CULTURAL RESOURCES GIS: THE CASE FOR SPATIAL DATA CONTENT STANDARDS

by

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(Under Direction the of Professor John C. Waters)

ABSTRACT

Cultural resources are inherently spatial entities, and the paper based inventory systems that have prevailed for cultural resources have been relatively effective at recording and storing cultural resources data, but have limitations in the retrieval, analysis, and management of that data. The modern Geographic Information System (GIS) has made investment in cultural resources GIS (CRGIS) a priority for public and private organizations. But, uniformity in the approaches to developing CRGIS data is of greater value than a fragmented approach. Before the benefits of GIS can be fully realized, standardized approaches to developing and maintaining CRGIS data must be put into place. Therefore, industry-wide data standards and models must be developed and implemented as soon as is practicable. This research provides an overview of GIS and spatial standards development methods and techniques, highlights current technological and disciplinary trends, reviews current CRGIS standards development, and identifies key players in this process.

INDEX WORDS: Historic Preservation, Cultural Resources, Archaeology, Geographic Information Systems, Standards, Federal Geographic Data Committee, Metadata

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CONTENT STANDARDS

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TABLE OF CONTENTS

Page

LIST OF TABLES vi

LIST OF FIGURES vii

CHAPTER

1 Overview of Cultural Resources GIS 1

A. Introduction 1

B. Definition of GIS 6

C. History of GIS use for Cultural Resources Management 11

2 Needs For Standards 26

A. Characterization of Cultural Resources Data 26

B. Core Data Standards 28

C. Needs for Standards 29

3 Spatial Standards 44

A. Overview of Spatial Standards 44

B. Methods of Standards Development 46

C. Industry Model Examples 58

4 Related Standards and Technological Trends 80

A. Metadata 80

B. GIS Technology 86

C. Data Formats and Transferability 87

D. Temporality 88

E. Data Security..90

5 Current CRGIS Standards Development 92

A. Spatial Data Structure for Facilities, Infrastructure and Environment 93

B. Western States 98

6 Participants and Roles..105

7 Conclusions and Recommendations 110

A. Conclusions 110

B. Recommendations...111

SELECTED BIBLIOGRAPHY..115

APPENDICES 121

A. Acronyms Used...121

LIST OF TABLES

Page

Table 1: FGDC Standards Process......49

Table 2: State CR GIS Survey, Geospatial One Stop......84

Table 3: SDSFIE Entity Sets......96

Table 4: Cultural Entity Classes and Types......97

Table 5: Spatial Feature Methodology and Metadata......100

Table 6: Summary of Recommendations......111

LIST OF FIGURES

Page

Figure 1: Vector Data....7

Figure 2: Raster Data 8

Figure 3: Data Analysis 9

Figure 4: Information Management....11

Figure 5: Cultural Resources Information Flow. 24

Figure 6: Data Pyramid....27

Figure 7: FGDC Standards Process Flow Diagram 50

Figure 8: Transportation Features UML Diagram....61

Figure 9: Biodiversity Data Flow 66

Figure 10: Biotics 4 Conceptual Model....68

Figure 11: Metadata Organization 81

Figure 12: Geospatial One-Stop Portal Concept....82

Figure 13: Spatial Selection Bounding Box....85

Figure 14: Archaeological Site Screen Comparison....91

Figure 15: SDSFIE Data Model....95

Figure 16: Western States Logical Data Model....103

Chapter 1: Overview of Cultural Resources GIS

A. Introduction

Identification and assessment of historic properties and archaeological sites are standard preservation practice at many organizational levels, and pursuant to a wide variety of processes. Federal agencies identify cultural resources in response to federal historic preservation regulations. State Historic Preservation Offices (SHPOs) are charged with maintaining statewide inventories of cultural resources, and may also maintain the statewide registries of archaeological sites (although this function may also be performed by a separate agency). Local governments, especially those that participate in the Certified Local Government program (CLG), identify, designate and regulate cultural resources within their jurisdiction. These efforts, collectively, have generated volumes of invaluable information about cultural resources. But the viability of this information depends on the consistency and adaptability of the techniques used to organize, retrieve, and analyze it.

Cultural resources are inherently spatial entities, and the paper based mapping and inventory systems that have prevailed in historic preservation and archaeology have been relatively effective at recording and storing cultural resources information, but have severe limitations in the retrieval, analysis, and general management of that information. Today, however, the convergence of computer technology and spatial analysis in the form of the modern Geographic Information System (GIS) has made investment in Cultural Resources GIS (CRGIS) a priority for public and private organizations at all levels.

The benefits of GIS for Cultural Resources Management (CRM) have been addressed on numerous occasions. Papers by Rakos, 1995, McCarthy, 1998, and Fields, 2003 are but a few of the efforts to qualify and quantify CRM applications of GIS. While the adoption of such techniques in historic preservation has been slow to evolve, a summary of the general benefits one can expect from CRGIS implementation includes:

Comprehensiveness: Mapping of cultural resource locations has always been a key component of identification, but such efforts generally include only the resources within the scope of the study. Evaluation of a given geographic area often means comparison of multiple separate sources of information. In GIS however, all relevant cultural resources data can be displayed at the same time, providing a more comprehensive understanding the preservation issues.

Data Integration: GIS integrates data from different sources such that it can be combined and analyzed in various ways. For instance, the integration of archaeological site locations with data for river and stream networks can highlight areas with potential for new archaeological sites. Conversely, the availability of cultural resource data elevates the status of historic preservation in other planning processes. Consideration of environmental issues in project planning relies on a wealth of data about rare and endangered species, wetlands, water quality, and much more, but the consideration of cultural resources is often addressed separately or later in the process because the data has not been available. GIS data for cultural resources will ensure that critical early decisions are made with the full environmental picture, avoiding the "too-little too-late" scenario for historic preservation

Data Availability: The timing of cultural resources GIS development creates added benefits for historic preservation. Currently, preservationists can take advantage of extensive libraries of GIS data that already exist in many forms at little or no cost. In addition to the environmental data mentioned above, there are satellite and aerial imagery, topography and elevation data, as well as cadastral, or tax parcel, data.

Advancements in GIS technology: Historic preservation also benefits from newer and better technology for using GIS data. Prior adoption of GIS technology was often stymied by the high costs of software, hardware, and expertise required to operate a GIS. Today however, freely available data viewers such as ESRI's ArcExplorer, and Internet based mapping services are enabling GIS on every desktop computer. While there is a learning curve to working with GIS applications, once learned, the skills translate easily between the wide varieties of applications available. While these "free" tools will not solve the needs of the agencies and organizations charged with mandated CRM responsibilities, they provide an outlet for the CRGIS data once developed.

The potential applications of CRGIS range from resource specific documentation to broad resource inventories and macro analysis. A review of how GIS supports historic preservation functions at the various levels of government and in the private sector illustrates the critical role GIS can play in maximizing efforts to conserve our shared cultural heritage:

Local Government:

- Assists the Historic Preservation Commission (HPC) in administration of local ordinances by indexing locally designated landmarks and districts and recording the status of pending and completed applications for approval.
- Informs municipal planning processes such as master plan development, community development and redevelopment activities, zoning, and general community public relations.

County/Regional Government:

- Informs regional planning processes such as regional master plans, and transportation planning.
- Provides a basis for implementing historic preservation grant and loan programs.

- Enables park and recreation management by integrating cultural resource issues with other park and recreational management issues such as infrastructure, resource allocation, environmental quality, etc..

State Government:

- Informs statewide regulatory programs administered by the State Historic Preservation Office (SHPO).
- Enables park and recreation management by integrating cultural resource issues with other park and recreational management issues such as infrastructure, resource allocation, environmental quality, etc.
- Informs project planning across state agencies by allowing for earlier consideration of potential cultural resource impacts.
- Establishes a basis for administration of inventory and recordation programs such as the National and State Registers of Historic Places, Archaeological site registration, general statewide cultural resource inventory, and resource documentation programs (such as HABS or state equivalents).

Federal Government:

- Informs national regulatory programs administered across federal agencies
- Enables park and recreation management by integrating cultural resource issues with other park and recreational management issues such as infrastructure, resource allocation, environmental quality, etc..
- Informs project planning across federal agencies by allowing for earlier consideration of potential cultural resource impacts.
- Enhances recordation programs.
- Supports broad cultural resource analysis and research across state and regional boundaries.

Academic:

- Informs and enhances research activities.
- Enables comparative analysis.

Private:

- Enhances CRM efficiency in research and data collection.
- Enables commercial integration into pre-packaged planning and zoning management solutions.

But, uniformity in the approaches to developing CRGIS data is of greater value to all organizational levels and constituents than a fragmented approach. Before any of these uses and benefits can be fully realized, standardized approaches to developing and maintaining cultural resources information must be put into place, which will ensure the viability and effectiveness of the investment in GIS technology and data. Therefore, industry-wide data standards and models must be developed and implemented as soon as is practicable. The Federal Geographic Data Committee (FGDC) has recognized this issue as paramount for all GIS development:

> To reap the benefits of the vast data resources being generated today and expected in the future, it is important that agencies make the investment in and the commitment to... basic tenets - common standards, data partnerships and accessible data.[1]

Similarly, the National Park Service responded in 1999 by establishing a Cultural Resources Working Group (CRWG) under the FGDC's Subcommittee on Cultural and Demographic Data. The mission of the CRWG as stated in its charter is to "develop, update and review recommendations for the collection and maintenance of spatial cultural resource data, as well as metadata."[2] That initiative, however, has yet to result in demonstrable progress towards nationally applicable CRGIS spatial data standards. The National Park Service has promulgated draft standards, but those are not yet available for public review.[3]

In light of this situation, this research is intended to justify the need for CRGIS standards and outline the factors that impact bringing those standards to fruition. It is not the purpose of this research to achieve that end, but rather to motivate the preservation and archaeological communities to undertake this critical step in the development and dissemination of CRGIS data. This research proposes to:

- Provide an overview of GIS and its use for cultural resources,
- Provide an overview of spatial standards development methods and techniques through the examination of other industry standards and models,
- Highlight current technological and disciplinary trends that impact standards development,
- Review the status of current CRGIS standards development, and
- Identify the key players in this process.

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[1] Federal Geographic Data Committee. "The Federal Geographic Data Committee: Historical Reflections - Future Directions," January 2004. Document online (accessed 31 August 2004), available from <www.fgdc.gov/publications/fgdc_history.html>, 1; Internet.
[2] National Park Service. "Subcommittee on Cultural and Demographic Data: Cultural Resources Work Group Charter," 1998. 2.

B. Definition of GIS

In order to understand the importance of standardization, one must first understand the basics of Geographic Information Systems (GIS). GIS are multi-faceted tools for spatially enabling all types of data. As defined by the National Research Council, "…GIS is a structural approach to collecting, archiving, analyzing, manipulating, and displaying data having one or more spatial components, using a combination of personnel, equipment, computer software, and organizational procedures."[4] But more fundamentally, GIS are digital maps ("Geographic") combined with electronic databases ("Information") organized and integrated ("System") to support effective decision-making. Databases record the descriptive data, or tabular attributes, of the entities involved, while the mapping records the location, size, shape, or spatial attributes of those entities.

GIS has evolved in step with the general evolution of computing and information management. The first commercial GIS packages appeared in the 1970's, and spread with the overall increase in computing accessibility in the 1980's. The 1990's saw "geometric increases in computing power" and increased access to geographic data.[5] The internet revolution has similarly transformed access and management of geographic information and will likely continue to do so for the foreseeable future. The proliferation of mapping and spatial information in everyday life is evidenced by the multitude of address finding and mapping websites (MapQuest, Yahoo, and Expedia), inclusion of on-board navigational systems in vehicles, and the more recent advent of true three-dimensional mapping applications such as Google Earth, which puts a

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[3] Knoerl, John. National Park Service.(personal communication, 23 February 2006).
[4] National Research Council. "Spatial Data Needs: The Future of the National Mapping Program," 1990. Online (accessed 11 March 2006), available from <newton.nap.edu/html/spatialfuture/ch3.html>; Internet.
[5] Rutgers University. "Desktop Mapping with ArcView (Coursebook)," 2001.

worldwide library of spatial data on any computer desktop. But in spite of this continued proliferation, the functions of all of these systems can be summarized into four basic categories: Data Input, Data Storage and Manipulation, Data Analysis, and Data Output.

It is clear that *data* is a key component of any GIS, and there are a multitude of spatial data types that can be used, primarily: vector (points, lines or polygons, Figure 1), raster (imagery, elevation, etc., Figure 2), and tabular (alphanumeric data in rows and columns). Each of these data types exist in a multitude of formats depending on software applications, storage needs and analytical uses for the data.

Data Input involves creating or accessing data in one of the formats referenced above for use in GIS. Data sources can include aerial or satellite imagery (raster), Global Positioning System (GPS) data (vector), or spatially representing a table of addresses or coordinates (tabular). These data sources may need to be created or captured for a specific project, or may already exist as data that can be brought into the GIS project.

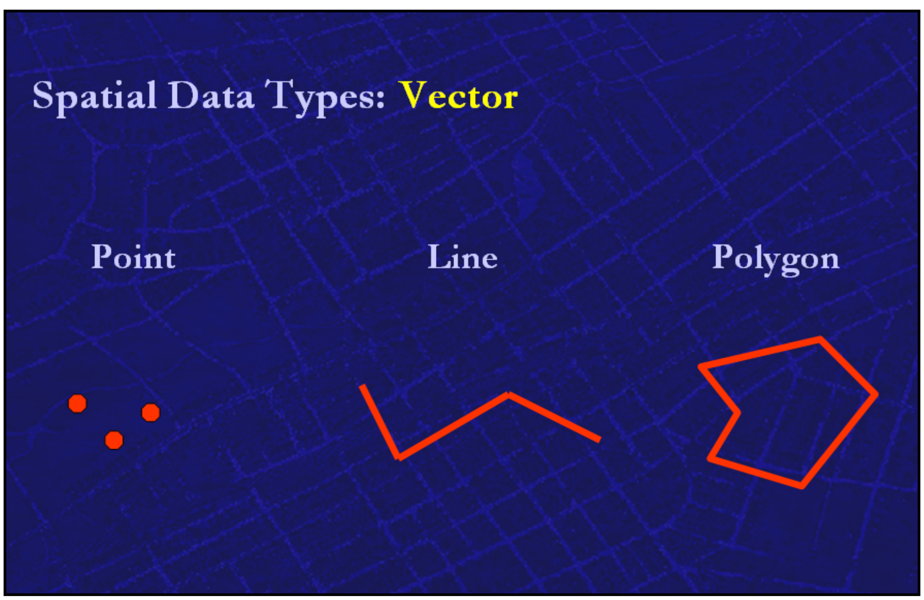

Figure 1: Vector Data

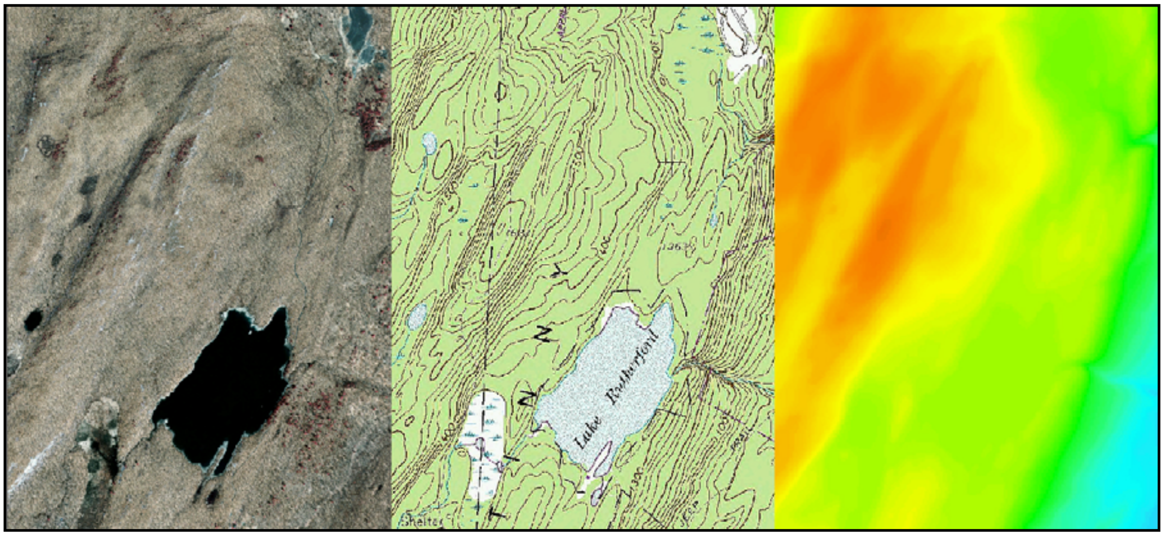

Figure 2: Raster data.

Data Storage and Manipulation involves the management of various formats for each of the data types, and may involve conversions of data format or type as necessary. Common vector formats include ESRI Shapefile, CAD, and ArcInfo Coverage. Raster formats include JPEG, MrSID and DRG for representing images, and DEM or GRID for representing elevation or other measured phenomenon. Tabular formats include d-Base (DBF) tables, Microsoft Excel spreadsheets, Microsoft Access tables, or any enterprise database application table (Oracle, Sybase, etc.)

Data Analysis is at the heart of why GIS is such a powerful tool, and involves accessing the above referenced data to answer specific questions through spatial queries, evaluate conditions through spatial analysis, or simulate real world conditions through spatial modeling. Spatial queries can be characterized as “to the map,” where underlying tabular data is queried for a specific value (ie. Soil Type = Sandy, or Age < 30) and the results are displayed on the map, or “from the map,” where an area of interest is defined on the map, and the values of features from one or many layers is selected in the underlying tabular data.[6] Spatial analysis involves combining a variety of data layers to derive certain spatial characteristics that can be further combined to result in a spatial interpretation of those characteristics. A typical spatial analysis is presented in Figure 3, where various land data layers are combined to derive Slope, Erodabilty and Runoff, which can then be interpreted as Potential Soil Erosion.[7] Finally, spatial modeling involves the combination of the prior two techniques in a systematic series of steps to achieve a spatial representation of a known, desired or likely phenomenon. As defined in the ESRI GIS Dictionary, spatial modeling is, "A methodology or a set of analytical procedures that simulate real-world conditions within a GIS using the spatial relationships of geographic features."[8] A common example in historic preservation is the predictive modeling of archaeological sites:

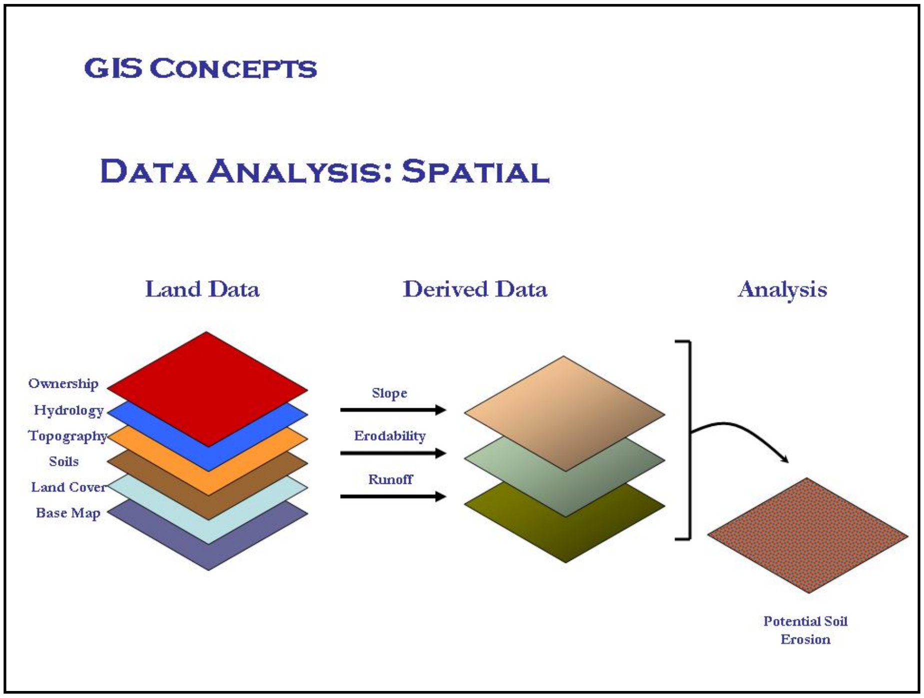

Figure 3: Data analysis

[6] Rutgers University, "Desktop Mapping," 13.
[7] Ibid., 16.
[8] Earth Systems Research Institute. "GIS Dictionary," March 2006. s.v. "Spatial Modeling." Online (accessed 21 July 2006), available from <support.esri.com/index.cfm?fa=knowledgebase. gisDictionary.gateway>; Internet.

> An archaeological predictive model is a tool that indicates the relative probability of encountering an archaeological site. These are sometimes referred to as archaeological ‘sensitivity’ maps because they indicate that some locations are more sensitive than others for cultural resources. These predictive maps usually contain three zones: a high sensitivity area where archaeological sites are most likely, a medium sensitivity area where sites are less likely, and a low sensitivity area where sites are unlikely.[9]

In all, these analysis techniques provide answers through the application of geoprocessing tools to combinations of spatial and tabular data to satisfy particular information needs. Seeing these results as graphical representations, however, is handled by the final GIS function: Data Output.

Data Output involves generating a visual representation in a variety of forms or providing data to other processes. Visual representations include, most basically, the computer display, and printed (hardcopy) maps. Both of these combine a representation of data or analysis with common cartographic elements such as symbology, labels, legends, and scales. Additionally, output includes providing GIS data to other applications or processes. Internet mapping applications provide a customized interactive view of GIS datasets that can be accessed remotely via the internet. Such datasets can also be made available for real-time use directly within a remote users GIS application. Finally, GIS data may serve as one element of an overall information management strategy such as illustrated in Figure 4.

This overview of GIS barely scratches the surface of the topic, but it is apparent, even from this abbreviated snapshot, that data and the methods used to process it are fundamental to GIS. Key to ensuring consistency among those data and methods are the standards that define the

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[9] Gibbon, Guy. “Archaeological Predictive Modeling: An Overview” (Appendix A of *A Predictive Model of Precontact Archaeological Site Location for The State of Minnesota: Final Report*), 2003. Document online (accessed 19 March 2006), available from <www.mnmodel.dot.state.mn.us/chapters/app_a.htm >; Internet.

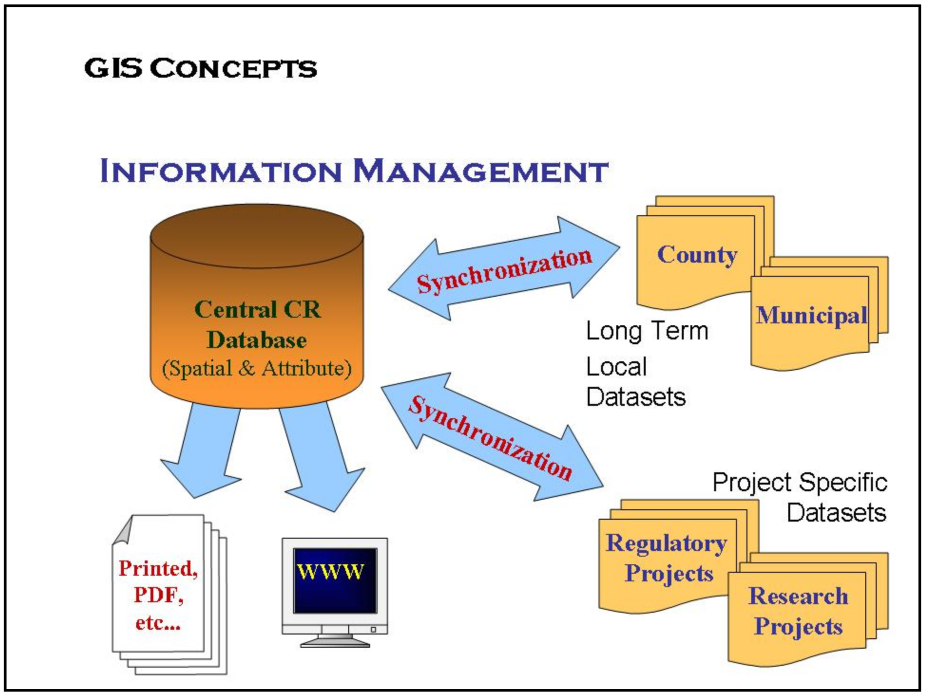

Figure 4: Information Management

various data types, software environments, and analytical processes. With an understanding of these basic concepts, it is now appropriate to address how GIS has so far been applied to historic preservation issues.

