

**NATIONAL PARK SERVICE**  
**BIOLOGICAL INVENTORY DATABASE DEVELOPMENT**  
**--**  
**REPORT ON THE WORKING GROUP MEETING**  
**AND**  
**RECOMMENDATIONS**

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BIOLOGICAL INVENTORY DATABASE DEVELOPMENT**

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AND  
RECOMMENDATIONS**

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Peter S. White  
Joy Bannerman  
Jeffrey Nekola  
Botanical Garden Foundation, Inc.  
North Carolina Botanical Garden

--

Sue Glenn  
National Park Service and  
Oklahoma Natural Heritage Program

--

Patricia Mehlhop  
New Mexico Natural Heritage Program

--

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## INTRODUCTION

In September, 1993, 37 government and non-government researchers and resource managers came to Chapel Hill, North Carolina, to discuss databases needed by the National Park Service to support one of the agency's most basic missions, the conservation of biological diversity in the National Parks. This report documents the discussions that took place in that workshop and describes recommendations that were formulated and reviewed subsequent to the workshop itself.

This report consists of two sections:

**Part A** documents the workshop held in Chapel Hill and cosponsored by the National Park Service and the North Carolina Botanical Garden on September 21-22, 1993, including attendees, topics, discussion summaries, and follow-up materials such as letters and database descriptions.

**Part B** presents an outline of a database system for biological inventory data. This outline is based on the workshop discussions, but includes additional ideas and information developed after the workshop itself. Part B is divided into two sections: (1) an overview of recommended databases for information on biological taxa and (2) an overview of biological diversity database needs that are not based on biological taxa. Both sections discuss implementation of the recommendations.

There was a general consensus and considerable enthusiasm at the workshop for the development of databases to support the conservation of biological diversity in the National Parks. It was strongly felt that this was a feasible program that could be accomplished, particularly with leadership from the National Biological Survey for the development of data needed by a wide variety of users at the national level (e.g., basic nomenclature and synonymy, national endangerment status, and distribution by state, county, and landform) and for the exploration of issues such as the ecosystem/community and genetic levels of biological diversity. The next steps recommended were: (1) detailed database design, including documentation of that design, and (2) establishment of standing committees to guide database implementation, database maintenance, and the flow of information between the various organizational levels of the National Park Service and the National Biological Survey.

## PART A

THE CHAPEL HILL WORKSHOP:  
BIOLOGICAL INVENTORY DATABASE DEVELOPMENT

A six person planning committee (Appendix 1) met in Chapel Hill in May, 1993, and under the leadership of Sue Glenn, then on work assignment from the Oklahoma Natural Heritage Program to the Washington Office of the National Park Service, developed the agenda and list of invitees to the September workshop. A report of the planning meeting is included as Appendix 1. As formulated during those discussions and distributed with the agenda, the goal of the workshop was:

*to make recommendations for a biological inventory data system to be used by the National Park Service that is compatible with other Department of the Interior systems.*

**Background**

Many federal, state, and non-governmental agencies are investing in inventory and monitoring of biological diversity. There would be substantial benefit from standardizing a core set of databases that not only derive from this effort but also support continued work to improve our understanding of the distribution of biological diversity. Standardization and centralization of some databases and services would reduce duplication of effort and enhance quality and communication. In addition, a standardized database system could serve organizations that currently lack such a system. It is important that a standard database system be made, where possible, compatible with already existing databases to enhance the sharing of information in support of the overall goal of the survival of the nation's biodiversity.

While a number of agencies, including the National Park Service and other Department of the Interior agencies, already have database systems in use or development, there has been no coordinated effort to design these databases in a way that would provide maximum benefit and minimum duplication of effort. Within the National Park Service, NPFlora and NPFauna have been produced and made accessible, but there is no overall structure that links these databases with field information nor an institutionalized framework for continued updates to these databases. There are other databases within the National Park Service, such as the catalog of museum specimens being produced under the Automated National Catalog System (ANCS) and other observation-based records in Park files, that are not integrated with NPFlora and NPFauna. Further, it is uncertain whether the existing databases adequately meet the needs of the National Park Service at the National, Regional, and Park levels.

The recent formulation of the National Biological Survey (NBS) within Department of the Interior represents an opportunity to address the question of whether there are Departmentwide needs that might be best handled through that new agency. There is a clear need to examine the requirements of the National Park Service for biological diversity data and to design an integrated system of databases that allows the efficient flow of information among programs and across the organizational levels of the agency.

Typical challenges that would be addressed by a more structured approach to biological diversity data include the following:

Park-level challenges. Taxonomic names on Park museum specimens and in park publications and checklists are often out of date and do not take into consideration

the latest findings of the scientific community. Federal endangered species lists, by contrast, do follow more recent taxonomic opinion and take into account nationwide distribution, not just local distribution. Scientists and resource managers in individual parks have been unaware of the presence of endangered species in their Parks due to simply nomenclatural problems. Also, status on federal endangered species list changes through time. Workers in the Parks may be unaware that the particular species they are managing occur on lands adjacent the Park and may miss opportunities for collaborative work with other land managing agencies. Scientists and resource managers in Parks may be unable to evaluate the completeness and accuracy of their organism checklists and may, therefore, be unable to prioritize future work to meet information needs. Many issues are common to all Parks: design and quality control for databases, systems for information flow among organizational levels, and confidentiality of species location records to prevent exploitation of economically valuable species.

Challenges at the level of the Regional Office. Many Parks lack a science or resource management staff and so the kinds of problems described above. Further, Regions find it hard to recognize common problems across Parks and thus miss opportunities to coordinate work across units. The Regions also share with the National Office the inability to fully gauge the performance of Parks in the conservation of biological diversity.

Challenges at the level of the National Office. Without some flow of information to the National Office, it is difficult for the Service to assess its own performance, to report to Congress and the nation, and to prioritize its work and request the resources to adequately carry out its responsibilities. The Service also needs to be able to devise strategies for nation-wide issues (e.g., air quality effects in Parks), to set priorities for future research and for the acquisition of new lands, and to participate with other federal, state, and local groups in an overall strategy to conserve the nation's biological diversity. There have been cases when outside groups or individuals have questioned the National Park Service's programs and the Service lacked an adequate information base for a response. The National Park Service should be able to write an annual report on the status of biological diversity in the Parks, including the assessment of the adequacy of existing information and the outline of information needs.

These are important problems on which individual Parks and government offices are already expending energy; it seems logical that this effort be made more efficient and more complete through a structured program.

### **The Workshop**

To initiate discussion of these issues, a Biodiversity Database Working Group was formed. On September 21 and 22, 1993, 37 professionals from 15 agencies and organizations (Appendix 2) met at Chapel Hill to consider and make recommendations for an integrated biodiversity database which the National Park Service could adopt at all levels and integrate with other Department of the Interior systems. An outline of the Agenda is presented in Appendix 3. The first morning consisted of a welcome and introduction (by Sue Glenn and Peter White), an overview of the relationship of the discussions to the National Biological Survey (by Michael Ruggiero), and eleven presentations of existing data bases (see also Appendix 6 which summarizes much of the information distributed at the meeting).

The major work of the meeting took place in six topical discussion sessions held in two sets of three concurrent sessions (see Appendix 3 and 4 for issues listed under these topics on the agenda). These six discussion sessions were:

A. Concurrent sessions on specific recommendations for biological inventory data bases (including recommendations on data fields):

1. Vascular plant and vertebrate nomenclature standards  
*Sue Glenn, Chair*
2. Data field standardization required to meet national and Regional needs  
*Gary Waggoner, Chair*
3. Data field standardization required to meet Park level needs  
*Steve Tessler, Chair*

B. Concurrent sessions on recommendations for general implementation in the National Park Service:

4. Recommendations regarding roles and functions of Park, Regional, and national offices  
*Trish Patterson, Chair*
5. Schedule and updating recommendations  
*Tim Goddard, Chair*
6. Recommendations of design and linkages of system  
*Linda Pettit-Waldner, Chair*

The last afternoon was devoted to a final discussion of recommendations (chaired by Patricia Mehlhop and Peter White) and an overview of current activities of the National Park Service Inventory and Monitoring Program (by Gary Williams).

Before summarizing these discussion sessions, general observations on the workshop will be presented under three headings: levels of biological diversity, the National Parks and National Park Service in a larger context, and future directions.

### **General Observations on Workshop Discussions**

#### Levels of Biological Diversity

Biological diversity is defined broadly to include the variety of life and life processes at all levels of organization, with usual emphasis on genetic diversity, species diversity, and community/ecosystem diversity. The central and recurrent theme in the workshop was that of the taxon (species, subspecies, and variety) level. This is compatible with the title of the workshop, the goal statement formulated by the planning committee, and the general guideline on inventory and monitoring of the National Park Service (this is the report frequently referred to as 'NPS-75'). However, most participants felt that genetic diversity, community/ecosystem diversity, and ecological processes were critical and that the general issues discussed at the workshop could be applied to the management of data at those other levels of biological diversity as well. The application of workshop findings to other levels of biological diversity is one of the areas for which leadership from the National Biological Survey is recommended.

For the taxon-oriented level of biological diversity, two basic kinds of databases were frequently discussed at the workshop:

A taxon-based database in which each record in the database is a unique taxonomic entity (e.g., class, order, family, genus, species, subspecies, or variety), the database thus comprising a checklist of a particular group of organisms for a particular geographic area (e.g., a park). In the terminology of The Nature Conservancy these are 'elements' of biological diversity. Taxon-based databases in their simplest forms are checklists but they often include other information such as status as exotic species or endangered species. These databases should be linked to maps, documentation files, and other information critical to management.

A specimen or observation-based database in which each record in the database is an occurrence of a single taxon at a particular time and place. Each taxon can be represented by one or many occurrences. Specimen or observation-based records are called 'element occurrences' in the Biological Conservation Database developed by the Nature Conservancy. Specimen and observational records are the raw material for checklists and, thus, for taxon-based databases and should be linked to them. They also provide essential information for conservation management.

Although the discussion at the workshop focused on taxon-level data, at several points in the discussion participants indicated that the ecosystem and community context was critical to management questions. They urged that future research should be associated in the both taxon-based and specimen-based databases with information on distribution among habitats, ecosystems, and communities. Genetic diversity, except in so far as it underlies subspecies and varietal ranks, was not discussed at the workshop.

To the degree that communities and ecosystems can be categorized as 'types', they can also be defined as taxonomic 'elements' of biological diversity in a database similar to the 'taxon-based' database described above. The occurrences of these types (including an indication of quality such as pristine or exemplary) can also be recorded in an 'element occurrence' database, an approach used by The Nature Conservancy and its cooperators. The National Park Service is pursuing the production of basic ecosystem type maps for its lands; at the time of the workshop, however, these efforts were not yet far enough advanced for thorough discussion. The sense of the meeting was that the National Biological Survey and national office of the National Park Service could play an important role in developing a standardized approach to the definition and mapping of ecosystem types and the capturing of data on ecosystem type, quality, and occurrence. The Gap Analysis Project, begun by the US Fish and Wildlife Service and now part of the National Biological Survey, is also addressing the protection of biodiversity at the community or ecosystem level. The goal of devising a system for inventory data and conservation planning at the community/ecosystem level needs to be pursued and completed. This is a Department-wide (indeed, government-wide) need, suggesting that leadership ought to reside in the National Biological Survey.

