



**The National Park Service**

**Northeast Region I&M Program**

# **Product Specifications**

**Draft 6/2002**

## **Introduction**

The National Park Service (NPS) Inventory and Monitoring (I&M) Program is in the initial stages of developing Product Specifications. The current specifications may change as the program develops, and especially as data management programs evolve. This document was written to provide cooperators/contractors with a straightforward list of deliverables that are required at the completion of each biological inventory project. If any inconsistencies or errors are detected, please contact Sara Stevens at 401-874-4548 or [sara\\_stevens@nps.gov](mailto:sara_stevens@nps.gov). Just as a reminder, all non-NPS science activities require a permit. Applicants can apply on the web at: [http://science.nature.nps.gov/servlet/Prmt\\_PubIndex](http://science.nature.nps.gov/servlet/Prmt_PubIndex).

Cooperators and contractors are to provide the following deliverables (some specifications in this document are described in greater detail in the product specifications developed by the National Program at <http://www.nature.nps.gov/im/apps/specs.htm>

### **1. Species Data**

#### ***Raw Data***

Copies of all raw data, such as hand written field forms (if used), must be provided if requested. Do not destroy any forms without first contacting Sara Stevens.

#### ***Species Inventory Database***

All inventory and monitoring data must be provided in an MS Access relational database using the NPS I&M Program Database Template. The core structure of the database template along with a data dictionary can be found at: <http://www1.nature.nps.gov/im/apps/template/>. Database template modules are in development and will eventually be available on a web-based clearinghouse. Please contact Sara Stevens for information on existing modules.

Each relational database template has a spatial component to it, and all cooperators must provide GPS coordinates for all fixed sampling locations (e.g. plots, transects, etc...). Cooperators are also encouraged to obtain GPS coordinates for observations obtained from general search areas or opportunistic sightings, but are not required to do so. Please review the GPS standard operating procedures for field data collection and the spatial data format requirements if coverages, or shape files are being submitted (Appendix sections I& II).

### **3. Metadata**

Cooperators must provide metadata for all data sets developed (e.g. GPS coverage of fixed sampling locations, attribute data and MS Access databases). All geospatial metadata must follow Federal Geographic Data Committee (FGDC) compliance standards which can be found at <http://www.fgdc.gov/metadata/metadata.html>. Metadata for all biological data sets (e.g. MS Access Databases) must follow the Biological Data Profile of the Content Standard for Digital Geospatial Metadata, which can be found at: [http://www.fgdc.gov/standards/status/sub5\\_2.html](http://www.fgdc.gov/standards/status/sub5_2.html).

## **4. Voucher Specimens**

The Northeast Region I&M Program chooses to leave the issue of vouchering up to the discretion of the park where the inventory is taking place. An agreement on vouchering must be reached prior to initiating the inventory. All specimens regardless of their repository will remain the property of the National Park Service and are assumed to be on long-term loan to the housing institution/collection outside of the Service. It is mandatory that cooperators catalog all collected specimens in the Automated National Catalog System (ANCS+). See Section III of the Appendix for further guidance on voucher specimens.

## **5. Reports**

### ***Progress Reports***

Progress reports must be submitted digitally in MS Word format, and as paper copy if requested. Minimally, they will be due annually dependent upon the length and scope of the project. See Section IV of the Appendix for report guidelines.

### ***Final Reports***

A draft final report must first be submitted electronically in MS Word, and as paper copy if requested, to the Regional I&M or Network Coordinator for management and scientific review and comment. It must include methodology, analysis, results and discussion. The final report must be submitted both on CD-ROM and in hard copy. Because the final report will be made available on an NPS website, it must be submitted both as 1) a Word 6.0 or higher version document (.doc) in its entirety CD-ROM, and 2) a Word 6.0 or higher version document (.doc) containing all text and tables, and individual Tiff documents (.tif) for each graphic image contained in the report on that same CD-ROM. See Section IV of the Appendix for report guidelines. Cooperators are responsible for submitting all other required products with or prior to the final report.

## **APPENDIX**

- Section I**            **Field Data Collection with Global Positioning Systems**
- Section II**           **Spatial Data format**
- Section III**          **Voucher Specimen Collection**
- Section IV**          **Report Guidelines**

## Section I

### Field Data Collection with Global Positioning Systems Standard Operating Procedures and Guidelines

The purpose of this section is to complement the (Draft) Natural Resources Data and Information Handbook (NRDIH). This section addresses instrument settings, field operation and data processing for GPS data collection only. It does not address the important issues of database design, applicable scientific measurement protocols, data verification/validation, data documentation, data maintenance, archiving, security or distribution. Please consult the NRDIH for further information on those critical subjects.