C. History of GIS use for Cultural Resources Management

GIS has long found applicability in many disciplines, including: environmental science, ecology, forestry, and local land use planning, and has more recently found application in such areas as health, public safety; and commercial routing and scheduling. While the conceptual application of GIS to cultural resources has been around as long as GIS itself, the implementation of such techniques has been slower to evolve at the broad management scale that is the focus of this research. As with the benefits outlined above, projects and initiatives for CRGIS development have been well documented in previous research and site specific examples abound, but three key studies provide a glimpse of the evolution of CRGIS techniques and applications:

- U.S. Congress, Office of Technology Assessment, *Technologies for Prehistoric and Historic Preservation,* September 1986,
- Lynn Rakos, *The Use of Geographic Information Systems (GIS) in U.S. Historic Preservation Offices and a Preliminary Survey and Needs Assessment for a New Jersey Cultural Resources GIS Database*, May 1995, and
- Stefan Claesson, *Phase I: feasibility Study for the Development of Software Applications for Cultural Heritage Management,* March 2002.

What follows is an overview of each of these studies, with a summary of how they relate to the current need for cultural resource standards.

1. 1986: Office of Technology Assessment

In 1986, a series of workshops empanelled by the Congressional Office of Technology Assessment (OTA) explored a wide variety of technological issues and their applicability to historic and prehistoric preservation.[10] As noted in the introduction, "In this assessment, preservation technology refers broadly to any equipment, methods, and techniques that can be applied to the discovery, analysis, interpretation, restoration, conservation, protection, and management of prehistoric and historic sites, structures, and landscapes."[11] The results of this work were summarized in a September 1986 report entitled *Technologies for Prehistoric and Historic Preservation,* which presented a variety of issues associated with the application of technology to the "preservation process," defined as:

- discovery,
- recording and measurement,
- analysis and evaluation,

[10] U.S. Congress, Office of Technology Assessment. *Technologies for Prehistoric and Historic Preservation, OTA-E-319* (Washington, DC: U.S. Government Printing Office, September 1986), iii.
[11] Ibid., 5.

- restoration, conservation and maintenance,
- protection from catastrophic losses,
- data and information storage and retrieval, and
- public education and involvement[12]

Generally, the report highlighted the need for better use of technology to address the overall needs of the Nation's cultural resources, noting that,

> Preservationists in all preservation disciplines share problems of obtaining access to information about technologies, training, and coordination of research on technologies. They also share the constraints of inadequate and decreasing funding and lack of coordinated implementation of Federal policy.[13]

Among the issues raised as contributing factors were, "few standards exist for the use of some new preservation techniques."[14] As written, this applies mainly to physical preservation techniques, but it is equally applicable to GIS technology. The report also notes that "there is a strong need for better coordination in the use of new technologies for preservation," pointing out a general lack of information sharing and transfer across the wide variety of organizations and agencies with responsibility for historic preservation.[15] Finally, the report notes that "new technologies are slow to become part of preservation research planning and research design."[16]

Recommendations for solving these issues included creation of a preservation technology clearinghouse, which was the genesis for National Center for Preservation Technology and Training (NCPTT).[17] The work of the NCPTT has inspired much progress in addressing these broad technology issues for many aspects of historic preservation (materials conservation, archeological methods, etc…), but the same has not been true for CRGIS or general cultural

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[12] Ibid., 16.
[13] Ibid., 35.
[14] Ibid., 36.
[15] Ibid.
[16] Ibid., 37.
[17] Ibid., 38.

resources information management. The role of NCPTT in CRGIS Standards development will be addressed in more detail below at Chapter 6, Participants.

Of all the technologies considered by the report, GIS was addressed only briefly relative to others, but was noted as being "available for a wide variety of analytical and management chores because many cultural resource data are spatial in nature."[18] This limited treatment may be reflective of GIS as a young technology at that time, with high barriers to entry:

> In discussing the use of such advanced techniques, participants in this study noted that many administrators who control the purse strings regard GIS, remote sensing, and other advanced methods as expensive, yet for large areas, it can be one of the cheapest methods for gathering data, especially because it allows access to information impossible to retrieve in any other way.[19]

The report goes on to recommend the establishment of Regional GIS Centers to minimize the expense of GIS and "help spread this technological innovation more rapidly and effectively through the preservation community."[20] It is not clear whether any such centers were ever established, but given the state of GIS hardware and software, at the time it was a reasonable proposition. These recommendations have since been overtaken by unforeseeable advances in computing power and speed, as well as radically different software environments. Many necessary datasets are available remotely and computing power to run GIS on the desktop is much more affordable.

The report devoted substantial coverage to remote sensing, a seemingly related technology. This may be reflective of a wider gap between the disciplines of GIS and remote sensing than exists today. Remote sensing was referenced as most applicable to archaeology and landscapes, but with some applicability for historic structures:

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[18] Ibid., 66.
[19] Ibid., 77.
[20] Ibid.

> Remote sensing technologies that hold the greatest future promise for improving site and landscape discovery, identification, and evaluation are those that provide a broad, overall (synoptic) view and record data in digital form for direct computer processing (e.g., multispectral scanners on spacecraft or aircraft). However, for most applications today, aerial photographs are extremely valuable and much cheaper than multispectral scanners. They can also be used for identifying and assisting in determining the significance of historic structures.[21]

It is worth noting that today, consistent with the technical advances noted above, digital ortho-photography is widely available at resolutions exceeding one foot per pixel, which is invaluable for evaluating condition and context for historic structures and archaeology alike.

Generally, these spatial technologies are referenced with specific limited applications such as predictive modeling, rather than a broader information management perspective, which is addressed separately in the report as “Data and information storage and retrieval.” Primarily referencing tabular data, the report cites that "efficient access to information remains one of the greatest impediments to effective management of cultural resources."[22] Despite 20 years of progress in information management, this lack of access continues true today for many cultural resources datasets. The interesting aspect of this section of the report, however, it that the issue of standards for cultural resources information is raised numerous times.

The role of the SHPO’s is addressed in this regard, noting that, “All States via the State Historic Preservation Offices maintain the most systematic lists on archaeological sites and prehistoric and historic structures within the States and Territories.”[23] The report further notes that:

> The Computers Committee of the National Conference of State Historic Preservation Officers has, since 1983, attempted to standardize certain elements of the State-Federal preservation program. The committee’s effort will link individual State computer databases with the National Register Information System and aid those preservation

[21] Ibid., 47.
[22] Ibid., 23.
[23] Ibid., 113.

> offices in the early phases of computerization. This initiative will greatly facilitate, with the adoption of common data fields, each preservation office's ability to engage in information exchanges and cooperative studies. In addition, it will give greater uniformity to the year-end reports the State offices must submit to NPS in order to receive Federal historic preservation funds.[24]

This Computers Committee found, however that there was difficulty in resolving the variety, quality, and completeness of State databases, and "…completed a list of fields for rehabilitation tax credit databases, fields for bibliographies, and an overview of database design."[25] The report found that:

> Although the goal of coordinating the voluminous amount of existing preservation information and creating a national database for historic preservation might be attractive for reasons of simplicity of research, a national database looks neither technically feasible nor affordable in the short run. Because the field is multi-disciplined and fragmented, it is not bound by one accepted set of terms. There is a need to provide data to a variety of preservation practitioners–scholars, Federal managers, architects, scientists, and craftsmen. Therefore efforts might be better expended on the technically easier task of establishing a network of links and keys to tie multiple databases together.[26]

Today, there remains a need to connect varieties of disparate databases that either share a common schema, or with inconsistent schema's that can be mapped together, and integrate those various information sources for particular purposes. But the feasibility of a "national database" should not be dismissed without further investigation.

The report's summary of the issues regarding preservation information clearly establishes that standards are a vital component of any overall information management strategy. Issues 2, 3, and 4 directly cite the need for standards:

> Issue 2. A number of impediments exist to the application of computer technology to historic preservation information needs:
>
> - lack of communication and coordination among database designers, leading to duplication of effort,

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[24] Ibid., 111.
[25] Ibid., 116.
[26] Ibid.

- lack of standardization in data systems and language,
- lack of Federal level leadership and commitment regarding the improvement of preservation data management,
- lack of computer networks for historic preservation,
- costs.

> Issue 3. Standardized formats are essential for convenient and reliable access to databases. Yet, except in the world of research libraries, there has been little or no attempt to standardize or strictly define the various data elements or to create compatible formats and terms that would provide common access to documentation for individual sites or structures.
>
> Issue 4. The preservation community needs a variety of information on preservation technologies and sources of expertise, delivered expeditiously. …However, before delivery of such information is possible, it will be necessary to develop a nationally accepted format within which existing and new information can be incorporated." [27]

While these issues are referencing tabular data and databases available in the mid 1980's, the same issues apply to today's needs for integrated spatial and tabular data management.

In conclusion, the work of the OTA in 1986 revealed a highly varied technological landscape for the cultural resources disciplines. With regards to the federal agencies, for instance:

> For the most part the regional offices of the various land managing agencies have traditionally operated with great autonomy. This autonomy has resulted in a fragmented approach to applying computer technology to historic preservation information. Regional offices would benefit greatly from compatible hardware, software, and standardized formats.[28]

Generally, the cultural resources applications of GIS are characterized by a number of issues. First, GIS is clearly only in use for specific applications, primarily archaeological predictive modeling. The high cost of entry dictates shared data and hardware resources. GIS has yet to find widespread use as an overall data management tool. Finally, tabular databases were becoming

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[27] Ibid., 115-116.
[28] Ibid.,111.

more widely used, but without a comprehensive standards, and the level of development was in part dependent on where the SHPO was located in state government. Overall, this report clearly shows that GIS had taken hold as a tool for CRM, but has not yet become a unifying and integrative technology.

2. 1995: Rakos

Moving ahead to the mid 1990's and the technological revolution that was occurring at that time, one finds that while computer technology, and in particular use of the internet as an information tool, had advanced tremendously, the issues surrounding management of cultural resource information had not necessarily advanced accordingly. Lynn Rakos' thesis, entitled *The Use of Geographic Information Systems (GIS) in U.S. Historic Preservation Offices and a Preliminary Survey and Needs Assessment for a New Jersey Cultural Resources GIS Database*, provides a comprehensive overview of how GIS had developed since the 1986 OTA report.

One issue dealt with by Rakos was the use of GIS for CR beyond archaeological research and predictive modeling. Rakos lists the benefits of GIS for broad based cultural resources inventory and management, including: the integration of large amounts of spatial and tabular data, higher profiles for cultural resources in other planning processes, and enabling new spatio-temporal analysis in the evaluation of impacts to cultural resources from undertakings proposed by regulated agencies.[29] These reflect the generally acknowledged benefits for adopting GIS for any discipline.

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[29] Lynn Rakos, "The Use of Geographic Information Systems (GIS) in U.S. Historic Preservation Offices and a Preliminary Survey and Needs Assessment for a New Jersey Cultural Resources GIS Database" (Master's Thesis, Rutgers University, 1995), 55-61.

A primary component of this work was a survey of State Historic Preservation Offices (SHPOs) for status of CRGIS development. The results were compiled and presented as states with working GIS (seven), states in database development (seven), and states in the "advanced planning stage" (sixteen).[30] At the time of the survey, nineteen states did not have and were not developing CRGIS, although several were "considering obtaining a GIS as soon as it were feasible,"[31]

States determined to have active CRGIS included: Arkansas, Hawaii, Illinois, Maryland, Massachusetts, Rhode Island, Vermont, and Wisconsin.[32] A follow-up written survey was sent to these States, which revealed that configurations, levels of investment, and procedures regarding CRGIS development varied widely depending on numerous factors. Common among these states, however, was a precursor tabular database upon which to base creation of spatial data. The age and level of detail varied for these tabular datasets, but that early work jumpstarted the delineation of those resources in GIS.[33] Arkansas was an early adopter of digital data for archaeological resources; Beginning in the 1970's "detailed field descriptions and allowable data lists provide a good basis for "statewide standards."[34] Maryland was another early adopter of databases and GIS for cultural resources. Although they abandoned their first system (MAGI) in the 1980's, Rakos notes that they were able to develop a system that "vies with Arkansas for the position of having the most comprehensive GIS setup."[35]

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[30] Ibid., 65.
[31] Ibid., 66.
[32] Ibid.
[33] Ibid., 100.
[34] Ibid., 66-67.
[35] Ibid., 69.

The seven States characterized as in "limited development" included: Connecticut, Minnesota, New York, North Carolina, Oregon, Virginia, and Wisconsin.[36] Rakos defines limited development as partial data development or hardware and software investment.

Sixteen States were in the “planning" stage in 1994, including Alaska, Arizona, California, Florida, Georgia, Kentucky, Maine, Mississippi, New Mexico, Ohio, Pennsylvania, Tennessee, Texas, Utah, West Virginia, and Washington, and they all "present different approaches to the GIS issue.”[37] It is the variety of approaches that most impacts the standards issue.

Finally, the states that did not have and were not developing CRGIS at the time included: Alabama, Colorado, Delaware, Idaho, Indiana, Iowa, Kansas, Louisiana, Michigan, Mossouri, Nebraska, Nevada, New Hampshire, New Jersey, North Dakota, Oklahoma, South Carolina, South Dakota, and Wyoming.[38] Of those, several now have CRGIS in some form, including: Colorado, Nevada, New Jersey, and South Carolina.

3. 2002: Claesson

The most recent study that charts the evolution of CRGIS was completed in 2002 by Stefan Claesson & Associates for the Federal Highway Administration’s Small Business Innovation Research Program. The final report, *Phase I: Feasibility Study for the Development of Software Applications for Cultural Heritage Management*, was issued March 2002 and distributed to the SHPOs that participated in a survey conducted in the Fall of 2001. “The survey was intended to gather specific information about SHPOs individual efforts to develop GIS and

[36] Ibid., 86.
[37] Ibid.
[38] Ibid., l65.

relational-database systems to manage cultural resources."[39] The study was also intended to "focus on the feasibility of developing a software application to identify, evaluate, and consider the impact of transportation projects on a broad range of cultural resources."[40] However, as Claesson points out, "there remain many challenges in developing GIS *SuperApps* for managing cultural resources, and that the development of a data standards software application with a common open interface is necessary."[41]

The focus on application based development has not proven entirely successful in the past, and Claesson's assessment that a standards based development approach is necessary for CRGIS dovetails nicely with the goals of this research. Once standards are in place, applications will follow of their own accord as government and private sector needs dictate. Without standards, any such application development only results in isolated datasets and management systems.

While Claesson did not include specific states responses in the report, he did summarize the results of the survey, noting that fifty-one SHPOs returned a completed survey.[42] One-hundred percent responded that they used computer software to manage cultural resources. While 45% currently have a GIS in place (25% for greater than 3 yrs and 20% for 1 to 3 yrs), 39% indicated they were currently implementing a GIS, and the remaining 16% were "gathering information about GIS."[43] This means that 100% of SHPOs will be using GIS at some level to manage cultural resources by the end of this decade.

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[39] Claesson, Stefan. "Phase I: Feasibility Study for the Development of Software Applications for Cultural Heritage Management." March 2003, 4.
[40] Ibid., 12.
[41] Ibid.
[42] Ibid, 6.
[43] Ibid, 4.

The results also show SHPOs in a variety of technology positions,[44] which is not surprising given the non-technical nature of the discipline. However, this may also be reflective of a lack of strong support for upgrading computer hardware and software on a regular basis. Such cyclical upgrades have been required by the ever changing computer environment, but the procurement process and funding restrictions for computing equipment make it difficult for SHPOs to "keep up".

Regarding databases, the results indicate that SHPOs use different databases for different types of resources, which Claesson notes as "prolific among SHPOs."[45] It is likely that this condition stems from the strict disciplinary view of cultural resources, rather than a more holistic view of resources as a single class of entities with distinct but related subtypes. For example, archaeological resources have been treated as wholly separate from architectural resources, and had generally received greater attention in GIS development. Claesson's surveys reveal that SHPOs are progressive in converting archaeological records to databases.[46] One reason for less GIS emphasis on architecture may be historic preservation's focus on above ground resources as an understandable and more easily dealt with resource type. As a less tangible entity, archaeological resources become more manageable, both conceptually and administratively, when dealt with in a GIS context. Archaeological GIS provides a greater sense of understanding and objectiveness to an inherently more complex resource type. The struggle with how to analyze archaeology on broader scales is suited to GIS. Architecture is more easily analyzed in basic ways without GIS, although with GIS the possibilities for such analysis are greatly

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[44] Ibid, 9.
[45] Ibid, 10.
[46] Ibid, 16.

expanded.[47] However, when viewed from a macro-management perspective; both architecture and archaeology have much in common. Both resource types: a) occupy some geographic space with definable boundaries (even if those boundaries are not yet known), b) have some status in relation to the National register of Historic Places, and c) can have similar threats and opportunities for long term preservation. It is these common elements that can form the basis of a core data standard for cultural resources.

The results also show that SHPO use of spatial data varies widely, noting that, "Geographic reference Systems are outdated and location data is irregular. There also is confusion among map projections and Cartesian coordinate systems. The data quality of feature data, therefore, must be 'carefully reviewed."[48] Until the advent of GIS, SHPOs simply relied on the USGS 7.5 minute topographic map for locational recording, without necessarily realizing the underlying projection and coordinate system issues. Primarily, that the projection upon which the topographic map series was based changed over time, meaning that locations plotted in different projections will not align with each other. It was not until SHPOs began applying GIS to their recorded data that inconsistencies were found.

Claesson further notes that lack of standardization in data types is a critical issue for CRGIS:

> The most prominent comment received during the course of this survey is that there are no data standards or guidelines for SHPOs to follow in developing GIS and relational database systems. Clearly, the needs of individual states and agencies vary greatly as do the cultural resource under their jurisdiction.[49]

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[47] Armstrong , Douglas V, LouAnn Wurst, and Elizabeth J. Kellar. *Archaeological Sites and Preservation Planning in Central New York: A Unified Site File and GIS Database for NYSDOT Region 3, Volume I.* (Waterford, N.Y.: New York State Historic Preservation Office, 2000), 28.
[48] Claesson, 12.
[49] Ibid.

This lack of data standards is key, and greatly impacts each State's individual efforts, but it is questionable that the needs of the states and their cultural resources are so highly varied. While all SHPOs and agencies must operate in an administrative context and must be able to function in that context, their basic regulatory functions are the same, as is the need to manage cultural resource information. Standards will enhance these basic functions by allowing agencies, CRM firms, and SHPOs to speak same language. Figure 5 illustrates the basic information flow that applies to the CR Inventory process. Finally, Claesson concludes that data interchange and internet based applications are underdeveloped due to the lack of standards.[50]

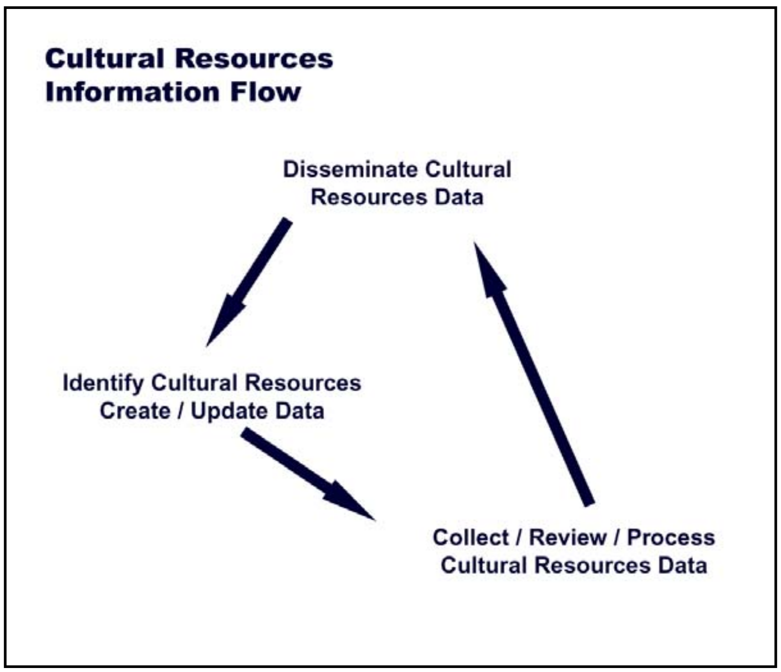

Figure 5: Cultural Resources Information Flow

In each of these three studies, the issue of standards and standardization is a recurrent theme. While the use of GIS for cultural resource management has grown, the effort to

[50] Ibid., 12.

standardize that use has seen little success. In order to understand why such standardization is relevant to CRGIS, we next consider the need for CRGIS standards.

Chapter 2: Needs For Standards

Given the continuing development of CRGIS, and the likelihood that more and more CRGIS data will be developed at an ever increasing rate, it is reasonable to assume there will be a need to integrate and manage that data in a more formal and controlled way. Standards can enable that integration. But, in dealing with the question of the need for CR spatial standards one must be prepared to answer the question: Why bother? What benefits result from standardization? How can standardization further historic preservation goals? Possible answers are many, but before examining the detailed answers to such questions, it may well be useful to better understand the nature of cultural resources data and to expand on the concepts of "core" vs. "exhaustive" standards approaches.

A. Characterization of Cultural Resources Data

Rakos relates an accurate summary of cultural resource data: "This data has been succinctly summed up as ‘descriptive, interpretive and administrative (Eric Komori, personal communication 1994)."[51] But it is possible to expand that characterization further into four general categories in a “data pyramid,” as illustrated in Figure 6: Basic or "Core" Data, Characterization Data, Administrative Data, and Project or Research Specific Data. The potential number of data elements, or level of detail, increases with each level of the pyramid.

Basic or "core" data are those elements that describe the most basic information common to all cultural resources. Such elements include name, address, county and municipality, block

[51] Rakos, 100

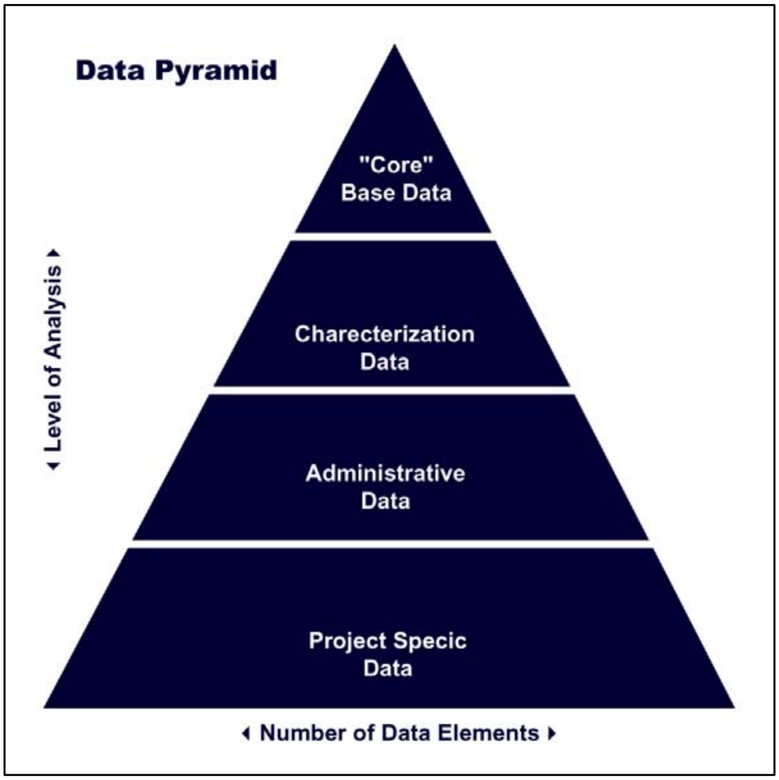

Figure 6: Data Pyramid

and lot, and National and/or State/Local Register Status. These elements are all that are required to represent a cultural resource in a tabular or spatial dataset. The key here is commonality among all resources.