The National Park Service issued the Natural Resources Inventory and Monitoring Guideline (NPS-75) in 1992. The taxon-level objective of the workshop means that only part of this document (Appendix A--Species Information) was directly addressed and only in the context of inventory. Similarly, the focus of this report, like that of the workshop, is on the taxon-level. Further, the focus, as the goal statement for the workshop suggested, is on inventory rather than monitoring databases. Certainly, monitoring databases should be linked to the biological diversity databases discussed at the workshop (the Biological Conservation Database of The Nature Conservancy provides one model of how to do this), but there was not detailed discussion of this linkage at the meeting. Databases for monitoring data were the subject of the one of the letters received after the workshop was



held (Appendix 5), but are not a focus of this report. We feel that the National Biological Survey, because of its focus on biodiversity trends for the nation, should be charged with recommending standard procedures for monitoring data.

### The National Parks and National Park Service in a Larger Context

Obviously, the National Parks were the focus of the discussion and the central question in that context was: what databases will assist the National Park Service in the conservation of the biological diversity entrusted to the agency? Can we use such databases to help us assess, for example, on an annual basis, the performance of the National Park system in the protection of biological diversity?

However, it was also clear from discussions at the workshop that the National Park Service needs to look beyond its own boundaries--beyond the boundaries of individual Parks and beyond the boundaries of the agency. The survival of some of the biological diversity of individual Parks depends on habitat and land use in surrounding areas. Some of the critically endangered species of Parks also occur in surrounding areas and an interagency cooperative effort will be required for the recovery of these species. Finally, an analysis of the biological diversity of the Parks in relation to regional and national biological diversity will help us identify species and ecosystems that are not yet adequately protected.

As a result, the national nomenclatural database that is described below was intended to include taxa for the entire nation (preferably for all of North America)--not just those reported from Parks. Such a database would be widely useful within the Federal, State, and conservation communities. It would seem logical that the National Biological Survey take the lead in the development of such a database, although that agency could contract with other agencies or parties for the actual development and maintenance of the data.

Many federal, state, and non-governmental institutions are addressing issues in the conservation of biological diversity. Some of the data described at the workshop has been or is under development by other agencies. National databases were envisioned that would be of generally usefulness in the Department of the Interior and throughout the federal government. The formation of the National Biological Survey suggests the potential for the centralized leadership that could establish Departmentwide and nationwide programs. Thus, some of the efforts described here should not be considered to be the sole responsibility of the National Park Service. Indeed, the National Park Service must participate, presumably under the leadership of NBS, in interagency task groups to develop coherent national databases on biological diversity.

### Workshop Findings and Future Directions

The sense of the workshop was that the development and maintenance of biological diversity databases for the National Parks would require permanent organizational structures and work assignments, and the appointment of task groups to guide the process. These task groups would be standing committees, rather than ad hoc groups such as the group that attended the workshop, and would be narrowly focused on individual disciplines (e.g., vascular plants, non-vascular plants, fungi, vertebrates, selected invertebrates) and program areas (e.g., data management, communication protocols), in contrast, to the workshop which included a wide spectrum of disciplines and interests. These task groups would address with more detail and with more investment of time many of the questions and issues posed at the workshop. At the time of the workshop there was considerable uncertainty as to the role of the new National Biological Survey in helping to lead and organize this effort, but as the role of this organization becomes clear, it is hoped

that the standing committees can be appointed and continue the development of databases discussed at the workshop.

This report recommends a leadership role for NBS in three areas:

- (1) The development and maintenance of basic, national-scale, taxonomic data that is required by a wide variety of users. This includes nomenclature, synonymy, endangerment status, exotic status, and other fields (see elsewhere in this report). There has been and would continue to be a tremendous duplication of effort within the federal government, state governments, and conservation agencies (including the National Park Service) unless NBS takes a strong role in this area (NBS could, however, contract with other parties for the actual development and maintenance of these data, but would serve as a reference point for agencies seeking to use the data).
- (2) The development of data standards and protocols for kinds of information for which there is no national taxonomic scheme: protocols for inventory data for ecosystem/community and genetic diversity; and databases for monitoring data, whether physical or biological.
- (3) Research and development for additional databases related to biological diversity. Many database designs have been developed or implemented for data from museum specimens. A consistent national model for this kind of data should be developed. This need transcends taxonomic groups and agencies.

It is critical that the role of NBS be resolved. After this is determined, other report recommendations can be implemented.

This report recommends National Park Service leadership in the following areas (NPS could, of course, contract with NBS for leadership for the initial steps in some of these areas):

- (1) Final design and documentation of databases, including quality control and assurance procedures. Three types of databases are recommended: a Park-level taxon-oriented database; a Park-level specimen or observation-based database; and a Regional/National Office level taxon by park database. Part B of this report gives more detail on these databases.
- (2) Establishment of standing committees, work assignments, reporting assignments, and pathways for information flow for implementing the databases. One of the original recommendations that is made here is that the National and Regional database be a subset and linked to the Park level databases.

To implement the databases, a minimum set of standing committees or task groups is required (the minimum set for taxonomic groups follows the guidelines in NPS-75, but the National Biological Survey will presumably have interest in Protists and Monerans, as well):

National Biological Survey task groups  
Taxonomic databases  
Vascular plants  
Non-vascular plants  
Fungi

- Vertebrates
- Invertebrates
- Community/Ecosystem classification
- Cross-discipline task groups
  - Data management, including information access and flow
  - Specimen- and observation-based records
  - Monitoring data
  - Assessment of genetic diversity
- National Park Service task groups
  - Task groups to finalize and guide databases by organizational level
    - National-Regional databases
    - Park-Regional databases
  - Task groups to address cross-level needs
    - Data management, including information access and flow
    - Database training
    - Interface with the Automated National Catalog System

The recommendations are discussed with more detail in Section B of this report.

### **Workshop Sessions**

In the remainder of Part A we review the reports from the six concurrent sessions, including additional points made in the summary sessions. Session leaders contributed summary outlines of the discussions in their sessions; some editing was done to improve the organization and comprehension of these summaries.

Appendix 5 presents several items of correspondence received from participants after the conclusion of the meeting. Appendix 6 presents a synopsis of databases presented formally and informally during the workshop.

### **Workshop Accomplishments**

In terms of the workshop objectives, Sessions 1 to 3 were clearly successful. A full and thorough discussion took place on nomenclatural standards (Session 1), and data fields for the Park and Regional/National Levels (Sessions 2 and 3). These three discussions contributed the heart of the material presented above and the suggested database fields given in Section B of this report.

For taxon-based data, there was a general consensus that the National Office of NPS could lead the effort to describe database structures and then have these reviewed at the Regional and Park-levels, thus providing the opportunity for additional input (there was concern that not many individual Parks were represented at the meeting). There was a consensus that there be a requirement for certain generic elements in the databases, but that individual Parks should have the ability to add additional fields for information they track (e.g., key cultural uses of biological diversity). The National Office could then provide leadership for the final design, documentation, and training for the databases issued to all offices.

As described elsewhere in this report, the work we outline for NPS will be greatly aided if the National Biological Survey provides leadership for basic taxon-based databases. Before NPS can make progress on specimen and observation-based data and on the linkage between biodiversity data and the Automated National Catalog System (ANCS), it

would also be helpful if the National Biological Survey assumes the recommended leadership in this area.

Sessions 4 to 6 considered the roles and functions of Park, Regional, and National NPS offices, updating procedures, and linkages with other systems. The recommendations for these sessions are less complete, perhaps necessarily so because they focus on administrative procedures and the assignment of responsibilities to individuals and programs. The recommendations from these sessions are most specific when they deal with issues related to the data themselves. Once NPS commits to this program, more work will have to be done on administrative structure, requirements for updates and the annual flow of information, and linkages to other systems. We have outlined a minimum set of task groups and the subjects they would address in this report.

### Session 1 Vascular Plant and Vertebrate Nomenclature Standards

This session discussed the need for a centralized database on the nomenclature, taxonomy, status, and distribution of the biological diversity of the nation. Vascular plants and vertebrates were the focus of the discussion because these are groups that are reasonably well-known taxonomically and because several existing databases focus on these groups (including the National Park Service's own NPFlora and NPFauna).

Two kinds of databases were described:

- (a) a taxon-based database of the biological diversity (which may include such information as synonymy, status, overall distribution) and
- (b) a database of specimen and observation-based records of occurrence of these taxa (The Nature Conservancy's element occurrence records are a model for these).

There are several taxon-based databases available or in development for vascular plants (all were presented or on display at the workshop): PLANTS (Soil Conservation Service, US Department of Agriculture), BONAP (the database developed by John Kartesz and which forms the nomenclatural basis of PLANTS, the current version of NPFlora, and The Nature Conservancy databases), IOPI (an international database), and TROPICOS (which will presumably hold the information published by the Flora North America project).

The discussion also implied that a national taxon-based database should be developed with National Park Service participation but under the leadership of the National Biological Survey. This database would serve a variety of government and non-government parties and should be easily accessed electronically. The government-wide need for this database and the contributions that could and should be made from other agencies (e.g., wetland species and endangered and listing status from Fish and Wildlife Service) and institutions (e.g., the publication data available through the Gray Card Index, made available by Harvard University Herbaria) strongly suggest that one central national taxon-based database be developed and that the responsibility for this lies at a higher level than the National Park Service itself.

Individual Parks, Regions, and the national office of the National Park Service would all have access to the central database. Such topics as nomenclature, synonymy, legal status, national endangerment, and native distribution could all be searched on such a database and queries, comments, and corrections could be posted to the central task group that would manage the database.

The discussion also implied there would be databases within Parks and that these would include both taxon-based databases (checklists for that Park with taxon attributes of interest like endangerment, exotic status, and the others) and specimen- and observation-based databases. The former would be developed with the aid of the national taxon-based database, as described above. The Regional and National Offices of the National Park Service would receive annual updates from the Parks and maintain a taxon-based database of all of National Park lands.

#### 1. Synonymy and nomenclature

- a. It is essential that the database include synonymy because existing checklists of Park organisms may be based on names not in current use by the scientific community (there must be a capability to equate these names with current names); because names in use by

one agency (e.g., the endangered species list maintained by the US Fish and Wildlife Service) may be different than those maintained by another (e.g., the specimen-based records of the National Catalog of the National Park Service); because new records of occurrence for particular Parks may be added at any time; and because systematists will continually revise our systematic and taxonomic understanding of organisms. An agreement on a way to handle synonymy in nomenclature standards is critical to standardizing, managing and sharing biodiversity databases. Even if one name is universally recognized as the only valid name, other names for that taxon will have to be maintained to ensure ease of movement between historic and modern data. Since this is a highly specialized area, it was suggested that workshops of experts in such fields as invertebrates, birds, amphibians, reptiles, fishes, and plant families might be important to develop standards and/or that existent standard reference works be used to develop levels of assurance related to names. A relational structure for such a database has been thoroughly worked out for vascular plants by IOPI (Appendix 6).

The maintenance of a national database of scientific names for organisms (including synonymy and hierarchical taxonomic categories) is an essential function that transcends agency boundaries and missions. Such a function falls under the general definition of the mission of the National Biological Survey. Nomenclature for individual groups could be contracted out to professional societies that maintain such data or to professionals who are assembling such data, or could be carried out by staff of NBS. NBS should serve as a national clearinghouse of information on the nomenclature of organisms of the United States.

The national nomenclatural database must include taxa for the entire nation (indeed, the task should be defined on geographic grounds to include all of North America)--not just those of the Parks. This will ensure that the database is the common link between all land managing agencies and the scientific community and that information particular to the Parks will be cast against the fullest possible background of understanding.

