and the GIS Theme Manager can be used to display the data in the Access tables after zooming in to an area of the park where the data were collected.

The following Data Dictionary describes each field and shows which fields are required for use with the GIS Theme Manager and which ones are presented only as an example of a relational database structure.

MS Access Natural Resource Database Template
Data Dictionary

Primary Keys are noted in **bold** type (see Figure 1 for examples of the relationships among tables). Fields that are REQUIRED for use with the GIS Theme Manager or because of relationships with other tables are noted with an asterisk (*).

**Locations Table**

*ParkCode:* Identify the four-character NPS unit code. This code is necessary because many of the databases will be managed at the network level, and it is important to identify which data were collected in which parks. It will also make it possible in the future to do rollups of data for certain regional or Servicewide needs.

*Program:* This is a 1-10 character code, developed by the park or network, that describes which component of the overall inventory and monitoring program the data pertain to such as water quality monitoring, vegetation plots, bird monitoring, bat monitoring, soil erosion, etc. (e.g. VEGPLOT for vegetation plots, BVCP for bird VCP counts). There are no National Park Service standards or naming conventions for developing this code.

*LocationID:* This is a 1-10 character code that, in conjunction with the ParkCode and Program code, provides a unique identifier for a sampling location or sampling unit (e.g., a plot, transect, stream segment, or sampling station). In the example, T0200S0001 is the code for transect number 200, Station 1 in Rocky Mountain NP for the land bird monitoring program, and VEGP0029 is the LocationID for vegetation plot number 29. This code will be developed by the park; there are no National Park Service standards or naming conventions for developing this code.

**Descript:** This is an optional field that provides a brief description of the unique sampling location identified by the ParkCode + Program + LocationID fields (up to 200 characters in length). In the example, a Program code of BVCP, and a LocationID of T0200S0002 is described as ‘Bird vcp count Transect 200, station 2’.
*StartUTMX: Identify the UTMX (easting) coordinate for the center of the plot OR the starting point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto. Double precision to 15 significant digits should be maintained. This is extremely important to maintain millimeter accuracy anywhere on the globe. 

Note that in order to preserve the integrity and accuracy of the original data, coordinate information should be entered in either UTMs or latitude/longitude, but not both. The data can later be converted, if required.

*StartUTMY: Identify the UTMY (northing) coordinate for the center of the plot OR the starting point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto. Double precision to 15 significant digits should be maintained to allow millimeter accuracy anywhere on the globe. 

Note that in order to preserve the integrity and accuracy of the original data, coordinate information should be entered in either UTMs or latitude/longitude, but not both. The data can later be converted, if required.

StopUTMX: Identify the UTMX (easting) coordinate for the ending point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto.

StopUTMY: Identify the UTMY (northing) coordinate for the ending point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto.

*UTMZone: Identify the UTM zone (zones 1-52). This information is required if coordinates are specified with the UTM grid coordinate system.

*StartLat: Identify the latitude in decimal degrees of the coordinate for the center of the plot OR the starting point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto. Double precision to 15 significant digits should be maintained. This is extremely important when converting coordinates to UTM to avoid truncation or rounding off of fractional values, and to maintain millimeter accuracy anywhere on the globe. 

Note that in order to preserve the integrity and accuracy of the original data, coordinate information should be entered in either UTMs or latitude/longitude, but not both. The data can later be converted, if required.
**StartLon**: Identify the longitude in decimal degrees of the coordinate for the center of the plot OR the starting point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto. Double precision to 15 significant digits should be maintained. This is extremely important when converting coordinates to UTM to avoid truncation or rounding off of fractional values, and to maintain millimeter accuracy anywhere on the globe. 

*Note that in order to preserve the integrity and accuracy of the original data, coordinate information should be entered in either UTMs or latitude/longitude, but not both. The data can later be converted, if required.*

**StopLat**: Identify the latitude in decimal degrees of the coordinate for the ending point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto. Double precision to 15 significant digits should be maintained.

**StopLon**: Identify the longitude in decimal degrees of the coordinate for the ending point of a line or polygon. The field should represent the data in the following manner: data type = number; field size = double (double precision floating point, 15 significant figures); decimal places = auto. Double precision to 15 significant digits should be maintained.

**Datum**: Identify the reference system used for defining the coordinates of points (i.e. North American Datum of 1927 or North American Datum of 1983 (NAD27 or NAD83)).

**EstHError**: (Estimated Horizontal Error) Calculate the “error buffer” associated with the x,y coordinates for the location. This value makes it possible with a GIS to show the uncertainty associated with a location, depending on how the coordinates for that location were obtained. Report error in meters for both UTM and latitude/longitude coordinates. The required Federal reporting standard in the horizontal component is the radius of a circle of uncertainty, such that the true or theoretical location of the point falls within that circle 95% of the time.