Characterization Data are those data elements that provide a detailed understanding of specific resources. Data such as temporal associations, typologies, methods and materials, historic contexts, significance, and justifications. Associated documents such as National Register nominations, Historic American Buildings Survey (HABS) documentation, etc. also fall within this category, as do links to other datasets.

Administrative data are those elements that provide details of the identification, evaluation, and preservation constraints and opportunities for specific resources. Such data may also include histories of activity (constructive, investigative, restorative, or adaptive) at a resource.

Finally, project and research specific data are those data elements that support specific research or analysis at one or many resources. For instance, data that support predictive modeling: slope, aspect, proximity to hydrology, and soil type are all initiative specific for a given geographic area. Broad based resource analysis for a particular resource type may require additional data as well. A study of bridges for instance would benefit from road development data and analysis. An analysis of general community development would benefit from historical demographics and real estate transaction data. Project specific data may exist or need to be created.

These four data types apply to both spatial and non-spatial, or tabular data, and are present in various ways in most CRGIS datasets that have been generated to date. Characterizing each data element in a dataset in this manner gives us the means to identify which data elements are common across datasets and ultimately allow for establishing a minimum "core" definition for CRGIS representation.

B. Core Data Standards

What is a "core" standard? An overview of the standards development process will be provided in Chapter 3, but an understanding of "core" vs. "exhaustive" standards approaches can provide insight to the discussion of the need for standards that follows. Standards that define the minimum number of data elements that adequately describe and identify an entity can be referred to as "core" data standards. Such standards would only deal with data elements that fall within the first level of the data pyramid illustrated in Figure 6. Alternatively, standards that attempt to define every logically relevant data element associated with an entity can be referred to as "exhaustive" standards, which would capture at least the first three levels of the data pyramid, and possibly some aspects of level four. Of course, many standards development initiatives fall somewhere in-between these two extremes.

There is merit however, to limiting the attributes included in a standard to those absolutely necessary. A study of transportation data standards for the New Jersey Department of Transportation (NJDOT) notes that:

> A data model that is more complex than necessary increases the administration burden of keeping all the feature classes up to date and increases the likelihood that high data quality cannot be maintained. The effort to keep the data model as simple as possible, yet maintain the capability to add functionality as needed is the keystone of this analysis.[52]

This approach lets specific detailed data be maintained by user separately, but the model or standards allow for easy integration as needed.

Another reason to maintain only the core elements in a standard is that there are likely to be multiple standards which could be applied to cultural resources activity that operate at multiple levels on the data pyramid. One approach would be to scope out the full suite of cultural resource related standards, then assess the status of each and only move forward with specific development initiatives based on perceived need, funding and other factors. An alternative approach is to move ahead on one specific standard, such as a core content standard, recognizing that it fits into a broader, if undefined, standards context.

C. Needs for Standards

Now that we have identified how CRGIS data is structured and our options for approaching a standards initiative, we can consider those questions left un-answered from above:

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[52] Michael Baker Jr., Inc. "New Jersey Department of Transportation: Transportation Data Model Analysis Report," 5 September 2003. Document online (accessed 25 February 2006), available from <www.nj.gov/transportation/gis/datamod.pdf>, 15; Internet.

Why bother? What benefits result (or perhaps more appropriately, what needs are met by such standardization)? How does meeting those needs enhance cultural resources management?

First and foremost, we must "bother" with standards because they are required. President Clinton issued Executive Order 12906 on April 11, 1994 coordinating implementation of the National Spatial Data Infrastructure (NSDI) and establishing a geospatial data clearinghouse based on NSDI. Similarly, in 2002, the Office of Management and Budget (OMB) revised Circular A-16 "to reflect changes in technology, further describe the components of the National Spatial Data Infrastructure (NSDI), and assign agency roles and responsibilities for development of the NSDI."[53] Circular A-116 "…requires the development, maintenance and dissemination of a standard core set of digital spatial information for the Nation [the NSDI] that will serve as a foundation for users of geographic information."[54]

NSDI is defined as a combination of technology, policies, standards, human resources, and related activities.[55] More specifically, "The components of the NSDI are data themes, metadata, the National Spatial Data Clearinghouse, standards, and partnerships."[56] Standards are further defined as "...common and repeated rules, conditions, guidelines or characteristics for data, and related processes, technology and organization."[57]

Circular A-16 also assigns federal agencies certain responsibilities regarding implementation of NSDI, and notes that, "No federal funds will be used directly or indirectly for

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[53] Office of Management and Budget. "Circular A-16. Revised." 19 August 2002. Document online (accessed 17 July 2005), available from <www.whitehouse.gov/omb/circulars/a016/a016_rev.html>; Internet. Circular A-16 was originally promulgated in 1953 to ensure coordination of federal mapping activities.
[54] Ibid., 2.
[55] Ibid. This is similar to the National Research Council's definition of GIS referenced above.
[56] Ibid., 2.
[57] Ibid., 3.

the development of spatial data not complying with NSDI standards, as specified by the FGDC."[58] Cultural resources spatial data is generated everyday without conformance to any standard through the Section 106 process and Historic Preservation Fund pass through to local governments, among others. The National Park Service (NPS) is designated lead agency for cultural resources data.[59] Accordingly, NPS is responsible under section 8d(1) to:

> Provide leadership and facilitate the development and implementation of needed FGDC standards, especially a data content standard for each data theme. Agencies will assess existing standards, identify anticipated or needed data standards, and develop a plan to originate and implement needed standards with relevant community and international practices in accordance with OMB Circular A-119...[60]

NPS progress in this regard is detailed in Chapter 5, but the requirement for standards is clear, and underpins much of NSDI development:

> A coordinated approach for developing spatial data standards that apply to collecting, maintaining, distributing, using, and preservation of data will improve the quality of federal spatial data and reduce the cost of derivative products created by federal and non-federal users.[61]

Circular A-16 also requires coordination of these standards initiatives with States, Tribes, and other stakeholders, so presumably this will be part of the NPS's ongoing development.

But beyond the requirement to do so, development of cultural resources data standards addresses a variety of issues and needs for CRM, among them:

- Consistency / Uniformity
- Interoperability
- Dissemination of Data
- Understandability
- Commercial Viability
- Quantifiable
- Fiscal Responsibility

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[58] Ibid.
[59] Ibid., 10.
[60] Ibid., 6.
[61] Ibid., 4.

- Comprehensiveness
- Jurisdictional Clarity

Satisfaction of these issues is in many cases directly related to the realization of the benefits for GIS implementation.

Consistency / Uniformity: The need for consistency or uniformity in cultural resources tabular and spatial data is fundamental to achieving the benefits of CRGIS outlined above. However, there are distinct aspects of "consistency" as applied to CRGIS. Primarily there are internal and external consistencies. Internal is relative to the values in a particular data element: Do they all refer to the same thing in the same way? External refers to similarly constructed and populated values across distinct data sets: Is the data element, or elements, that convey "address" in data set A constructed the same way as "address" in data set B?

In general, the process of developing any digital dataset introduces some level of consistency to the data. The Office of Technology Assessment noted in 1986 that, "...making effective use of such technologies will require the development of standardized formats for data collection and recording. Improved coordination within the preservation community could assist in the development of such standards."[62] Rakos notes that, "standardization was expressed by two other offices as one of the main advantages of implementing a computer system."[63] But this refers to standardization within a single dataset when converting from manual recording systems. It is true that the manual systems that evolved for recording cultural resources have resulted in a wide variety of information conditions, but computerization does not magically cure those conditions. "The shift from analog files and maps to electronic form brings all the data flaws,

[62] Office of Technology Assessment, 23.
[63] Rakos, 103.

lying dormant in stacks of paper, to the fore where they must be addressed."[64] The problem to date has been that, in the absence of nationally applicable standards, organizations have had to deal with both developing their own data schemas, as well as seeking resolutions for these "data flaws."   Standardization across jurisdictions, agencies, and regions will allow all CRIGIS initiatives to focus on data quality rather than the data structure and format.

Rakos also relates comments by Hillard and Riggs regarding consistency that highlights clearly the need for standards:

> Consistency in the data, or rather the lack thereof, can cause difficulties. Terms, such as those concerning topographic features or cultural affiliations, need to be clearly defined. Landforms termed one thing by one researcher can be called something else by another which skews analytical results. Consistent simple terms need to be developed which can be used as sites are recorded in the field. The Arkansas site encoding manual includes a term definition section which help foster data standards (Hilliard and Riggs 1986).[65]

But this and other references to "standardization" seem to consider it an ad-hoc result of the application of digital tools. As will be seen below, this is not the case. Standardization must be a pro-active, concentrated effort by a representative group of interested organizations.

Rakos also noted that the National Park Service was developing standards at the time, but points out that, "The adoption of a National standard has been maligned as each state has its own needs."[66] She goes on to note:

> Data fields in the tabular databases, and ultimately the GIS, reflect certain characteristics of individual states and their methods of maintaining their cultural resources inventories, the state political boundary divisions, and their own particular prehistoric and historic development. A number of general baseline data are however entered in all cases.[67]

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[64] Ibid.
[65] Ibid., 113.
[66] Ibid., 62.
[67] Ibid.

But as noted above, the need and application for cultural resource data should be similar across federal agencies, states, and local government.

Consistency in the data is necessary to expand the scope of analysis for cultural resources. Rakos points out that,

> A common system... will facilitate data sharing between political boundaries. These demarcations are often meaningless when discussing cultural affiliations and patterns. The ability to access quickly information from neighboring states will help enrich the overall picture of both prehistoric and historic settlement.[68]

This is reinforced by Claesson:

> The United States cultural resource community has not adopted a single set of standards to describe the different cultural resource information classes; each municipal, state, and federal agency has designed databases, schemas, and standards for their own specific purposes, tailored to their own regions. Although the standards for a particular dataset are functional to the specialist, they are confusing and do not facilitate use by the non-specialist. In addition, the inconsistency in how cultural resources are documented and archived does not facilitate cross-boundary or cross-jurisdiction analysis. Standards allow for reliable and consistent data for review and compliance procedures, data discovery, accuracy assessments, and predictive modeling.[69]

Ultimately, consistency in disparate datasets enables all of the benefits for GIS already mentioned, as well as allowing for CRGIS data to meet the following needs.

Interoperability: "Interoperability" refers to the ability of CRGIS data to be integrated into distinctly different applications and analysis both within and beyond the discipline of historic preservation. Within preservation, the consistency noted above will enable various jurisdictions to draw upon disparate datasets to perform specific tasks, or populate specific GIS based applications. Rakos cites Allen, et. al, noting that “At a regional level, archeological databases will be encouraged and be increasingly incorporated (or at least made compatible with) statewide

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[68] Ibid.
[69] Ibid., 19.

and federal GIS databases."[70] In a 1993 proposal to the National Science Foundation, Ebert notes that "...effecting consistent GIS site and survey databases nationwide will facilitate the interconnecting of these data, possibly in a national network of state, federal, and private data providers and users."[71] Similarly, Diedre McCarthy of the National Park Service CRGIS Facility noted in 2001 that:

> Sharing GIS and cultural resource data across local, state, and national boundaries will soon become commonplace, enabling researchers and planners to interpret cultural resource data in ways never possible before.[72]

But, as Claesson points out, "...the lack of data standards for cultural resources does not allow for the interchange of data between state and federal agencies, or meet geospatial data standards mandated, for example, by the Federal Geographic Data Committee (FGDC)."[73] Up to now, the "compatibility" of disparate datasets could only be resolved through case by case re-engineering of the data required for analysis, an expensive and time-consuming proposition. This is changing however through the concept of "schema mapping," but there remains a need for a minimum level of standardization ("core" standards). Alternatively, such issues can be largely avoided through "exhaustive" standardization, also an expensive and time-consuming proposition, albeit a one-time expense.

At the federal level alone, agencies with cultural resources responsibilities have had to develop their own recording and mapping systems to aid in compliance with Section 106. The

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[70] Ibid., 61.

[71] Ebert, James. "A Study of the feasibility of developing generally applicable methods and techniques for conversion of existing State cultural resource databases to geographic information systems (Phase I Small Business Innovation Research (SBIR) proposal to the National Science Foundation, June 14, 1993)."14 June 1993, 8. This proposal gets at concept of data standardization without the terminology. Ebert refers to more directly connected data, but such connections rely on consistent databases.

[72] McCarthy, Deidre. "Applying GIS Technology to Preservation Planning," *Forum Journal* 15 (Summer 2001): 48.

[73] Claesson, 1.

US Fish and Wildlife Service (USFWS) has developed an archeological database with procedures for creating spatial data.[74] Bureau of Land Management (BLM) has done extensive work with the western SHPOs to standardize cultural resources data processing. The military has made much progress on CRGIS standards development, but according to a 2001 General Accounting Office (GAO) report still "lacks reliable data on cultural resources."[75]

Beyond historic preservation, the ability to incorporate cultural resources into transportation planning, municipal planning, facilities management, and other such disciplines allows broader use, understanding, and impact of CRGIS, as well as increasing chances of successful outcomes for cultural resources. Unfortunately, it is an area of CRGIS which has had the least documented success.

Dissemination of Data: Similar to consistency and interoperability, the need to disseminate data to varied users is key to the successful application of CRGIS to cultural resources management. The manner in which data can be disseminated follows along the lines of the "data output" function of GIS detailed above, and standards can be applied to this process in various ways. The benefits of standards have already been proven by the success of metadata standards in allowing creation of GIS data clearinghouses. Known as the Content Standard for Digital Geospatial Metadata (CSDGM), these are the standards by which GIS data are documented, and their application to CRGIS datasets will be discussed in detail in Chapter 4: Related Standards and Technological Trends.

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[74] Barr, Victoria. "USFWS Cultural Resources Data Set and GIS Mapping Instruction Guide," 27 October 2004. Document online (accessed 6 February 2006), available from <www.fws.gov/historicPreservation/crp/pdfs/FWS_CRdataSet_GISmappingGuide.pdf>; Internet.
[75] United States. General Accounting Office. "Defense Infrastructure: Military Services Lack Reliable Data on Historic Properties," 2001, April. Document online (accessed 5 December 2005), available from <www.gao.gov/new.items/d01437.pdf>; 1; Internet.

Other standards, such as for graphic display of CRGIS data, will provide a minimum level of uniformity to on-screen and hard copy representations. This is particularly beneficial given the inherent ability of GIS to integrate multiple data layers. This does not mean that changes to symbology and labeling can't be applied when necessary and appropriate, but when the standard symbols are used, the cultural resource data will be readily apparent to users familiar with the standard representation.

Understandability: Standards for CRGIS objectify the terms and definitions used to describe cultural resources, providing greater understanding of data for users outside the cultural resources disciplines. The general GIS community may not readily grasp how and why historic preservation professionals record information about these entities, and further, how we apply that knowledge. Standards will help bridge that gap.

At the beginning of a CRGIS implementation, "the interview process can be facilitated if the interviewer has at least a familiarity with both GIS and the discipline for which the database is being created."[76] Similarly, as CRGIS evolves, extending that familiarity through standardization will ensure users confidence in and ability to utilize the resulting datasets. For example, data quality is a fundamental issue for CRGIS, and attributing that quality must be a key component of these standards.[77] When delineating a specific cultural resource, the accuracy and method of that delineation must be recorded in order for users to understand whether to rely on that boundary or location for a particular purpose and/or at particular scales.

Commercial Viability: While government is and will continue to be the likely stewards of CRGIS data, the use of such data will be greatly enhanced when packaged into commercial

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[76] Rakos, 21.
[77] Rakos, 112.

software applications and data services. Numerous vendors provide packaged zoning, permitting, and infrastructure management applications for local government. Products such as City View Software Solutions, GeoPlan, and Cityworks represent just a few of many similar applications offered nationwide. Incorporation of historic preservation modules that serve local commissions in the design review process would ensure that the administration of local historic preservation regulation receives the same treatment as other local operations. Having standardized cultural resources data enables such modules such that the vendors can design for the standard, rather than for each potential dataset that may be maintained at the local level.

Another form of commercial data delivery comes from companies such as GDT, EarthData, and Tele Atlas which deliver complex suites of data for various applications and purposes such as interactive mapping or enterprise data management within a particular organization. Primarily focused on transportation networks, these services are constantly updating and improving the accuracy of the data they deliver. Incorporation of CRGIS data here would not only broaden the reach of CRGIS, but would also allow updates and corrections to data to be incorporated on a regular basis.

Finally, while the previous examples are rather specialized, the most far reaching applications may be those designed for general internet users such as Google Earth, Microsoft Virtual Earth and others. These "killer maps" provide an amazingly diverse set of geographic data to anyone with an internet connection. Our experience of the web is changing as a result, notes Wade Roush in a recent issue of *Technology Review*:

> The mapping revolution could, in short, change the way we think of the World Wide Web. We've long spoken of the Web as if it were a place -- with "sites" that we "go to" -- but as places go, it's been a rather abstract, disembodied one. Now that's changing. Geotagging means the Web is slowly being wedded with real space,

> enhancing physical places with information that can deepen our experiences of them…[78]

There are drawbacks however to each of the above scenarios. The most obvious is the potential for misuse or misunderstanding of what the data represents. It will be vital to ensure that the factors contributing to the "understandability" of the data as described above are prominently made available with the application or data service. Full metadata delivery may not be possible, but links to the metadata and/or the data steward must be provided. For example, currently on Google Earth, it is not possible to tell when a set of imagery was captured, and given the rapid rate of change in the American landscape, especially in our urban and suburban areas, such facts become vital in understanding the data presented.

Despite this potential however, and despite the reluctance of public data stewards to release data to commercial enterprises, such efforts are worth pursuing. These issues can be addressed up-front through data sharing agreements that clearly establish the parameters by which such vendors license the data for incorporation into their products, and perhaps with some return on investment for the data creators.

Quantifiable: Generating statistics and numeric justifications has always been a part of ensuring adequate resources are devoted to historic preservation initiatives. Economic impact studies, annual counts of properties identified, protected, or lost are promoted and compiled across the nation. Yet much of that data must be interpolated from sources other than comprehensive CRGIS data since it is often incomplete. Steven Tepper notes that:

> …there is a need for more research that describes the condition of our heritage in the U.S. We need better information about how many historic properties and artifacts there are. Who owns them? Where are they located? and, What is their condition?[79]

[78] Roush, Wade. "Killer Maps," *Technology Review*, October 2005. 54.
[79] Tepper, Stephen J. “Policy and Historic Preservation: A Preliminary Research Agenda,” (Remarks prepared for the Social Theory, Politics and the Arts Conference, Charleston, S.C., October 2002), 1.

GIS may be the tool to answer these questions, but the lack of coordinated development of CRGIS means that we must often use other data sources to aid in this analysis.[80]

Standardization will enable the full accounting of cultural resources, or at least the knowledge of where the gaps in cultural resources information exist. Standards will define consistent resource types, and identify how resource features relate to resources and resource aggregations (districts, thematic groupings, etc.). Further, standards will define how to represent resources no longer extant. Only then can meaningful statistics be generated about how many resources exist, in what geographic distribution, and how many are lost, preserved, or re-used.

Fiscal Responsibility: Costs in developing any GIS are always a predominate factor governing the results of the development process. As noted by the Office of Technology Assessment (OTA) in 1986:

> Primary constraints to widespread use by preservation professionals include high costs of hardware and data entry, which is extremely time-consuming and labor-intensive; lack of standards for documenting historic preservation information; inadequate coordination among Federal, State, and local agencies in harnessing computer technology; and lack of familiarity with the technology itself.[81]

Note the reference even then to the lack of standards. The Cultural Resources disciplines are not alone in this however: "Because it is time consuming and produces no end-use applications, the design process often receives little attention, if any."[82] This applies at both organization specific implementations as well as at an industry wide level. But in the long run, resources effectively applied at the design stage can generate significant saving later. Along those lines, Rakos also notes, "It is clear that creating a database for cultural resources is an expensive proposition. It is

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[80] Ibid.
[81] Office of Technology Assessment, 110.
[82] Zeiler, Michael. *Modeling Our World: The ESRI Guide to Geodatabase Design* (Redlands, Ca.: ESRI Press, 1999), 182.

apparent though that 'sharing' hardware, software and even data with other programs is key to providing an affordable system."[83] While it is not clear whether she refers to development resources or to end-use systems, in today's GIS environment, hardware and software are not the overriding cost factors that they once were, and sharing "framework" data (roads, ortho-imagery, hydrology, etc.) is the rule rather than the exception. That leaves data development as the primary "cost culprit." Developing data alone can consume much of any organization's limited GIS budget.

Another example of cost savings through design is application development. Well designed interfaces and functionality are based on strategic thinking about the purpose and need for the application. But such issues apply equally to standardization of data. Standards are the design process for data. Strategic thinking about the nature and uses of data allows implementation efforts to focus on populating those datasets, rather than on the data format. Similarly, with standardized data in place, cultural resources application development can occur around a common data platform, resulting in cost savings in the overall development process.

Comprehensiveness: The analytical capabilities of GIS cannot be brought to bear on solving preservation planning questions in a meaningful way until there is sufficiently comprehensive data to support the analysis. In order for data to be comprehensive, it must be compiled from across regions germane to the goals of the analysis. Complete coverage for each State will come in time, as demonstrated by Rakos and Claesson above, but in order to be truly comprehensive, the data must be of a uniform structure.

Jurisdictional Clarity: Cultural resource data standards will help allocate responsibilities for data management among federal, state, and local practitioners. There is a

[83] Rakos, 100.

disconnect in the cultural resources discipline between the States, mandated to maintain their own statewide inventories, but not to set standards for those inventories, and the Federal Agencies, mandated to develop and conform to data standards, but who, except for the National Park Service and other large land holding agencies (BLM, Interior, Defense), don't necessarily maintain any cultural resources data. Further, NSDI requires "collaborative partnerships" because, "NSDI standards are developed and promulgated by the FGDC in accordance with OMB Circular A-119 using an established process determined by the FGDC with input from a broad range of data users and providers."[84] Intra-disciplinary development of standards and best practices will clarify what information is to be maintained at the various organizational levels and how interoperability among those information sets can be achieved.

Summary: Finally, related to all of the categories of need referenced above, the National Park Service (NPS) summarized it best in 1999:

> State historic resource inventories provide Federal, State, and local governments important information on a daily basis in concurrence with national historic preservation laws. Lack of inventory automation, through computerized databases or geographic information systems (GIS) in a majority of states renders these inventories ineffective for land use planning and regulatory compliance, resulting in increased costs for government agencies and uninformed land development decisions. [85]

NPS predicted at the time that it would cost approximately $25 million over five years to fully automate all SHPO inventories,[86] and warned that failure to act would have far reaching consequences. We've seen today that the scenario presented by the NPS has come true. By failing to integrate cultural resources data with other environmental data, land use decisions are made without benefit of cultural resource constraints, resources have been lost, and historic

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[84] Office of Management and Budget, "Circular A-16," 3.
[85] National Park Service. "From Paper File to Digital Database," 10 March 1999. Document online (accessed 5 January 2000), available from <www.cr.nps.gov/hdp/standards/CRGIS/paper.htm>, 1; Internet.

preservation is too often a “too-little, too-late” exercise. Ultimately, the utility of a collective cultural resources inventory is marginalized.

[86] Ibid., 2.

Chapter 3: Spatial Standards

A. Overview of Spatial Standards

There are many types of standards and standards bodies that may exist or be developed that relate to geospatial data, including Agency Standards, Federal Information Processing System Standards (FIPS), Industry Standards, Federal Geographic Data Committee standards (FGDC), American National Standards (ANSI), and International Standards (ISO).[87] The preceding sections establish that CRGIS standardization will most likely occur through the Federal Geographic Data Committee (FGDC) with the National Park Service (NPS) as lead agency. Therefore, FGDC Standards and standards development processes are the focus of the following sections. While the other standards are not likely to directly impact CRGIS standards development, it will be important to coordinate with any relevant aspects of these standards in the future.