Maintenance of the nomenclatural data base will require a nomenclatural committee ("caretaker committee" which functions as an arbitrator of names) to preside over the procedures by which the database incorporates new information and establishes synonymy. Each taxonomic group should have such a nomenclatural committee and a set of procedures for ensuring the integrity of the database. The nomenclatural standards must follow those established by professional groups (e.g., the Botanical Code) and should allow for peer review. The national nomenclatural databases should be updated at least annually.

b. Taxon-based records should include, minimally (see also IOPI, PLANTS, and the BONAP databases):

- i. genus, species, and subspecific names;
- ii. common names;
- iii. synonymous names (this implies a linkage code to the accepted name);
- iv. authorities;
- v. position within the taxonomic hierarchy.
- vi. information on the source of the record and its updates.

2. The national database should also maintain specific categories of information that is essential to management and legal mandates. Although each taxonomic committee and the staff of NBS might add categories, a minimum set of categories is: nationally threatened, endangered, or extinct species; CITIES species; and exotic species (include

subcategory for pest species) and native distribution. The National Biological Survey should act as a national clearinghouse for these status categories.

3. Distributional data. It is unclear what kind of distributional data should be maintained in a nationally coordinated database. Options include: distribution by political unit (e.g., State/Territory or even County/Parish), natural features (e.g., river basins for aquatic organisms), polygon outlines of ranges as determined by specialists, or locations based on individual specimens/observations. Choices may vary with taxonomic group (e.g., bird distribution will require an indication of transitory, resident, or breeding status). It is clear that we need to be able to aggregate spatial data with full relational capabilities. The NBS should coordinate spatial data conversion across agencies and researchers. Regardless of what distributional data is maintained on the national level, specimen and observation-based data must be maintained at the Park level and, for the National Park Service, should be capable of being aggregated at the Park, Regional, and National scales. IOPI has developed a set of standards that allow distributional data to be entered in a variety of formats so that the computer record retains the resolution of the original record.

All attribution of a taxon to a Park should be accompanied by a citation of the basis of the record. This could include such categories as: specimen, sight record, publication, unpublished correspondence, and investigator's annual report. The database should allow linking to a specimen-based database of the actual records.

Specimens and observations of species in a Park (or in a specific place within the Park) add an important temporal dimension to the database: the database is a taxon by place by time matrix.

4. Specimen-based records should include a set of standard catalog information (see the Automated National Catalog System (ANCS) specifications that the National Park Service's museum program has developed) including:

- a. Nomenclature and taxonomic position (see above) and records of changes in identification/nomenclature.
- b. Museum where stored and accession number.
- c. Minimum collection information:
  - (i) place collected (include UTM coordinates and/or Latitude/Longitude (note precision of these numbers and whether GPS was used), political unit (State, County), Park name, location description, natural features, habitat);
  - (ii) date collected;
  - (iii) person(s) collecting;
  - (iv) collector's field collection number.

It is essential that records of occurrence include place and date of observation to as much precision as is possible. Sometimes this will be limited by the precision of the original record; care should be taken to increase the standards for precision of records in the future, but no information should be created by the coder of the specimen record (that is, the coder should not indicate a higher degree of precision of location than is warranted by the original record). The Smithsonian Institution is testing some alternatives for collection location data in its CRIS program.

The Smithsonian Institution in its CRIS program, the Association of Systematics

Collections through its Committee on Computerization and Networking, and the University of California at Berkeley in the SMASCH project are working on and refining detailed structures for specimen-based databases. The workshop suggested that discipline specific task groups be appointed to guide the development of biodiversity databases and these task groups should review these other efforts closely.

5. The nomenclatural database system should allow for easy access and interaction between the professional taxonomic community and users (e.g., resource managers, ecologists, field surveyors). This implies that the database be accessible through electronic communication. This could allow users to post questions and review comments, and suggest new records, improvements, and updates. A task group within NBS would oversee the process by which comments were evaluated and the database updated.



## Session 2 Data Field Standardization For National/Regional Needs

Session 1 described a need that transcends individual agency and Park needs: access to basic taxonomic and nomenclatural information. Essentially this is envisioned as a service to the National Park Service that is best coordinated at the national level, presumably by the National Biological Survey for the Department of the Interior as a whole. If located in NBS, such a database will need to be coordinated with other biological diversity databases of other agencies (e.g., PLANTS of the USDA's Soil Conservation Service). Although it is envisioned that information would flow from the field to the national database (the flow of this information would be regulated and not all the detail required at the field level would be maintained in the national database), the primary function of the national database would be the flow of information downward: Parks and other field units (including those of other agencies and the non-governmental agencies) would have access to basic and consistent information on nomenclature, rarity, endangerment, exotic status, and other fields, as described above.

In Session 2, a different issue was discussed: what kinds of information on biological diversity in the Parks should be maintained and managed in the National and Regional Offices of the National Park Service? For example, it would seem unnecessary that Regional or National databases have detailed specimen-based or observation-based location information unless those offices are maintaining data for Parks that do not have a science or resource management staff (e.g., the Southeast Regional Office maintains biological diversity data for some small and medium-sized Parks in that Region). By contrast, that specific locational information is critical at the Park level for resource managers, Park scientists, Park interpreters, and outside scientists.

Before we can more fully answer the question of what databases are required at the National and Regional Offices, we must know to what use the data will be put by those Offices. Several uses were discussed:

- (a) Assessment of the state of biological diversity within the Parks and of the contribution of Parks to the conservation of biological diversity for the nation. One of the most basic of the National Park Service missions is the survival of the biological diversity with which the Parks are entrusted. Regional and National Offices ought to be able to answer basic questions about the state and trajectory of biological diversity in Parks.
- (b) Assessment of impact and reduction of threats to biological diversity in Parks. Information on the biological diversity of Parks would help the National Office participate in various efforts, legislative and otherwise, to reduce direct threats to biological diversity of Parks. For example, the Clean Air Act required assessment of pollutant impacts to Park species and ecosystems in Class I Airsheds. The original funding for NPFlora and NPLichen came from the Air Quality Office because of the need to assess how many air pollution sensitive species were found within Parks. This information was used to determine research needs and to assess impacts of new pollutant sources.
- (c) Interagency cooperation for enhancing the survival of biological diversity. A given endangered species may be found across a spectrum of land ownership categories: Federal, State, and private. Information is needed at the National and Regional levels to spur the coordination of work on these species among all parties.
- (d) Setting priorities for future inventory and monitoring. Regional and National

Offices can improve our knowledge about the biological diversity of Parks if they can assess where the critical information needs are. Information should be kept on the level of past inventory effort and the quality of existing inventory data should be assessed.

(e) Recognition of Inter-Regional and Region-wide issues. Information is needed at the Regional and National levels to coordinate work on problems common to several Parks (e.g., impacts of white tailed deer in many eastern Parks and the designing of inventory and monitoring projects for coastal Parks).

Given this outline of uses, the following points were made:

1. The National and Regional Offices require access to the basic taxonomic information described in Session 1 and must coordinate the availability of this information to the Parks and field offices.

2. The National and Regional Offices probably do not require the detailed specimen and observation-based information that is essential at the Park level, but they do require data summarized from this data--a taxon by Park (and Region) by time matrix annotated with important management and conservation characteristics of the species. An improvement to the basic taxon by Park matrix would be to resolve distribution within the Parks to the County level, because this is a common level of geographic reference for endangered species in federal and natural heritage databases. This would enhance information exchange with other agencies and the NBS. It should be possible to design these databases in a way that would allow access to Parks and Counties through defined polygons within a geographic information system (GIS), as well as by political name.

We should also note that Parks often have data on species occurrences that may not be inside the legal boundaries of the unit. This is for several reasons: (1) the record may predate the Park, with the result that the collector did not note the location with enough precision relative to the boundary that was created; (2) the actual boundary of the Park may not match the Congressionally authorized boundary because of inholdings and other tracts that were never acquired by the Federal government; (3) Park organisms may regularly move or migrate across Park boundaries into surrounding areas, and (4) Park collectors may have been interested in documenting species of potential occurrence in the Park and so may have collected from a halo around the Park itself. The Automatic National Catalog System (ANCS) of the National Park Service will capture such records when they are based on museum specimens and Park taxon-based databases and specimen-based databases should maintain these records. It is important, however, to code all locations as in the Park, outside the Park, or uncertain.

3. In addition to the database information described in Session 1, the National and Regional Offices will need to identify specific data categories for use in National and Regional assessments and planning (e.g., air pollution sensitive species). These categories may emerge from a consideration of the Resource Management Plans developed for Parks (see RMP database). Further work must be made to define these categories. Several were discussed of which the one that was most supported was the habitat and ecosystem affinities of the taxa. Ecosystem-oriented questions are likely to be important, and habitat information can be used to suggest species that should be looked for as a function of habitat-ecosystem type maps. It is also likely that there are categories of convenience (e.g., plant growth form like 'trees' and behavior 'resident' or 'migratory') that will be part of the data forwarded to the Regional and National Offices from the Parks. Other categorical data include: indicator taxa, taxa endemic to a Park or cluster of Parks, taxa

legally or illegally taken from Park lands, taxa that are characteristic of or keystones in particular habitats or ecosystems, heroic species, and taxa described in enabling legislation for particular Parks.

The National Office and Regions should communicate to the Parks what additional data categories they require. These data categories should be maintained on Park databases as well since it is envisioned here that the Regional and National Office databases be annual summaries of Park databases. The National and Regional Offices may have to participate in the development of the data for Parks, as was done when the National Office funded NPFlora and NPLichen to identify species sensitive to air pollution that occur in Parks, particularly Class I Airshed Parks.

4. Regardless of what databases are required at the Regional and National levels, it is clear that the databases should be linked. That is, the Regional and National databases ought to represent aggregations of the more detailed data held at the Park level. This requires a coordinated flow of information and a regular update schedule. The most detailed information is best curated at the Park level, closest to where the data are developed, although these tasks can be contracted out or done by the Regional Office when no inhouse science or resource management staff exists in a Park.

### Session 3 Data Field Standardization For Park Level Needs

A high level of detail is required for Park level information on biological diversity. In addition to information already discussed, examples of this further level of detail are: specific records of occurrence and location linked to a GIS; Park rarity and endangerment; State rarity and endangerment; presence of type locales; detailed habitat descriptions; special management issues (e.g., response to fire; sensitivity to recreational impacts; threats; interaction with other species; status as exploited; legally or illegally taken species); number of populations; population size and trends; monitoring data; summaries of overall trends; evaluations of historic vs. current data and any apparent discrepancies; phenology; location; and dates of observation. These categories of information are relevant to resources management and detection of trends. Additional information may be desirable based on interpretive programs (e.g., ethnobotanical information, characteristics for identification, record tree sizes).

#### 1. Overview of Park-level Needs

a. In terms of legislative authority, the primary boundary for data acquisition is the border of the Park and its immediately adjacent lands. Nonetheless, information on the status of the species outside Park boundaries may aid the assessment of Park populations and may allow for coordination of Regional efforts. Some species migrate seasonally from the Park to other locations and the survival of some species in some Parks may depend on habitat and populations that are outside the Park boundary itself.

b. The data must serve the management needs of the Park (as usually specified in the Resource Management Plan) and must have well-defined accuracy ratings so that inventory and monitoring work can be prioritized and partial data will not be mistaken for complete information. Park data must ultimately be highly accurate and legally defensible.

2. Based on the success (with some modification) in the Southeast Region of the National Park Service (including Great Smoky Mountains National Park, as demonstrated by Keith Langdon at the workshop) of the Biological Conservation Database (BCD) system developed by The Nature Conservancy, it was suggested that the BCD should be the starting point of specimen and observation-based tracking of biological diversity in Parks. The BCD must be integrated with software that will enhance its graphic capability. The BCD system is also in use in most State Natural Heritage Programs and already incorporates the review of many records of occurrence for plants, animals, and natural communities. The BCD was the subject of a presentation at the workshop and descriptive material is included elsewhere in this report.