Determining error from maps:

If using standard mapping sources to determine the spatial coordinates (e.g. USGS 1:24,000 quadrangle topo map), the following are the standard values for errors inherent in the source data, as determined by the National Mapping Accuracy Standards:

- 1:2,500 = 6.94 feet or 2.12 meters
- 1:5,000 = 13.88 feet or 4.23 meters
1:12,000 = 33.33 feet or 10.15 meters
1:20,000 = 55.50 feet or 16.91 meters
1:24,000 = 40 feet or 12.19 meters
1:62,500 = 104.17 feet or 31.75 meters
1:100,000 = 166.67 feet or 50.80 meters

Determining error from GPS data:

If using a Global Positioning System (GPS) to determine the spatial coordinates, accuracy varies and is dependent on a number of values (e.g., maximum PDOP and minimum number of satellites). For point data, when you export a file from Pathfinder Office (PFO), point features have an instantaneous attribute value for Vertical Precision, Horizontal Precision and Standard Deviation. Use the Standard Deviation to determine the value of Estimated Horizontal Error. For line and polygon data, accuracy cannot be clearly determined (according to Trimble), and we recommend that you enter the horizontal error for the starting point as an approximation of the positional error associated with the line.

**AccNotes:** This memo field may be used for any notes related to the positional accuracy of the coordinates. Identify the source data (map, date of map and scale, or GPS unit, or other) used to determine positional coordinates. Another option is to make this a text field with a list of choices of how the coordinates were determined.

**Elevation** (optional, for demonstration purposes): Identify the elevation of the data point, line, or polygon (in meters).

**EstVError:** (Estimated Vertical Error) This is the vertical error (in meters) associated with the elevation for the location.

**Aspect** (optional, for demonstration purposes): Identify the aspect of the data point, line, or polygon as one of the following: N, NW, NE, S, SW, SE, E, W.

**Slope** (optional, for demonstration purposes): Identify the slope of the data point, line, or polygon (in degrees).

**Events Table**

**ParkCode:** Identify the four-character NPS unit code. This code is necessary because many of the databases will be managed at the network level, and it is important to identify which data were collected in which parks. It will also make it possible in the future to do rollups of data for certain regional or Servicewide needs.
*Program*: This is a 1-10 character code, developed by the park or network, that describes which component of the overall inventory and monitoring program the data pertain to such as water quality monitoring, vegetation plots, bird monitoring, bat monitoring, soil erosion, etc. (e.g. VEGPLOT for vegetation plots, BVCP for bird VCP counts). There are no National Park Service standards or naming conventions for developing this code.

*LocationID*: This is a 1-10 character code that, in conjunction with the ParkCode and Program code, provides a unique identifier for a sampling location or sampling unit (e.g., a plot, transect, stream segment, or sampling station).

*EventID*: This code, when used with ParkCode and Program, provides a unique identifier for the starting time of a particular sampling event. The duration of a sampling event may be minutes, hours, or days, depending on what is being sampled. We recommend a code with the format of YYYYMMDD for cases where only one sampling event can occur each day, or YYYYMMDDhhmm (24 hour clock) where a field crew may conduct many sampling events in the same day for a particular component. In the example, a code of 200007110730 is entered for a 5-minute sampling period for land birds that began at 7:30 am on September 11, 2000.

Year: Identify the year (YYYY) the sampling occurred for this record. Year is also part of the StartDate field (type = Date), but we recommend having it as a separate field to use with various queries.

*StartDateTime*: Identify the date (YYYYMMDD) when sampling began.

EndDateTime: Identify the date (YYYYMMDD) when sampling ended.

Time: Identify the time of day when sampling began (hhmm, 24-hour clock).

Observer: Identify the initials of the lead observer. This should be selected from a pick list or Observers Lookup Table. Additional observers could be added through an Observers table linked to the Sampling Events table.

Temperature (optional, for demonstration purposes): Ambient temperature at the time of sampling (in degrees F).

WindSpeed (optional, for demonstration purposes): Wind speed (using Beaufort scale).
Rain (optional, for demonstration purposes): Identify a code for rain (e.g., clear, foggy, light rain, steady rain, etc.).

Clouds (optional, for demonstration purposes): Percent cloud cover to the nearest 10 percent.

Noise Level (optional, for demonstration purposes): For bird counting, an entry is made for the amount of background noise that might affect the probability of hearing bird calls.