The definition of geospatial data standards was briefly presented above as: "...common and repeated rules, conditions, guidelines or characteristics for data, and related processes, technology and organization."[88] The FGDC presents a refinement of that definition in their "Standards Reference Model":

> Data standards describe objects, features or items that are collected, automated or affected by activities or functions of agencies. Data are organized and managed by institutions. Data standards are semantic definitions that are structured in a model.[89]

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[87] Federal Geographic Data Committee. "FGDC Standards Reference Model," 'March 1996. Document online (accessed 26 August 2006), < www.fgdc.gov/standards/process/FGDC-standards-reference-model>, 2-3; Internet.
[88] Office of Management and Budget, 3.
[89] Federal Geographic Data Committee, "Standards Reference," 7.

Further, "FGDC Standards are intended to increase interoperability among automated geospatial information systems,"[90] particularly with respect to the National Spatial Data Infrastructure (NSDI). As defined by the FGDC's standards working group, standards in support of NSDI must be:

- Within FGDC Scope,
- Future Focused,
- Structured,
- Technology Independent,
- Integrated,
- Evolving,
- Supportable,
- Publicly Available,
- Complete and Consistent.[91]

The FGDC has adopted an information engineering approach for standards development, which includes "four basic categories" of standards: data, processes, organizations, and technology.[92]

Data*:* Standards for CRGIS would primarily be data standards, of which there are four types: Data Classification, Data Content, Data Symbology or Presentation, Data Transfer, and Data Usability.[93] All of these data standard types have implications for CRGIS. Absent any standardization, Data Classification and Data Content are the most critical components, but Data Symbology and Usability will need to be explored as well. It would be beneficial to establish a common cartographic approach for CRGIS through Data Symbology standards, and Data Usability standards would identify methods of data development and associated fitness for particular uses.

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[90] Ibid., 5.
[91] Ibid., 3-4.
[92] Ibid., 6.
[93] Ibid., 7.

Process: Process standards, "...describe tasks and how information and technology are used to accomplish organizational goals."[94] Types of process standards include:

- General Data Transfer Procedures (SDTS),
- Specific data transfer protocols,
- Existing Data Access Procedures,
- Classification Methodology,
- Data Collection,
- Storage Procedures,
- Presentation Standards,
- Data Analyzing Procedures,
- Data Integration, and
- Quality Control and Quality Assurance.[95]

While such standards do not seem obviously relevant to CRGIS, Data Collection, Data Integration, and Quality Control / Quality Assurance may have the most utility. Specific process standards might also be considered for processes such as Section 106 of the NHPA.

Organization: "Organizational or institutional standards are the specifications for communication among communities,"[96] but are not within FGDC's scope.

Technology: Finally, Technology Standards define the hardware and software associated with creation and maintenance of particular datasets. Again, such standards are outside the scope of FGDC development.

B. Methods of Standards Development

In general, geospatial content standards are part of a continuum of development that begins with an assessment of necessary standards types (overview), followed by classification of the entities that will be subject to the content standards (semantic or taxonomic classification).

[94] Ibid., 8.
[95] Ibid., 8-9.
[96] Ibid., 9.

Actual standards development occurs next, and finally a data model based on those standards can be developed and implemented. These phases are detailed below with particular emphasis on the Development phase as established by the FGDC.

Overview Phase: Cultural resources disciplines are currently in the "overview" phase of development. In part, the purpose of this research is to further the disciplinary overview of standardization and standards needs, and move towards classification as the next step in the process.

Classification: Review of several disciplinary standards development initiatives reveals that taxonomic development preceded geographic standards development. These disciplines have codified their language such that intra-disciplinary communication is better enabled, and implementing geographic structure is made much easier. When the taxonomic framework already exists, it can become the framework from which content standards are derived.

With regard to cultural resources, there is no nationally accepted classification system. The National Register has established generic classification of resource types, and the National Park Service's (NPS) List of Classified Structures may be the closest current model for a broadly applicable classification. Classification has been criticized as too restrictive, particularly as it regards archaeology, but well designed systems should be able to accommodate variability in certain aspects of semantic definition**.**

Standards Development: The Development phase is established by the Office of Management and Budget's (OMB) "Circular A-16, Revised," which:

> …provides direction for federal agencies that produce, maintain or use spatial data either directly or indirectly in the fulfillment of their mission. This Circular establishes a coordinated approach to electronically develop the National Spatial Data Infrastructure and establishes the Federal Geographic Data Committee (FGDC).[97]

[97] Office of Management and Budget, "Circular A-16," 1.

Specifically, the Circular restricts standards development to areas not already addressed by other consensus standards bodies:

> …the FGDC adopts national and international standards in lieu of federal standards whenever possible and will restrict its standards development activities to areas of spatial data standardization not covered by other voluntary standards consensus bodies, as defined by OMB Circular A-119. Through active participation in voluntary consensus standards bodies, the FGDC works to link its standardization activities to the work of those standards bodies and thereby create an integrated suite of standards for the NSDI.[98]

This is clearly the case for cultural resources GIS, unless the discipline forms its own standards group, which is unlikely given the lack of coordinated development thus far. The emphasis here is on "coordinated" development, as there are several examples of discrete efforts at CRGIS standardization which are detailed below in Chapter 5.

This phase is primarily guided by the FGDC's "Standards Reference Model," which provides a comprehensive outline for the development of geospatial content standards. "FGDC Standards development occurs in 12 steps from initial standard proposal through FGDC adoption."[99] These twelve steps are organized into five stages: Proposal Stage (Steps 1-2), Project Stage (Step 3), Draft Stage (Steps 4-5), Review Stage (Steps 6-11), Final Stage (Step 12).[100] In order to move through the process, at each step the standards initiative must be reviewed and approved: "In each step an identified group has responsibility for the standard this is the custodian [*sic*]. The custodian is responsible for determining when the standard is ready to advance to the next step." [101]The group acting as custodian is largely predefined by this development process, and may be the Standards Working Group, a disciplinary FGDC Subcommittee or Working Group, the FGDC Secretariat, the FGDC Coordination Group, or the

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[98] Ibid., 3.
[99] Ibid., 10.
[100] Federal Geographic Data Committee, "Standards Reference," 11.

FGDC Steering Committee. Much of the responsibility falls to the Standards Working Group (SWG), which is comprised of a cross section of FGDC and industry representation: The SWG:

> …actively promotes and coordinates FGDC standards activities. The SWG provides guidance on FGDC standards policy and procedures, facilitates coordination between subcommittees having overlapping standards activities, and reviews and makes recommendations on the approval of standards proposals, draft standards for public review, and draft standards for FGDC endorsement.[102]

The steps of standards development are outlined in Table 1 below and illustrated in Figure 7, FGDC Standards Process Flow Diagram. While complex, this process is designed to conform with the guidance of OMB "Circular A-119, Revised" which prescribes that a voluntary consensus standards body such as FGDC "be defined by the following attributes: (i) Openness, (ii) Balance of interest, (iii) Due process, (iv) An appeals process, and (v) Consensus."[103]

Table 1: FGDC Standards Process[104]

Stage	**Step**	**Custodian**
Proposal	1. Develop Proposal	Standards Working Group
Proposal	2. Review Proposal	Standards Working Group
Project	3. Set Up Project	FGDC Subcommittee or Working Group
Draft	4. Produce Working Draft	Standards Development Group
Draft	5. Review Working Draft	FGDC Subcommittee or Working Group
Review	6. Review and Evaluate	Standards Working Group
Review	7. Act on Recommendation	FGDC Coordination Group
Review	8. Coordinate Public Review	FGDC Secretariat
Review	9. Respond to Public Comment	Standards Development Group
Review	10. Evaluate Responsiveness to Public Comment	Standards Working Group
Review	11. Act on Recommendation	FGDC Coordination Group
Final	12. FGDC Steering Committee Adoption	FGDC Steering Committee

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[101] Ibid., 11.
[102] Federal Geographic Data Committee. "FGDC Standards Working Group," 16 March 2006. Document online (accessed 26 August 2006), available from <www.fgdc.gov/standards/organization/FGDC-SWG/index_html>, 1; Internet.
[103] Office of Management and Budget. "Circular No. A-119. Revised," 10 February 1998. Document online (accessed 6 August 2006), available from <www.whitehouse.gov/omb/circulars/a119/a119.html>, 4; Internet.
[104] Federal Geographic Data Committee, "Standards Reference," 11-16.

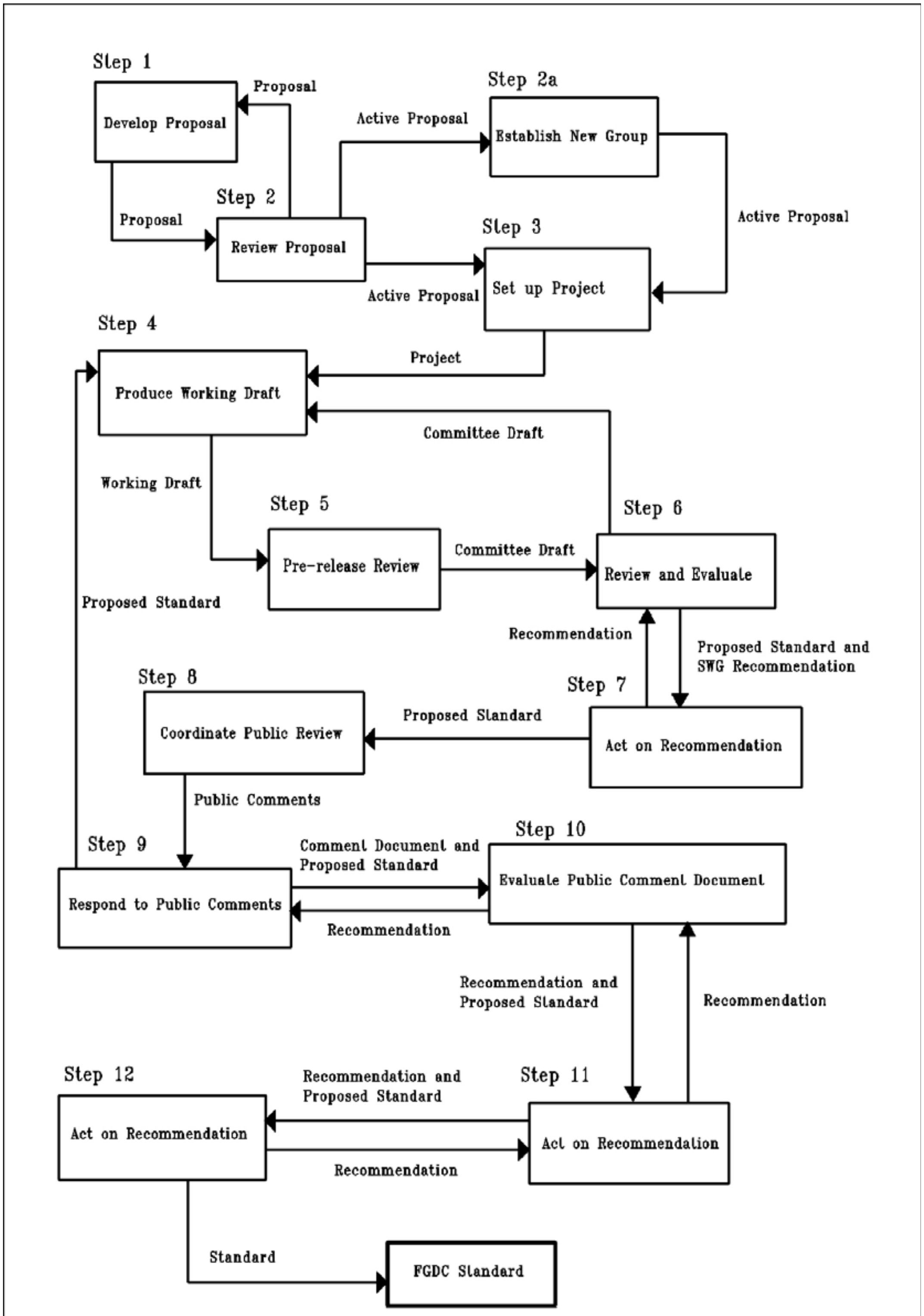

Figure 7: FGDC Standards Process Flow Diagram[105]

[105] Federal Geographic Data Committee, "Standards Reference," 17.

The Proposal Stage, steps 1 and 2, sets out the purpose and need for a standards initiative. "A standards proposal identifies the need, the scope of the project, the benefits of the new standards, the consequences of not standardizing, and a date by which the new standard is needed."[106]A standards proposal should contain the following sections: “Standard subject area scope; Need for the standard; Standard project timeline and resources; Participation; and Integration..."[107] “A proposal may be made by any FGDC subcommittee or working group, any member agency, any agency of the Federal Government, State or local government agencies, or national or regional government councils."[108] Criteria for review of the proposal at Step 2 is based on the list attributes for standards in support of the NSDI referenced above (within FGDC scope, future focused, structured, etc.)..

The Project Stage, step 3, is carried out by the Subcommittee or Working Group that proposed the initiative, and consists of registering the standards project and assigning a group leader and editor to coordinate and maintain documentation for the project.

The Draft Stage, steps 4 and 5, is carried out by the Standards Development Group, and consists of producing a working draft (step 4) which is then referred to the sponsoring Subcommittee or Working Group for review (step 5). Prior to initiating new standards development, “international, national, agency, or de facto standards should be considered first" for adoption or adaptation.[109] Also, representatives outside the FGDC and Federal Government may be brought into the development process when appropriate. Upon completion, "the pre-public review of the working draft is coordinated by the Standards Development Group. In this step the working draft standard is provided to the sponsoring FGDC Subcommittee or Working

[106] Ibid., 11-12.
[107] Ibid., 20.
[108] Ibid., 12.

Group for broader input and review."[110] Necessary revisions are made to the working draft, which when complete results in a Committee Draft ready for the Review Stage, consisting of steps 6-11.

At step 6, the Standards Working Group reviews the Committee Draft and either recommends revision by the Standards Development Group in consultation with the sponsoring subcommittee, or recommends the draft be promulgated for public comment by the FGDC Secretariat. The Secretariat’s review of that recommendation constitutes step 7, and if approved, the draft becomes a FGDC Proposed Standard. Coordination of public review by the Secretariat is Step 8, and involves publication with request for comments in the Federal Register. In addition, a variety of outlets may be used to promote the draft standard and solicit comment, including disciplinary journals, on the internet, and in conference presentations.[111] At Step 9, the Standards Development Group prepares responses to public comment and makes appropriate changes to the draft standard. This response document is reviewed by the Standards Working Group at Step 10, and if acceptable, is forwarded to the FGDC Coordination Group. They similarly review the document in Step 11, and forward it to the FGDC Steering Committee for final adoption, Step 12.[112]

This process raises a number of issues regarding a CRGIS standards initiative. First, because of the large role the Standards Working Group plays in this process, it would seem that the issue of capacity to undertake standards initiatives will become an issue for the FGDC. What capacity the FGDC has to handle active proposals and how many the FGDC can take on at one time are questions that should be evaluated prior to implementation of a CRGIS initiative. The

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[109] Ibid., 13.
[110] Ibid.
[111] Ibid., 14.

Standards Reference Model notes that, "Testing of the Proposed FGDC Standard is done as part of the public review."[113] Therefore, it will be critical to establish a logical and meaningful testing phase for CRGIS standards. Maintenance of the standard is not included in this development process,[114] but maintenance issues would have to be addressed at some point prior to completion of development. Responsible organizations and methods will have to be in place to ensure the CRGIS standard remains viable and responds to changes in preservation theory and practice. Finally, the requirement for consideration of existing standards means that ongoing cultural resources GIS standardization such as the military's Cultural Resource Component of the Spatial Data Structure for Facilities, Infrastructure and Environment (SDSFIE) and the Western States Cultural Resources Metadata and Data Models will need to be scrutinized for adaptability. This research will begin that examination in Chapter 5: Current CRGIS development.

The time required to complete this process should also be carefully considered when planning a development initiative. Review of a number of standards initiatives on the FGDC website show initial activity, with little or no follow-up. This may be due to lack of resources, personnel changes in the membership of subcommittees or workgroups, or other factors. In order to avoid such stagnation, the proposal stage should identify and outline a comprehensive plan for seeing the process through to completion.

Models: After standards are in place, or while in development, data models should be developed that assist in implementing the standard. Models promote existing standards and

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[112] Ibid., 15.
[113] Ibid., 14.
[114] Ibid., 10.

“simplify the integration of data at various jurisdictional levels."[115] Basically, "data modeling describes how the bits of information are defined and structured so they can be applied in a meaningful way."[116] However, in order to understand how models accomplish this, the term “model” requires clarification. The concept has varied application in cultural resources GIS, each with slightly different meanings. The concept of “predictive model” was briefly addressed above, but there are also “virtual models” and at least a couple of meanings for the term “data model.”

Predictive models are tools to aid in determining the likelihood of finding cultural resources in a given geographic extent. As noted by Clement, et. al.:

> The premise behind modeling is that historic and prehistoric peoples were closely tied to their natural and cultural environment, and that these environments were a significant determinant in their choice of site location. Predictive modeling examines soils, distance to water, and slope as potential natural variables, and subsistence systems, transportation systems and previous settlement as potential cultural variables.[117]

There are numerous examples of predictive models at both small and large scale applications. The State of Minnesota has developed a statewide archaeological predictive model known as *Mn/Model*, which is described in their “Summary Report” as follows:

> Mn/Model consists of a series of high-resolution digital maps alerting planners and cultural resource managers of the presence of potential precontact archaeological resources. These maps were developed using a combination of GIS and statistical modeling procedures, which allowed for the efficient, cost-effective, and repeatable generation of scientifically testable models. Because high, medium, and low site potential assignments are based on correlations between known archaeological site

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115 Breman, Joe, Dawn Wright, and Patrick N. Halpin. “The Inception of the ArcGIS Marine Data Model,” 2002. Online (accessed 29 July 2004), available from <gis.esri.com/esripress/shared/ images/61/data_model.pdf>, 6; Internet.

116 Federal Geographic Data Committee, “Standards Reference,” 7.

117 Clement, Christopher Ohm, Sahadeb De, and Robin Wilson Kloot. “Using GIS to Predict Likely Archaeological Sites,” 2001. Online (accessed 1 December 2004), available from <gis.esri.com/library/ userconf/proc01/professional/papers/ pap651/p651.htm>, 3; Internet.

> locations and a number of environmental variables, the models can be improved as new archaeological and environmental data become available."[118]

At a more discrete scale, a predictive model for Ft. Stewart, near Savannah, Georgia enables better allocation of limited funding for archaeological survey by establishing low and high probability testing zones. For prehistoric sites, the model combined eight environmental variables, including soil permeability, elevation, slope, relief, distance to water, and aspect, and used the spatial analysis functions of GIS to develop a probability map for the entire facility.[119]

Virtual models are digital reconstructions of historic places that rely heavily on Computer Aided Design (CAD) and 3D rendering to create stunning visualizations of historic places. Digital visualization techniques have advanced tremendously as computing power continues to grow and costs continue to decline. A prime example of such techniques includes the reconstruction of the Forum in Rome, by the Cultural Virtual Reality Lab at UCLA,[120] among many others worldwide.

The term data model is also used to describe the format by which geographic data are stored. Over the years, a number of formats have evolved, including ArcInfo coverages, CAD drawings, and shapefiles, among others. The culmination of format development is represented by the geodatabase data model for use in ESRI's ArcGIS suite of applications. ESRI is among the industry leaders in developing and promoting applications for GIS, and introduction of the geodatabase model was a significant improvement over previous data formats. Zeiler notes in

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[118] Minnesota Department of Transportation. "A Predictive Model of Precontact Archaeological Site Location for The State of Minnesota: Final Report" 2002. Online (accessed 22 October 2006), available from <www.mnmodel.dot.state.mn.us/pages/executive_summary.html>; Internet.
[119] Johnstone, Seth. "Past and Prediction: Archaeology and ArcGIS in Cultural Resource Management," (Paper presented at the 2003 ESRI User Conference, San Diego, Calif., 7-11 July 2003). Document online (accessed 15 June 2005), available from <gis.esri.com/library/userconf/proc03/p0153.pdf>, 11; Internet.
[120] See <www.cvrlab.org>.

Modeling Our World that, "A geographic data model is an abstraction of the real world that employs a set of data objects that support map display, query, editing, and analysis."[121]

This is true of most of the data formats that exist, but the power of the geodatabase lies in the ability to establish relationships among feature types: "The defining purpose of this new data model is to let you make the features in your GIS datasets smarter by endowing them with natural behaviors, and to allow any sort of relationship to be defined among features."[122] Not only can relationships be established with spatial data within the geodatabase, but also with tabular or spatial data that resides in other databases. Such relationships are known as "general relationships" or “relationships with features not on the map or not obvious from spatial proximity.”[123] For instance; an individual property’s relationship to the historic district in which it stands is not obvious from proximity. A property is evaluated as contributing or non-contributing to a district based on the areas of significance and period of significance of the district, and the integrity of the property. This relationship can be modeled in the geodatabase such that all property features that are spatially within the bounds of an historic district feature must coded with their status.

The design of a geodatabase “…starts with understanding goals and progresses through increasing levels of detail as information is gathered and you approach implementation."[124] The design steps outlined by Zeiler include: 1. Model users view, 2. Define entities and relationships, 3. Identify representation of entities, 4. Match to the geospatial data model (ie data format: vector, raster, etc.), and 5. Organize into geographic data sets[125] If the model design is based on

[121] Zeiler, 4.
[122] Ibid., 5.
[123] Ibid., 6.
[124] Ibid., 182.
[125] Ibid., 184.

or implementing an existing standard, the “users view” would be the standard itself. Otherwise, the logical data model or entity model can become the standard. Defining the entities, relationships and appropriate representations “implements the data model within the framework of relational database technology."[126] Matching the logical model to geospatial data model means identifying the appropriate data format to represent the entities. The geodatabase can contain the four basic formats: vector, raster, tin and geocoding.[127] Model development does not end with the geodatabase, however.

ESRI also promotes an expanded “data model” concept that enables a particular disciplinary implementation of geospatial data. The ESRI data model consists of the following basic components:

- Case study implementation
- Geodatabase template
- White paper
- Data model poster
- Tips and tricks documents[128]

These components combine to provide a complete picture of the structure and application of particular types of geographic data. The intent is that such models are not software specific, such that "...ArcGiS data models can be widely adopted regardless of the user's system architecture."[129]

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[126] Ibid., 16.
[127] Ibid., 8.
[128] Earth Systems Research Institute. “Data Models,” 2002. Online (accessed 29 July 2004), available from <www.esri.com/software/arcgis/geodatabase/ about/data-models.html>, 1; Internet.
[129] Ibid., 4.

C. Industry Model Examples

The following sections will consider the standards, models, and information systems initiatives of other disciplines. It is anticipated that such review will reveal issues and techniques pertinent to a cultural resources standards initiative. The selected examples were chosen from a variety of unrelated disciplines in order to provide the broadest possible perspective on this task. They include initiatives from the transportation sector, ecological and biological sectors, and marine sciences.

1. Transportation

Transportation data has been an integral part of GIS development for many years. The foundation of such data sets is the network of transportation routes that provide the basis for cartographic, geocoding, routing, and infrastructure management applications. Methods for representing these networks in GIS and managing their associated attributes have evolved over the years, but the most recent developments of interest for this research are the Transportation Theme of FGDC's Framework Data Content Standard and the UNETRANS data model. Both of these initiatives attempt to provide a transportation feature model applicable to the broadest set of users and applications. Additionally, the UNETRANS model is designed to provide "a much wider range of transportation related objects… essential for advanced transportation planning and management tasks."[130] While much of the detail in these models is not directly relevant to a cultural resources initiative, specific aspects of these models are of interest, including an exhaustive modeling approach, flexibility of application, and multiple representation.