Some thought that, at a general level, the discussions were attempting to reinvent the wheel particularly when what was needed was a detailed review and analysis of existing and competing data structures to determine what elements would best serve Park needs in the future. There was also concern that small Parks and Park data managers were not well-represented at the meeting. A recommendation from these discussions was that focused task groups should be convened to continue the discussion of database specifics and to guide the development of the databases themselves.

#### 3. The following recommendations were made to ensure flexibility of the database use:

- i. ASCII import/export capability
- ii. ability to link to GIS

- iii. ability to manipulate spatial and temporal scale
- iv. ability to aggregate spatial and temporal data
- v. relational structure

4. Every Park should maintain a single taxon-based database for each group of organisms and this should be able to receive information from the National and Regional levels and transmit information to those levels. The National and Regional databases should primarily be summarized or aggregated data from Park databases.

5. Two types of species endangerment status information are required in the Parks:

- i. Biological endangerment (global, national, state, Park).
- ii. Legal status (listings in IUCN Red Book; CITES; federal, state, Park regulations).

The history of and changes to the legal status should be recorded in the database.

6. The taxon-based database in the Park database should contain categorical data that will assist in management and interpretation including such information as sensitivity to threats (e.g., air pollution sensitive species), distribution in habitats and ecosystem types, taxa that are characteristic of or keystones in particular habitats or ecosystems, geographic distribution within the Park, abundance in the Park, growth form and behavior (e.g., 'trees, shrub, herb' and 'resident, migratory'), use as indicator taxa, endemism in the Park, taxa legally or illegally taken, heroic species, and taxa described in enabling legislation for particular Parks.

7. The taxon and specimen-observation-based databases must be able to exchange information with other Park databases, the most important and obvious of which is the Automated National Catalog System (ANCS, described elsewhere in this report; this system has already incorporated specimen data for many museum natural history collections in Parks).

8. Park level data should include not only the taxon-based and specimen-based occurrence databases (e.g., like the 'element occurrence' part of the BCD), but also separate monitoring and management tracking databases linked to the taxon-based database. The requirements for monitoring and management databases were not discussed at the workshop. The biological diversity databases should also be linked to bibliographic databases for published sources of taxon occurrence records and other data.

9. The source for all records in the databases must be documented and the history of changes to the database must be recorded.

10. A major concern was expressed over the confidentiality of occurrence records. If precise locations are freely available they can be used to locate species that can be exploited for profit. The National Park Service should fully investigate the legal status of species occurrence records and should work with the National Biological Survey to develop policy and procedural standards in this area.

Session 4 Recommendations On Roles and Functions of Park, Regional, and National Offices

1. The Washington Office of the National Park Service (WASO) should convene a committee to perform a functional needs assessment and develop system requirements for a database system to meet Park-level Inventory and Monitoring data needs (as identified by a separate working group). The role of the National Biological Survey in leading this effort should be defined. The committee should have adequate Park representation and should consider existing data management systems.
2. WASO should make available the database program identified in (1) above. Parks and Regions should be free to use this database program or to develop their own system (see next item--such systems must be able to interchange information with the databases envisioned for WASO, Regions, and NBS). WASO should develop and maintain a standardized data dictionary to accompany the database program that is developed.
3. Those Parks using their own system should be required to provide data as specified by WASO and their Regional office. Templates (structures) should be provided to Parks for reporting this information.
4. WASO, in conjunction with Regions, should provide training for the generic data base program, including professional data management principles. User manuals and technical support should also be provided.
5. WASO, in conjunction with Regions, should provide training in principles of professional data management for Parks using their own data management system and for project managers at the WASO and Regional levels.
6. Professional data management will be the responsibility of the project manager (whether at the Park, Regional, or Washington level).
7. The cost of professional data management (including staff, hardware, software, QA/QC, training, etc.) should be considered an integral part of the resource data management program.
8. Parks should be encouraged to cooperate with neighboring land managers to develop integrated resource databases using locally agree-upon structures.

### Session 5 Schedule and Updating Recommendations

A database system is envisioned that includes a national taxon-based database maintained by the National Biological Survey, and both taxon-based and specimen-based databases at the National, Regional, and Park levels. These databases must be linked; in particular, the National and Regional databases should be based on the Park-level databases. Obviously, coordination and a procedure for regular updating of these databases is a central issue in their design. Their development and maintenance requires assignment of these responsibilities.

The discussion started with three broad questions (see Appendix 3 and 4):

1. How will the system provide accountability and assure high levels of data accuracy at site, Regional, and National levels?
2. Will the central database be maintained in a static or dynamic method?
3. What documentation should be developed to support the system?

The following general recommendations were made to enhance the updating and improvement of the databases:

1. Historic data should not be lost when updates are made. Historic records should be maintained so that trends can be examined. New information should not simply replace past information. Documentation of how historical data were collected is important and should be maintained. Procedures (including an assessment of strengths and weaknesses of the past data) for the analysis of trends should be fully documented. Even where past data were inaccurate, it is important to be able to trace the evolution of scientific understanding and to be able to document the decision that past data were inaccurate. The system should allow the tracking of the changing endangerment and legal status of a taxon and should allow recovery of information on the taxon despite nomenclatural changes.
2. The data must be consistent, assessed for accuracy, and be the product of documented (and, where possible, standardized) methods. To ensure consistency, a manual should be developed for data entry technicians and users. Methodology and accuracy level should be documented for all data fields. Methodologies should be standardized to the degree possible; where standards do not now exist, the National Office and National Biological Survey should assist in the development of these. It is recommended that Collections Standards Teams be appointed to develop and review methodologies for information on biological diversity.

Technical code should be documented by programmers, including flow charts, data dictionaries, data element relationships, data structures, and data verification.

The procedure for regular maintenance of the database system must be documented.

As described elsewhere in this report, the Park level data should: use standardized taxonomies provided at the National level, including authority of name; include source name for records, including observer or collector name, date of collection or observation, address, affiliation, and publication; be based on at least one museum specimen or other physical evidence--in any case, the source of the record must indicate what kind of evidence the record is based upon.

3. The system should be easy to access and allow feedback. Users should be able to send

'notes' to data base administrator, and incentives need to be provided to encourage user feedback. The ease of interchange of information will foster higher data quality (more review and verification will be possible). There should be a standard set of procedures for including the feedback within the database itself. The National and Regional Offices should send copies of documents that use the database so that Parks can see how their efforts contribute to Regional and National goals. This should serve to increase willingness of Park staff to respond to Regional and National requests for data. Credit should be given to all who participate in the database development--original observer or collector, scientists and resource managers who analyze the information, and data managers.

Easy access will provide opportunities for review and verification of data, thus increasing data quality. Standard procedures must be developed for the review, verification, and correction of data.

4. A series of standing committees, like the 'Users Requirements Teams' of the Bureau of Land Management, should be appointed to define information requirements for the databases. These committees will define database uses for the initial development of the system, but will also help revise database content as new needs and perspectives develop.

User requirement teams should contain people from all types of the National Park Service sites (e.g., large to small, rich to poor).

5. The National Park Service should develop a Memorandum of Agreement with the National Biological Survey to participate in User Requirement Teams and to develop standards for data collection and entry on biological diversity; and encourage other DOI/USDA agency involvement.

6. An annual national report (e.g., 'The Status of Biological Diversity in the National Parks') should be produced, but there should also be the ability for dynamic 'on demand' information searches.

7. Updates to the national National Park Service database should be annual. Park databases should be updated on an ongoing basis. Nationally maintained data should be sent or downloaded to individual Parks so that corrections and additions can be made.



Session 6 Recommendations of Design and Linkages of System

Session 6 addressed general issues of system design and linkage with other database systems.

1. The National Park Service's Inventory and Monitoring program should support Z39.50 standard for data systems because it:

- (a) eliminates the need for further standardization
- (b) is compatible with MARC
- (c) would accommodate commonly used systems

2. The National Park Service should have GOPHER server capability on INTERNET at each Park or Park cluster in order to:

- (a) access major scientific data sets - weather data - USFWS, GAP, countrywide TM satellite imagery
- (b) communicate with other agencies and enhance interagency coordination
- (c) have ease of information transfer within the National Park Service - software and data
- (d) communicate with university researchers

3. The National Park Service's Inventory and Monitoring program should use USGS spatial metadata standards, the consensus of government agencies.

4. The Department of the Interior should take the initiative to create a similar entity to INFOSHARE in Department of Agriculture, perhaps through NBS for:

- (a) non-spatial metadata standards
- (b) communication between agencies

5. Inventory and Monitoring information should be tended by those with the greatest interest in the information (Park/Region/coop unit. . .). Due to the complexity of information, the National Park Service should bring information specialists with professional qualifications into Parks/Regions where information is managed.

6. To allow communication between agencies, the National Park Service should not use acronyms, e.g., in posting information on INTERNET.

7. The National Park Service should have 1-2 people to support, coordinate, troubleshoot, and assist data managers in the use of the GOPHER system.

8. The National Park Service should make data available to the worldwide community as quickly as possible following the lead of USGS. To this end, the National Park Service should use the INTERNET database service to make efficient the Inventory and Monitoring information available on WAIS.

9. There is a major opportunity to link these efforts to the Automated National Catalog System developed for the National Park Service museum collections.

## PART B

## (1) AN OUTLINE OF A DATABASE SYSTEM FOR INFORMATION ON TAXA

The National Park Service guideline on inventory and monitoring (NPS-75) suggested that Parks be inventoried for major, well-known biological groups: vascular plants and vertebrates, with non-vascular plants, fungi, and terrestrial and aquatic invertebrates added if possible and where needed. The work was to begin with documentation of the historic data (in the form of specimens and published records), with subsequent work adding field surveys to complete checklists and assess population distributions, sizes, and trends. It was also suggested that special categories of species (examples, including endangered, endemic, heroic, indicator species, and sensitive species, are given but no complete list is prescribed) be assessed.

## I. DATABASES

The discussions held at the workshop suggest several interacting databases that would capture this inventory information. These are briefly outline below.

A. National Biological Survey*National Synonymized Checklist of Taxa Annotated with Certain Categorical Data*

This is the national taxon-based database of nomenclature, synonymy, distribution, and categorical variables (e.g., rarity, endangerment, listing status--see below for a list).

Linked to documentation files, in terms of the source of the taxa on the list.

Linked to GIS for coarse-level distributions (native range; states).

B. National Park Service

## 1. Park-level

Two Linked Biodiversity Databases:

a. *Park Synonymized Checklist of Taxa Annotated with Certain Categorical Data*

This is a matrix of taxon by Park.

Taxon-based with nomenclature, synonymy, authority names, basic categorical data from the NBS database, plus additional Park and Regional/National office categorical variables (see below for a list).

Linked to specimen- and observation-based database, documentation files, and GIS.

b. *Park Occurrence Records*

Specimen and observation-based database with location and date, linked to:

GIS--mapped occurrences

ANCS museum records--park museum specimen holdings

RMP--Resource Management Plan statement of management issues and priority research projects

Monitoring data

Documentation database, including bibliographic data

## 2. Region and National Office levels

*Synonymized Checklist of Taxa Annotated with Certain Categorical Data*

This is a matrix of taxon by Park (and Region).