TripReport: A short trip report in MS Word could be made part of the database to describe any special circumstances that future users of the data need to be aware of for proper use and analysis of the data. For example, the trip report might describe who did the sampling, which sampling protocol was used, any deviations from the standard protocol, weather conditions, and any problems with finding sampling locations. The trip report can be imbedded into the Access database or can be linked to it using an OLE object field.

**Sampling Component Tables**

Each component of an inventory and monitoring program (e.g., water quality monitoring, vegetation plots, bird monitoring, bat monitoring) will require one or more tables to store the data for that component. The table structure and fields in these tables will be determined by the sampling protocol. For example, a coastal park may have separate tables for land birds, shorebirds, marsh birds, and nest surveys because different sampling protocols are used and different types of data are collected for each component.

The ParkCode, Program, LocationID, and EventID fields should be included in each component’s table as foreign key fields. The primary key for a component table could either be a composite key that includes these four fields, or it could be an autonumber or other record identifier that uniquely references each record in the table. In the example, a RecordID field is used as the primary key, and the other required fields are foreign keys.

*ParkCode: see description under “Locations Table” above.
*Program: see description under “Locations Table” above.
*LocationID: see description under “Locations Table” above.
*EventID: see description under “Sampling Events Table” above.

Other fields: dependent upon sampling protocol used.
For additional information and updates on the development of the Database Template, see the website http://science.nature.nps.gov/im/apps/template/index.htm
Figure 1. Database structure for an Integrated Natural Resource Database. The two required tables that are shared by all components of the inventory and monitoring program for a park or network are the Locations and Events tables. The other three tables (VCPCounts, Veg Plots, WQ_Storet) are included only as examples of monitoring components and most of the fields are for demonstration purposes only.
Appendix C. Example Dataset Catalog Entry Form
Copy and use a separate form set for each data set. Complete all fields. Numbers after field names are the sizes of the fields.

Dataset Title (150):
_________________________________________________________________

Citation Info: (Use Citation Form or Author/Origin, Date, Ver./Ed., Series, Issue, Pub. Place, Publisher, Larger Work Cit.): ____________________________________________________________________________

Project ID (20): ____________________________________________________________________________

Data Originator (Name/Source, Position, Affiliation, Address, Phone, Fax, E-mail):
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________

Dataset Contact (Name/Source, Position, Affiliation, Address, Phone, Fax, E-mail):
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________

Subject (30): _______________ Keywords (100): _______________

Dataset Abstract: (250):
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________
Dataset Purpose (250):


Related Data (# of Citation Forms or Author/Origin, Date, Ver./Ed., Series, Issue, Pub. Place, Publisher, Larger Work Cit.):


Related Document(s) (# of Citation Forms or Author/Origin, Date, Ver./Ed., Series, Issue, Pub. Place, Pub., Larger Work Cit.):

Single/Begin Date: ______________________ End Date: ______________________

Update Frequency (10): ______________________

Multiple Dates (Date/Time): ______________________

Status (10): New __ Active __ Inactive __ Partial __ Legacy __ Historic __ Other
Progress of Work on Data Set: Planned __ In Work __ Complete __

Location (100):
______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

W. Longitude (Dec. Degrees): ________________________________

N. Latitude (Dec. Degrees): ________________________________

E. Longitude (Dec. Degrees): ________________________________

S. Latitude (Dec. Degrees): ________________________________

UTM Zone (Optional): ______

W. Easting (Opt.): ________________________________

N. Northing (Opt.): ________________________________

E. Easting (Opt.): ________________________________

S. Northing (Opt.): ________________________________

Coverage (6): In __ Out __ In&Out __ Park Clip __ Park Area __ NPS-wide __ Region-wide __ Other

Data Type (6): GEORAS __ GEOVEC __ GEODB __ DIGRAS __ DIGVEC __ DIGDB __ ANAORG __ ANAUNO __

Data Type 2 (20): Polygon __ Line __ Point __ DEM __ Raster __ DOQ __ Landsat __ Imagery __ Spreadsheet __ Database __ Document __ Delimited text __ Tagged text __ ASCII text __ Other

Coordinate System: UTM __ Lat/Lon __ State Plane __ Other

Datum: NAD27 __ NAD83 __

Source/Attribute?, Table/Layer Name (50 each) Optional Table Page(s)?, Scale Denominator, Cit.?
File Location (100):

Data at Park? Yes or No  Distribution Costs: None __ Other

Distribution (100):

Online Link URL (150):

Quality (15): Unknown __ Not Ver./Val.(?) __ Verified __ Validated __ Metadata __ Quality Report: (250):

Metadata Status: None __ Planned __ In Work __ Complete __
Metadata Priority: High __ Medium __ Low __
Metadata Standard: FGDC __ NPS Dataset Catalog __ None __ Other