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[130] Curtin, Kevin, Valerian Noronha, Mike Goodchild, and Steve Grisé. "ArcGIS Transportation Data Model (UNETRANS)," 1 December 2003. Document online (accessed 29 September 2006), <www.geog.ucsb.edu/~curtin/ unetrans/TransDataModel08.zip>, 14; Internet.

The concept of “core” vs. “exhaustive” standards was addressed earlier, and the transportation initiatives are good examples of the exhaustive approach. FGDC’s Framework Data Content Standards (Framework) consist of a number of data themes identified by the GIS community as of vital importance for GIS implementation and analysis, including, geodetic control, orthoimagery, elevation, transportation, hydrography, governmental units, and cadastral information. The transportation theme is further broken down into five subtypes related to transportation modes: air travel, railroads, roads, mass transit, and inland waterways. The UNETRANS data model is similarly comprehensive. This ArcGIS data model was developed by a consortium of transportation industry organizations, ESRI, and academia:

> The goal of the group was to define an ‘essential data model’ for ArcGIS user organizations within the transportation industry, and in particular for roadway management organizations (e.g., DOT's), as well as for road and rail network topology, linear referencing systems, dynamic event representation and asset location and management.[131]

Further, UNETRANS is intended to support existing standards such as FGDC’s framework transportation standard.[132] These integrative approaches seek to represent a conceptual model of all aspects of transportation, from the linear network, to the objects that make up and occur in that network, to the movements through that network. For instance, Framework Standard Part 7c: Roads notes that:

> The road system model describes the geographic locations, interconnectedness, and characteristics of the street[s] and roads in the larger transportation system. The transportation system includes physical and non-physical components representing all modes of travel that allow the movement of goods, services, and people between locations.[133]

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[131] Michael Baker Jr., Inc., 11.
[132] Curtin, 13.
[133] Information Technology Industry Council. "Information Technology -- Geographic Information Framework Data Content Standard, Part 7C: Roads," 12 January 2006. Document online (accessed 29 September 2006), <www.fgdc.gov/standards/projects/incits-l1-standards-projects/framework/documents/Part_7c-Transportation-Roads-20060112-1948.pdf>, 3; Internet.

In contrast to a core data standard, the transportation models fully define all of the features and relationships that exist in the transportation network, and places roads within the fullest possible context.

But in spite of this full and complex structure, both models allow flexibility in applying the features and relationships defined in the model: “To ensure maximum utility in a variety of contexts, this road model does not prescribe any specific business rules for the segmentation of the road system.”[134] This means that the organization implementing the model can decide, for instance, how to segment the road system, what measurement units to apply (referred to as linear referencing systems), and how to represent the routes (centerlines, paved way, or individual lanes of travel). This inherent flexibility is achieved by defining a generic set of features and relationships. The FGDC Transportation base defines transportation features (TranFeature) with three subclasses: transportation segments (TranSeg), transportation points (TranPoint), and transporation paths (TranPath) as illustrated in Figure 8. As described in the standard:

> TranSegs represent individual pieces of the physical network, such as that part of Main Street that exists between First and Second Avenue. TranSegs are topologically connected by TranPoints. TranPoints merely serve to connect two TranSegs. TranPaths prescribe a usage of part of the transportation network. They represent a path through a set of whole or partial TranSegs, such as Route 66 or Bus Route 101.[135]

These basic components apply to all five transportation themes in the Framework standard. The UNETRANS Model, taking a slightly different approach, presents “packages” of logically related objects and features that “hold complementary sets of essential objects within the larger

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[134] Ibid., 4.

[135] Information Technology Industry Council. "Information Technology -- Geographic Information Framework Data Content Standard, Part 7: Transportation base," 12 January 2006. Available online <www.fgdc.gov/standards/projects/incits-l1-standards-projects/framework/documents/ Part_7-Transportation-Base-20060112-1948.pdf> (accessed 10 October 2006), 7.

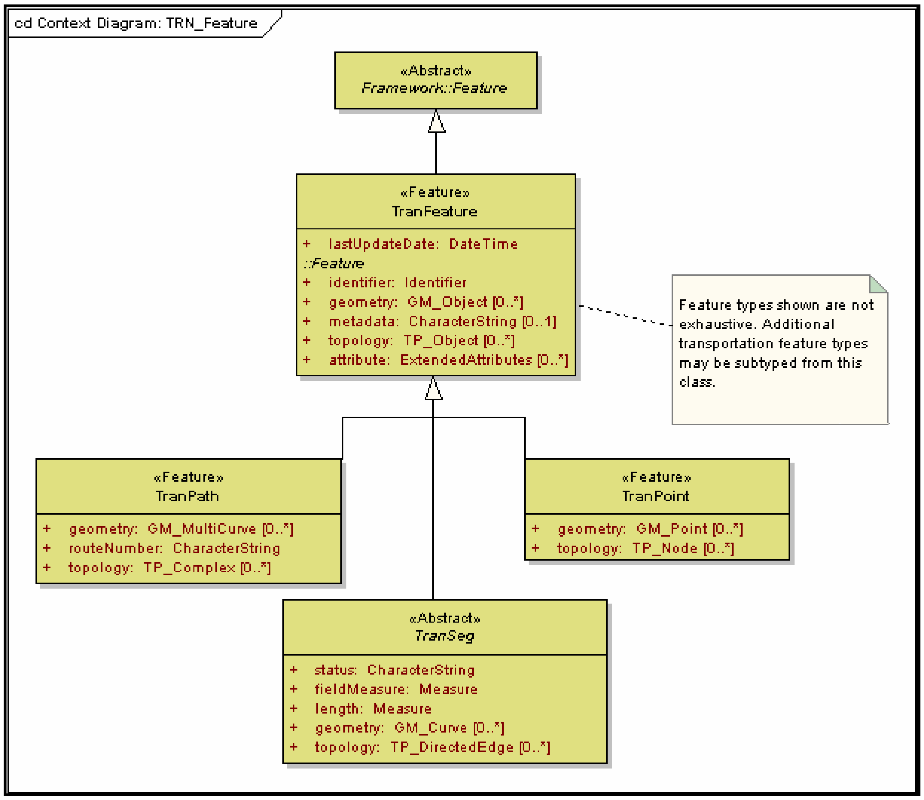

Figure 8:
Transportation Features UML Diagram

data model."[136] Flexibility in implementation is enabled by allowing the user to implement only the packages related to their needs. The six packages consist of: Reference Network, Routes and Location Referencing, Assets, Activities, Incidents, and Mobile Objects. The Reference Network package "corresponds closely with the Framework Transportation Segment (FTSeg) and Framework Transportation Reference Point (FTRP) components of the FGDC standard."[137]

Finally, the ability of the transportation models to enable multiple representation and spatial configurations of the same feature is a technique that may have utility for CRGIS. The UNETRANS model enables such multiplicity because "multiple representation add to the number and type of analytic and display techniques that can be employed for transportation

[136] Curtin, 24.
[137] Ibid., 25.

applications."[138] Such techniques are generally either cartographic or spatial. Cartographic needs for multiple representation relates to the concept of generalization: the ability of the GIS to simplify complex features as the presentation scale decreases. This can be achieved through complex manipulation of the feature geometry by the GIS, or by establishing scale-dependencies for the various representations. Spatial needs for multiple representation relates to the spatial characteristics of the features themselves and the need for GIS analysis or management of those characteristics. In the transportation scenario, "commonly, road and rail networks are represented by single centerlines."[139] But many applications require that the roads be represented by the paved way (or "Carriageway"), or by individual lanes of travel. In order to achieve this, multiple spatial features must be maintained with a consistent identification system so that each version can be attributed to the same real world feature. For cultural resources data, the cartographic need is similar, but the need to maintain multiple spatial representations may be based on several issues. First, evolution of the spatial extent of a resource over time may require that different time-based representations of the same feature be maintained. For example, assume the boundaries and resources of a historic district included in the National Register in the 1970's are delineated in the GIS. A re-survey of that district today may reveal substantial loss of historic fabric on the periphery of the district. A new feature delineating the currently eligible district should be created in the GIS in order to preserve the understanding of the change from the district's original extent. Formal action may reconcile the listing to the current boundary, but the knowledge of how cultural resources have evolved will be a valuable tool in the future. Second, it may be necessary to maintain multiple representations for cultural resources delineated at

[138] Ibid. 50.
[139] Ibid., 51.

different times with variable scale and precision. Such data may become secondary to more accurate delineations, but can serve to inform how the understanding of the resources has evolved. Finally, for archaeological resources, the details of investigation, excavation, and artifact distribution can generate many overlapping layers of data, particularly for important well documented sites, that should be maintained and tracked to serve as an aid to future research.

The FGDC's Transporation Framework standard and UNETRANS model offer some useful characteristics to strive for in a CRGIS initiative:

- An appropriate level of detail in the core standard that conveys a reasonable understanding of the resource while minimizing the burden of administering the data;
- Methods for achieving similar flexibility in a CR standard that will ensure the widest possible use and "buy-in" from the CR community; and
- Establishing rules and procedures for inclusion of multiple feature representations and dealing with changed features.

It will be up to the principal organizers of the cultural resources initiative to ensure such elements are addressed in the resultant standards.

2. Natural Heritage and Vegetation Classification

Next we will consider two related initiatives dealing with the natural environment: the Natural Heritage Network's NatureServe and the US National Vegetation Classification system. These are separate but interrelated initiatives dealing with information about the ecology and conservation of natural environments in the United States. Both of these programs were established in part by The Nature Conservancy (TNC), an international non-profit with a mission "to preserve plants, animals and natural communities that represent the diversity of life on Earth by protecting the land and waters they need to survive."[140] While there are significant differences between the natural and manmade worlds, there are many similarities to dealing with the information about those environments. Grossman, et. al., in *Terrestrial Vegetation of the United States*, note that, “The Conservancy’s approach to conservation relies on the consistent and systematic accumulation, management, and analysis of scientific information on the ‘elements of biological diversity,’ -- specifically the status and location of plants, animals, and ecological communities." [141] Similar methodologies may have applicability for successful analysis and preservation of cultural resources.

NatureServe is “a non-profit conservation organization that provides the scientific information and tools needed to help guide effective conservation action.”[142] The foundation for NatureServe grew out of The Nature Conservancy’s work to establish natural heritage programs “to collect and manage data bout the status and distribution of species and ecosystems of conservation concern.”[143] Natural Heritage information management provides a good model for cultural heritage initiatives due to the similarities in the mission, organization, and applicable information management methods between natural heritage conservation and historic preservation.

First, the missions of the two programs are substantially the same: the protection and preservation of critical resources for future generations. NatureServe implements this mission

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[140] The Nature Conservancy. “About the Nature Conservancy,” 2006. Online (accessed 18 September 2006), available from <www.nature.org/aboutus/>, 1; Internet.

[141] Grossman, D. H., D. Faber-Langendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. D. Patterson, M. Pyne, M. Reid, and L. Sneddon. *International classification of ecological communities: terrestrial vegetation of the United States. Volume I. The National Vegetation Classification System: development, status, and applications* (Arlington, Va.: The Nature Conservancy, 1998), ix.

[142] NatureServe. “NatureServe: Who We Are,” 2006. Online (accessed 29 September 2006), available from <www.natureserve.org/aboutUs/index.jsp>, 1.

through “information products, data management tools, and conservation services to help meet local, national, and global conservation needs.”[144] The partner programs may also provide comment in regulatory compliance. It is these dual roles, service and regulatory, that are reflective of the National cultural heritage programs.

Second, the organizational structure of the NatureServe network resembles that of the National Historic Preservation program, whereby a centralized organization with a nationwide scope partners with “member” organizations which administer the programs in their respective areas. For natural heritage, NatureServe acts as the central repository, while the partner programs at the state and regional level collect, update, and manage information about all aspects of biodiversity and endangered plants, animals and ecological communities. The network includes a central office, four regional offices, and fifty-four member programs in the United States.[145] The National Park Service fulfills the central organizational role for cultural resources, while the SHPOs and THPOs manage detailed cultural resource inventories as the “member programs.” There is not, however, a strong regional component to the historic preservation program, although the regional offices of the NPS probably fulfill that role for some aspects of the program.

Finally, a key difference between the programs is that NatureServe was founded on the use of ecological information as a key component of conservation, and has developed advanced information management methods as a result. NatureServe’s reliance on information resources to

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[143] Ibid.
[144] Ibid.
[145] Brown, Nick, Larry Master, Don Faber-Langendoen, Pat Comer, Kat Maybury, Marcos Robles, Jennifer Nichols, and T. Bently Wigley. “Managing Elements of Biodiversity in Sustainable Forestry Programs: Status and Utility of NatureServe’s Information Resources to Forest Managers (Technical Bulletin 884),” August 2004. Document online (accessed 19 September, 2006), <www.natureserve.org/library/ncasi_report.pdf>, 2; Internet.

support its mission requires that the information be scientifically sound, justifiable, and consistent. To that end, "NatureServe's data development and management approach… emphasizes data quality over data quantity. A detailed and rigorous set of scientific methods has been developed for documenting and mapping element occurrences…"[146] Elements are defined as units of biodiversity, "generally a species, ecological community, or ecological system,"[147] while "an element occurrence is an incidence of a population, community, or ecological system in a specific location."[148] Elements are the focus of typology and classification, while element occurrences are the focus of conservation action. Both of these information types are managed in a variety of information systems, from the local to the national and international levels, and back out to users, as illustrated in Figure 9.

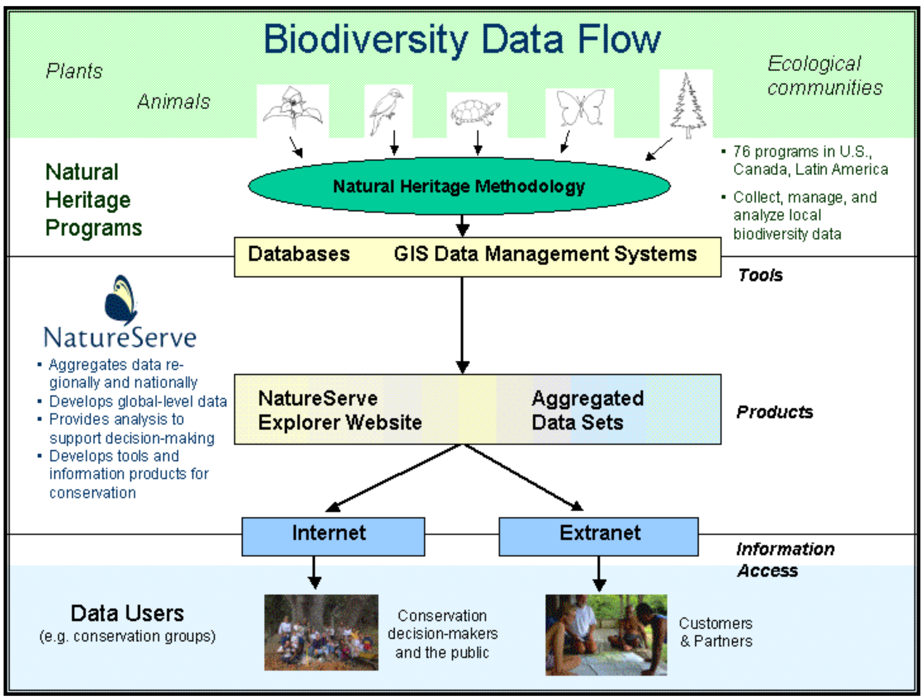

Figure 9: Biodiversity Data Flow[149]

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[146] NatureServe. "NatureServe: Standards & Methods > Biodiversity Data Model." 2006. Online (accessed 29 September, 2006), available from <www.natureserve.org/aboutus/index.jsp>, 1; Internet.
[147] Brown, et. al., 5.
[148] Ibid.
[149] NatureServe. "Biodiversity Data Flow." Online (accessed 15 September 2006), available from <http://www.natureserve.org/images/biodataflow.gif>; Internet.

The standards applied to managing this information flow are known as the “natural heritage methodology,” which is defined by a number of key characteristics:

- It is designed to support a decentralized database network that respects the principle of local custodianship of data.
- It supports the collection and management of data at multiple geographic scales, allowing decisions to be made based on detailed local information, yet within a global context.
- It encompasses both spatial and attribute data, but emphasizes the type of fine-scale mapping required to inform on-the-ground decisions.
- It includes multiple quality control and quality assurance steps to ensure that data products have the reliability needed to inform planning and regulatory actions.
- It incorporates explicit estimates of uncertainty and targets additional inventory work to reduce levels of uncertainty.
- It integrates multiple data types, including: species and ecological communities; collections and other forms of observational data; biological and non-biological data.[150]

These characteristics are easily transferable to a cultural resources information initiative, which should strive to incorporate as many of them as possible. For example, local custodianship across a distributed network provides the jurisdictional clarity outlined in Chapter 2. Similarly, interoperability will enable the aggregation of data and operation at multiple geographic scales. Current cultural resources information processes will need to be examined for methods that ensure data quality. The last two points are key for cultural resources. Estimates of uncertainty in location, age, or any other cultural resource attribute must be provided for individual resources, along with areas where additional or updated investigation is required. Finally, the incorporation of multiple data types is crucial to providing the fullest understanding of cultural resources in a given location. Cultural resource information systems should accommodate imagery, testing and

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[150] NatureServe. “NatureServe: Standards & Methods > Natural Heritage Methodology,” 2005. Online (accessed 6 September 2006), available from <www.natureserve.org/prodServices/ heritagemethodology.jsp>, 1; Internet.

sampling results, artifact inventories, and links to archival information, even if such data is not included in a core standard.

Among the many information applications developed by NatureServe, Biotics is the primary system for managing element occurrence records. As illustrated in Figure 10**,** the information tracked by the Biotics model reflects a number of levels of the “data pyramid” (Chapter 2, Figure 6). The Location section is part of the Core Data level, Element and Taxonomy sections fall within the Characterization data level; and the Stewardship section falls within the Administrative level. Because Biotics manages both spatial and attribute data, it may serve as a good model for future cultural resource applications. Biotics data is exchanged annually between NatureServe and the member programs.

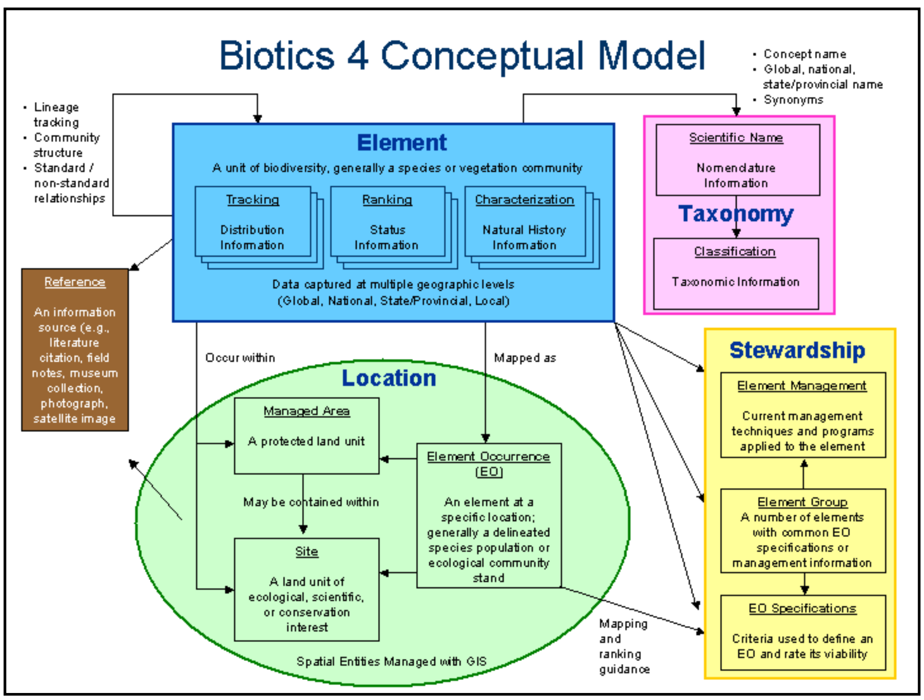

Figure 10: Biotics 4 Conceptual Model[151]

151 NatureServe. “Biotics 4: NatureServe’s Biodiversity Management System.” Online (accessed 15 September 2006), available from < www.natureserve.org/prodServices/bodytext/biotics_slideshow.jsp >; Internet.

Among the many procedures and standards implemented by NatureServe, the United States National Vegetation Classification System (USNVC) serves as the classification system for plants and ecological communities. Development of the USNVC began in the 1980's and continued through the 1990's with the first complete draft available in 1998.[152] Prior to the USNVC, "…protection proceeded on a state-by-state or agency-by-agency basis, based on independently developed classifications."[153] These state classifications form a basis for the USNVC, as did a pre-existing international classification system by the United Nations Educational, Scientific and Cultural Organization (UNESCO) from 1973.[154] The USNVC was initially only partially developed, then approached regionally by ecologists from The Nature Conservancy for the four regions: West, Midwest, Southeast and East. The "regional ecologists then worked together to standardize the units across regions, leading to a series of revision and refinements in all levels of the hierarchy."[155] Partnerships in developing USNVC evolved and strengthened as "agencies and organizations have become increasingly aware of the need for a standardized national classification to accomplish their conservation and resource management goals more efficiently and effectively.[156]

The USNVC was designed to deal with a number of issues related to the classification of natural vegetation. Among them, "...from a national and international perspective, the lack of a standard system resulted in unnecessarily redundant protection of a few types and inadequate protection of many others."[157] Also, variations in definitions resulted in different interpretations

[152] Grossman, 28.
[153] Ibid., 1.
[154] Ibid., 27.
[155] Ibid., 28.
[156] Maybury, Kathleen P., editor. *Seeing the Forest and the Trees: Ecological Classification for Conservation* (Arlington, Va.: The Nature Conservancy, 1999), 29.
[157] Grossman, 1.

of "ecological units"[158] Finally, national, state and local inventory program data could not be integrated.[159] In response, the TNC developed a "hierarchical taxonomic structure with physiognomic criteria used at the coarsest levels of the hierarchy and floristic criteria used at the finest."[160] In other words, the classification system ranges from very generalized, broad categories based on physical structure at the upper levels, to a very fine level of detail based on taxonomic classification at the lowest levels. This is also similar to the “data pyramid” concept illustrated above (Chapter 2, Figure 6). It must be noted, however, that "USNVC represents a simplification of natural complexity and consequent loss of information, as does any classification."[161]

In 1997, the development of the USNVC was noted as "far from complete,” with “numerous steps that must be taken to ensure the continued development and refinement of the classification."[162] There are several aspects to this review and refinement. First, the system is "continuously under review by Heritage ecologists as well as by academic and government agency experts,"[163] including a national review panel under the auspices of the Ecological Society of America.[164] Also, regional ecology teams review the application of the system to ensure consistency nationwide.[165] The results of such activities become part of the system:

> Classification revisions and additions and new descriptive information are periodically incorporated from these reviews. The classification has been made available to an increasingly wider audience of users and reviewers, and successive

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[158] Ibid., 2.
[159] Ibid., 1.
[160] Maybury, 25. These terms are defined as follows: "*Physiognomy* refers to the structure (height and spacing) and overall shape of plants, and to leaf characteristics, such as seasonality, shape, duration, size and texture;" "*Floristics* refers to species composition."
[161] Grossman, 15.
[162] Ibid., 2.
[163] Ibid., 29.
[164] Maybury, 23.
[165] Grossman, 30.

> iterations of the classification system have resulted in a dynamic product that is increasingly consistent, accurate, and detailed.[166]

Should a national cultural resources classification be developed, this process of review and refinement will be crucial to maintaining an effective and valid classification system.