Taxon-based with nomenclature, synonymy, authority names, basic categorical data from the NBS database, Regional and National office categorical variables

C. Categorical variables to taxon-based database and proposed leadership roles

NBS = proposed for development by National Biological Survey

NPS = proposed for development by National Park Service, some of which may be developed cooperatively with NBS)

Global -NBS; link to The Nature Conservancy

State -NBS; link to The Nature Conservancy and State Heritage Programs

Park -NPS

Number of populations or occurrences

Size of populations or occurrences

Endangerment/extinction/extirpation

Nation -NBS; link to The Nature Conservancy

State -NBS; link to The Nature Conservancy and State Heritage Programs

Park -NPS

Legal, listing, status

ESA, CITIES -NBS

State -NBS; link to The Nature Conservancy and State Heritage Programs

Sensitivity to threats/changes

Indicator taxa -NPS

Illegally or legally taken taxa -NPS

Declining/increasing taxa, park level -NPS

Declining/increasing taxa, national level -NBS

Other special concern species

Heroic species -NPS

Species named in enabling legislation -NPS

Type locale populations -NPS

Community, ecosystem, and habitat types -NPS

Native/exotic

Exotic status at the National level -NBS

Exotic status at the Park level -NPS

Description of distribution where native -NBS

Pest taxa -NPS

Distribution

Overall distribution -NBS

Political units, such as States and Counties

Natural features, such as river basins, mountain ranges

GIS polygons of range

Recognition of narrow endemics

Park distribution -NPS

Growth form/habit/behavior -NBS

Taxon-specific terms (e.g., tree, shrub, herb; resident, migratory)

Ethnobotany, Ethnozoology -NPS

**D. General features for all databases**

All records must have an indication of the source and quality of the information.

All records would be linked to a documentation file.

An assessment of the accuracy and precision of the data would be used in determining the need for additional field work and verification.

When entering information, the level of precision of the original record should not be obscured.

The history of the databases, as a record of the evolving knowledge about biodiversity in Parks, would be retained.

Procedures for quality control and quality assurance would be established, including:

Task groups for updates within taxonomic groups

Data dictionaries and manuals

Training

The goal of high quality, legally defensible data would be pursued.

Databases would be easily used and accessed, but procedures would be determined to prevent the release of locational data that would endanger exploited species.

**II. IMPLEMENTATION**

The National Biological Survey: determination of its role

Will NBS take leadership in constructing and managing national databases for nomenclature and synonymy and important categorical data, including rare/endangered categories, exotic status, and distribution?

This includes evaluation of existing national databases as models for this work.

This also includes provision for access to the basic nomenclatural database for NPS.

It was suggested that each major taxonomic group should be represented by a Task Group to guide implementation.

Will NBS develop a national classification to be used for inventory data for the community/ecosystem level of biological diversity?

This requires evaluation of work done by The Nature Conservancy in collaboration with the US Forest Service and Department of the Interior.

Will NBS develop national standards for specimen- and observation-based data?

This will require evaluation of existing efforts in this area, including ANCS of NPS, the Smithsonian's CRIS program, the work of the Association of Systematics Collections, the Biological Conservation Database of The Nature Conservancy, and UC-Berkeley's SMASCH project.

National Park Service: implementation within NPS

Establish and describe the program:

Publish an overview of the program on databases for biodiversity inventory and distribute to Regions and Parks

## Complete database design:

Appoint a task group to determine final database structures and to finalize categorical variables for Park and Regional/National needs (see above for a list of recommended data fields).

This should include a set of required fields and the option to add fields at the Park level.

Publish documentation on database structure, a users guide, data dictionary, and training materials.

This must include opportunity for review and comment at all levels of the organization and the evaluation of NPFlora, NPFauna, and NPLichen.

Assign responsibility within NPS for database management and updates and the flow of information among Parks and the Regional and National Offices

Fund development of databases in Parks with significant natural resources.

Begin with large natural area Parks which have well-developed documented checklists and ANCS databases.

Complete procedures for downloading the required subset of Park data to Regional and National databases.

A minimum set of task groups for these tasks is outlined below:

## National Biological Survey task groups

## Taxonomic databases

Vascular plants

Non-vascular plants

Fungi

Vertebrates

Invertebrates

## Community/Ecosystem classification

## Cross-discipline task groups

Data management, including information access and flow

Specimen- and observation-based records

Monitoring data

Assessment of genetic diversity

## National Park Service task groups

Task groups to finalize and guide databases by organizational level

National-Regional databases

Park-Regional databases

Task groups to address cross-level needs

Data management, including information access and flow

Database training

Interface with the Automated National Catalog System

## (2) AN OUTLINE OF A DATABASE NEEDS FOR INFORMATION NOT BASED ON BIOLOGICAL TAXA

There was a general recognition at the workshop that there were three aspects of biological diversity for which taxonomic schemes were lacking, but for which inventory data should be collected:

Ecosystem/community diversity. A nationwide classification scheme is needed so that databases on this important level of biological diversity can be developed and conservation status assessed. The classification scheme should address structural issues (dominant growth forms, density, amount of dead and living biomass), compositional issues (specific taxa present or dominant), animals as well as plants, dominant physical and ecological processes (e.g., hydrology, fire regime), and history (e.g., old growth, disturbed). The various classification schemes used in the past and the diverse uses for this kind of information may mean that several taxonomic schemes must be maintained (e.g., structural, compositional, disturbance history). The lack of such a nationwide scheme hampers efforts to include this level of biological diversity in inventory data. The need for this is basic to a wide variety of agencies and conservation groups, that it should be addressed in a nationally coordinated manner by NBS. Individuals with remote sensing and GIS expertise should participate in this development. Several agencies, including the National Park Service, currently have initiatives in this area and it is timely to address this issue.

Genetic diversity. We do not know of standards for databases to hold inventory data for genetic diversity. This issue should be examined by NBS.

Monitoring data. At several points during the workshop it was suggested that there needed to be a way of crosslinking monitoring data with the inventory databases that were the focus of the workshop. Monitoring data on populations of organisms are often highly taxon- and habitat-specific, but nonetheless could be crossreferenced to inventory and taxon-based databases. Databases for monitoring data for physical parameters are being developed by a variety of agencies (see letter in Appendix C), but these were not specifically addressed at the workshop. However, this topic does need to be addressed by NBS and NPS as part of the Inventory and Monitoring program.

**LIST OF APPENDICES**

- Appendix 1 Planning Meeting Report and Planning Committee Members
- Appendix 2 Participants and Affiliations
- Appendix 3 Meeting Agenda
- Appendix 4 Session 5 Discussion Questions
- Appendix 5 Correspondence
- Appendix 6 Databases and Other Reference Materials

Appendix 1

PLANNING MEETING REPORT AND PLANNING COMMITTEE



National Park Service Biological Inventory Database Development  
- a working group -

PLANNING MEETING  
8:00am-5:45pm, Tuesday May 25, 1993  
NC Botanical Garden, Chapel Hill, NC

The planning meeting was chaired by Susan M. Glenn (National Park Service Wildlife and Vegetation Division), was hosted by Peter White (University of North Carolina), and included Linda Pettit-Waldner (NPS, Global Change Program), Patricia Mehlhop (New Mexico Natural Heritage Program), Tim Goddard (NPS Biological Resource Information) and Gary Waggoner (NPS GIS Division).

CONCLUSIONS OF THE PLANNING COMMITTEE

- PURPOSE of the meeting being planned will be to:

***MAKE RECOMMENDATIONS FOR A BIOLOGICAL INVENTORY DATA SYSTEM TO BE USED BY THE NATIONAL PARK SERVICE THAT IS COMPATIBLE WITH OTHER DEPARTMENT OF INTERIOR SYSTEMS***

*Justification: This is an achievable goal that does not go beyond the authority or interests of the National Park Service but may result in products that are useful to other organizations.*

- INVITATIONS will be issued jointly by the North Carolina Botanical Garden Foundation and the National Park Service.

- MEETING AGENDA:

September 21, 1993

Morning

PRESENTATION OF RELATIONSHIP OF THIS PROJECT TO THE BIOLOGICAL SURVEY.

PRESENTATION OF EXISTING NPS AND NON-NPS DATABASES WITH QUESTION/ANSWER SESSION.

*The databases presented will be chosen from approximately 25 systems that will be surveyed prior to the meeting by the planning committee. Members of the working group will be provided with*

*an abstract describing each database presented. The individuals presenting the databases will be invited to stay for the entire meeting to answer questions.*

=  
Afternoon

**CONCURRENT WORKING GROUP SESSIONS RECOMMENDING SPECIFIC DETAILS OF BIOLOGICAL INVENTORY DATABASES:**

(SESSION 1) Vascular plant and vertebrate nomenclature standards.

*This group will also consider synonymy, QA/QC, documentation, consistency with other agencies, and if other taxa should be standardized.*

(SESSION 2) Data field standardization required to meet National and Regional needs.

*This session will involve presentation of a "strawman" system to be refined. The planning committee, with Sue coordinating, will prepare the strawman system based on the current NPFLORA, NPFISH, NPHERPS, NPMAMMAL, and NPBIRDS databases. Topics will include linking to other systems, location information, species status and distribution (T/E, exotic, etc.), species descriptions including habitat requirements, reliability of information, QA/QC, documentation, and consistency with other agencies.*

(SESSION 3) Data field standardization required to meet Park level needs.

*This group will cover topics using approaches specified in SESSION 2. A large generic "strawman" database system will be developed by the planning committee with Sue coordinating. Topics to be included are field data, records of observations, location information, species status in parks, reliability of information, QA/QC, voucher tracking, documentation, and level of detail to standardize,*

**REPORTS OF WORKING GROUPS (SESSIONS 1-3) WITH DISCUSSION**

September 22, 1993

Morning

CONCURRENT WORKING GROUP SESSIONS MAKING  
RECOMMENDATIONS ON GENERAL IMPLEMENTATION ISSUES:

(SESSION 4) Recommendations regarding roles and functions of park, regional and national offices.

*This group will include consideration of QA/QC responsibilities, documentation, system maintenance, and consistency with other agencies.*

(SESSION 5) Schedule and updating recommendations.

*This group will include consideration of QA/QC techniques, static versus dynamic systems, documentation, system maintenance, and consistency with other agencies.*

(SESSION 6) Recommendations of design and linkages of system.

*This group will include consideration of retrieval technology (i.e. thesaurus issues), QA/QC documentation, other documentation, system maintenance, and consistency with other agencies.*

REPORTS OF WORKING GROUPS (SESSION 4-6) WITH DISCUSSION

Afternoon

FINAL DISCUSSION OF SPECIFIC RECOMMENDATIONS

*This discussion should include consideration of policy of regarding the use and application of these recommendations and the proposed database system.*

CLOSING PRESENTATION on the goals and activities of the National Park Service Inventory and Monitoring program by Gary Williams.