Metadata Link URL (150):

Metadata Contact (Name/Source, Position, Affiliation, Address, Phone, Fax, E-mail):

Is the Dataset Sensitive? Yes or No  If So, How is the Dataset Sensitive?
Archaeology __ Cave __ Classified __ Law Enforcement __ Paleontology __ T&E Species __ Other ____________________________
Classified Data Type:  N/A __ Unclassified __ Sensitive __ Restricted __ Confidential __ Secret __ Top Secret __

Access Restrictions (12):  Public __ Fed. Only __ NPS Only __ Park Only __ Contact Only __

Comments: (250):

____________________________________________________________________
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GUIDELINES FOR BIOLOGICAL INVENTORIES
Revised September 8, 1999

Inventory and Monitoring Program
National Park Service

INTRODUCTION

The National Park Service's primary mission is to conserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment of this and future generations. In 1998, Congress passed the National Parks Omnibus Management Act, which recognized the need for good scientific information to manage parks by mandating 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". Currently, the Service is unable to attain its mission in many parks, owing to a serious lack of scientific information about the nature and condition of resources in those parks, especially biological resources. In addition to a lack of basic information about what biological resources occur in the parks, the Service also generally lacks credible information about the current status of those resources and how they are changing over time in response to the myriad threats and issues impacting those resources.

To address this general lack of credible information about park resources and the new congressional mandate, Congress funds the Servicewide Inventory and Monitoring (I&M) Program of the National Park Service. This national program coordinates systematic efforts to acquire 12 basic data sets for 265 parks with significant natural resources, including basic information on air and water quality; base cartography; weather data; geology, soil, and vegetation maps for the park; a natural resource bibliography; and information about the occurrence, distribution, and relative abundance of vertebrate and vascular plant species in the parks. The I&M Program views these inventories as an iterative process, whereby the national program funds the initial efforts in all parks to compile and organize existing data and fill data gaps through targeted field investigations, after which further additions and refinements to these initial inventories can be made during more in-depth field investigations funded by various sources including the national program. This document defines the general guidelines that the Servicewide I&M Program will
follow to conduct those inventories in the 265 parks participating in the program.

**PROGRAM GOALS AND OBJECTIVES**

The basic goal of the NPS biological inventory program is to provide park managers with comprehensive, scientifically-based information about the nature and status of selected biological resources occurring within park boundaries in a form that increases its accessibility and utility for making management decisions, for scientific research, and for educating the public. The inventories will also lay the groundwork necessary for park managers to develop effective monitoring programs and to formulate effective management strategies for resource management and protection. To attain these basic goals, NPS biological inventories will be designed to meet three basic objectives:

- To document through existing, verifiable data and targeted field investigations the occurrence of at least 90 percent of the species of vertebrates and vascular plants currently estimated to occur in the park.

- To describe the distribution and relative abundance of species of special concern, such as Threatened and Endangered species, exotics, and other species of special management interest occurring within park boundaries.

- To provide the baseline information needed to develop a general monitoring strategy and design that can be implemented by parks once inventories have been completed, tailored to specific park threats and resource issues.

Geographic Information System (GIS) technology has proven to be a powerful and useful tool for organizing, displaying, analyzing, and integrating natural resource information, and most parks routinely use GIS in park management. Many of the 12 basic inventory data sets are GIS themes (maps), and even information such as species lists and tabular information can be organized and integrated by presenting them as tables in GIS themes. To promote the usefulness and accessibility of natural resource information to managers and scientists, the Servicewide I&M Program will support the development and refinement of Arcview GIS tools and training for their use by parks, and wherever possible will provide information in a form that is compatible with or can be downloaded into a GIS format.

**GUIDELINES FOR STUDY PLAN DEVELOPMENT**

The Servicewide I&M Program will eventually fund inventories of vertebrates and vascular plants in all 265 parks with significant natural resources, and will use several approaches to allow parks to obtain credible, organized information in a cost-effective manner. Our initial experience has shown that there are considerable advantages, in terms of cost-efficiency and the consistency and interpretability of inventory data, to conducting
inventories for all vertebrates and vascular plants in a group of parks working together rather than funding inventories of each taxa on a park-by-park basis. Therefore, the I&M Program will search for opportunities to minimize duplication of effort and increase efficiency and the quality and consistency of park information by providing funding to efforts involving groups of parks or regional efforts. Funding may also be provided to individual parks if better results cannot be obtained through a multi-park approach. In FY2000, the I&M Program will request a pre-proposal from groups of parks that are next in line to receive funding. Once the pre-proposal has been reviewed and accepted, funding will be provided so that the group of parks can initiate the steps leading to and including the development of a full study plan. The format for the pre-proposal and full study plan are as follows.