But our focus is not limited to classification. Accordingly, the Vegetation Subcommittee of the FGDC has promulgated standards based on the USNVC: "The overall objective of the National Vegetation and Information Standard (NVCS) is to support the use of a consistent national vegetation classification to produce uniform statistics in vegetation resources from vegetation cover data at the national level."[167] The NVCS addresses terminology, core data, and vegetation classification.[168] The NVCS also aims to meet FGDC requirements without hindering local or agency actions necessary for their own programmatic goals.[169] As noted in the published standard:

> The standard presented represents more the minimum required than the ideal or maximum. The purpose of the national standard is to require all federal vegetation classification efforts to have some core components that are the same across all federal agencies to permit aggregating data from all federal agencies. The NVCS does not prevent local federal efforts from doing whatever they want to meet their specific purposes. NVCS does require that when those local efforts are conducted, they are conducted in ways that, among whatever else they do, they provide the required core data.[170]

This core data concept is clearly indicated as the solution for a complex standard where multiple agencies and organizations must "buy-in" in order for the system to achieve the goals of

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166 Ibid., 29.
167 Federal Geographic Data Committee, Vegetation Subcommittee. "Vegetation Classification Standard," June 1997. Document online (accessed 29 August 2006), available from <www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/standards/projects/vegetation/vegclass.pdf >, 1; Internet.
168 Ibid., 1.
169 Ibid., 3.
170 Ibid., 1.

consistent, reliable, and justifiable data. This adds weight to the case that cultural resources data standards should take a similar approach.

It should be noted that there are key differences between ecological and cultural resources. A primary difference is that vegetation classification is a generalization of any given area, (ie. can't map every plant), while cultural resources documentation is generally a discrete inventory process. Cultural resources data doesn't need to be generalized except for specific statewide or regional purposes and/or presentation scales. Also, the methods of classification and inventory can be quite different. Vegetation mapping can be based on remote sensing and photo interpretation which enables relatively quick coverage for large areas. Due to its discrete nature, cultural resources inventory requires much more field work and archival research.[171] Finally, vegetation either does or does not exist in a natural state.[172] The concept of "cultural resource" is a "condition" of the existing built environment. All elements of the built environment are cultural resources, but preservation and protection hinges on the determination of significance. The implications for CRGIS are, do we map everything and wait for the resources become old enough to evaluate their significance, or do we map only those features that have been evaluated. Also, how do we handle those buildings, structures, objects and sites evaluated as ineligible? Standards are necessary to clarify issues such as these. In spite of these differences, there are numerous common aspects between cultural resources and the USNVC and NVCS that can inform a cultural resources standards effort throughout all phases of development, from inception to long-term maintenance.

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[171] Grossman, 13.

[172] While TNC and Natural Heritage programs are only classifying natural vegetation, the system could be applied to "heavily human-influenced types such as those in developed areas, croplands, and places severely altered by past logging or farming," (Maybury, 7).

Regarding inception, one interesting aspect of USNVC is that, despite broad partnerships and multi-organizational participation, the fundamental effort was initiated by a non-profit.[173] It raises the question of whether there is a sufficiently capable historic preservation non-profit that could tackle a similar initiative. It seems that the USNVC benefited from a non-governmental foundation that focused on the mission of conservation, rather than being hindered by agency mandates or jurisdictional boundaries. Federal, state and local support will be key in this effort, but it may be useful to explore the potential for the the National Trust for Historic Preservation or other organization of similar scope to play a more than supporting role in this initiative.

In its initial stages, "Conservancy ecologists... made a pivotal decision to develop a terrestrial classification system that is base primarily on vegetation."[174] Is there need for a similar decision regarding cultural resources? Archaeology seems to have been the focus of the majority of early GIS efforts, but for cultural resources as a whole, the relatively non-pivotal decision will be to include all resources, archaeological and architectural, in one core standard.

Also, as noted above, the Ecological Society of America has established a Panel for Vegetation Classification. Is there a professional society in the cultural resources disciplines that could provide similarly objective input for a cultural resource standard? The Society of Architectural Historians comes to mind for architecture as does the Society of American Archaeologists, but such a role would may not fit within their respective missions as currently defined.

Regarding implementation and use, Grossman, et. al. note in *Terrestrial Vegetation* that, "A common information structure enables the aggregation and assessment of local and regional inventories. Patterns of relationships between vegetation and species, and between vegetation

[173] Grossman, 29.

and ecological processes, can then be developed across the landscape."[175] The historic preservation movement can only guess at the possible benefits that will be enabled by a similarly uniform information structure. There are likely a host of new relationships and analysis that cannot yet be conceived of, including patterns and spread of particular trends in architecture, engineering, and even economic processes could be discerned from analysis of sufficiently comprehensive cultural resource data. The archaeological disciplines have begun to approach new spatial techniques for analyzing site data based on this comprehensiveness, even if the data must be generated as part of the analysis.

Full understanding of historic resources often depends on knowing how a specific resource compares to similar resources. So too does natural heritage:

> The conservation of exemplary occurrences of all community types (as well as those of rare species) has been fundamental to the conservation strategy of The Nature Conservancy and the Natural Heritage Programs for many years. The USNVC is critical to the consistent application of conservation status ranks, which are the basis for prioritizing conservation action within the Conservancy.[176]

Further, "Rarity, diversity, and representativeness are commonly chosen as critical values for selection of conservation areas."[177] This knowledge of status can only come from comprehensive inventory. Cultural resources need property type data that allows extraction of "best," "last remaining," or "typical example of a type" at the local, statewide, regional, or national scales. This assessment of relative significance is an important consideration in most day-to-day preservation decisions, which today is generally based on individual familiarity with either the resource type or the amount of inventory available in a given geographic area.

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[174] Maybury, 24.
[175] Grossman, 58.
[176] Ibid., 60.
[177] Ibid., 69.

But this raises another question: Does the amount of inventory skew the status ranks applied by the USNVC? Does a better state of knowledge about a particular vegetation class lead to a false perception of either abundance or scarcity? Grossman notes that, “These patterns of imperilment are likely to change as additional classification and ranking of USNVC types is completed,”[178] which indicates that that state of knowledge does impact the assessment of relative significance. This is certainly be the case for cultural resources given the current state of knowledge, and is why decisions based on relative significance are currently made only with great effort. As an example, archaeological investigation pursuant to Section 106 and other processes has resulted in identification of hundreds of sites in Gloucester County, NJ. However, when the locations are plotted in GIS, the majority of sites follow the pattern of the major roads through the County. This pattern reveals that our state of knowledge is limited to areas of regulatory activity, rather than an absence of sites away from the roads. A similar but opposite pattern emerges for archaeological sites relative to protected open space. In New Jersey, there has been little investigation of such areas because of the general perception that such areas are protected from the kinds of activities that may impact archaeological sites, and because limited budgets leave little room for what might be considered a purely academic exercise. Of course, when land management activities that could impact archaeological sites are planned in parks and other open spaces, the lack of inventory makes effective decision making difficult.

Another commonality between natural heritage and cultural resources is, “a growing trend across the international conservation community to address conservation at larger scales.”[179] The heightened consideration of ecological communities is the primary evidence of

[178] Ibid., 62.
[179] Ibid., 67.

this, and a similar trend has been seen in historic preservation over the years. The recognition of designed and cultural landscapes is perhaps the most resent manifestation of this trend.

The resultant FGDC Vegetation Standards "…must be followed by all federal agencies for data collected directly or indirectly (through grants, partnerships, or contracts)."[180] During CRGIS standards development, it will be important to consider impacts to the primary preservation programs administered by the States. Once in place, FGDC standards for cultural resources will apply to all phases of Section 106, to the National Register nomination process, and to HPF funded projects undertaken by local HPC's. While this is beneficial in the long term, in the short run, the transition process must be carefully managed in terms of new procedures, rules or policy in order to effectively apply the standards and ensure that incoming data meets the standards.

As part of that process, enabling the incorporation of existing data must be a high priority. For the NVCS, "Most existing vegetation inventory/classification data bases may be cross-walked to populate the uniform NVCS. It is not the intent to throw out previous work and redo inventory."[181] The same holds true for cultural resources. This is probably one of the most crucial issues for cultural resources, especially. when considering the wide variety of inventory data that exists in cultural resource repositories nationwide, including: paper forms, archival images, tabular data, and even existing GIS data.

Finally, regarding maintenance and continued development, "Future development and implementation of the classification will become increasingly dependent upon the strong shared vision of a national classification system and a continued spirit of cooperation…"[182] Among the

[180] Federal Geographic Data Committee. "Vegetation Classification Standard," 4.
[181] Federal Geographic Data Committee. "Vegetation Classification Standard," 12.
[182] Grossman, 73.

first challenges facing a CRGIS initiative is creation of a “strong shared vision” for cultural resources information that will survive the development process and sustain the initiative into the future.

3. Marine

While not a standard, the ArcGIS Marine Data Model demonstrates some interesting qualities that may prove applicable to a CRGIS initiative. The Marine Data Model is an ESRI geodatabase implementation designed to "provide a structured framework that more accurately represents the dynamic nature of water processes."[183] Developed by the ArcGIS Data Model working group, "…the data model provides a basic template for implementing GIS projects" for users, and "for developers it provides a basic framework for writing program code and maintaining applications."[184] The model will also allow practitioners to "spend more time at sea collecting data and in the lab analyzing their information, and less time at the computer planning the data structure."[185]

Among the "dynamic" issues referenced above is an "...inherent fuzziness of boundaries in the ocean."[186] While one may not typically characterize above-ground cultural resources data as "fuzzy," the boundaries for such resources are often determined by rationale not inherently obvious. For instance, the boundaries of a cultural landscape district would be based on spatial patterns of a particular cultural phenomenon, which may be quite different from spatial

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[183] Breman, Joe, Dawn Wright, and Patrick N. Halpin. "The Inception of the ArcGIS Marine Data Model," 2002. Document online (accessed 29 July 2004), available from <gis.esri.com/esripress/shared/images/61/data_model.pdf>, 4; Internet.
[184] Ibid., 5.
[185] Ibid., 4.
[186] Ibid., 3.

relationships in the modern built environment. Archaeological boundaries, on the other hand, can be "fuzzy" depending on the extent of documentation and testing of a particular site.

The marine data model also seeks to address temporal considerations in marine data. "As measurements gathered at sea are usually time dependent, different types of time-dependent features are included in the data model."[187] Cultural resources have temporal issues as well, related both to the features themselves as well as the data collected about them. In order to be effective, a CRGIS data standard must effectively capture the temporal components of both.

Finally, both marine data and archaeological artifact data "require depth values (z) as an integral part of data collection and analysis."[188] Therefore marine data model has defined features that "recognize the z-value as part of their 'shape' field" rather than as an appended attribute, which is typically how such elevation data are currently stored. [189] Such customized features greatly enhance the ability to analyze, interpret, and visualize the collected data.

The marine data model also embodies the concept of core data: "One model cannot include a comprehensive catalog of objects meeting the needs of all user groups and applications."[190] But in the end, the model is only a model. Real world testing will be the ultimate determinant of how effective the model is and/or the need for revision or refinement.[191] This suggests that, for both this model and for any CRGIS standard/model, it will be important that adequate reporting systems and processes are in place to ensure necessary revisions are implemented. With adequate resources for continued maintenance, the internet is the logical

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[187] Ibid., 7.
[188] Ibid.
[189] Ibid.
[190] Ibid., 8.
[191] Ibid.

choice for this. The marine model was published for peer review during development through website registration, which allowed for a broad comment set upon which to base revisions.[192]

[192] Ibid., 5.

Chapter 4: Related Standards and Technological Trends

There are other standards and a number of technological issues that relate to a CRGIS standards initiative in various ways. Primary among related standards are the Content Standards for Digital Geospatial Metadata (CSDGM), otherwise known as Metadata Standards. Technological trends that impact a CRGIS initiative are many, and as noted in the introduction, the convergence of affordable hardware, advanced software and the internet have made implementation of CRGIS easier now than ever before. Such trends include the current state of GIS technology generally, the evolution of data formats, temporal issues, and data security.

A. Metadata

As noted above, the Content Standards for Digital Geospatial Metadata (CSDGM) should be adhered to when documenting GIS datasets. As defined by the FGDC, “Metadata are ‘data about data.’ They describe the content, quality, condition, and other characteristics of data. Metadata help a person to locate and understand data.”[193] The information recorded in metadata consists of the following main topic areas outlined in the FGDC’s Metadata Workbook: Identification, Data Quality, Spatial Data Organization, Spatial Reference, Entity and Attribute Information, Distribution, and Metadata Reference.[194] As illustrated in Figure 11, the CSDGM organizes metadata into ten sections, seven of which correspond to the main topic areas outlined above, and three supporting sections used in conjunction with main sections.

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[193] Federal Geographic Data Committee. "Content Standard for Digital Geospatial Metadata Workbook Version 2.0," 1 May 2002. Document online (accessed 19 February 2006), available from <http://www.gislab.lanl.gov/docs/workbook_0501_bmk.pdf >, 1; Internet.

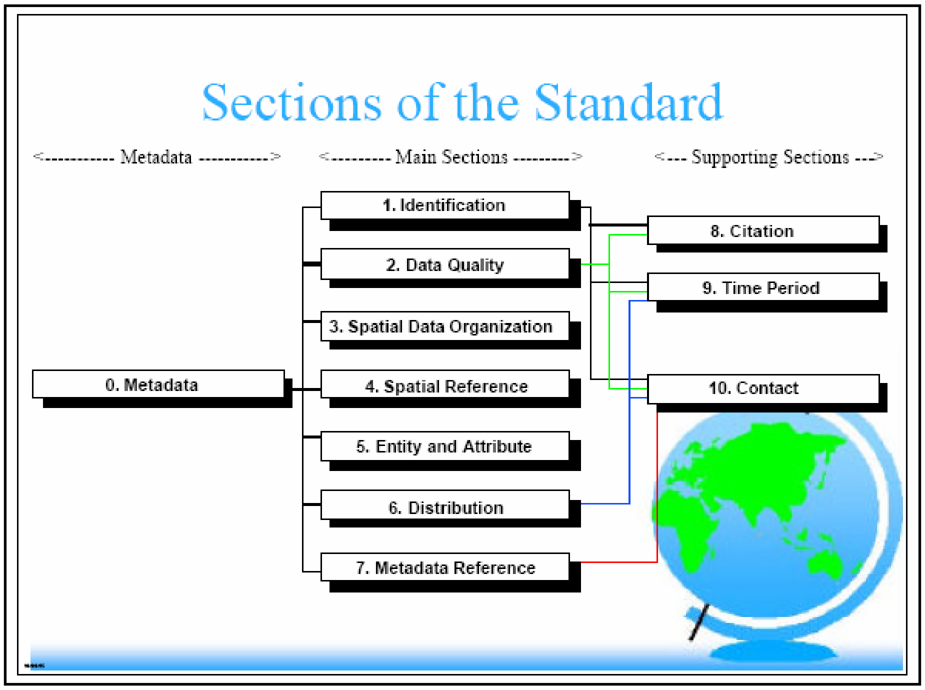

Figure 11: Metadata organization.[195]

Conformance with CSDGM provides potential users sufficient information about the data to make informed decisions about its usability for their particular purposes, and allows for inclusion in GIS data clearinghouses and certain kinds of data servers. Geospatial clearing houses such as the NSDI clearinghouse at Geospatial One Stop (www.geodata.gov), allow for structured query and browsing over vast collections of metatdata to quickly and easily find data needed for a particular analysis or application. The intent of such clearinghouses is to index and make available metadata from a wide variety of providers to a wide variety of users, as illustrated in Figure 12. This is a primary means to disseminate CRGIS data.

A query of terms related to cultural resources and historic preservation was conducted on the Geospatial One Stop (GOS) search portal in July and August 2006. The results of these queries reveal a need for a more systematic approach to documenting cultural resource datasets. The search parameters outlined in Table 2 were executed for each of the fifty states plus

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[194] Ibid., 2.

Washington, DC and Puerto Rico. The results were then evaluated to determine how many were actually from the state in question (marked as "valid"), and further, how many of those actually depicted cultural resources (marked as "CR"). This interpretation was fairly strict in that the dataset needed to be vector or raster data representing historic or prehistoric cultural features.

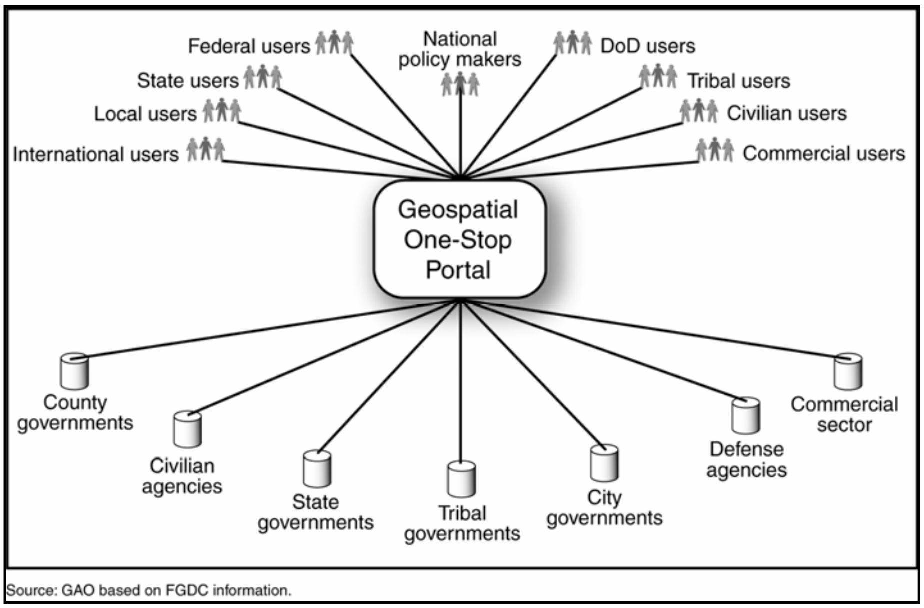

Figure 12: Geospatial One-Stop portal concept.[196]

Political or administrative boundaries, place names, and general cultural features (schools, parks, etc.) were not counted. Searches on the GOS portal can be further refined by selecting a time frame, content type, or data category, but these additional categories were not used for this analysis in order to retrieve as many relevant cultural resource datasets as possible. Content type refers to the format of the data, including: live data and maps, downloadable data, offline documents, applications, geographic services, clearinghouses, or geographic activities. Data

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[195] Ibid., 13.

category refers to themes such as agriculture and farming, administrative and political boundaries, or elevation and derived products, among others.[197] These themes are derived from theme keywords assigned in metadata Section 1: Identification.

When tallied, a total of 537 records were returned, of which 375 were considered “valid.” Based on review of the data abstracts, 218 of the “valid” records appear to be actual cultural resource datasets. These results are not an indication of the level of cultural resource GIS development in these states, but only that metadata has been submitted to GOS. Why then, were there so many “false hits” returned? First we must look at how the search is defined spatially.

The selection of each state was made by using the “Search within” field of the portal. This selection defines the spatial extent that will be searched, and can alternatively include metadata overlapping the search area, or metadata fully within the search area. For this analysis, only data fully within the search area were requested. The spatial extent of the selected state is defined by the smallest rectilinear polygon, or bounding box, that fully encompasses the state boundary. For irregularly shaped states, a lot of area outside the state boundary is included in the search. A search of West Virginia, illustrated in Figure 13, would include portions of Ohio, Maryland, Virginia, and Kentucky. The spatial extent of a dataset is recorded by its bounding coordinates in metadata Section 4: Spatial Reference. If this extent falls fully within the search extent, that dataset may be included in the search results, providing the other search criteria are met.

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[196] United States General Accounting Office. "Geographic Information Systems: Challenges to Effective Data Sharing. Statement of Linda D. Koontz, Director, Information Management Issues," 10 June 2003. Document online (accessed 14 July 2006), available from <www.gao.gov/cgi-bin/getrpt?GAO-03-874T>, 11; Internet.

[197] “Geospatial One Stop.” Online (accessed 21 July 2006), available from <gos2.geodata.gov/wps/portal/gos>; Internet.

Table 2: State CR GIS Survey, Geospatial One Stop

Search Parameters:

Search terms: "cultural resources" or "historic preservation" or archeology or archaeology or "historic districts" or "historic properties" or "historic sites"
Time frame: Anytime
Content: All types
Categories: All categories

	Totals:									
Where:		**AL**	**AK**	**AZ**	**AR**	**CA**	**CO**	**CT**	**DE**	**FL**
Results:	**537**	1	31	3	7	2	0	0	38	0
Valid*:	**375**	1	31	3	7	2	5	0	30	0
CR*:	**218**	1	11	3	5	0	5	0	0	0
Date:		7/21/06	8/6/06	7/21/06	8/6/06	8/6/06	8/6/06	8/6/06	8/6/06	8/6/06

Where:	**GA**	**HI**	**ID**	**IL**	**IN**	**IA**	**KS**	**KY**	**LA**	**ME**
Results:	4	2	12	1	5	1	17	1	20	0
Valid*:	2	2	0	1	5	1	17	0	20	0
CR*:	2	1	0	1	3	1	12	0	0	0
Date:	8/6/06	8/6/06	8/6/06	8/6/06	8/6/06	8/6/06	8/6/06	8/6/06	8/6/06	8/6/06

Where:	**MD**	**MA**	**MI**	**MN**	**MS**	**MO**	**MT**	**NB**	**NV**	**NH**
Results:	72	0	5	15	0	3	22	0	0	0
Valid*:	22	0	3	8	0	0	21	0	0	0
CR*:	17	0	3	8	0	0	17	0	0	0
Date:	8/6/06	7/21/06	7/21/06	7/21/06	7/21/06	7/21/06	7/21/06	7/21/06	7/21/06	7/21/06

Where:	**NJ**	**NM**	**NY**	**NC**	**ND**	**OH**	**OK**	**OR**	**PA**	**RI**
Results:	37	23	13	2	2	0	12	17	8	0
Valid*:	33	22	9	2	2	0	3	17	8	0
CR*:	32	15	4	0	2	0	3	11	8	0
Date:	7/21/06	7/21/06	7/21/06	7/21/06	7/21/06	7/21/06	7/21/06	7/21/06	7/21/06	7/21/06

Where:	**SC**	**SD**	**TN**	**TX**	**UT**	**VT**	**VA**	**WA**	**DC**	**WV**
Results:	2	0	1	60	22	0	40	7	15	1
Valid*:	2	0	1	38	22	0	8	7	8	0
CR*:	0	0	1	16	14	0	8	0	5	0
Date:	7/21/06	7/21/06	7/21/06	7/21/06	8/6/06	8/6/06	8/6/06	8/6/06	8/6/06	8/6/06

Where:	**WI**	**WY**
Results:	8	5
Valid*:	7	5
CR*:	5	4
Date:	8/6/06	8/6/06

*Valid: Result is within state boundaries.
*CR: Result is cultural resource related

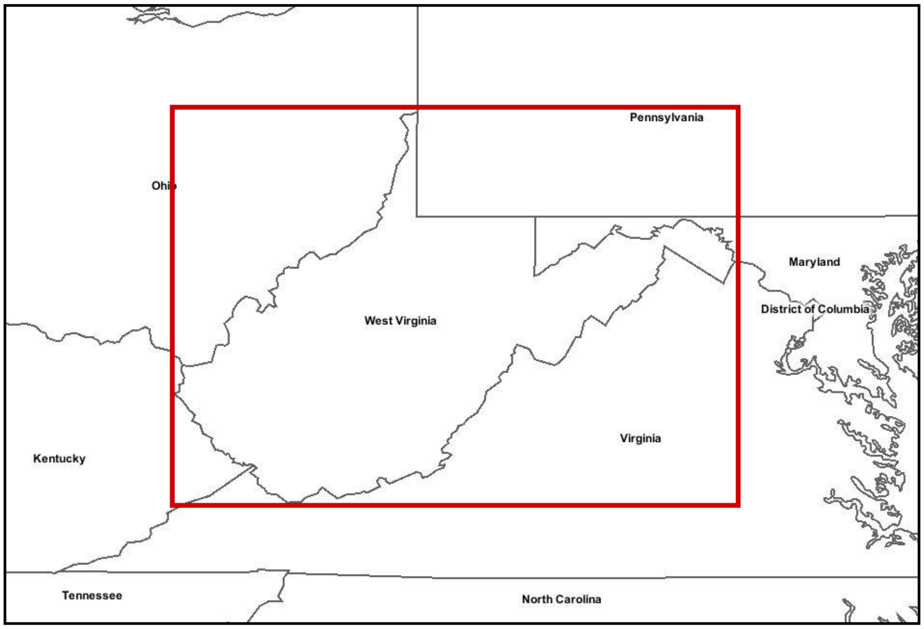

Figure 13: Spatial selection bounding box.