- **DATABASES TO REVIEW** and person responsible for getting the information. We are requesting database descriptions of the structure, datafields and codes with a brief review of the successes, failures and limitations of the systems (3 pages max). This information should be forwarded to Sue Glenn to summarize. The planning Committee will decide who to invite to present their databases, therefore the date of the workshop should be mentioned to each of the following database administrators to give them fair warning of the meeting.

|                   |       |                     |       |
|-------------------|-------|---------------------|-------|
| TROPICOS          | Sue   | PLANTS              | Sue   |
| TNC/Heritage      | Pat   | NWI                 | Gary  |
| Quinn             | Sue   | NPLICHEN            | Sue   |
| NPFLORA           | Gary  | SMASCH              | Peter |
| ANCS              | Sue   | ASC                 | Sue   |
| Smithsonian       | Pat   | NOAA                | Sue   |
| EMAP              | Pat   | BLM                 | Sue   |
| FLA/FS Fire       | Sue   | LCTA                | Pat   |
| DoD/CERL          | Sue   | CaNHP               | Sue   |
| Great Smokies BCD | Peter | GAP                 | Sue   |
| RMP               | Tim   | IAR                 | Tim   |
| PROTRAK           | Linda | Science Dir.        | Linda |
| NBS               | Sue   | Circum Boreal Flora | Sue   |
| BONAP             | Peter |                     |       |

- **PARTICIPANTS**

Participants will have their travel expenses covered. Hardy Pearce will be asked to be a facilitator for SESSION 1, and the FINAL DISCUSSION Session. The following people were suggested by the planning committee:

NPS (Pay expenses for 15 Maximum, with alternates in brackets)

Linda Pettit-Waldner, Tim Goddard, Sue Glenn, Gary Waggoner, Anne Frondorf, Sarah Wynn, Keith Langdon, Noel Pavlovic, Diane Mallis, Kathy Jope, Miguel Flores, Gary Sullivan, Julie van Stoppen, Peter Bennett, Mike Gossett, (Gary Johnson, Dave Graber, Joe Meyer, Jim Holland, Kim Keating or Carl Key, Trish Patterson, Bob Krumenaker, Tom Stohlgren, Lloyd Loope, Margaret Osborne)

Non-NPS (15 Maximum)

Presenters of databases to be determined subsequent to review.

Suggestions included: Tom Duncan (UC Berkeley), Jim Quinn (UC-Davis), Larry Masters or Jeff Hammerson (TNC), Keith Carr (TNC), Buck Reed (USFWS), Cliff Wetmore (U.Minn.), Nancy Morin (Mo.Bot.Gard.), Scott Peterson (SCS), Jay Shepard (USFWS), John Kartesz (UNC), Doug McLeary (USFS), Dave Tazik (CERL-US Army), Dan Basta (NOAA), Jim Beach (Harvard).

- **OBSERVERS**

A maximum of 15 observers will be attending and they will be responsible for their own expenses. The following observers were suggested:

Gene Hester, National Park Service  
Tom Lovejoy, National Biological Survey  
Ann Hitchcock, National Park Service  
Ted LaRoe, National Biological Survey  
Gary Williams, National Park Service

- **PRODUCTS**

- Summary of databases prepared prior to meeting
- Recommendations for Data Fields (SESSIONS 1-3)
- Recommendations for Implementation in NPS (SESSIONS 4-6)
- Any Recommendations to NBS
  
- Manuscript of recommendations for data fields for submission to *Conservation Biology*.

## PLANNING COMMITTEE

Sue Glenn  
Wildlife and Vegetation Division (MS 490)  
National Park Service  
PO Box 37127  
Washington DC 20013-7127  
Phone: 202-343-8104  
FAX: 202-343-8137

Peter White  
Dept. Biology, Coker Hall  
Univ. North Carolina  
Chapel Hill, NC 27599-3280  
Phone: 919-962-6939 UNC  
919-962-0522 NCBG  
FAX: 919-962-1625 UNC  
919-962-3531 NCBG

Tim Goddard  
Wildlife and Vegetation Division (MS 490)  
National Park Service  
PO Box 37127  
Washington DC 20013-7127  
Phone: 202-343-8136  
FAX: 202-343-8137

Pat Mehlhop  
New Mexico Natural Heritage Program  
University of New Mexico  
2808 Central Ave. SE  
Albuquerque, NM 87131  
Phone: 505-277-1991  
FAX: 505-277-7587

Linda Pettit-Waldner  
Global Change Data Coordinator  
Wildlife and Vegetation Division (MS 490)  
National Park Service  
PO Box 37127  
Washington DC 20013-7127  
Phone: 202-343-8135  
FAX: 202-343-8137

Gary Waggoner  
GIS Division  
National Park Service  
PO Box 25287  
Denver, CO 80225-0287  
Phone: 303-969-2595  
FAX: 303-969-2822

## Appendix 2

## WORKSHOP PARTICIPANTS AND AFFILIATIONS

*National Park Service*

Sarah Allen, Western Regional Office  
Joan Bacharach, Curatorial Division, Washington, D.C.  
Terry Boyle, Water Resources Division, Ft. Collins  
Linda Clement, Curatorial Division, Rocky Mountains  
Amalin Ferguson, Regional Librarian, Southwest region  
Sue Glenn, Wildlife & Vegetation Division, Washington, D.C.  
Tim Goddard, Wildlife & Vegetation Division, Washington, D.C.  
Dave Graber, Sequoia & Kings Canyon National Park  
Ann Hitchcock, Curatorial Division, Washington, D.C.  
Keith Langdon, Great Smoky Mountains National Park  
Diane Mallos Woods, Information and Telecommunications Division, Washington, D.C.  
Marilyn Ostergren, Pacific Northwest region  
Trish Patterson, Southeast region  
Noel Pavlovic, Indiana Dunes National Lakeshore  
Linda Pettit-Waldner, Wildlife and Vegetation Division, Washington, D.C.  
Michael Ruggiero, Wildlife and Vegetation Division, Washington, D.C.  
Steve Tessler, Shenandoah National Park  
Gary Waggoner, GIS Division, Denver  
Gary Williams, Natural Resources, Washington, D.C.

*Other Government Agencies*

Eliot Christian, USGS, National Center  
Marty Gurtz, USGS  
Alison Hill, USA CERL, Champaign, Ill.  
Barbara Lamborne, EPA, Washington, D.C.  
Doug Ouren, BLM, Ft. Collins  
Scott Peterson, SCS, National Plant Materials Center, Beltsville  
George Russell, NMNH, Smithsonian

*Botanical Gardens*

Debra Kama, Missouri Botanical Garden  
Nancy Morin, Missouri Botanical Garden  
John Kartesz, North Carolina Botanical Garden  
Peter White, North Carolina Botanical Garden and University of North Carolina at Chapel Hill

*The Nature Conservancy*

Keith Carr, Arlington  
Pat Mehlhop, New Mexico Natural Heritage Program  
Larry Morse, Arlington

*Universities*

Christopher Meacham, UC-Berkeley  
Jeff Nekola, University of North Carolina at Chapel Hill  
Jim Quinn, UC-Davis  
Leila Shultz, Harvard (also Utah State)

Appendix 3  
MEETING AGENDA



## National Park Service Biological Inventory Database Development

- working group meeting hosted by the North Carolina Botanical Garden  
and the National Park Service -

= *Make recommendations for a biological inventory data system to be used by The National Park Service that is compatible with other Department of the Interior Systems*

### AGENDA

Tuesday 21 September 1993

Morning

8:00 **Welcome & Introduction**

8:15 **Relationship to the Biological Survey**  
Dr. Michael Ruggiero, Inventory & Monitoring Program,  
National Biological Survey

**Presentation of existing databases with questions.**

Session Chair: Dr. Patricia Mehlhop, University of New Mexico & TNC

Scribe & Timekeeper: Volunteer?

8:50 National Park Service NPFLORA/NPFAUNA  
9:10 National Park Service & Dept. Interior Specimen Standards  
9:30 Department of Defense/CERL  
9:50 Soil Conservation Service - PLANTS  
10:15 Confidentiality of Information  
10:30 Break  
10:50 Flora of North America  
11:20 Smithsonian  
11:40 Environmental Protection Agency  
12:00 Bureau of Land Management  
12:30 The Nature Conservancy - BCD

1:00 Lunch

Afternoon

1:45 **CONCURRENT sessions on specific recommendations  
for biological inventory databases.**

**(SESSION 1)** Vascular plant and vertebrate nomenclature standards.

Session Chair: Sue Glenn

Scribe & Timekeeper: Volunteer?

This group will consider sources, synonymy, QA/QC, documentation, consistency with other agencies, and if other taxa should be standardized.

Tuesday 21 September 1993  
Afternoon CONTINUED

**(SESSION 2)** Data field standardization to meet National and Regional needs.

Session Chair: Gary Waggoner, Nat'l Park Serv., Biological Survey

Scribe & Timekeeper: Linda Pettit-Waldner

Topics will include linking to other systems, location information, species status and distribution (T/E, exotic, etc.), species descriptions including habitat requirements, community/ecosystem/landscape level information, voucher tracking, reliability of information, QA/QC, documentation, and consistency with other agencies.

**(SESSION 3)** Data field standardization required to meet Park level needs.

Session Chair: Dr. Steve Tessier, National Park Service

Scribe & Timekeeper: Tim Goddard

Topics to be included are field data, records of observations, location information, species status in parks, reliability of information, community/ecosystem/landscape level information, population data including genetics, QA/QC, voucher tracking, documentation, and level of detail to standardize.

3:30 Break

3:50 Continuation of SESSIONS 1, 2, & 3.

4:30 Reports of working groups (SESSIONS 1-3, 15 minutes each) with discussion (45 minutes total).

Session Chair: Dr. Peter White

Scribe & Timekeeper: Dr. Patricia Mehlhop

6:00 Break

6:30 *Vans will pick up participants and take them to the North Carolina Botanical Garden for dinner. Anyone wishing to further demonstrate their database system can bring it on computer and set up at the garden for anyone interested.*

\*\* \*\* \*

Wednesday 22 September 1993

Morning

8:00

**CONCURRENT working group sessions making recommendations on general implementation.**

**(SESSION 4)** Recommendations regarding roles and functions of park, regional and national offices.

Session Chair: Trish Patterson, National Park Service

Scribe & Timekeeper: Volunteer?

This group will include consideration of QA/QC responsibilities, documentation, system maintenance, and consistency with other agencies.

Wednesday 22 September 1993  
Morning CONTINUED

**(SESSION 5)** Schedule and updating recommendations

Session Chair: Tim Goddard, National Park Service

Scribe & Timekeeper: Gary Waggoner

This group will include consideration of accountability and data accuracy at site, regional, and national levels, static versus dynamic systems, documentation, system maintenance, and consistency with other agencies.

**(SESSION 6)** Recommendations of design and linkages of system.

Session Chair: Linda Pettit-Waldner, NPS, Nat'l Biological Survey

Scribe & Timekeeper: Sue Glenn

Eliot Christian (USGS) will show a video on linking systems at 10:00 am. This group will include consideration of retrieval technology (i.e. thesaurus issues), QA/QC documentation, other documentation, system maintenance, and consistency with other agencies.

10:30 Break

11:00

**Reports of working groups (SESSIONS 4-6, 15 minutes each) with discussion (45 minutes).**

Session Chair: Gary Waggoner, Nat'l Park Serv., Biological Survey

Scribe & Timekeeper: Dr. Peter White

12:30 Lunch

Afternoon

1:15

**Final discussion of recommendations.**

Session Chairs: Dr. Patricia Mehlhop & Dr. Peter White

Scribe & Timekeeper: Dr. Peter White

This discussion will include consideration of policy regarding the use and application of these recommendations and the proposed database system.

3:30 Break

**4:00 Closing presentation on current activities of the NPS Inventory and Monitoring Program.**

Dr. Gary Williams, National Park Service

4:45 adjourn

9/18/1993 (11:34pm)

Appendix 4

SESSION 5 DISCUSSION QUESTIONS

## Biological Inventory Database Development

### Session 5: Schedule and updating recommendations.

#### Ideas to start the discussion:

1. How will the system provide accountability and assure high levels of data accuracy at site, regional, and national levels?
  - a. Should the system store/track the name, organization, site, credentials, date, etc., of individuals providing source data? If yes - define each data element that should be stored.
  - b. How should the data be verified?  
(consideration for site, region, and national)
  - c. Should (or can) the system provide useful feedback to the source data collectors?  
If yes, how?
- \* *PERSONNEL / STAFF REVIEW*
2. Will the central database be maintained in a static or dynamic method?
  - a. How should database updates be scheduled?  
(annual, quarterly, monthly, or "on-demand")  
Justify the recommendation.
  - b. How can the system provide future comparative analysis (comparing one data "snapshot" with another)?  
  