#### **Positional Data:**

The National Map Accuracy Standard (NMAS) published by the USGS is the NPS *minimum* standard for map data accuracy. Typically a GPS will provide much better accuracy than NMAS if it is used carefully and with full attention to the parameters that the user can set or track. To achieve a reasonable and reliable level of accuracy with a GPS, please use the parameter settings described below. Please note that different GPS units use different names for these parameters or define them slightly differently. The discussion below tries to accommodate for these differences. For further discussion of the significance of these parameters and rationale for the recommended settings please see the NRDIH. If you have any questions please contact Tim Smith at [Tim\\_Smith@nps.gov](mailto:Tim_Smith@nps.gov).

#### *Definition of the Global Positioning System*

GPS (Global Positioning System) is currently a constellation of 25 Department of Defense satellites that orbit the earth approximately every 12 hours, emitting signals to Earth at precisely the same time. The position and time information transmitted by these satellites is used by a GPS receiver to trilaterate a location on the earth using three or more satellites to determine a coordinate on earth.

The satellites broadcast on two carrier frequencies in the L-band of the electromagnetic spectrum. One is the "L1" or 1575.42MHz and the other is "L2" or 1227.6MHz. On these carrier frequencies are broadcast codes, much like a radio or television station broadcast information on their channels (frequencies). The satellites broadcast two codes, a military-only encrypted code (PPS) and a civil-access or Standard Positioning (SPS) code.

#### *GPS Receivers*

All commercial consumer GPS receivers are SPS (Standard Position Service) receivers. There are two basic types of SPS receivers, those that use the broadcasted code to do their positioning (code-phase) and those that do carrier phase measurements (carrier-phase). PPS (Precise Position Service) or P(Y)-Code (Rockwell PLGR and Trimble Centurion) receivers utilize the P(Y)-code broadcast on the L2 carrier frequency for positioning. This type of receiver is only available to the military and some government agencies.

### *GPS Positional Accuracy*

Positional accuracy for autonomous, code-phase, resource grade or C/A-code receivers range from 100 meters to less than 2 meters. Accuracy for carrier-phase units (commonly referred to as geodetic receivers) can be measured in millimeters.

Accuracy is dependent on a number of factors. Several factors that can significantly impact data accuracy can be monitored in the field: the number of satellite vehicles, Positional Dilution of Precision (PDOP) and Estimated Horizontal Error (EHE). One should always acquire at least 4 satellites. This gives you a 3D position. More satellites are better than fewer. PDOP relates to satellite geometry at a given time and location. Keep the PDOP as low as possible (ideally, maximum PDOP=4) when collecting mapping data. Some receivers have the ability to stop collection of a position if the PDOP value rises too high. This is referred to as "PDOP masking". Most receivers (but not all) give you a field estimate of horizontal error (EHE or EPE). With the Rockwell PLGR and Garmin GPS III Plus, the EHE (or EPE) has been shown to be a very good indicator of overall positional accuracy (most of the time your accuracy is going to be better than the EHE). In the field, EHE is not presently available on the Trimble GeoExplorer 3.

Positional accuracy for both C/A Code and Carrier types of receivers strongly depends on a process called differential correction. In order to achieve greater accuracy, the differential correction procedure is used to limit Selective Availability (controlled by the Department of Defence [DoD]) and Ionospheric/Tropospheric degradation of the satellite signals. Although DoD has now set Selective Availability degradation to zero, Ionospheric / Tropospheric degradation can add from 1 - 7 meters of error to your position. Therefore, differential corrections are required to improve accuracy, maintain positional integrity (confidence), and make a survey tie to a ground-based geodetic survey network.

Real-time differential corrections should be used whenever possible. This saves both time and money. Real-time differential corrections are available through the NDGPS/Coast Guard Beacon System, the WAAS (FAA) satellite based differential system, OmniStar, or a variety of paid private differential services.

#### Receiver Specific Recommended Settings:

##### Garmin and PLGR units:

1. *EHE*: less then or equal to 12 (this will keep you just within the NMAS for a 1:24,000 map, which is the maximum acceptable for GPS in the eastern parks).
2. *Minimum of 4 satellites (3D)* for every position.
3. *Position Type*: real-time differentially corrected position.