**Pre-proposal**

Initial project evaluation and acceptance will be based upon consideration of a 4-10 page pre-proposal that provides an overview of the proposed inventory project. The pre-proposal should describe how the group of parks and their partners will work together to complete the initial steps of the inventory leading up to and including development of the full study plan. The pre-proposal should succinctly describe for each park: (1) the park’s general situation and resources, including a summary of any previous biological inventories conducted in the park; (2) a preliminary list of park-specific objectives for the current inventory, including species and habitats of special concern (including sound justification for why more detailed information is needed for these species) and key management issues relating to biological resources in the parks; (3) the principle members of the inventory team (including phone numbers and email addresses) and a description of how the parks and their partners plan to organize themselves and make decisions about funding allocations and completion of the inventories; (4) a description of how the initial steps of compiling existing information and holding a scoping workshop to determine priorities will be completed, including who will do the work and a proposed schedule; (5) the proposed budget, including any cost-share, to complete the initial steps including development of the full study plan; and (6) specific deliverables, such as summaries of existing information entered into the Dataset Catalog or in tabular form, a report on findings from the scoping workshop, and the full study plan, including delivery dates for these products.

**Full Study Plans**

The pre-proposal will be reviewed by the I&M Program and discussed with the group of parks or their contractors, after which partial funding will be provided to complete the initial steps (Steps 1-4 in the appendix) of the inventory that lead to the development of the full study plan. The full study plan will define the technical aspects of the proposed inventory in considerably more detail, and is an important component of the overall quality assurance for the project. The following outlines the basic format for sections to be included in full study plans.

**Section I: Introduction**

The first section of the full project study plan should provide a general introduction
to the park ecosystems and biological resources, any completed and ongoing resource management efforts including inventories, monitoring, and research projects, major unresolved management issues and concerns, and how the proposed inventory will address those issues and concerns.

Section II: Project Description

Biological inventories are to be completed through a 7-step process as described in more detail in the Appendix to these guidelines. Section II of the study plan must provide detailed information for Steps 1-6 (Step 7 in the appendix dealing with deliverables are described in Section VIII of the study plan), indicating how the investigators propose to accomplish the stated requirements. A summary of the information from the first six steps to be included in the study plan is as follows:

1. The full study plan should list sources of existing information on vertebrates and vascular plants in each park, including the format (report, paper map, GIS theme, dBase file, Access file, photographs, voucher specimens, wildlife observation cards) and physical location of each item. Step 1 includes a data inventory, and the results of this inventory should be presented as tables or text descriptions in the study plan. The study plan should also present the list of species that is expected to occur in the park that will be used to determine whether the 90% goal has been reached.

2. Park-specific objectives for the biological inventories that resulted from the scoping workshop should be included in the full study plan, including a listing of management and scientific issues for each park. This section should list the species or habitats of special concern for which more detailed information is required, and provide strong justification for why more detailed information such as distribution maps and relative abundance are required for those species. Decisions made at the workshop regarding the level of detail required for different species or habitats should be presented here.

3. A description of the habitats or strata that have been delineated for each taxa (vegetation, mammals, birds, herps, fish) is to be included here. Special consideration should be given to how these strata will be used with the park GIS and existing GIS themes.

4. For many parks, the actual field work and analysis will be done by different contractors for each taxa, and the following information can be organized by taxa in the full study plan if different contractors or survey teams are responsible for the field work. For each taxa, the study plan should describe the overall sampling strategy for the park, taking into account both spatial and temporal factors. What is the sampling frame for each survey, and how are sample sites to be selected? Are specialized searches planned for rare species or habitats?

5. A description of the specific methods to be used during field surveys should be described for each taxa. Methods that are compatible with other well-established local, regional, or national inventory and monitoring efforts are preferred. For species of special concern for which relative abundance data are required, we recommend multi-scale plot sampling for vegetation (as opposed to a single plot size), and distance estimation methods for birds (as opposed to fixed-radius point counts). For herps, it should be recognized that methods such as cover boards and time-constrained searches do not give good measures of relative abundance, but can be used to obtain abundance categories such as "abundant" or "rare". Additional guidance on field methodology will
be developed during FY2000.

6. The study plan should describe how existing data and data collected during field surveys are to be analyzed. How will distribution maps be generated from presence/absence data for some species or relative abundance data for others? Are predictive models to be developed using methods such as logistic regression or discriminant analyses, and who will do the work? How will you determine whether the goal of 90% of vertebrates and vascular plants occurring in the park has been reached?