Example:
    - b.1. Annual publication?
    - b.2. Annual data archive?  
(When? - fiscal or calendar or other)
3. What documentation should be developed to support the system?  
Ideas: Metadata, detailed sys. description, user's manual, organizational/managerial chart, data flows, technical manual, etc..  
Define the functionality and use of each type.
- \* Each discussion should include considerations of inter-agency procedural and technical consistency.

## Appendix 5

## CORRESPONDENCE

The attached letters were submitted to the committee following the workshop and contain a number of suggestions pertinent to data base development. Summary points are described below.

*Letter #1*

Leila Shultz to Peter White  
Harvard University Herbaria  
Cambridge, Mass.  
October 3, 1993

re: collections by botanical specialists, access to databases, systems in place in other countries (esp. Australia's Environmental Resources Information Network - Erin), Internet as access to Flora North America

*Letter #2*

Terence Boyle to Peter White  
Department of Fishery and Wildlife Biology  
Colorado State University  
October 1, 1993

re: NPS's Inventory and Monitoring documents NPS-75 and 'Strategic Plan for Conducting Natural Resource Inventories in the National Park Service'; park classifications under I&M; components of the resources therein; cross classification with biogeographical considerations; consideration of using Storet and Bios; I&M as means of ecological risk analysis system for parks

DEPARTMENT OF FOREST RESOURCES

College of Natural Resources

Utah State University

Logan, Utah 84322-5215

L. Shultz  
c/o Harvard University Herbaria  
22 Divinity Avenue  
Cambridge, Massachusetts 02138



(801) 750-2455

(801) 750-2456

3 October 1993

Dr. Peter White  
North Carolina Botanical Garden  
University of North Carolina  
Chapel Hill, North Carolina 27599-3375

Dear Dr. White,

Thank you for implementing the interchange of ideas for the National Park Service workshop on natural resource inventories and databases. I know that providing a setting for such a multilayered meeting is no small task. You were a gracious host throughout. And thanks to Sheila Nickerson for so pleasantly working through all the details with us.

After the meetings, I drove west to the Blue Ridge area and became so fascinated by diversity there--walking trails to Mount Mitchell and Mount Pisgah--seeing *Abies fraseri* death and regeneration, *Galax* understory and *Sarracenia* habitat for the first time--that I drove no further. I was very pleased that the meetings were held in North Carolina.

As to recommendations for the workshop, there are some items I discussed in working groups, but would like to re-emphasize them here.

There is a clear mandate and some urgency to document species diversity within our National Parks. Speaking as a botanist, I make the following suggestions:

- Botanical specialists should be encouraged to collect within the National Parks. While this can be a controversial issue, sensitivity and clear guidelines should work for the mutual benefit of scientists and managers. Scientists should be able to register at visitor centers, fill out permit forms, state the purpose of their work, and receive some kind of identification tag while working in the park. [ I would suggest like an official researcher/NPS or NBS logo "patch" on an elastic band, to be worn around the arm. When the patch is returned to Park Superintendent, Chief Naturalist, or whomever is appropriate, scientists would have the opportunity to report their findings, and show specimens. If park offices have plant driers, specimens could even be dried overnight. ] Leaving numbered sheets with a general locality-- (one voucher per collection) *at the time of the visit* could make everyone's job much easier. Botanists could take duplicates with them, work at their institutions, and communicate findings by reference to their collection numbers. [These general guidelines could be adapted for systematics and ecologists in general--whether making observations or collections.]

- Access to databases should be encouraged--to provide an interchange of information between park managers and resource specialists. Internet provides an opportunity to link personnel at academic institutions with government agencies as well as the private sector. There should be some kind of on-line bulletin board (through Gopher, WAIS, or whatever seems appropriate) showing what information is available and whom to contact for further information. There should also be some kind of mechanism for researchers in the field to leave comments, reports of new information, etc. on the system. [For instance, herbarium taxonomists should be able to "call up" inventory lists for review. This would give people in the field a chance to try to correct erroneous reports, provide comments on appropriate nomenclature, and add new records. ]

I suspect that NBS decision makers will be looking closely at systems already in-place in other countries. The importance of using some of the lessons learned in other places cannot be over-emphasized. Working to develop international networks will be to everyone's benefit. In particular, the Australians, with their Environmental Resources Information Network, have developed guidelines appropriate to discussions of inventories within the U.S. National Park system. I am extracting quotes of some of the advice of the authors of ERIN, taken from "Environmental Resources Information Network (Erin) - An Overview", by Arthur Chapman ('arthur@erin.gov.au') for the Biodiversity Information Network (which I obtained through an internet 'gopher' system):

- "environmental information should be available through a network so that access is possible at the point where the information is required, rather than through a bureau-type service"
- "data should be stored on a network of computers, rather than on a central system, so that creators of a particular dataset can update and maintain it"
- "every effort must be made to acquire and store primary, rather than aggregated, data."
- "planning, research, development and management in relation to environmental information must be based on established and well organized interdisciplinary and multi-agency collaboration"
- "there should be easy access to data at minimum charges and without unnecessary administrative and other arbitrary encumbrances which would impede responsible environmental decision-making"

From the discussions taking shape during the NPS workshop, I believe that most of the above advice would be well received and endorsed by other workshop participants. On the second item, I think most of us would agree, however, that there should be some central archival point for storage of data. And on the last item, I think most of us would agree that easy access to information is vital.



In the past week, I have had the pleasure of 'logging on' to internet and searching the free-access database which the *Flora of North America* project has put on-line from published information in volumes 1 & 2 of the flora. Checklists and synonymy, literature citations, and distributions by state and Canadian province are available for all ferns and gymnosperms. One can do a "Boolean" search of associated names--extracting lists by state, family, or whatever information field is available. I understand that morphological descriptions are soon to go on-line as well. This access is one example of on-line information which is in keeping with the spirit of an open interchange.

Well, that's probably enough for now of my ideas. I would be happy to answer any questions you might have of me. Thank you, again, for your hospitality.

Sincerely,

A handwritten signature in cursive script, appearing to read 'Leila M. Shultz', written in black ink.

Leila M. Shultz

Dr. Peter White  
CB# 3280  
Coker Hall  
University of North Carolina  
Chapel Hill, NC 27599-3280

October 1, 1993

Dear Peter;

I would like to summarize several aspects of our discussion earlier this week with respect to the National Park Service's Inventory and Monitoring documents NPS-75 and 'Strategic Plan for Conducting Natural Resource Inventories in the National Park Service'. I believe several criteria not present in the document should be included into a process that strategizes I & M priorities and data collection. Just as the economics of small countries are not simply miniatures of the economics of large countries, and small wars are fought very differently than large conflicts, I believe that an adaptive strategy and tactics should be developed for conducting I & M that would accommodate a range of park needs in protected areas with different types of resources.

To be brief my comments will be directed to five points.

1) The 250 parks slated for natural resource I & M should be classified according to several criteria for type of I & M and level of effort. Factors to be considered in the classification of parks include:

- a) size/shape *ie* intermediate and smaller sized parks, long narrow parks such as riverways, national lake/sea shores, may need special considerations;
- b) the scientific value of resources in a particular park would need to be assessed to determine what level of effort might be supplemented by outside research;
- c) the nature and magnitude of threats to specific park resources.

2) The components of the resources should be defined by discipline or natural classification so that methodological aspects for each component can be systematically addressed. Some classifications that have been used in other similar efforts include: surface waters (streams and lakes), wetlands, near coastal, forests (by type), arid lands (grassland & deserts), etc. Standardization of I & M procedures should be done at a lower level of organization, that is at the individual or aggregate variable. For example there should be protocols and QA/QC for individual chemical tests, collection procedures for fish or invertebrate communities—not for all vertebrates or all tracheophytes.

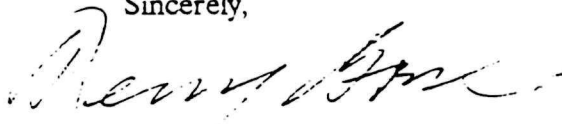
3) Cross classified with (2) above should be a biogeographical consideration. There are several systems available including the USEPA's *Ecoregions* map. This biogeographical system was designed to aide state regulatory agencies. The classification produced is a synthesis of land form, geology, soils, potential vegetation, and land use. It has been adapted by various states to set biogeographically based water quality standards.

4) I strongly recommend consideration of using *Storet* and *Bios* which are USEPA data handling programs for handling water resources/water quality data, including chemical, fish, benthic macroinvertebrate, and physical habitat descriptor data. The USGS contributes to *Storet* in its *Watstor* data base which includes all the chemical and hydrological data they collect around the nation. It is extremely important to the NPS I & M program that all of this data on water resources be capable of synthesis and integration with the data they will be collecting. This program is accessible via PC modem and is interactive. It holds and uses the complete NOAA taxonomic list that was described during the Chapel Hill workshop in Barbara Lamborne's presentation. The importance of using *Storet*, *Bios*, and *Watstor*, is that in order for water quality data to be used in a regional framework or in the regulatory arena, it must be available to the state agencies.

5) The final consideration for I & M is that it should be strategized to form an ecological risk analysis system for the park. The science of ecological risk is becoming well developed, and application of this perspective could help ask and answer the important question, "What will the park do with all this data when we get it?" This strategy should be explicit and should be in accord with the data requirements of existing legal and regulatory agencies.

Please excuse me if this appears to be forcing my views on a process that has had some considerable time in the development, but I have been developing strategies for I & M projects in a number of parks which at present have active ongoing monitoring activities, and I think this experience is of some value to the overall I & M strategy. Please incorporate the ideas in this letter in any form you see fit.

Sincerely,



*Terence P. Boyle Ph.D.*

Research Ecologist

Tel. 303 491-1452

FAX. 303 491-1511

E-mail [tpboyle@lamar.colostate.edu](mailto:tpboyle@lamar.colostate.edu)

## Appendix 6

## DATABASES AND OTHER REFERENCE MATERIALS

Items are listed alphabetically within two categories:

National Park Service and  
Other Agencies and Organizations

--

## National Park Service

**National Park Service Automated National Catalog System (ANCS)**

Contact: Museum Registrar  
NPS Curatorial Services Division  
P.O. Box 37127  
Washington, D.C. 20013

Developed by the Curatorial Services Division to access and catalog its extensive museum collections, including history, archives, fine arts, archaeology and ethnology, and a natural history component to catalog biology, geology, and paleontology specimens. Field-generated data such as field notes, photographs and media files are accommodated in the system. Can process large volumes of museum records that will be entered in over 300 park museums throughout the United States with capability for networking and centralization of records at regional and national levels. User-friendly system validating data and producing reports on fields such as collection provenance and object condition, scientific and common names, photo identification, eminent figure association, and materials. Classification system applicable to cultural objects and natural history specimens.

**National Park Service Investigator's Annual Report (IAR) Database System**

Contact: Washington Office, National Park Service  
USDI, Washington, DC

The IAR system is used servicewide to uniformly gather information on research activities being conducted within park units. The National Park Service *Annual Science Report -- Inventory of Research Activities in the National Parks* is created from data provided by this system. The IAR database contains data regarding research description, activity tracking, researcher information, bibliographic information, and budget information.