The second issue contributing to irrelevant records retrieved in the search has to do with the descriptive sections of the metadata. In most cases, records evaluated as not cultural-resource-related contained one or more of the search terms in metadata Section 1: Identification. While it is unlikely that the spatial extent issue will change, the way in which cultural resources datasets are documented and described can be improved. One method for achieving this involves creating a "metadata profile" for cultural resources. As noted in FGDC's Metadata Workbook, "A profile is [a] subset of the metadata entities and elements of the base standard that describes the application of the CSDGM Standard to a specific user community."[198] Further, "Profiles are formalized through the FGDC standards process or may be used informally by a user community."[199] The FGDC offers extensive guidance on profile development, including the following:

[198] Federal Geographic Data Committee, "CSDGM Workbook," 98.
[199] Ibid.

- A profile may impose more stringent conditionality on standard elements than the Standard requires. (Elements that are optional in the Standard may be mandatory in a profile.)
- A profile may contain elements with domains that are more restrictive than the Standard. (Elements whose domains have free text in the Standard may have a closed list of appropriate values in the profile.)[200]

Incorporating more controlled guidance for certain descriptive metadata elements such as dataset titles, abstract contents, and keywords will enable more consistent discovery of cultural resource datasets. This process may be where the classification issues addressed above come in to play. Establishing a reasonably controlled vocabulary for cultural resources will feed directly into profile development. These metadata issues were also explored by the Western SHPOs and are covered below in Chapter 5.

B. GIS Technology

The issue of "convergence" has been mentioned previously, but how does the trend of converging hardware, software, and internet technology benefit a CRGIS standards initiative? As noted by ESRI, GIS has evolved from a map production (enhanced cartography) tool to an information management tool:

> In the early days of GIS, the focus, with rare exceptions, was on individual, isolated projects. Today the focus is on the integration of spatial data and analysis in the mission-critical business process and work flows of the enterprise and on increasing the return on investment (ROI) in GIS technology and databases by improving interoperability, decision making, and service delivery.[201]

This integrative and information management approach has been enabled by continually decreasing hardware costs for both computing power and storage capacity. James Ebert notes in

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[200] Ibid.
[201] Earth Systems Research Institute. "Spatial Data Standards and GIS Interoperability: An ESRI White Paper," January 2003. Document online (accessed 29 July 2004), available from <www.esri.com/library/ whitepapers/pdfs/spatial-data-standards.pdf>, 2; Internet.

a 1993 proposal to the National Science Foundation:

> The widespread use of GIS in archaeology, as in almost every other profession based on spatially referenced data, is today virtually poised to occur within the next few years as *software* and *hardware* technologies converge on technically workable and flexible, while at the same time affordable systems.[202]

In 2006, it is safe to say this has now occurred. GIS software, and the hardware capable of running it are within the means of most organizations that must use or create CRGIS data. Many tools and resources to use CRGIS data can be obtained for free, and the delivery of data via the internet enables quick and easy access to an almost unlimited amount of data and spatial information without the overhead of storage and maintenance. For those organizations responsible to create and maintain CRGIS data, the costs of higher end software and storage solutions can be effectively managed through partnerships and intra-organizational specialization. The New Jersey SHPO relies heavily on a departmental investment in GIS software, support, and storage, allowing the agency to focus on data development and quality. Where such access does not exist internally, similar relationships can be enabled through interagency agreement and public private partnerships.

C. Data Formats and Transferability

Past GIS data formats required advanced skill and computing overhead to effectively manage, while current options for storing CRGIS data range from the lightweight, such as ArcView Shapefiles, to the robust, such as the enterprise Geodatabase. Further, software has become flexible in the data formats supported, allowing for the incorporation of widely divergent data sets in the same application, as well as the ability to import and export that data should the

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[202] Ebert, 5.

format need to be converted. For instance, a CAD based parcel delineation can be integrated with raster ortho-photography, and vector feature data in the same map, and any or all of these may reside in remote locations.

D. Temporality

The issue of representing time in GIS is a longstanding and expansive area of ongoing research. Fundamentally, realization of true temporal GIS requires that time be treated as a temporal coordinate equal to three-dimensional spatial coordinates.[203] This has not yet occurred, and as noted by Stephan Freelan, to date, “temporal analysis, such as it is possible at all, is dependent on inefficient data searching methodologies where time is treated as an attribute… rather than a coordinate of space-time.”[204] Susan Lassel also points out challenges for temporal GIS:

> To understand the differences between merely storing out-dated data and the storage of data histories for automated spatio-temporal analysis; To identify the basic elements of temporality in planning data and how they relate to a revised form of analysis for decision-making; and to focus on long term effectiveness during the planning stage of implementation.[205]

Freelen points out two concepts of time that must be accommodated in what he refers to as “quasi-temporal GIS”: world time (when an event occurred in the world) and database time (the time at which information is entered or changed in the database).[206] For CRGIS, these two concepts relate to the events and changes to a resource in “world time,” and the events and

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[203] Freelan, Stephan. "Developing a Quasi-Temporal GIS for Archival Map Data," 2003. Document online (accessed 15 July 2006), available from <gis.esri.com/library/userconf/proc03/p0987.pdf>, 4; Internet.
[204] Ibid., 3.
[205] Lassell, Susan E. "Space, Time, and Technology: Incorporating Time into GIS," *CRM,* Volume 21, Number 5 (2003), 36.
[206] Ibid., 8.

changes to the information recorded about that resource in “database time.” The former will evolve as the capabilities of temporal GIS evolve, but the latter can be a function of CRGIS standards for processing CRGIS data.

The issue is a question of retaining versions of spatial delineation and or attribute descriptions. Do we need to know how a site or property was delineated or described at a previous point in “database” time? For spatial changes, it depends on the reasons for the change. For example, consider an archaeological site investigated at a phase-one level which is defined as having approximate dimensions and bounds. If during later phases of investigation it is determined that the site is either a) smaller than previously delineated due to absence of artifacts, or b) larger than previously delineated due to presence of artifacts beyond previous delineation, then retaining the prior delineation is not critical as the site never existed in reality as originally delineated. If however, the site limits change through destruction or damage, then it is useful to retain the original extent along with the current. The original provides context for other archaeological data, and the current informs future planning processes and resource strategies. This scenario applies to architectural resources as well. Delineations of resource boundaries that were inaccurate need not be retained,[207] but changes based on resource integrity should be preserved. Once a versioning schema is in place, capturing both scenarios is not burdensome; it is only necessary to code the prior versions as to the reasons for their change. The answer to these issues may depend on the purpose and need of the organization managing the data, but such processes should be enabled by a CRGIS standards initiative.

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[207] There may be some validity to retaining even inaccurate delineations as they could serve to improve site assessment through macro comparisons of initial and revised delineations when errors are known to have existed.

E. Data Security

The issue of data security in CRGIS is an unresolved question for many CRGIS data providers. Relating primarily to prehistoric archaeology, the question is how to balance protection of such sensitive sites from intentional looting, while informing legitimate planning and research. The Office of Technology Assessment recognized this issue in 1986, noting that, "Remote sensing and other locational technologies can be used by looters as well as professional archaeologists."[208] This tension will always exist, and the solution lies in adequate site protection laws and effective enforcement. Data for these sites must still be created and provided so legitimate planning and research can occur, but with one of several strategies to minimize the potential for misuse.

The most restrictive means of protecting sensitive archaeological site data is not to release data to anyone, for any reason. This however, places a burden on the data stewards to ensure those who may encounter archaeological sites in project implementation are adequately informed before such projects are planned and executed. A common compromise solution is to provide data that indicates archaeological presence without revealing precise locations. Blocks or cells of some reasonably large dimension can do this effectively as illustrated in Figure 14 below**,** where a cluster of prehistoric sites are effectively screened by one-half mile square cells. The user knows only that archaeological sites occur somewhere within the screened area, but the number, location, and type of sites is not apparent. This alerts project planners and others to contact the data steward to see if their particular project area intersects with the known site location. The final strategy relies on registration and approval processes for access to restricted datasets.

[208] Office of Technology Assessment, 71.

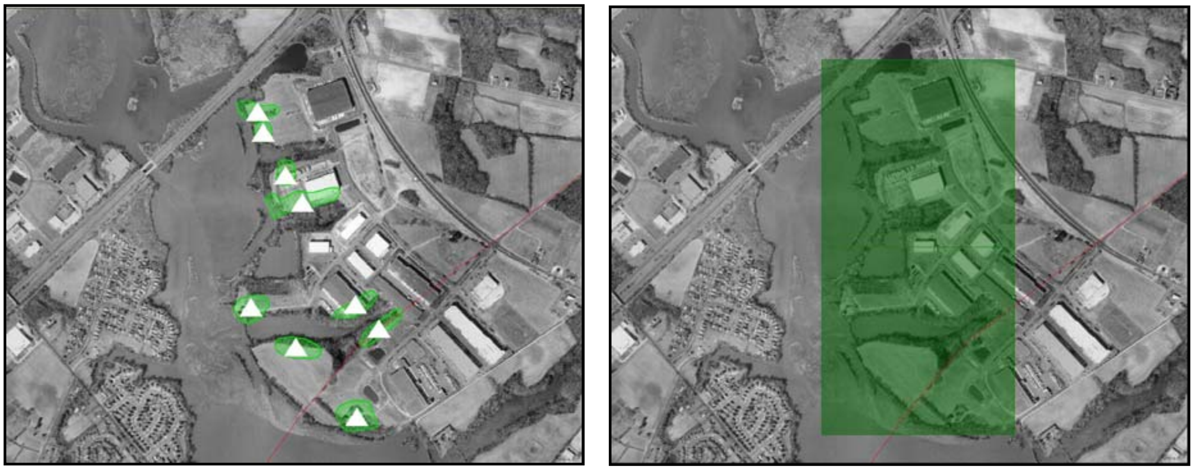

Figure 14: Archaeological site screen comparison

Several states have implemented such access for cultural resource professionals engaged in legitimate research. This strategy entails an administrative burden on the data steward to process requests, manage the user accounts, and be watchful for abuse of the system. As above, the methods employed will depend in part on the purpose and need of the data steward, recognizing that security concerns should not inhibit the development of accurate CRGIS data for sensitive resources.

In all, these represent just a few of the issues that will impact a CRGIS standards initiative. As technology evolves and new and different means to develop, manage, and deliver GIS data present themselves, new issues will undoubtedly arise. It will be up to organizations that participate in such an initiative to recognize and address or discount these issues in the standards development process. The next chapter will turn to those models and standards that do address cultural resources, and which organizations are likely to play a role in this process.

Chapter 5: Current CRGIS Standards Development

Why, in light of the benefits and needs for standards, has so little CRGIS standards development occurred? Claesson presents three principal reasons for lack of standards development, at least in regard to SHPOs:

- Limited resources (including budgets, personnel, learning curves, and software maintenance and upgrades (Klein et al, 2002: 88);
- Resistance to new standards initiatives because of failure of past initiatives;
- Diversity of cultural resources requires broad standards, but with sufficient detail to enable decision making.[209]

Similarly, Linda D. Koontz, Director of Information Management Issues at the General Accounting Office reported in testimony before a subcommittee of the US House of Representative in 2003 that:

> Developing common geospatial standards to support vital public services has proven to be a complex and time-consuming effort. The number of types of geospatial data and the complexity of those data make developing geospatial standards a daunting task.[210]

Koontz goes on to note that state and local data and applications are developed to meet internal needs, not necessarily to be compatible with federal standards.[211] The challenge, then, for a CRGIS standards initiative will be to overcome these issues. Substantial effort will be required by those involved with CRGIS standards development see it through to completion. As we have seen above, however, complex, multi-organizational standards development can succeed, and we look to the following efforts for additional guidance.

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[209] Claesson, 17.
[210] United States General Accounting Office. “Statement of Linda D. Koontz,” 9.
[211] Ibid., 11.

Unlike the variety of standards and models presented in Chapter 3, there are only a couple of initiatives that deal directly with cultural resources data. The initiatives considered below are those which will be included as part of existing standards review in the FGDC standards development process outlined above, and include:

- Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE),
- Western SHPOs in cooperation with the Bureau of Land Management (BLM),

While the National Park Service will play a large part in this initiative as lead agency under the FGDC development process, and has promulgated draft standards, because those standards have not been released for public review, they are not considered here. They will, however, need to be evaluated and integrated as this process moves forward.

A. Spatial Data Structure for Facilities, Infrastructure and Environment (SDSFIE)

The military's Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) is perhaps the most extensively developed spatial and attribute data standard that addresses cultural resource features. Developed and maintained at the Department of Defense's CADD/GIS Technology Center (the Center), "SDSFIE is the only 'nonproprietary' GIS data content standard deigned for use with the predominant commercially available off-the-shelf GIS, CADD... and relational database software."[212] According to its mission, the Center is:

> …a multi-agency vehicle to coordinate facilities, infrastructure, and environmental use of Computer-Aided Design and Drafting and Geographic Information Systems (CADD/GIS) activities within the Department of Defense (DoD) and with other participating governmental (federal, state and local) agencies, and the private sector.[213]

[212] "The CADD/GIS Technology Center SDSFIE Page." Online (accessed 20 July 2005), available from <https://tsc.wes.army.mil/products/TSSDS-TSFMS/tssds/html/>; Internet
[213] "The CADD/GIS Technology Center Information Page." Online (accessed 20 October 2006), available from <https://tsc.wes.army.mil/Center_Info/>; Internet

As such, the Center has developed information processing tools and models for almost every aspect of spatial data management, facilities management, and computer aided design and drafting (CADD).

Originally referred to as the Tri-Service Standards, SDSFIE began in 1993, and as noted in the Center's SDSFIE development overview document: "Since its conception… the structure of the SDSFIE has evolved to keep pace with the rapidly expanding capabilities of GIS software."[214] In order to remain flexible however, "the SDSFIE employ terminology and data structures not specific to any software product. Provisions for raster and vector data and CADD, GIS, AM/FM systems have been made to accommodate the widest user base in the GIS user community."[215] Development of SDSFIE was based on this use of generic terminology, and became the basis of its overall structure:

> Numerous guidelines and existing schema were evaluated by the CADD/GIS Technology Center and none satisfied the generic and extensible requirements needed to define standards for a DoD military installation and Civil Works project. Therefore, the SDSFIE schema was developed by the CADD/GIS Technology Center from a combination of many schemas, using broad data groups as chapter divisions. These chapter divisions are now referred to as *Entity Sets*, and they consist of both graphic and tabular data related to a specific area or discipline. They represent related groupings of *Entities*, the geographical features that are the basis for all GIS- and CADD-based FM systems.[216]

SDSFIE contains five basic levels: Entity Sets, Entity Classes, Entity Types, Attribute Tables, and Domain Tables (Figure 15). Entity sets are the highest level categories within the

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214 The CADD/GIS Technology Center. "Spatial Data Standards for facilities, infrastructure, & environment (SDSFIE): History of Development and Benefits," April 2004. Document online (accessed 27 January 2005), available from <https://tsc.wes.army.mil/products/tssds-tsfms/tssds/articles/papers/benefits/history_benefits.pdf>, 7; Internet.

215 The CADD/GIS Technology Center. "Spatial Data Standards for facilities, infrastructure, & environment (SDSFIE): Data Model and Structure," April 2004. Document online (accessed 27 January 2005), available from <https://tsc.wes.army.mil/products/tssds-tsfms/tssds/articles/papers/data_model /sdsfiem250.pdf>, 3; Internet.

216 The CADD/GIS Technology Center. "History," 5.

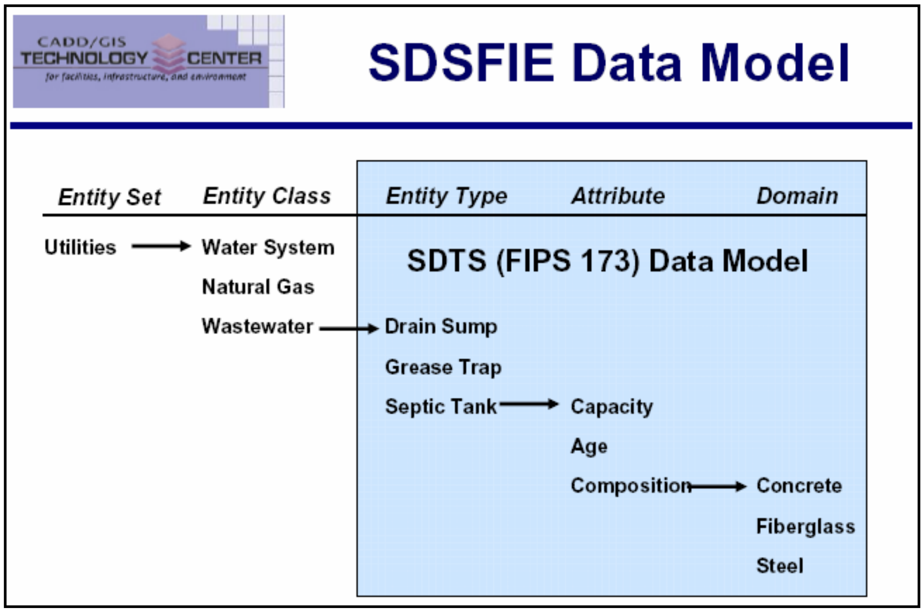

Figure 15. SDSFIE Data Model.[217]

standard and are organized by major disciplinary areas, illustrated in Table 3. Entity classes "contain groupings of similar features (called Entity Types) and related 'graphic' attribute data."[218] An Entity type is the "logical name assigned to graphic features,"[219] and an Attribute table is a "relational database table containing data, or information, about a specific SDSFIE entity."[220] Finally, Domains are restricted data lists for specific attribute fields.

The cultural entity set consists of four entity classes: *cultural_archaeological* (crarc), *cultural_general_si* (crgen), *cultural_historic* (crhst), and *cultural_management* (crmgt). In parentheses are the prefix codes used in the entity type and table names. Each entity class contains a complex set of related features, attribute tables, and domains that combine to define the necessary parameters for implementing that entity class in GIS. It is clear that SDSFIE is an "exhaustive" standard in regards to most entity types, and it has been difficult to find clear

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[217] Towne, Nancy. "Intro to SDS," Document online (accessed 21 October 2006), available from <https://tsc.wes.army.mil/products/tssds-tsfms/tssds/slides/SDSFIE_DataModel.pdf> 25; Internet.
[218] The CADD/GIS Technology Center. "Data Model," 7.
[219] Ibid., 8.
[220] Ibid., 11.

Table 3: SDSFIE Entity Sets [221]

Auditory	au	Fauna	fa	Soil	so
Boundary	bd	Flora	fl	Transportation	tr
Buildings	bg	Future projects	fp	Utilities	ut
Cadastre	cd	Geodetic	gd	Visual	vs
Climate	cl	Geology	ge		
Common	cm	Hydrography	hy		
Communications	co	Improvement	im		
Cultural	cr	Land status	ls		
Demographics	de	Landform	lf		
Ecology	ec	Military operations	ml		
Environmental Hazards	eh	Olfactory	ol		

documentation of the hierarchy of entity types contained within each entity class. This may be due in part to the way entity type assignments are made: "The assignment of specific entities to entity sets is a function of data maintenance. In this way, it is possible to more easily reduce the redundancy of information within the standard."[222] In other words, it is up to the user implementing SDSFIE to categorize and create spatial features within the SDSFIE framework. Futher, SDSFIE allows for user modified domains to incorporate "installation-specific values as needed."[223]

While this inherent flexibility is good, it would seem to dilute the benefits of standardization. Ad-hoc changes by disparate users could lead to long term problems with data integration and interpretation. Another fundamental characteristic of SDSFIE is that each entity class incorporates entity types and attributes from other entity sets to record common data. For instance, the *cultural_historic* entity class, carries a relationship between the *historic_structure_site* and *buildings_general_structure* tables to capture both general building details and its specific historic details. Table 4 lists entity types under each cultural entity class.

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[221] Ibid., 7.
[222] The CADD/GIS Technology Center. "History," 6
[223] The CADD/GIS Technology Center. "Data Model," 14.

Table 4: SDSFIE Cultural Entity Classes and Types

Entity Class	Entity Type Name	Entity Type Definition
cultural_archeological	terrestrial_archeological_site	The location of a registered archeological site.
cultural_archeological	marine_archeological_site	The location of a registered underwater archeological site.
cultural_archeological	archeological_artifact_point	Objects of archeological significance which, due to their size or nature, have not been removed from the site.
cultural_archeological	cliff_dwelling_point	Rock ledges or natural recesses of canyon walls where people of a prehistoric American Indian tribe of the southwestern U.S built their homes.
cultural_archeological	milling_site	A site where flour, meal, or powder has been ground or processed.
cultural_archeological	rockart_site	Artistic decoration or illustration made by humans on a rock surface.
cultural_historic	historic_feature_site	Historically or culturally significant points of interest. These include monuments, memorials, landmarks, museums, historic markers, interpretive sites, etc.
cultural_historic	historic_district_area	A group of related buildings or streetscapes that demonstrate the historical development of an area.
cultural_historic	historic_structure_site	A structure that has cultural significance due to its historic background, association with a famous person, or its architectural features.
cultural_management	cultural_study_site	A site under study for archeological or historic resources.
cultural_management	cultural_probable_sensitive_site	A site suspected to contain archeological or historic resources that has not been verified by a detailed archeological study.
cultural_management	cultural_restricted_area	An area that needs to be preserved due to the sensitive nature of the archeological or historic site. The area designated as restricted is intended to prevent access or development that will disturb the site.
cultural_management	cultural_survey_site	A site where detailed investigation has been conducted for cultural resources. This investigation could involve test pits, excavation areas, surface surveys, etc.
cultural_management	cultural_cleared_area	An area that has been cleared of any cultural concerns, through negative survey, negative site evaluations, or data recovery.

The use of SDSFIE as a base for a nationally applicable core CRGIS standard is not without problems, however. First, the extraction of core elements from SDSFIE's extraordinary detail will require extreme care. The SDSFIE model contains over 33,000 attributes in 1,220 tables,[224] and because each entity class includes multiple tables from other entity sets, sorting out what to take and what to leave behind will be challenging at best. The complexity of SDSFIE may relate in part to its use for managing conditions and compliance for Department of Defense (DoD) facilities nationwide. Second, the basic cultural resource typology established by NPS is not well represented in SDSFIE. Classification of resources as buildings, structures, objects and sites pursuant to National Register criteria should be a fundamental schema of any CRGIS standard. The terminology of SDSFIE would create confusion in relation to common cultural resource usage. For instance, the entity type *historic_structure_site* is intended to record data about buildings and engineered structures, but by name alone could be interpreted to be a historic period archaeological site. Finally, SDSFIE includes unusual entity types that seem to be arbitrarily restrictive. For instance, the *cultural_archeology* entity class contains an entity type *milling_site*, defined as "A site where flour, meal, or powder has been ground or processed."[225] Overall, the extensibility and flexibility built into SDSFIE should be goals for a CRGIS standard, but the underlying entity model would need significant revision to be truly representative of cultural resources nationally.

B. Western States

In the late 1990's, a cooperative of Western SHPOs, in coordination with the Bureau of Land Management (BLM) began a series of related initiatives to improve the development and

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[224] Ibid., 5.

management of cultural resources information. The two principal components of these projects were development of initial metadata standards and a common logical data model for cultural resources. Both efforts were funded in part through grants from the FGDC and the National Center for Preservation Technology and Training (NCPTT), and summarized in reports in 1999 and 2000.

The metadata project began as an effort to develop standardized documentation for CRGIS data; Specifically: "…this project is concerned with geographic data technology in managing large sets of cultural resource information in formal administrative settings. So, the primary focus of this project is data stored in paper and electronic files at Federal and state agencies."[226] The result however, was that the participants realized that the needs of CRGIS standardization extended beyond metadata documentation:

> This project was started to develop documentation standards for cultural resources geographic information systems. We soon found that defining documentation standards meant defining what was being documented in the first place. Necessarily, then, the project participants had to achieve a consensus about the content of cultural resources datasets (spatial or aspatial).[227]

The focus of the project was workshops in January 1998 and February 1999 which involved "professionals with backgrounds in cultural resources, database modeling and design, and geographic information systems."[228] The resulting logical data model will be discussed below, but the metadata recommendations were fairly straightforward, and addressed metadata for spatial features, spatial datasets, and systems.