Section III: Coordination and Logistical Support

This section of the full study plan should provide a general description of how the contractor plans to keep park personnel informed of their activities in the park, as well as conduct other general coordination activities. Also included should be a description of any logistical support the contractor's field crews are likely to require from the park staff. This should include any needs related to housing, transportation, or equipment. Park managers should be aware of these requirements and agree to provide those needs prior to submitting the full study plan for final approval.

Section IV: Budget

The full study plan must include a detailed, itemized budget for the entire project in tabular format. In addition, the budget must also include a written narrative section that describes the basis for calculating the personnel, fringe benefits, travel, equipment, supplies, contractual support, and other costs identified in the itemized budget and explain the basis for their calculation. This should also include an explanation of how indirect costs were calculated. The I&M Program will not provide funding for the purchase of GIS hardware and/or software.

Section V: Resumes

Brief resumes of approximately 1-3 pages in length should be included for all principal investigators and key coworkers. The resumes should emphasize the investigator's experience and familiarity with other projects that relate specifically to the approach and methodologies to be used in the park inventories.

Section VI: Project Completion Schedule

A timeline needs to be included in the full study plan that illustrates when major events are to occur during each year of the project, as well as the final completion date. Report submission dates also need to be indicated.

Section VII: Voucher Specimens

Voucher specimens are to be collected for all species that are identified through the inventory, except where park vouchers already exist or for species that are readily identified through photographs or other documentation. Voucher specimens for threatened,
endangered, or candidate species are not to be collected. This section of the full study plan must describe how those specimens will be catalogued in NPSpecies and ANCS+ and made available for future reference and use.

Section VIII: Products and Deliverables

Required project deliverables include: (1) annual progress reports, (2) a final report, and (3) Arcview GIS themes and Microsoft Access databases of all information collected during the project stored on CD media. The Servicewide I&M Program will provide specifications for GIS products to ensure that they are compatible with other data sets and the Arcview GIS data browser extension that is being developed by the program for use in each park. The study plan should also describe the structure of any MS Access databases that are to be developed, and should show how these are compatible with those developed for other taxa so that data can be integrated among inventory components. Investigators will be required to use their findings for the park to update the NPS Servicewide biological data bases maintained by the I&M Program, including NPSpecies, the Natural Resource Bibliography, and the Dataset Catalog. Metadata, in accordance with FGDC standards, is required for GIS products. Copies of these products must be submitted to the park, the Regional I&M Coordinator, and the Servicewide I&M Program Manager. In the case of multi-year projects, funding will not be provided until an acceptable progress report for the previous year has been received by the I&M Program Manager.

STUDY PLAN SUBMISSION AND REVIEWS

The NPS goal is to complete biological inventories for all 265 parks with significant natural resources. The major focus of the review process is to make sure that the inventories meet park needs and provide specific products that will be useful to park management, are conducted in accordance with accepted technical standards by qualified personnel, are consistent with other local or regional approaches where appropriate, and achieve as much cost efficiency as possible.

Pre-proposals should be submitted to the Servicewide I&M Program Manager by December 31, 1999, after which it will be reviewed by personnel from the I&M Program, parks, and USGS/BRD. Parks will be informed of the outcome of the review and given an opportunity to address any noted deficiencies.

Full study plans are to be submitted to the Servicewide I&M Program Manager according to the schedule outlined in the pre-proposal and agreed upon by the park and the I&M Program, which will generally be within six months after partial funding is received. The study plan will undergo technical peer review by individuals from the NPS, the USGS-BRD, or universities. Study plans found to be technically or economically unacceptable will be returned for revision.

APPENDIX

Basic Steps to be Completed for Biological Inventories of Vertebrates and Vascular Plants
**Step 1: Compile and Verify Historical and Predicted Species Data**

Considerable information on vertebrates and vascular plants exists for most parks, but the information is usually stored in numerous locations and formats such that it is not readily accessible to park managers, interpreters, scientists, and the public. Also, much of the existing information needs to be evaluated for its accuracy and consistency before it can be relied upon for making management decisions. Field investigations to obtain distribution and abundance information for all vertebrates and vascular plants in a park would be prohibitively expensive, and for many species the level of information that is already available from past field studies, museum and herbarium collections, regional field guides, and park observation records are adequate for park planning and public education if the information can be compiled, verified, and made available in a useable format. Also, information on the historical occurrence of species in parks has considerable value to park managers as well as the scientific community. The first step in conducting biological inventories is to compile and organize existing information of what is known from the park and areas adjacent to the park, and to use this information to identify gaps that can be filled by targeted field investigations. A software tool that can be used to complete this "data inventory" is the Dataset Catalog, which is available in both a distributed MS Access version and a web-based version from the I&M Program. The park should compile relevant information from existing species lists, data available from other Federal and/or state resource management agencies, museum and herbarium collections, information in reports and publications from previous field investigations, wildlife observation cards and similar information available in the park, and from regional and national databases such as the Biota of North America Project, State Heritage Programs of The Nature Conservancy (TNC), Breeding Bird Survey, NPFlora/NPFauna databases, and other sources.