##### Trimble Units (GeoExplorers, Pathfinder Pros)

1. *PDOP*: less then or equal to 5 (we recommend starting with a PDOP maximum of 4 and shifting to 5 if data collection is not successful at 4;this will keep you around the NMAS for a 1:5,000 map).
2. *Minimum of 4 satellites (3D)* for every position.
3. *SNR*: less then or equal to 5.
4. *Elevation Mask*: 15.

5. *Antenna height*: be sure to check for correct antenna height setting. This setting should be the typical height at which the antenna will be carried. If the antenna is attached to a pole, it must be located above the user's head and the antenna height setting should be the height of the top of the pole. Wherever possible, the antenna should be clear of any obstructions.
6. *Position Type*: must be post-processed or real-time differentially corrected.

#### All GPS units:

1. Check the graphics data collection screen regularly to see if you are getting multi-path or other apparent distortions to the data.
2. Be aware of the possibility of multi-path interference and use offsets or other methods to keep the antenna away from building overhangs, tall fences or walls, and heavy canopy wherever possible.
3. ALWAYS do differential correction, either real-time or post processed
4. Feature settings:

##### Point

- *Trimble* - minimum of 5 positions, collected at 5 second interval and averaged.
- *All Others* – 90 to 120 positions, collected at 1-2 second interval and averaged.

##### Line/Polygon

- use a 3-5 second interval for walking, force (i.e. wait for) a position at each corner, and use a minimum of 3 positions to define any curve/change in direction.
- use a 3-5 second interval for road driving, depending on the road type and speed of the vehicle, force (i.e. wait for) positions at each corner and use a minimum of 3 positions to define any curve or change in direction.

Try to map all features in a single area in a single day or on consecutive days.

#### **Attribute Data:**

##### Data Dictionaries

Data dictionaries are designed to simply, efficiently, and without redundancy, describe features (landscape, biological, cultural, or historical). It organizes data into types or 'themes'. It is an inefficient use of time and energy not to use a data dictionary. Set up a menu and picklists in a database and load them into the GPS unit or data collection device prior to going out into the field. Create and use a data dictionary whenever you anticipate collecting attribute data.

#### **Data Conversion to GIS/Data Archiving**

Always record the EHE/EPE or maximum PDOP (using 4 satellites) for a file to record in the metadata associated with the resulting GIS data. Without this information the GPS data are considered unreliable and may not be useable for spatial analysis and map production.

## Section II

### Spatial Data Guidelines

Spatial data, which include GPS generated files, must conform to the following guidelines:

#### Projection and Coordinate System

All digital geospatial data should reference the coordinate system corresponding to the standard presently in use at the park which, for most parks, will be the correct UTM zone in which the park is found. The datum should be the North American Datum of 1983 (NAD83); the ellipsoid should be the Geodetic Reference System 80 (GRS80); and the units of measure should be meters. The contractor should contact the park's GIS Coordinator for specific instructions and/or refer to the contract or cooperative agreement.

#### Scale and Spatial Resolution (Vector Data)

New data should not exceed 1:24,000. The contractor should contact the park's GIS Coordinator for specific scale and spatial resolution requirements for vector data or they may be specified in the contract or cooperative agreement.

#### 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 for image data or they may be specified in the contract or cooperative agreement.

For vegetation classification under the NPS/USGS vegetation classification project, 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 the following National Map Accuracy standards (Source: USGS Fact Sheet 078-96, September 1997). 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 benchmarks, 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.

The following table provides the allowable horizontal accuracy for some common scales:

<u>Scale</u>	<u>Allowable error (feet)</u>
1:40,000	111
1:24,000	40
1:20,000	33
1:12,000	20
1:9,600	16
1:4,800	8
1:2,400	4
1:1,200	2

#### Attribute Accuracy

At a minimum, an 80% or greater overall thematic attribute accuracy at the 90% confidence interval is required. The contractor should contact the park's GIS Coordinator for specific attribute accuracy requirements or they may be specified in the contract or cooperative agreement.