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225 "Spatial Data Structure for Facilities, Infrastructure and Environment," s.v. "milling_site".
226 Ingbar, Eric E, Mary Hopkins, and Timothy J. Seaman. "Final Report: Creating a Cultural Resources Metadata Standard for the Western United States," May 2000. Document online (accessed 10 February 2006), available from <wyoshpo.state.wy.us/SHPOweb2002/2002webpages/fgdcrpt.pdf>, 2; Internet
227 Ibid., 9.
228 Ibid.

Regarding spatial feature metadata, the report calls for documentation of spatial source and accuracy for individual features within the dataset. This was noted as particularly important for spatial data derived from the legacy data sources that comprise the bulk of information in current SHPO inventories.[229] Four categories of locational methods and associated metadata were recommended and ranked for accuracy: map-derived coordinates, global positioning system (GPS)-derived coordinates, geocoded coordinates, and cadastral survey or parcel map coordinates. These methods and associated metadata are outlined in Table 5.

Table 5: Spatial Feature Methodology and Metadata[230]

Rank	**Method**	**Metadata**
Minimal	Map-derived coordinates: UTM or State Plane coordinates, Lattitude/Longitude, etc.	Source map, scale, date
Better	GPS-derived coordinates: UTM or State Plane coordinates, Lattitude/Longitude, etc	Estimate of positional accuracy
Better	Geocoding (street address matching)	Base map or geospatial dataset series, scale, name, date, etc.
Best	Cadastral/parcel map coordinates	Estimate of positional accuracy, and/or recorded legal map file reference

While these locational methodologies cover the most common techniques that may be applied, there are a myriad of other techniques that may be used singly, or in combination for delineation of any individual cultural resource feature. This is best summarized by Ingbar, et. al. in a 2002 report:

> For paper cartographic purposes, the draftsman can synthesize multiple sources of spatial information into a coherent single map. In digital cartography one is always tempted to retain the original digital data to the fullest possible extent, yielding a map that is complex and possibly difficult to interpret. For example, a site boundary could be created from GPS lines, GPS points, interpolations between points and lines,

[229] Ibid., 20.
[230] Ibid., 22

> topographic lines from a USGS map, and a fenceline traced from digital aerial photography. If one asked, ‘what is the spatial accuracy of the boundary?’ there would be no simple answer.[231]

Perhaps “retention” of multiple data sources is less an issue than the integration of multiple techniques in delineating the same spatial feature. Modern GIS enables flexible editing techniques in feature creation and editing, and there is almost no way to fully describe all of the inputs. The list above does begin a process of categorization, which can capture the general issues associated with each major technique. Features can then be coded with the most applicable technique used.

The recommendations for spatial dataset metadata were simply to follow the CSDGM standards. The CSDGM was covered in detail above, and the recommendation of this research, which goes beyond that of the Western States project, is to develop a formal metadata profile to provide better guidance in documenting CRGIS datasets. Finally, regarding systems metadata, the report recommends system documentation for any major cultural resource information system serve as the metadata for that system. The goal of interoperability of these separate systems was not addressed here, but in general, we may look to the work of other data interoperability initiative to assist in resolving these issues in the near future.

Eric Ingbar, of Gnomon, Inc., a participant in the Western States projects, expounds on the “feature metadata” concept in a 2001 report, noting that, “cultural resource data is not collected in a uniform manner. Some resources are mapped at small scale, some a large scale, and so on. This differs from a ‘standard’ GIS dataset like roadways, which typically has a single

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[231] Naylor, Laird, et. al. “Standards for Transmittal of GIS Data to SHPO Data Systems,” 29 August 2002, online (accessed 4 April 2005), available from <www.blm.gov/heritage/docum/ GISTransmittalStandardsver2.pdf> 2; Internet.

consistent source of observation."[232] He recommends the following minimum metadata elements for CRGIS features: Spatial data source, GIS data creation date, GIS data verification to original status, Locational confidence, and Boundary completeness.[233] The last three items are additions to those outlined in Table 5, and are key to conveying the most accurate information about the quality and completeness of the GIS data.

While the metadata discussion above is important, it is the data model components of these projects provides the most interesting results, and is most directly related to the goals of this research. As noted, the realization of the need for standards beyond metadata issues led the participants to consider how cultural resources should be represented in digital information systems. The summary report pointed out several reasons for the slow adoption of GIS in the preservation community:

- GIS not optimized for transaction-based computing environments typical among Western SHPOs,
- Spatial relationships are difficult to create an maintain at the statewide level, and
- Broad distribution of spatial data through GIS is difficult and expensive.[234]

While the evolution of GIS technology has since overtaken some of these issues, the fundamental concept is a valid one; Standardization of CRGIS will enable the primary functions of the CRGIS information flow: data capture, data management, and data dissemination (see Chapter 1, Figure 5 above).

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[232] Ingbar, Eric. "Bureau of Land Management Cultural Resources GIS: A Baseline Model," April 2001. Online (accessed 4 April 2005), available from <www.blm.gov/heritage/docum/GISBaseline.pdf>, 4; Internet.
[233] Ibid.
[234] Seaman, Timothy J. "Final Report: Advancing State Historic Preservation Office Geographic Information Systems in the Western United States," 31 March 1999, (US Department of the Interior, National Park Service, National Center for Preservation Technology and Training, Publication No. 1999-08), 3.

A stated goal of the project was to be consistent with the National Register of Historic Places (NRHP) in defining historic property types and the relationships between them, but Seaman notes that, "The NRHP is not concerned with such relationships at the logical level."[235] The means that cultural resources are classified as either buildings, structures, objects, sites or districts, without distinction of the relationships between districts and properties. Accordingly, districts, referred to as "Resource Aggregations," and individual "Resources" form the two primary entities in the Western States model. The addition of a third entity type, "Investigations" captures the remaining major category of cultural resources data that is part of SHPO inventories.

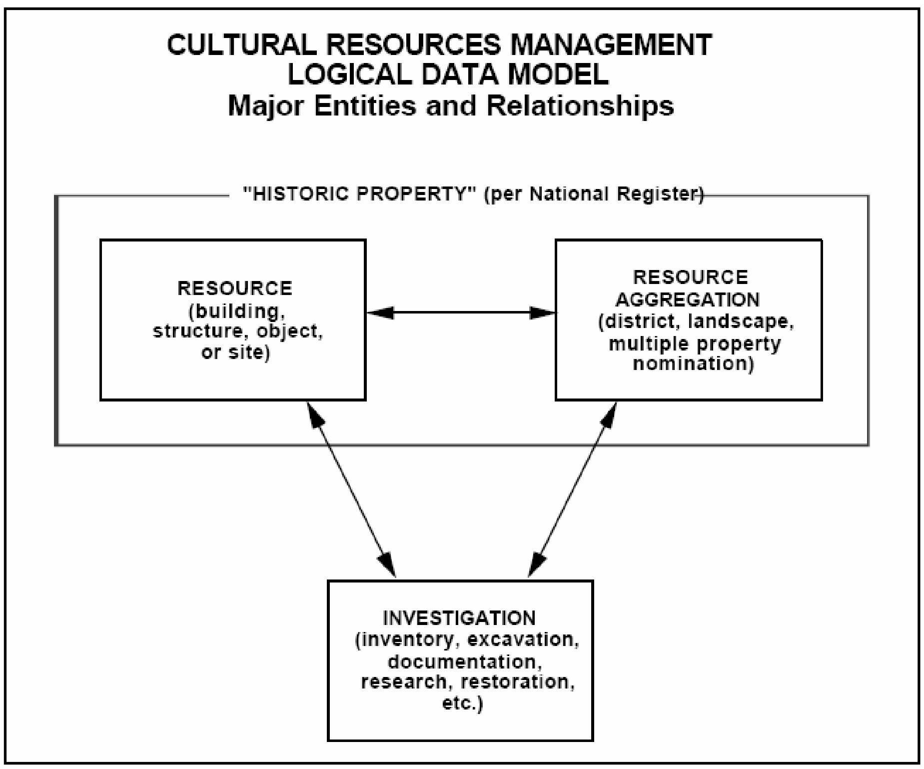

Figure 16: Western States logical data model[236]

[235] Ibid., 6.
[236] Ibid., 7.

One aspect of “resource” not addressed in this model is the presence of multiple features. The National Register of Historic Places (NRHP) classifies resources as one of the four primary types, but includes one or many of each type on the property. For instance, a historic farmstead would be classified as a building, and may have one or many additional buildings (barns, garages or other outbuildings), structures (silos, etc.), and sites (designed landscapes, agricultural fields or orchards). Under the above model, this could be interpreted as a resource aggregation. In order to clarify the relationship between resources and their features, the inclusion of a “Resource Feature” entity with a one-to-many relationship to “Resource” is recommended. Otherwise, it seems that this Western States model addresses the concerns raised about SDSFIE, and lends itself to adoption as the basis for a core CRGIS standard.

Chapter 6: Participants and Roles

There are many organizations that may potentially play a role in this process. Outlined below are examples of those that are likely participants. While this is not an exhaustive list, the potential for these groups to participate and the scope of that participation are discussed. Organizations include: the National Park Service (NPS), the National Conference of State Historic Preservation Officers (NCSHPO), the National Center for Preservation Technology and Training (NCPTT), the National Alliance of Preservation Commissions (NAPC), the State and Tribal Historic Preservation Offices (SHPO/THPO), local Historic Preservation Commissions (HPC), and other federal agencies generally

National Park Service (NPS): The role of the NPS as lead agency under OMB "Circular A-16" has been previously defined in Chapter 2. As an agency, however, NPS has a dual role regarding standards. First, they must respond, to and comply with, FGDC standards and reporting for non-cultural-resource-related data as part of the Department of Interior's overall compliance. Second, NPS must coordinate and promote a CRGIS standard for use among all federal agencies, states, and non-governmental users. To date however, NPS has not been able to devote the resources to furthering this initiative. In the late 1990's the CRGIS Facility at NPS was active in fulfilling that role through activities such as: creation of the Cultural Resources Working Group (CRWG) under the FGDC's Subcommittee on Cultural and Demographic Data, documenting the need for data automation, and developing CRGIS management applications. It will be crucial for NPS to resume that leadership role if a CRGIS standards initiative is to move forward.

National Conference of State Historic Preservation Officers (NCSHPO): NCSHPO can play a vital role in soliciting and coordinating SHPO input for a CRGIS standards initiative. NCSHPO has previously participated in technology issues, noted as having a "Computers Committee" in the Office of Technology Assessment's 1986 report.[237] However, Betsy Chittenden points out in a 1991 journal article:

> The National Conference of State Historic Preservation Officers, for example, has chronically had difficulty in maintaining a committee or task force dealing with computer-related issues, since most of the expertise exists an the staff level, not at the management level, and rarely are staff able to attend meetings.[238]

In order to be effective in the coordination role, NCSHPO must be able to overcome this tendency, and find ways to support the participation of staff level SHPO representatives in the standards development process.

National Center for Preservation Technology and Training (NCPTT): As a grant making organization, NCPTT could directly fund the costs associated with a CRGIS standards initiative, particularly as they relate to conferences and meetings. However, based on the research priorities outlined on their website, it does not seem as if GIS is a ready fit for their current mission. As noted above, creation of NCPTT came out of the Office of Technology Assessment's 1986 recommendations, and the research priorities appear to come directly out of that report as well:

- protect cultural resources against vandalism, looting, terrorism and natural disasters
- conserve architectural materials of the "recent past,"
- develop innovative techniques in dating, monitoring, analysis, and remote sensing of archeological sites and artifacts
- develop appropriate technologies to preserve houses of worship and cemeteries,

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[237] Office of Technology Assessment, 111.
[238] Chittenden, Betsy. "When Cultures Collide: Computer Technology and the Cultural Resources Professional," *The Public Historian*, Volume 13, Number 3, Preservation Technology. (Summer, 1991), 60, Retrieved from JSTOR, 25 August 2006.

- monitor and evaluate preservation treatments,
- study environmental effects of pollution on cultural resources, and
- document and preserve threatened cultural landscapes.[239]

NCPTT however did fund the western states CRGIS coordination initiatives, and it may be possible to bring their resources to bear on this issue once the formal process is under way.

National Alliance of Preservation Commissions (NAPC): Similar to the role NCSHPO would play for SHPOs and THPOs, NAPC could serve as a conduit for local input into the CRGIS standards initiative. As noted on their website, NAPC's mission is focused on local historic preservation commissions:

> The NAPC is the only organization devoted solely to representing the nation's preservation design review commissions. NAPC provides technical support and manages an information network to help local commissions accomplish their preservation objectives. The Alliance also serves as an advocate at federal, state and local levels of government to promote policies and programs that support preservation commission efforts.[240]

NAPC could also solicit and promote existing local CRGIS solutions that could inform the national process. Coordination of input for the CRGIS standards initiative would fall under their "promotion of policies and programs" function.

State and Tribal Historic Preservation Offices (SHPO/THPO): As the agencies charged with maintaining data inventories for their areas of jurisdiction, SHPOs and THPOs have a vital role in shaping CRGIS standards.[241] First, SHPO/THPO buy-in to the concept of standardization will be key to the ultimate success or failure of this effort. Many offices have already developed extensive cultural resource spatial and attribute data, and built applications to

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[239] National Center for Preservation Technology and Training. "Preservation Technology & Training Grants," 2006. Online (accessed 18 October 2006), available from <www.ncptt.org/default.aspx?m=36>; Internet.

[240] National Alliance of Preservation Commissions. "NAPC - National Alliance of Preservation Commissions," Online (accessed 20 October 2006), available from <www.uga.edu/sed/pso/programs/napc/napc.htm>; Internet.

capture, manage, and disseminate that data. The benefits of bringing that existing data into conformance with the ultimate standard must outweigh the natural resistance to devoting resources to yet another aspect of data management. Second, because SHPOs/THPOs are currently involved with almost every aspect of the federal, historic preservation program, they have a uniquely broad perspective on how standardization can benefit those various initiatives. For instance, spatial data that results from the Section 106 process can be used to inform the Investment Tax Credit program, provide context for the National Register program, and augment local efforts under the Certified Local Government program. Finally, SHPOs/THPOs must begin to see themselves as a network of related organizations in support of a common goal, rather than individual state agencies. This would be similar to the view of the Natural Heritage network referenced above. NCSHPO's listserv and other activities have helped foster this concept, but more fully realized view of SHPOs/THPOs as a national network will greatly assist in the CRGIS standards initiative and creation of a common cultural resources information network.

Local Historic Preservation Commissions (HPC): HPCs have a role similar to SHPOs on a smaller scale. The local knowledge of cultural resource conditions will be an invaluable asset, and will be best voiced in a standards initiative by the HPCs themselves. Their participation will ensure that the appropriate mechanisms enabling the "data update" function of the cultural resources information flow are created and maintained. Because there are so many, NAPC's role referenced above will be vital if HPCs are to have meaningful input.

Other federal agencies: The balance of federal agencies with responsibilities under any aspect of the national historic preservation program must also participate in this process. Such participation has been previously referenced for agencies such as the various branches of the

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[241] THPOs may or may not have assumed this role under agreement with the Secretary of the Interior.

military and the Bureau of Land Management, but there are many other agencies which may be both providers and users of such data that will need to be aware of this initiative. As reported by Koontz in 2003, “Given that most federal agencies—including large agencies such as DOE, Justice, and Health and Human Services— have not participated in the NSDI framework standards development process, the risk is substantial that the proposed standards will not meet their needs.”[242] It will be up to the NPS and the FGDC to foster and coordinate federal agency input.

[242] United States General Accounting Office. “Statement of Linda D. Koontz,” 10.

Chapter 7: Conclusions and Recommendations

A. Conclusion

One of the fundamental questions asked of participants in a GIS implementation process is this: “What is your unit of analysis?” Meaning, what is the core entity that your organization deals with on a day-to-day basis. For the preservation professional, the answer is easy: Cultural resources. But when one begins to dissect the concept of “cultural resources” in the way it must be dissected to take on life in the digital realm, one quickly realizes the broad and complex reality that is embedded in that term. It is that reconciliation of conceptual to logical that embodies the effort to standardize the means to represent cultural resources in GIS.

The use of GIS for cultural resources is well documented, but standardization was the underlying theme in each of the studies addressed in Chapter 1, and according to Claesson, use of GIS by SHPOs will only continue to increase. There are a multitude of reasons why such standardization is necessary. The FGDC’s requirements for federal data consistency and a variety of other direct and indirect needs clearly establish that a national CRGIS standards initiative must become reality. The standards process itself is daunting, but there are numerous examples of disciplinary standards initiatives for “units of analysis” with just as much complexity and broad organizational participation. Additionally, there are supporting standards, such as CSDGM that inform this initiative, as well as a number of technology and data trends that will enable the process. This process does not start from scratch however. With standards such as SDSFIE and the Western States Model as starting points, a core CRGIS content standard has much higher chance of succeeding, especially if the various organizations can be brought together efficiently and effectively throughout the duration of the process.

B. Recommendations

There are recommendations for specific aspects of CRGIS standards throughout this document. Accordingly, the following general recommendations, summarized in Table 6, are offered to inform the CRGIS standardization process.

Table 6: Summary of Recommendations

1.	Quantify funding needs and identify sources
2.	Reinvigorate National Park Service's (NPS) role as lead agency
3.	Adopt a core standards approach
4.	Establish a national cultural resources inventory
5.	Develop a formal metadata profile
6.	Convene a national or regional conference(s) on CRGIS standardization

1. Quantify funding needs and identify sources:

One of the most difficult factors in evaluating the feasibility of a CRGIS standards initiative is quantifying the resources required to bring such standards to fruition. In almost every instance, the conversion of legacy cultural resource data into GIS data has involved multiple organizations, funding sources, and cooperative input. Hard numbers are difficult to come by. As noted previously, NPS predicted $25 Million over five years to fully automate SHPO inventories,[243] but it is unclear whether this number made any provision for standardization in the automation process. Further, the scope of organizations that should participate adds another layer of complexity in the development process.

Among the commonalities in CRGIS development has been the involvement of federal agencies with extensive responsibilities under Section 106. The Army Corps of Engineers, Department of Transportation, and Bureau of Land Management have all provided significant resources to CRGIS development in their respective areas of operation. Perhaps some portion of those resources should be diverted to fund the CRGIS standards effort, thereby ensuring that the collective investment in CRGIS data, is not foreshortened by incompatible systems and arbitrary datasets.

2. Reinvigorate National Park Service's (NPS) role as lead agency:

The role of the NPS is crucial to seeing this process through to completion. The activities begun in the late 1990's need to be resumed by NPS with strong outreach to the SHPOs, and federal agencies as a core group, with follow-up outreach to the other organizations and disciplines outlined in Chapter 7. The expertise and effectiveness the NPS has applied to the identification and evaluation of cultural resources needs to be applied to the task of CRGIS standardization as well. Whether or not such changes can be made within the current NPS organizational structure remains to be seen, but without strong NPS leadership, this process is unlikely to succeed.

3. Adopt a core standards approach:

A key to widespread acceptance of this initiative is the ability to extract sufficient data from each organization's existing system to populate a standards-compliant dataset, without expending extraordinary effort at conversion. Most organizations that have invested heavily in enterprise CRIS and CRGIS systems will not change their day to day operations, but are more likely to contribute to the standardized dataset if that extraction can be made in a seamless,

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[243] National Park Service, "Paper File to Digital Database," 2.

economical, and routine way. Limiting the standard to the necessary core data will help with this, as will development of a generic and flexible model that can be implemented on a variety of platforms and systems.

4. Establish a national cultural resources inventory:

Many of the data activities associated with the USNVC and cited by Grossman relate to "national" inventory initiatives such as the National Wetlands Inventory and the National Cooperative Soil Survey. Other than the National Register of Historic Places (NRHP), there isn't a "national inventory." Inclusion in the NRHP is relatively ad-hoc, and does not represent a true collective cultural resources inventory. Therefore, an inventory that incorporates the core data of existing CRGIS datasets, modeled after NatureServe, should be established and maintained. The presence of such a resource will highlight the need for standardized data, and encourage the participation of data providers nationwide. Development of this inventory should encompass a re-examination of the National Archaeological Database for incorporation into the CRGIS standard.

5. Develop a formal metadata profile

As discovered by the Western States project, establishing rules for documentation of CRGIS data must be preceded by an understanding of the data being documented. We've seen how important such documentation is for the accurate discovery and assessment of CRGIS datasets, and is necessary to overcome the spatial search limitations of typical data clearinghouses. A formal metadata profile should include specific terminology and specific, structured locational references for use in describing the datasets, and should be developed either concurrently or immediately following a CRGIS standards initiative.

6. Convene a national or regional conference(s) on CRGIS standardization

In order to kick off this initiative, a national conference, or alternatively, a series of regional conferences, should be convened specifically addressing the issue of CRGIS standardization. Such a conference should be open to all interested parties, rather than through selective invitation, and should have the goals of: communicating the need for standards, gauging the receptiveness and potential "buy-in" from the constituency, and outlining a strategy for development and implementation. Resources to implement this recommendation will have to be identified, and it may be worth investigating how similarly discipline-specific conferences, such as the Preserving Historic Roads conference and associated initiatives have been developed and funded.

GIS use for cultural resources management and analysis will only continue to grow. States will continue to input their existing legacy data into GIS; the regulatory processes will become more adept at integrating CRGIS data into the information stream; and new forms of analysis will reveal themselves. Will all this occur without CRGIS standards? To some degree, yes, but at the expense of efficiency, cost and comprehensiveness. As noted at the outset:

> To reap the benefits of the vast data resources being generated today and expected in the future, it is important that agencies make the investment in and the commitment to... basic tenets - common standards, data partnerships and accessible data.[244]

The cultural resources disciplines must heed the advice of the FGDC if we are to fully capitalize on the true potential of CRGIS.

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[244] Federal Geographic Data Committee. "Historical Reflections," 1.

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Appendix A

Acronyms Used

ACHP – Advisory Council on Historic Preservaition

AM/FM – Automated Mapping and Facilities Management

ANSI – American National Standards Institute

BLM – Bureau of Land Management

CAD – Computer Aided Drafting / Computer Aided Design

CADD – Computer Aided Design and Drafting

CSDGM – Content Standard for Digital Geospatial Metadata

CLG – Certified Local Government

CRGIS – Cultural Resources Geographic Information System

CRM – Cultural Resources Management

CRWG – Cultural Resources Working Group (Federal Geographic Data Committee)

DEM – Digital Elevation Model

DoD – Department of Defense

DRG – Digital Raster Graphic

FGDC – Federal Geographic Data Committee

FIPS – Federal Information Processing Standards

GAO – General Accounting Office

GIS – Geographic Information System

GOS – Geospatial One Stop

GPS – Global Positioning System

HABS – Historic American Buildings Survey

HPC – Historic Preservation Commission

ISO – International Standards Organization

NADB – National Archaeological Database

NAPC – National Alliance of Preservation Commissions

NCPTT – National Center for Preservation Technology and Training

NCSHPO – National Conference of State Historic Preservation Officers

NJDOT – New Jersey Department of Transportation

NPS – National Park Service

NRHP – National Register of Historic Places

NSDI – National Spatial Data Infrastructure

NVCS – National Vegetation and Information Standard

OMB – Office of Management and Budget

OTA – Office of Technology Assessment (US Congress)

SHPO – State Historic Preservation Office

SDSFIE – Spatial Data Structure for Facilities, Infrastructure, and Environment

SDTS – Spatial Data Transfer Standards

THPO – Tribal Historic Preservation Office

TNC – The Nature Conservancy

UNESCO – United Nations Educational, Scientific and Cultural Organization

USNVC – United States National Vegetation Classification System

UTM – Universal Transverse Mercator