The Servicewide I&M Program will assist with this first step and provide a more complete, consistent, and cost-effective approach by funding national and regional searches of museum and herbarium collections, TNC databases, and the NPFlora/NPFauna database for verifiable records of voucher specimens and other documented occurrences of species in each park. The I&M program has developed a species database called NPSpecies, which will be available as both a distributed MS Access version and a web-based version linked to other NPS databases. The I&M program has already begun to develop a draft species database for each park based on existing species lists, voucher specimens, primary literature, and data from TNC and county records. Each park or their contractor should build upon and refine this initial database provided by the I&M Program by adding information from park records and other local sources not already included in the database, and by verifying each record and making necessary corrections and additions to the database using existing sources. The taxonomic authority for all vertebrates and vascular plants will be that accepted by the interagency Integrated Taxonomic Information System (ITIS), available on the internet at http://www.itis.usda.gov/plantproj/itis/index.html.

Step 1 will also generate the list of species that are expected to occur in the park that will serve as the master list to determine whether the goal to document 90% of vertebrate and vascular plant species has been achieved. This list will be generated from existing records from the park and adjacent counties, and regional guides and other range maps in conjunction with determining if the appropriate habitat for a species occurs in the park.
Step 2: Park-Specific Objectives

Each park will have specific objectives for the biological inventories based on the species and habitats occurring in the park, and different levels of information may be needed for each species or group of species to address park management issues. For example, for some parks, spring-migrant birds might be an important resource for which more detailed information is needed, whereas other parks may decide that the additional effort and funding needed to obtain more detailed information should be directed at some other species group or season. Park-specific objectives should be formulated from existing species information and data gaps identified in Step 1 during the compilation of existing information, input from park managers and other knowledgeable individuals about management and scientific issues of special concern, the park's natural resource management plan, reports from previous investigations conducted in the park, and other appropriate sources. This step should determine the level of information needed for various species given funding and personnel constraints, and identify the species of special concern for which more intensive field investigations are needed to determine their distribution and relative abundance. The proposal should include sound justification for the species or habitats that have been identified as a priority. For example, local rarity, in and of itself, does not translate into conservation/management priority. Rarity must be placed within the context of the species-wide distribution patterns to determine its conservation/management priority. The proposal should explain why more detailed information is needed for particular species.

Different degrees of inventory intensity will result in four basic levels of information: (1) presence/absence; (2) abundance categories; (3) relative abundance; and (4) absolute abundance. The goal of the Servicewide I&M Program is to document the occurrence of 90% of the vertebrates and vascular plants in each park, and for most species this can be done with existing information. For species of special management concern to the park, more detailed information on distribution and relative abundance in different habitats will be required, but for most species, only presence/absence level information is required. It would be cost prohibitive to obtain relative or absolute abundance data for all vertebrates and vascular plants in a park, and this level of inventory intensity is not needed for every species by park managers. (Note: most indices, such as those obtained by fixed-radius point counts for birds, or cover boards or time-constrained searches for herps, usually do not provide relative abundance information that is adequate for making important management decisions upon because there is no measure of differences in detectability among species, habitats, and observers; however, these methods do provide data that can be summarized in abundance categories such as "common" or "rare"; see recommended protocols for bird and herp surveys for more information). Presence/absence information is often associated with habitat information, and can be used to determine species richness for each habitat as well as to develop distribution maps. For many species, it is possible with little additional field investigation to assign an abundance category to each species for each habitat, such as abundant, common, or rare, rather than just documenting species occurrence. Whenever possible, it is better to attempt some quantitative approach to estimating abundance and to summarize these numerical estimates into abundance categories such as common or rare, than to initially collect the data in loosely-defined abundance categories. For species of special concern to the park, a well-designed field
inventory using methods such as multi-scale plots for vegetation or distance-estimation methods for birds may be needed to provide the level of information needed.

Based on park-specific objectives and the habitats delineated in Step 3, determine the level of inventory intensity needed for each species identified in Step 1. Use existing data compiled in Step 1 to determine whether each species occurs (or probably occurs) in each habitat type, and where possible, assign an abundance category (e.g., abundant, common, rare) for each species/habitat combination. Document in the database the source of information for each species. For species for which the level of information needed is already available from existing sources, proceed to the analysis and evaluation phase (Step 6). For species requiring additional field investigation, proceed to Step 4.