#### Spatial Data Formats

At a minimum, all vector data is to be supplied as an ArcInfo coverage and ArcInfo interchange file, e00, compatible with the current version of ArcInfo for the MS Windows operating system. All raster data is to be supplied as an ArcInfo GRID and ArcInfo interchange file, compatible with the current version of ArcInfo for the MS Windows operating system. All digital imagery, such as scanned aerial photographs, is to be supplied as tagged image file format (tiff) files with the proper header file for geo-referencing purposes. The contractor should contact the park's GIS Coordinator for specific data formats or they may be specified in the contract or cooperative agreement. All data should be delivered on CD ROMs compatible with the MS Windows operating system.

#### Quality Control

When the contractor has completed 10% of the spatial and attribute data development, the contractor must supply the data to the park and appropriate Regional Technical Support Center (RTSC) for quality control purposes. The data must be delivered in conformance to the Spatial Data Formats requirements. 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 Federal Geographic Data Committee (FGDC) compliant metadata before the job is considered complete.

Results of tests used to verify all applicable horizontal, vertical and attribute accuracy measurements should also be provided whenever data is provided to the park and RTSC.

#### Metadata

All digital geospatial data must have Federal Geographic Data Committee (FGDC) compliant metadata in digital form developed by the data producer. The metadata should be parsed using the metadata parser provided by the FDGC (<http://www.fgdc.gov>). The 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 appropriate RTSC for metadata development instructions.

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## Section III

### Voucher Specimen Collection

All vertebrate and vascular plant specimens collected in Northeast Temperate Network parks will be housed at Acadia National Park. Repositories for specimens collected in other Networks in the Northeast Region have not yet been determined. At this time, specimens collected in those parks will be housed at the cooperating University or associated institution with the stipulation that under federal law, all specimens are the property of the NPS and are on long-term loan to the receiving institution. Acquisition of a valid park permit to collect specimens is the responsibility of the cooperator. As well as the preparation of all specimens. The final decision on the collection of voucher specimens will be left up to the discretion of the park, but the collections policy for the Northeast Region I&M Program is as follows. **Cooperators may collect whole specimen vouchers** of amphibians, snakes, mammals, fish and plants **only if**:

1. **Identification of a species is in question.** This may mean that certain taxa, such as fish, may require more intensive vouchering than other taxa.
2. **Or if a particular species has not yet been collected in a park.** A list of existing voucher specimens will be available for each park, and cooperators are required to review this list prior to fieldwork.

Plants and animals that **may not** be whole-specimen vouchered include birds, turtles, large mammals (unless found as roadkill) and common plant species. If vouchering is necessary for any of these because no voucher exists for a particular park, photo documentation is required.

### Cataloging Specimens

Cooperators must catalog all specimens in the Automated National Catalog System (ANCS). Please contact Sara Stevens for information on obtaining the ANCS+ software. In some cases, depending upon where the specimens are housed and how many specimens are collected, collection curators will be available to assist cooperators in making the ANCS+ entries.

### Vouchering Methods

#### Photo Documentation

The Northeast Region I&M Program is requiring all cooperators to use non-invasive methods of vouchering, such as color photography, or other signs or remains (e.g. hair samples, scat or tracks) whenever possible. Photographs of a species will be considered a voucher and will be referenced in the NPS NPSpecies database. Photographs taken to provide documentation of a species must be taken with a macro or close-up lens. Photographs should show features used for identification of the species. It may be necessary to take more than one photograph of an individual from different angles. All photographs must be submitted with the pertinent raw data. All slides and photographs must be kept in appropriate protective sleeves. Digital photos must be provided on C/D.

#### Whole Specimens

Voucher preparation will be the responsibility of the cooperator who must have a valid park permit to collect specimens. All vouchers taken on NPS lands, regardless of their repository, will be the property of the NPS. Cooperators will be responsible for accessioning voucher specimens into ANCS+.

Voucher specimen collection must follow the guidelines defined by the Components of British Columbia's Biodiversity (CBCB) manual #4, Collection and Preparation of Voucher Specimens and any guidelines a cooperating institution's Animal, Care and Use Committee has developed.

#### *Mammalian Collection*

In order to minimize disturbance on mammalian populations in parks, photo vouchering and collecting animals where death resulted from either trap mortality or roadkill will be priority over euthanizing individuals. Guidelines found in the *Live Animal Capture and Handling Guidelines*, manual no.3, will be followed for proper capture, handling and euthanasia procedures. Guidelines and references for the preservation of voucher specimens can be found in *Measuring and Monitoring Biological Diversity, Standard Methods for Mammals* (Wilson et al, 1996).