**National Park Service Project Tracking System (NPS PROTRACK)**

Contact: Washington Office, National Park Service  
USDI, Washington, DC

NPS ProTrack is a pc-based application system that tracks the administrative status of approved NPS research Program projects and area activities. Includes information about research projects such as: investigator, project identification, summary, dates covered, dataset, subject categories, museum collection number, specimens, findings, objectives, bibliographic data, milestones, tasks, etc.

### National Park Service Science Directory

Contact: Washington Office, National Park Service  
USDI, Washington, DC

A file containing data about science databases (metadata) in the NPS. This information may be used to locate database and provide some descriptive information in order to determine whether an independent and more specific search should be undertaken. Currently it is a file with no application system for retrieval and entry of data.

### NPFlora

Contact: Gary S. Waggoner  
NPS Geographic Information Systems Division  
P.O. Box 25287  
Denver, CO 80225  
(303) 969-2590

A data base containing information on all native and introduced vascular plants down to the infraspecies level occurring in North America, Hawaii or the Caribbean region, whether occurring in national parks or not. Contains information on taxonomy; regional distribution; plant origin (native or introduced); general habit descriptors; USFWS status; national park system distribution; and park botanical source citations used in data base. Reports can be run in park, regional, or Washington office. Incorporated into the COMMON's Report Library data base system in 1987. Managed from NPFLORA unit in GIS office, Denver. Based on original data base produced by the Smithsonian Institution (published in 1982 as NLSPN - "National List of Scientific Plant Names") and augmented by Kartesz synonymized checklist.

### NPFauna

Contact: Dr. James Quinn  
Division of Environmental Studies  
University of California  
Davis, CA 95616  
ph. (916) 752-3940

A computer program to access, edit, and retrieve information in National Park vertebrate survey databases, providing a graphical user interface for simplifying species list data maintenance at the park, regional, and national level. Data assembled primarily from the NPS Biotic Inventory Survey (BIS) programs in 1991-92. Compiled and standardized by University of California at Davis. Current version contains species data from approximately 170 Park units. Data needs reviewing and augmenting.

### NPS-75: Natural Resources Inventory and Monitoring Guideline

Contact: Washington Office, National Park Service  
USDI, Washington, DC

The 1992 document providing general guidance for inventorying and monitoring programs in the National Parks. The I&M Program is a Servicewide program to provide leadership and information resources needed to preserve and protect the natural resources of the

NPS system. The I&M Program will: inventory the natural resources and park ecosystems under NPS stewardship to determine their nature and status; monitor park ecosystems to better understand their dynamic nature and condition and to provide reference points for comparisons with other, altered environments; and the integration of natural resource inventory monitoring and inventory to standardize these practices and to form partnerships with other natural resource agencies in order to pursue common goals and objectives.

**Resources Management Assessment Program (R-MAP)**

*Contact: NPS Regional Director, Western Region  
600 Harrison Street, Suite 600  
San Francisco, CA 94107*

A computerized inventory of park resources in Western Region Parks which is being developed as the first module of a NPS-wide process to objectively identify the natural resources management and research staffing and support needs for all regions of NPS. Development phase of R-MAP is now complete and testing/refinement phase of the prototype is now underway with Park Profiles being used to run analyses on each of the Allocation Tables. Pilot parks in the Mid-Atlantic, Midwest, National Capital, North Atlantic, and Southeast Regions now involved in refining R-MAP.

**Resource Management Plan (RMP) Database System**

*Contact: Washington Office, National Park Service  
USDI, Washington, DC*

A National Park Service system to uniformly organize cultural and natural resource management project proposals. Proposals include: project description; categorical project tracking codes; budget requirements; staffing requirements. Utilized in all ten regions for planning purposes. Project information is entered by the parks and submitted to regional offices at least once a year. WASO maintains annual servicewide database.

## Other Agencies and Organizations

**Biological Conservation Data (BCD) System**

*Contact: Science Division  
The Nature Conservancy  
Arlington, VA*

The Biological and Conservation Data (BCD) System was developed by The Nature Conservancy to integrate biological diversity inventory, real estate protection, land management, and general administration data. The BCD system may be used to track information on elements of biological diversity, occurrences of those elements, conservation sites, projects for protecting sites, real estate tracts and transactions, property tax obligations, ecological monitoring programs and observations, plans for land management actions, and individual and institutional contacts.

*Biota of North America Program (BONAP)*

Contact: John Kartesz  
North Carolina Botanical Garden  
CB 3280  
University of North Carolina at Chapel Hill  
Chapel Hill, NC 27599

This is an extensive database on vascular plants north of Mexico including the taxonomy, synonymy, computerized identification, distribution, and other fields of information. The BONAP nomenclatural data has been used as the basis of the nomenclature in PLANTS, the Soil Conservation Service database, by the Nature Conservancy, and by the US Fish and Wildlife Service. The project has computerized county records for a number of states and has worked with the University of California-Berkeley to produce a series of computer keys to North American plants in MEKA:

*Botanical Collectors Authority File*

Contact: David Boufford  
Harvard University Herbaria  
22 Divinity Ave.  
Cambridge, MA 02138

This is a database available over the INTERNET on GOPHER. The file includes standard references for authors of plant names as part of an effort to computerize data from type specimens.

*Collection and Research Information System (CRIS)*

Contact: CRIS Administrator, Department of Botany  
National Museum of Natural History  
Smithsonian Institution  
Washington, D.C. 20003

CRIS is designed to provide easy access to museum collection records related to five program areas: biological diversity; systematics and evolution; ecosystem history and global change; earth resources and planetary history; human cultural diversity; and collections as world resources. Provides an information architecture to support cross-disciplinary and inter-organization information retrieval, increase the quality of automated information, adhere to open system environment standards, speed application development, and control maintenance costs. Has a research catalog subsystem with information on collecting units, observations, species taxa, collecting localities, collecting events; and a transaction management subsystem supporting the processing of and containing information on collection transactions, permits, agreements, projects, and the like.

*Content Standards for Spatial Metadata*

Contact: Federal Geographic Data Committee  
USGS  
590 National Center  
Reston, VA 22092.

A draft report was issued in 1992 that sets forth guidelines and definitions for metadata

having to do with mapped or mappable information.

**Description of federal information programs and data bases for biodiversity**

Contact: Jacques Kapuscinski  
US EPA

Draft description of biological diversity databases, with contact names and addresses, for 10 federal agencies and the Nature Conservancy.

**Government Information Locator Service**

Contact: Eliot Christian  
U.S. Geological Survey  
802 National Center  
Reston, Virginia 22092

Intended to help the public locate and access public information resources throughout the U.S. Federal government. An approach to organizing information for maximum flexibility of search and retrieval. Uses information networks as its primary medium. A component of the National Information Infrastructure. Information providers from the private sector can also be affiliated with GILS. To be available in homes, workplaces, schools, and libraries throughout the United States.

**Information Model for Biological Collections**

Contact: Committee on Computerization and Networking  
Association of Systematics Collections  
Janet Gomon, Co-Chair  
Smithsonian Institution  
10th St. & Constitution Ave NW  
Washington, DC 20560

A draft report was issued in March, 1993, covering the computerization of natural history collection information.

**International Organization for Plant Information Global Plant Checklist (IOPI)**

Contact: George F. Russell  
Department of Botany  
Smithsonian Institution  
Washington, DC.

IOPI will establish a network of integrated, reliably documented, automated databases of plant names, biological attributes, potential utilization, and conservation needs. The first goal is to compile a Global Plant Species Checklist using data from a variety of sources. Raw data will be edited by specialists from various countries, and will be constantly updated and reviewed.

**Land Condition-Trend Analysis (LCTA) program**

Contact: Dave Kowalski



*U.S. Army Construction Engineering Research Laboratories  
2902 Newmark Dr.  
Champaign, IL 61821  
(217) 398-5450*

A U.S. Army program using standard methods to collect, analyze, and report natural resources data for land inventory and monitoring purposes. Inventory utilizes permanent field plots, stratified random sampling, and emphasizes multiple applications of data. Designed to assemble a complete collection of all vascular plants occurring on an installation and to produce a comprehensive, annotated list of all taxa present, including threatened and endangered species. Helps delineates biophysical and regulatory constraints, monitor changes in land resource condition, refine land management plans, implement standards in collection, analysis and reporting of acquired data for Army-wide complication.

### **MIDAS**

*Contact: Environmental Science and Technology Center  
2401 Research Blvd., Suite 205  
Fort Collins, CO 80526  
(303) 221, 4872*

MIDAS, Monitoring Information Data Analysis System, provides consistent, computerized management of monitoring data on renewable resources. Structured along ecosystem component themes and functions. Can show relationships between sites, provide observational data, display statistical information, allow communication with resource specialists in disparate locations and agencies for ecosystem management and biodiversity strategy planning. Modules being developed for air, water, soils, vegetation, animals, and a global comparator. Modules developed and in test are hydrology, aerometrics, and vegetation.

### **National Water Quality Assessment (NAWQA) Program**

*Contact: Martin E. Gurtz  
U.S. Geological Survey  
Raleigh, North Carolina*

NAWQA is a long-standing program of the USGS designed to describe the status of and trends in the quality of the nation's surface- and ground-water resources and to provide an understanding of the natural and human factors that affect the quality of these resources. The program evaluates water from local to national spatial scales. NAWQA is an integrated assessment which incorporates physical, chemical, and biological components. The biological components of NAQWA emphasize the development of an improved understanding of the relations among physical, chemical, and biological characteristics of streams as an integral part of interpreting water quality status and trends.

### **NODC Interagency Taxonomic Reference Database**

*Contact: Barbara Lamborne  
EPA's Office of Information Resources Management  
(703) 235-5609*

Taxonomic file of the National Oceanographic Data Center. In operation since 1976. Since 1985, EPA has provided systems support. Comprehensive list of taxonomic

information including: scientific name, taxonomic rank, taxonomic serial number, synonyms, common names, & author of name. Includes all categories of taxa, from bacteria to mammals. Current coverage includes over 200,000 names, 118,000 of which are species. Enables agencies without their own to access high quality taxonomic information, as it also facilitates sharing of biological information among cooperating agencies.

### PLANTS Database Access Guide

Contact: *PLANTS/PEAS Coordinator*  
*USDA, SCS, TISD*  
*2625 Redwing Road, Suite 110*  
*Ft. Collins, CO 80526*  
*(303) 498-1968*

PLANTS is the acronym for Plant List of Attributes, Nomenclature, Taxonomy, & Symbols. Presently designed primarily for agency database administrators to utilize in revising and standardizing their existing data. Serves as foundation data set for natural resource and plant databases for U.S. federal agencies, including NPS. Foundation is a list of native or naturalized plants known to occur in North America. Initially developed and is being maintained in cooperation with the Biota of North America Project of the North Carolina Botanical Garden, plus the input of over 700 botanists familiar with North American flora. Long-term updating of nomenclature is underway.

### SMASCH

Contact: *Tom Duncan*  
*University of California*  
*Berkeley, CA*

This is a project that has computerized a wide variety of museum collections, including natural history collections, at the University of California, Berkeley.

### Wide Area Information Servers (WAIS)

Contact: *Eliot Christian*  
*U.S. Geological Survey*  
*802 National Center*  
*Reston, VA 22092*  
*Phone: (703) 648-7245*  
*Fax: (703) 648-7069*

The USGS, in company with a consortium of major corporations and 150 universities are attempting to develop a public domain software version of the Z39.50 information retrieval protocols. WAIS is targeted to users who have limited computer skills and need a powerful search and retrieve mechanism. USGS began its involvement in WAIS in its efforts to enhance its Earth Science Data Directory, which contains references for earth science data from state to continental scales.