Step 3: Habitat Delineation

This step will usually involve bringing together all of the relevant GIS themes, aerial photographs, and other existing information needed to develop a basic habitat cover map for the park that delineates the appropriate habitat types for the taxa to be inventoried. This step essentially takes the information from Steps 1 and 2 and puts it into the context of statistical strata for planning the inventory. For many parks, rare habitats are of more interest or concern than common habitats, and some parks may identify a large number of habitats for which they want to summarize information. Habitats will probably differ for different taxa, such as for fish, herps, and plants. Management issues (e.g., fire management zones) and administrative boundaries should also be considered in this step. Decisions about the number and type of habitats to delineate should be based on information collected in Steps 1 and 2, with special consideration to the usefulness of the data summarized for each habitat type when used with the park GIS.

Step 4: Sampling Strategy, Sampling Frame and Sample Selection

Based on information from Steps 1-3, determine the appropriate habitats, season, and protocols to be used in conducting the inventory for the species requiring field investigations. The inventory design must take into consideration both spatial (habitat) and temporal (season and time of day) factors. This section of the study plan must also indicate which habitat variables will be collected in association with the inventories, keeping in mind that variables for which GIS themes exist or can be created will be most useful for future modeling and analysis. More specific guidelines regarding inventory design to obtain relative abundance information are provided in protocol documents for each separate taxa that will be provided directly to parks undertaking those inventories.

Using the habitat cover map developed in step 3, develop a sampling frame by identifying all potential search plots or paths and those selected to be sampled. In accessible areas with relative homogenous habitat, a systematic grid with a random start should be considered. If there are distinctly different habitat types, habitat stratification should be considered, with separate samples taken in each major habitat type. For species with very specialized habitat requirements and a spotty distribution, potential plots may be limited to patches of appropriate habitat. In each case, include a random component in selecting which sample units are to be sampled and collect independent samples so that statistical inferences can be made to the entire habitat or area. Keep in mind that systematic grids and
random sampling in proportion to the area of each strata tend to capture common species,
and that multi-scale plots for vegetation and specialized searches of rare habitats and species
may be required depending on park objectives. In mountainous terrain, there may be only a
few paths where it is possible to climb. In such situations, identify a relatively large number
of feasible sample plots or paths and then randomly select those to be inventoried.
Additional guidance regarding statistical design and data analysis may be found in National
Park Service Inventories: Statistical Methods that is available on the internet at

**Step 5: Field Survey**

Sample the randomly selected plots or transects for the species of interest, recording
habitat information at each sampling location. Use methods that are compatible with other
well-established local, regional, or national inventory or monitoring efforts wherever
possible to increase the comparability and interpretability of the park’s data.

**Step 6: Data Analysis and Evaluation**

Using a combination of information collected in Step 1 and new data from targeted
field sampling, evaluate whether the goal of 90% of species has been reached, and whether
additional sampling is needed to meet park objectives for the inventory. Conduct
preliminary analyses of the data to determine where additional sampling is needed. For
species for which only presence/absence or abundance category information is needed,
develop GIS themes based on the habitats delineated in Step 3. For species targeted for field
sampling, use the habitat information collected at locations where a species was found in
analyses such as discriminant function or logistic regression analysis to develop predictive
models of species occurrence that can be extrapolated to the appropriate habitats. For each
species of special concern, use these models with appropriate GIS themes to produce a
"probable distribution map", indicating areas of the park where the species is likely to occur.
For species requiring relative abundance information, analyze the results and develop GIS
themes describing relative abundance in different habitat types and seasons, including links
to tables that summarize mean values and their standard errors.

**Step 7: Database Development and Reporting**

A report should be prepared each year that summarizes the progress of the
inventories and documents key decisions in the process, such as park-specific objectives,
habitat delineation, and the sampling frame and layout of sampling plots or transects. At the
end of the project, the contractor should prepare a report in Microsoft Word format that
describes the work in enough detail that another person could conduct the inventory based
on the written report and associated GIS products. All data should be archived in a
Microsoft Access database, the structure of which should be described in the written report
(e.g., explain what each field and “pick list” item represents). All GIS products should be in
a format compatible with Arcview GIS software, and metadata compatible with FGDC
standards should be prepared by the contractor. Finally, the contractor should obtain the
latest version of the appropriate species databases for the park from the park or Servicewide
I&M program, and use information generated by the inventory to update the Servicewide species database for the park. Copies of all products will be delivered to the park, to the appropriate Regional I&M Coordinator, and to the Servicewide I&M Program Manager.

Guidelines revised September 8, 1999