#### *Fish Collection*

Digital photographs can be an accurate and economical method for vouchering fish specimens. Please follow the guidelines for vouchering fish specimens by Dr. Jay Stauffer and Timothy Stecko from Penn State University. (Please request this document from either Sara Stevens or Elizabeth Johnson). Although it may not be possible to identify all fish specimens from digital photographs taken in the field, these guidelines will be useful for most fish collected. Immature fishes of all species and some of the minnow species, particularly in the genus *Notropis*, need to be collected and properly preserved.

#### *Amphibian and Reptile Collection*

For identification purposes, most species of amphibians and reptiles can be adequately confirmed from photographs. Collecting whole specimens of amphibians and snakes will only be allowed as stated above, if a whole specimen does not exist for a park. Turtles may only be vouchered through photo documentation.

#### *Vascular Plant Collection*

Species that are common to the park or have already been vouchered should not be collected. Because any collection of specimens impacts a population, it is especially important when collecting rare species to weigh the destructiveness of collection against the amount of information gained. Federal and state Threatened and Endangered plants will not be collected in populations of less than 50 individuals (Elzinga et al, 1998). It is incumbent upon the cooperator to know which taxa are locally or nationally rare or protected, and to be familiar with all federal and state legal procedures for collecting. In small populations, only small portions of plants will be collected if necessary. Cooperators are advised not collect indiscriminately, even in large populations, and to collect only the minimum amount of plant material necessary. (The Plant Conservation Round Table, 1986).

Voucher specimens will be collected during inventory in accordance with collections policies outlined in *NPS Management Policies* ("Museum Objects and Library Materials" and "Preservation of Data and Collections and Protection of Research Potential") and NPS-77, *Natural Resource Management Guideline*.

## Section IV

### 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 MS Word (most recent version) files as an email attachment or on a CD.
- 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:

First Order Header [center]

Second Order Header [flush left]

Third Order Header [flush left, underlined]

Fourth Order Header: [flush left, colon, two spaces, continue with text].

*Fifth Order Header* [flush left, italicize]

- 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 MS Word (most recent version) files on CD.
- 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.
- 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.
- Use sentence case (i.e. capitalize only the first letter of the first word and any proper nouns) for titles.
- Repeat the heading (e.g. List of Figures) followed by “continued” in parentheses at the top and centered for each additional page of the list.
- Consult Tables. 1, 2, and 3 for example lists.

## 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.

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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

Kinbote, C. V., and D. N. Haze 1948. A new species of *Cyclarus* Nabokov. *The Entomologist*. 81(1027):273-280.

#### 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

Knight, S. V., and V. N. Darkbloom, editors. 1998. *Butterfly identification in our National Parks*. Second edition. Blackwell Scientific Publications, Ithaca, New York. 512 pp.

#### 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

Quilty, C. V., and A. N. Vokoban. 1961. A study of Lepidoptera at Shenandoah National Park. National Park Service Technical Report NPS/SHEN/NRTR-91/016. Luray, Virginia. 161 pp.

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:

Pnin, P. V., and H. N. Humbert. 1999. Yesterday's caterpillar: A re-examination of Lepidoptera morphology at Hopewell Furnace National Historic Site. Pages 131-313 in .S. V. Odon, and K. N. Krug, editors. Insect Studies in National Parks of the Eastern United States. University Park, Pennsylvania

Paper in Conference Proceedings:

Pnin, P. V., and H. N. Humbert. 1999. Yesterday's caterpillar: A re-examination of Lepidoptera morphology at Hopewell Furnace National Historic Site. Pages 131-313 in .S. V. Odon, and K. N. Krug, editors. Insect Studies 1998-1999. American Society of Entomologists. University Park, Pennsylvania

Thesis

Format

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

Example

Zembla, V. N. 1997. A comparative ecological study of Madeleinea mashenka and Madeleinea lolita in Northeastern National Parks. M. S. thesis, Cornell University. 242 pp.

## 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]
- Abstract and Key Words
- 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.

## Abstract and Key Words

Provide a brief abstract (a paragraph or two in length) which concisely describes or gives a brief overview of the research (i.e. where/when/how the research was conducted, results, and conclusions)

Also include a list of two to four keywords beneath the abstract.

The abstract and keywords must be together on no more than one page.

## 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